Farmers’ barriers to the access and use of climate information in the mountainous regions of Thừa Thiên Huế province, Vietnam

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ABSTRACT

Climate change is a major challenge to rural livelihoods in Vietnam, particularly in remote and mountainous areas. Access and use of climate information is considered vital to households’ and communities’ adaptive capacity. This research employed a survey to investigate barriers to the access, and use of, formal climate change information among two groups of farmers (ethnic minority and Kinh) in mountainous areas of Thừa Thiên Huế province, Vietnam. Adopting a logit model, the results show that the main barriers were: 1) farmers’ lack of trust of formal climate-related services; 2) farmers’ lack of perceived risk from climate change; and 3) difficulties in balancing climate adaptation and economic benefits of new interventions. Ethnicity was not a barrier, as all farmers looked for climate information from informal channels (friends, neighbors, market actors) rather than from formal channels (agricultural departments, television, radio), although cultural issues such as language did act as a barrier. This research recommends strengthening the networks and interactions between market actors and government staff with local people, through direct communication and adaptation demonstrations. Formal and informal climate information channels should be integrated to effectively combine local resources and indigenous knowledge with advanced technologies, to support farmers’ sustainable and robust climate adaptation responses. Further, the research found that while farmers have access to devices, such as smart phones, they prefer to use these for entertainment rather than climate information. The implications of the study therefore are that any future network or communication activities should be in local languages and note the limitations of using devices for information dissemination.

Practical implications

Climate information is a central component for smallholder farmers’ adaptation decision-making. While a lot of climate data is being produced, there is a gap between that production and usability by end-users such as farmers. While access to information is key to its use, access alone does not guarantee that the information is usable. This study interrogated the difference between climate information access and use among smallholder farmers in the mountainous areas of Vietnam. Our case study was based in Thừa Thiên Huế province, making use of a survey and interviews to consider how Kinh (ethnic majority) and ethnic minority farmers access and use climate information in their livelihood activities.

The key barriers to the access and use of climate information by farmers consist of: (1) the lack of farmers’ trust of these services; (2) their lack of perceived risk from climate change; and (3) difficulties in balancing climate adaptation and economic benefits of new interventions. The implications of these findings are:

- Farmers’ awareness and perceptions of climate change significantly influence their use of climate information. Particularly for ethnic minority farmers, cultural beliefs also play a role in climate perceptions and ultimate use of climate information.
- Agricultural development programs, including extension education programs, should focus on raising farmers’ awareness of climate change and disseminating climate change information.
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Introduction

Climate change is considered a major development challenge worldwide, particularly in developing countries (IPCC, 2014), causing negative impacts on various aspects of life including social, ecological, economic, and cultural activities (Rengalakshmi et al., 2020; Tliomy and Bhaskara, 2019). Adaptation is the adjustment of either human or natural systems in response to climatic impacts, which either limit harm or make use of favorable opportunities (IPCC, 2001). Adaptation processes are influenced by the interactions between these actors, institutional contexts and resource constraints (Adger, 2003). Therefore, adaptation decision-making is also driven by stressors and informed by perceptions and contextual factors such as gender, resource access and institutional dimensions (Phuong et al., 2017). A major dimension underpinning adaptation is adaptive capacity, which is the ability of an individual or household to draw on their resources to adapt to climate change or minimize the negative impacts of climate change (Sen et al., 2021). Central to this adaptive capacity is information, not just related to climate risks but also possible adaptation strategies (Grothmann and Patt, 2005).

In relation to agriculture, climate adaptations have been linked to access to weather forecasts and participation in social institutions (Wood et al., 2019). Adaptation is the adjustment of either human or natural systems in response to climatic impacts, which either limit harm or make use of favorable opportunities (IPCC, 2001). Adaptation processes are influenced by the interactions between these actors, institutional contexts and resource constraints (Adger, 2003). Therefore, adaptation decision-making is also driven by stressors and informed by perceptions and contextual factors such as gender, resource access and institutional dimensions (Phuong et al., 2017). A major dimension underpinning adaptation is adaptive capacity, which is the ability of an individual or household to draw on their resources to adapt to climate change or minimize the negative impacts of climate change (Sen et al., 2021). Central to this adaptive capacity is information, not just related to climate risks but also possible adaptation strategies (Grothmann and Patt, 2005). In relation to agriculture, climate adaptations have been linked to access to weather forecasts and participation in social institutions (Wood et al., 2019). Indeed, a lack of relevant climate information is one of the major barriers to effective climate change adaptation (Muema et al., 2018).

According to Jones et al., (2000) access to timely and accurate climate information services is critical for effective adaptation initiatives and risk mitigation, especially in the agriculture sector.

Climate information and support services help society cope with climate variability and change through the transformation of climate-related data, together with other relevant information, into customized products such as projections, trends, economic analysis and services to user communities in different sectors (European Commission, 2015). These information products all contribute to appropriate adaptation planning in a changing climate (WMO 2016). There are various definitions of these ‘climate services’, but essentially the term covers climate information that is user-centric, supported by active participation of various sectors (i.e. government, NGO, academia), supported by active research, and supported by a knowledge base with clear stewardship (Brasseur and Gallardo, 2016). Scientists have paid attention and effort to generating climate data, and as a result, a considerable amount of climate change research and scientific information is available for policy makers at different levels, to make use of in climate risk management planning (Muema et al., 2018). However, there is an existing gap between the produced information and what end-users, such as farmers, need for their decision-making (Lemos et al., 2012).

Climate information services in Vietnam are mainly provided by governmental agencies, international organizations, research institutes, local and international non-governmental organizations, and the private sector (Christoplos et al., 2017; Van et al., 2015). The Ministry of Natural Resources and Environment (MONRE) is the central department responsible for managing climate change impacts and it collaborates with related departments, particularly the Ministry of Agriculture and Rural Development (MARD), to produce climate change scenarios and to develop the National Target Program for Climate Change. These ministries operate at multiple scales, down to the local level, with a climate change division at each level (i.e. district, province, national). The Meteorology and Hydrology Agency is also mandated to collect and store weather data and manage the climate information provision framework. This information is mainly provided through public media (television, radio, websites), mobile phone (SMS), and newspapers. At local levels, particularly in remote and vulnerable areas, climate information has also been disseminated through awareness raising programs, such as trainings, community meetings, and community climate change contests organized by NGOs and local civil society organizations (i.e. Women’s Union, Youth Union).

Climate change awareness raising in Vietnam has been promoted and facilitated by both governmental and non-governmental organizations. Numerous NGOs have implemented climate change awareness programs to build adaptive capacity of vulnerable communities in many parts of the country, including the mountainous areas of Thừa Thiên Huế (TTH) province. Since 2014, a climate network of more than 30 NGOs has been operating to share and discuss climate change information and disseminate this to relevant stakeholders, including community members. Since 2009, all provinces have developed climate action plans based on the National Target Program on Climate Change. Awareness raising has always been central to these provincial climate change action plans. However, it is unclear how robust the access to, and use of, these climate information channels are to building local communities’ adaptive capacity.

In relation to farming adaptation measures undertaken by smallholders in Vietnam, strategies include diversifying crop varieties, changing cropping patterns, implementing crop protection (Pham et al., 2019), integrated cropping, income diversification (Phuong et al., 2018), soil conservation techniques and terracing (Sen et al., 2020b), managing water use, and migration (Le Dang et al., 2014). However, many barriers hinder smallholders’ adaptation, including access to credit and markets, market price fluctuations, climate change perceptions, land tenure, lack of skilled labor, and lack of capacity to learn and apply techniques (Huong et al., 2017; Le Dang et al., 2014; Phuong et al., 2018; Sen et al., 2020a; Sen et al., 2020b). Additionally, several studies acknowledge climate information as significant in influencing the spread of adaptation measures, while simultaneously, a lack of climate change information acts as a barrier. These studies call for improved information sources and quality, as a strategy for improved smallholder adaptation (Le Dang et al., 2014; Huong et al., 2017; Phuong et al., 2018). However, these studies do not distinguish between information access and use, or rather information use and usability, which is central...
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Study objectives

This study aims to address this gap by focusing on the following research questions:

(i) What climate information services/channels are available at the community level?
(ii) What is the current situation of access to, and use of, climate change information by farm households in mountainous areas of the TTH province?
(iii) What factors influence the successful access to, and use of, climate change information by farm households for their livelihoods?

Methodology

Study site and data collection

The two mountainous districts of Thừa Thiên Huế province, Nam Đông and A Lưới, were selected as the sites of this study (Fig. 1). The districts are sparsely populated with approximately 40 persons per km² (PSO 2017) and these communities are among the poorest in the province, with a poverty rate of approximately 21% in 2019. The ethnic minority population includes Cơ Tu, Văn Kê, Pa Cô and Tạ Ò peoples. Kinh people were only 34.56% of the population in 2018 (Thua Thien Huế, 2018). Six communes were purposively selected to be part of the study, based on their location adjacent to natural forest and them having a high percentage of ethnic minority population. These communes are Thượng Long, Thượng Lớ and Thượng Quang in Nam Đông district and A...
Roäng, Hong Van and Hong Quang in A Luoi district. These six communes are comprised of 3,815 households (in 2019). Agricultural production and collection of forest products are the predominant livelihood activities in the region (An, 2006; Hoang et al., 2017; Linh, 2018).

This study is based on data obtained through a household survey, group discussions and in-depth interviews, undertaken between July 2019 and July 2020 in Nam Dong and A Luoi districts. Households were randomly selected from the list of residents within the selected communes, provided by the Commune People’s Committee. Among the ethnic groups, Kinh people are considered as a majority group (throughout Vietnam), while all other ethnic groups are minority groups. Ethnic minority communities are often more vulnerable than Kinh people since they have different cultures, low education, and limited livelihood resources, and thus, have been receiving livelihood support from the government (UNDP, 2016). The sampling technique of the study, thus, tried to make sure the ratio of ethnic group (Kinh and minority) in the research sample be representative of that in the total population of the districts. The total sample size is 302 households, of which 77 were Kinh farmers and 215 were ethnic minority farmers. The number of Kinh respondents was much lower because a low proportion of Kinh people residing in the area are farmers, as the majority of Kinh people are dependent on business, rather than agriculture.

Household interviews were conducted in Vietnamese with the support of pre-tested questionnaires and commune staff with local languages. The questionnaires were used to obtain data on households’ socio-economic characteristics, livelihood activities, perceptions of climate change impacts, access to and use of climate information, and responses to climate change. Data from household interviews were input and managed in Excel 2010 and processed using SPSS 20.

Research framework

This research was developed based on the results from previous studies (Sen et al., 2020a; Hoang et al., 2017) which indicated that the mountainous areas of TTH province are among the most vulnerable regions of the country, with local people increasingly facing negative climate impacts. These previous studies also indicated that local communities, particularly the indigenous communities, have relatively low resilience and climate change awareness, with knowledge and access to climate information among the most critical determinants.

In this study, ‘climate information’ includes daily weather forecasts, observed climate change signals (including changes in behavior of animals, plants and insects), climate change impacts, as well as alerts on extreme climate events, climate change causes, adaptation strategies and related policies from media or government departments. This information is strongly associated with natural hazards and people’s responses. This information can be communicated through formal (e.g., village head, government department, television) or informal channels (e.g., social networks, successful farmers, neighbors).

An adapted conceptual model for information usability (Lemos et al., 2012) is applied in this study (Fig. 2), which allows for description of the barriers to the usability of information, and highlights strategies to move information from useful to usable, in order to reduce farm households’ climate-related risks. The model describes the common path between production and use of climate information. Theoretically, all produced information is usable as it is available for users’ uptake for their decision-making (McNie, 2007). However, in reality some scientific information is taken up by decision-makers while other information is not (Korfsmacher and Koontz, 2003). Previous studies indicated numerous factors influencing the movement of information along the path between information producers and information users (Korfsmacher and Koontz, 2003; Lemos et al., 2012; McNie, 2007). These factors could be enablers or barriers to the movement of the information from useful to usable (i.e., usability). Some factors are enablers in some cases but become barriers in other cases (denoted by the curved arrow in Fig. 2). Within this model, fit, interplay, and interaction are three major categories of influencing factors that shape each other to increase or constrain the usability of climate information for livelihood decision-making.

Fit refers to how users perceive the information that they’ve received, to meet their needs and suit their circumstances. This influences users’ willingness to apply the information into practice (Lemos et al., 2012). For the interplay category, the model considers the interaction or interplay between the new information and information that has been used in previous decision-making (Lemos et al., 2012). Because of interests and time availability, women and men exhibit differences in terms of their responses to climate change, their access to and use of climate information services, and their vulnerabilities and capacities to adapt to a changing climate (UNDP 2019). Interaction relates to the communication between farmers and information providers. Two-way communication facilitates the relationship between information users and providers and builds trust between them (Panago et al., 2002). When users trust the information and information providers, they perceive them to be credible, and as trust is established, greater interaction will proceed, thus improving information fit (Kirchoff 2010).

Access and use of information are two different steps of decision-making (Nicholson et al., 2015). In some cases, people search or access information services for objectives other than its use, for example just to know or understand, but not to form a decision. In other cases, users may not trust the information or are unable to analyze the information and therefore do not use this accessible information for decision-making and instead rely on their past experience. Alternatively, some people are able to use accessible information and this is an important input for their decision-making (Lemos et al., 2012; Muema et al., 2018). Therefore, this study separates access and use of information as two different phases for analysis. Through this, the study expects to identify influencing factors and draw out solutions to remove barriers for each phase.

Based on the information usability model (Fig. 2), a list of influencing factors relevant to this study is presented in Table 1.

Data analysis

Previous studies have used descriptive methods for analyzing the status of access and use of climate change information (Carr et al., 2016; Chukwuji et al., 2019), using regression models to identify and analyze the

| Table 1 List of factors that are expected to influence access and use of climate information. |
|-----------------|-----------------|-----------------|
| Influencing factors | Measurement (Scales) | Source |
| Availability of information | Dummy | Lemos et al. (2012); McNie (2007) |
| Perception of climate risk | Dummy | Mandlesi and Amin (2011) |
| Sex of household heads | Dummy | Cherovitch et al. (2012); Ndeye et al. (2019); Nicholson et al. (2015) |
| Age of household heads | Count | Nicholson et al. (2015); Muema et al. (2018) |
| Number of education of household heads | Count | Nicholson et al. (2015); Muema et al. (2018) |
| Farm size | Dummy | Nicholson et al. (2015); Muema et al. (2018) |
| Household economic classification (poor, non-poor) | Dummy | Nicholson et al. (2015); Muema et al. (2018) |
| Farming experience | Count | Oyekale (2015); Robert et al. (2016) |
| Access and use of communication assets: Television, Radio | Dummy | Nicholson et al. (2015) |
| Smartphone, computer | Dummy | Chanel and Chichilinsky (2009); Nicholson et al. (2015) |
| Culture/ Ethnicity | Dummy | Nicholson et al. (2015) |
| Income sources | Count | Kirchoff (2010) |
| Trust of information | Dummy | Lemos et al. (2012); Robert et al. (2016) |
| Networking (community organization membership) | Count | Nicholson et al. (2015) |
| Collaborative market actors | Count | Sen and Duyen (2016) |
factors shaping that access and use. Probit and logit models are the most relevant for this type of study because of the dichotomous nature of the dependent variable (Mueno et al., 2018; Ndeye et al., 2019; Oyekale, 2015). A logistic regression model was chosen over other models, such as discriminant analysis model, because of its advantage in mathematical simplicity to give meaningful results. There are no assumptions of normality of independent variables and equal variance within each group in logistic regression (Southavilay et al., 2012; White et al., 1986). However, discriminant analysis can only be used with continuous independent variables, keeping the assumptions of normality and equal variance. Hence, since the independent variables of this study are a mix of continuous and categorical, logistic regression is preferred and statistically robust in practice as compared to discriminant analysis (Halperin et al., 1971). In addition, the binary regression analysis is suitable for estimating discrete outcomes of dichotomous dependent variables from several explanatory variables that are dichotomous or continuous or discrete. In this research, the dependent variable is a dummy variable which takes a value of 1 for “households which access formal climate information channels” and 0 otherwise (households which have not accessed formal channels). The logit model was applied and specified as follows:

\[
P_i = \text{Prob}(y_i = 1) = \frac{1}{1 + e^{-\beta}}
\]

Where \(P_i\) = Probability of access or use of climate information of the \(i^{th}\) farm household and described by a function of the farm household’s socio-economic characteristics \(Z_i\). The relation between \(P_i\) and \(Z_i\) in this form creates some estimation problems whereby the ordinal least square (OLS) procedure cannot be used to estimate the parameters (Yabi, 2004). Hence, the following form is suggested by taking the natural log of the probability ratio.

\[
\ln P_i = \ln \left( \frac{P_i}{1 - P_i} \right) = Z_i = a_0 + a_1X_{i0} + a_2X_{i1} + \ldots + a_nX_{in}
\]

Where: \(a_0\) and \(a_1\) are parameters to be estimated. \(X_{in}\) is an independent variable \(n^{th}\) of \(i^{th}\) farm household. \(Z_i\) is the log odds ratio.

Since access and use of information are two different steps of a decision-making process, they may be shaped by different factors. Two separate logit models, thus, were used for analyzing the access to information of households and utility of information for decision-making.

Climate information services in Vietnam, including public media (TV, radio, governmental officers) are considered as formal information channels. Other information channels such as the market, neighborhoods, friends, and networks are considered informal. Almost all people in rural areas have access to climate information through either formal or informal channels (Sen et al., 2020b). This study, thus, considered households which access formal climate information channels as access households and households which have not accessed formal channels (have accessed informal channels only) were non-access households. Farm households who had access to (formal) climate information were coded 1, with non-access households coded as 0. Similarly, farm households who had used climate information for decision-making were coded 1, other households were coded 0.

**Results and discussion**

**Study site background and socio-economic characteristics of surveyed households**

The districts are in the upland agro-ecological zone adjacent to large areas of protected forests (including Bach Ma national conservation area; Saola (Pseudoryx nghetinhensis) conservation area and Phong Điền conservation area). The farming systems are mainly steep-slope land cultivation systems, dominated by small land holdings, degraded soil, low return on labor, and heavy dependence on the natural environment (Hoang et al., 2017). Previous studies within the region found agricultural households generally had low levels of climate resilience, particularly in relation to income and food access, assets, technology and adaptive capacity (Sen et al., 2020a). Since implementation of community-based forest management policies, which have restricted access to forest resources, household income from forestry has declined and income from wage labor has increased among resource-dependent households (Sen et al., 2021).

The districts are among the highest rainfall areas in the country, however rainfall patterns are erratic (Tham and Trung 2011). In recent years, the number of raining days decreased but raining intensity increased, leading to irregular seasons (Government Portal, 2018). Floods, droughts, and storms are examples of extreme climate events that occur in the study region (Tran et al., 2008; Vo et al., 2021). For example, the 1999 historical flood is deeply established in the minds of many individuals as a fearful event, as it was one of the most severe in Central Vietnam, resulting in over 600 deaths and loss of US$300 million worth of property (FAO, 2003). Heavy rain during late summer or early winter causes serious flash floods and landslides. In addition, the two districts are among the hottest areas in the country during summer, leading to drought and forest fires. Storms have decreased in frequency but increased in intensity posing risks for livelihoods, particularly tree plantations such as rubber, *acacia* and fruit trees (Sen et al., 2020b). An assessment report of the provincial Department of Agriculture and Rural Development (DARD, 2020) shows that in 2020, more than 320 houses and 15 ha of agricultural land were destroyed, as well as more than 2.5 km irrigation/canal infrastructure crushed by rock and sand. Additionally, approximately 50 dykes were damaged due to landslides and flashfloods and there were 32 forest fires that destroyed approximately 3,000 ha of plantation forest (DARD, 2020).

Table 2 describes the main socio-economic features of Kinh and ethnic minority household groups in the study area. The results show that there are considerable differences between these two social groups in terms of age, sex of household head, education level, economic situation, number of income sources, owned land areas and linkage with market actors. Heads of ethnic minority households are much younger

| Characteristic | Kinh households (n = 87) | Minority households (n = 215) | P. value |
|---------------|-------------------------|------------------------------|---------|
| Age (years)   | 50.48 ± 11.015          | 43.80 ± 12.45                | 0.000*  |
| Sex of household head (% of male head) | 57.5 | 76.3 | 0.001 |
| Education (grade) | 6.41 ± 3.40 | 7.59 ± 3.88 | 0.015 |
| Household labor force | 1.91 ± 0.71 | 1.99 ± 0.74 | 0.405 |
| Family size | 3.75 ± 1.45 | 4.08 ± 1.14 | 0.033 |
| Household economic classification (non-poor) | 83.9 | 65.6 | 0.001 |
| Number of social groups being connected | 2.29 ± 0.59 | 2.42 ± 0.69 | 0.108 |
| Income sources | 2.28 ± 0.68 | 2.63 ± 0.88 | 0.001 |
| Average income per year (million VND) | 35.37 ± 22.37 | 36.32 ± 27.75 | 0.779 |
| Land area (ha) | 0.03 ± 0.18 | 2.04 ± 2.38 | 0.000* |
| Farming experience (years) | 23.53 ± 9.88 | 22.38 ± 11.21 | 0.409 |
| Number of market actors/middlemen being connected | 2.20 ± 1.49 | 3.20 ± 3.15 | 0.005 |
| Perceived climate change as a risk (%) | 24.1 | 19.5 | 0.229 |
| Television (% households own at least 1 television) | 83.9 | 87.9 | 0.227 |
| Radio (% households own at least 1 Radio) | 9.20 | 12.6 | 0.270 |
| Smartphone (% households own at least 1 smartphone) | 42.5 | 42.3 | 0.537 |
| Computer (% households own at least 1 computer) | 0 | 7.4 | 0.004 |

Source: Survey

* Significant at P < 0.000 level
than Kinh households (around 50 years old for Kinh and 44 years old for ethnic minority households, (P < 0.000)). It was explained by commune and district leaders that ethnic minority people often get married at a much younger age than Kinh people, and upon marriage, separate from their extended family. Therefore, the average age of household heads for ethnic minority households is much lower than for Kinh people. More men than women are head of households in both groups. About 57.5% and 76.3% of household heads are men in Kinh and minority groups, respectively. The household heads involved in the survey had approximately 22–23 years of farming experience.

Interestingly, the education level of minority household heads is quite high and much higher than Kinh household heads in the area. In fact, many old people are illiterate or have a low education level but with many support programs in recent years, young people, and most ethnic minority young people, have completed high school, and even university. However, the quality of education received can be variable (Baulch et al., 2010), despite the appearance of higher levels of attainment.

All Kinh households in the study originated from the lowland areas of the province and have migrated to the mountainous areas to earn a living, therefore their livelihoods depend more on small business than agriculture. Their land areas are significantly smaller than the ethnic minority households because of local cultures in land ownership. Those who migrate first to a land area will be the owner of that land and ownership is passed down through generations. Therefore, Kinh people as outsiders have difficulty accessing land resources. On average, land area owned by ethnic minority households is over 2 ha, while it is only 0.03 ha for Kinh households (P < 0.000). The land resources were mainly used for cassava, maize, rice and planted forests (Acacia).

Almost all farmers in the study area have linkages with market actors, particularly agricultural middlemen or collectors. Ethnic minority farmers have more agriculture products and they sell these to anyone who comes to their farm offering a reasonable price. This means they often do not create long-term or stable linkages with market actors, whereas Kinh farmers do. The standard deviation value of 3.15 indicates a large variation in the number of market actors contacted among ethnic minority households, with some ethnic minority households having contacts with more than 15 actors. In contrast, Kinh farmers have linkages to around 2 market actors, who are often longer-term contacts.

Regarding information assets, a high percentage of households (above 80%) in the area own at least a television, or smartphone (above 42%). Very few households own a radio or computer. Only older generations own a radio, and the better-off households or those who are also commune officers, own a computer.

There is a relatively low percentage of both Kinh and ethnic minority farmers who perceive climate change as a risk (24.1% and 19.5%, respectively), though, they have heard about climate change and experienced damage due to extreme climate events.

### Households’ access to available climate information channels

|   | Kinh households (n = 87) | Minority households (n = 215) | χ² test |
|---|--------------------------|-------------------------------|---------|
| # Information channels |                           |                               |         |
| 1 Formal channels for climate information |                           |                               |         |
| Village head | 31.0 | 81.4 | 0.000 |
| Television | 42.7 | 47.0 | 0.003 |
| Radio | 9.2 | 5.6 | 0.185 |
| Community loudspeaker | 17.2 | 82.8 | 0.000 |
| None of the formal channels | 5.7 | 12.6 | 0.000 |
| 2 Informal channels for climate information |                           |                               |         |
| Smartphone | 10.3 | 31.6 | 0.000 |
| Community social network | 0 | 7.5 | 0.004 |
| Neighbors | 25.3 | 83.3 | 0.000 |
| Community key | 0 | 38.6 | 0.000 |
| informant/ successful farmers |               |                               |         |
| Market/ market actors | 17.2 | 11.2 | 0.000 |
| None of the informal channels | 58.6 | 0 | 0.000 |

Source: Survey

Table 3 presents the status of access to different climate information channels of the interviewed households. The results show that there were 5 formal channels and 5 informal channels. The status of access to information channels was significantly different between Kinh and minority farmers (P < 0.001). Ethnic minority farmers rely on the village head, television, community loudspeakers and neighbors for climate information, while Kinh people rely mainly on television. Ethnic minority farmers seem to access more diverse channels of both formal and informal climate information. It was explained by several elderly people in the community that the main reason for this difference may be because ethnic minority farmers have larger farms and their livelihoods are more dependent on agriculture, therefore they seek out more climate information. In addition, as part of their culture, ethnic minority people often have strong connections with each other, they have more collective action activities and joint decision-making than Kinh people. Television appears to be a common information channel for both Kinh and ethnic minority people. None of the interview households knew of relevant government departments from the district or provincial level. Respondents did not agree that they have received climate information from extension or agricultural departments.

Market actors (middlemen, collectors or even input providers) receive more attention from farmers in these areas. However, not many farmers could access market actors’ services, or were able to collaborate with them, because market actors often provide low quality inputs to make the price reasonable for farmers. Further, market actors often over-promised and under-deliver for farmers in relation to price for their products. Many farmers who have used their services, or have collaborated with them, feel trapped to stay with the market actors because they have few other choices (unable to sell their produce elsewhere). In isolated areas, markets for agricultural products is the biggest challenge for farmers, hence, having a connection with the middlemen provides an opportunity to get cash income and farmers often depend heavily on middlemen for selling their products despite the low price achieved compared to the actual market price. Other studies in Vietnam have also found that smallholder farmers can have weak links to market actors, which can impinge on their market access (Japar et al., 2006) and this reliance on private market actors can be insecure and less profitable (Ha et al., 2015).

The results show that ethnic minority farmers access more sources for climate change information than Kinh farmers and include more informal channels in their information seeking. Indeed, there are 5.7% of Kinh farmers and 22.8% of ethnic minority farmers who do not access formal channels at all. Reasons for not accessing formal channels are a lack of information in local language, lack of trust in the capacity of extension agents, and insufficient and unavailable information from television and radio (Table 4). This higher reliance on informal communication channels may contribute to the relatively large proportion of farmers, particularly ethnic minority farmers, who are not aware of climate change causes and potential impacts, rather believing that climate change is due to God or due to nature. This may affect ethnic minority farmers’ use of information in adaptation decision-making. Alternatively, 58.6% of Kinh farmers do not access informal channels for climate information (P < 0.001), although they may have accessed these channels for other purposes. Additionally, the services related to this information such as climate resistant/tolerant production inputs and technologies are also deficient.

Making information available is a major strategy to promote users’ access and use of information services (Ndeye et al., 2019), as information cannot be accessed and used if it is not first available. Previous research in Senegal (Ndeye et al., 2019), sub-Saharan Africa (Oyekale,
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Table 4
Reasons for not using or not effectively using climate change information from formal channels

| Reasons                                                                 | Kinh (n = 87) | Minority (n = 215) | Sig. |
|-----------------------------------------------------------------------|--------------|--------------------|-----|
| For local extension staff (village head, agricultural staff): Lack of trust on capacity and inconvenient to access to the information providers | 37           | 114                | 53.0| 2.73* |
| For public information channels (television, radio): Insufficient information and the unavailability of information | 34           | 147                | 68.4| 22.13*** |
| Language barriers (mainly with television, radio, outsiders)          | 0            | 93                 | 43.3| 54.37*** |
| Don’t know                                                            | 2            | 7                  | 3.3 | 0.20 |

Notes: ***, **, * presents 1%, 5% and 10% significant levels, respectively.

Table 5
Kind of climate information farmers collected (% respondents access to information)

| Type of information                      | Formal channels | Informal channels |
|------------------------------------------|-----------------|-------------------|
| Weather forecast (daily)                 | 255 94.4        | 51 100            |
| Extreme events and damages               | 59 21.9         | 15 29.4           |
| Successful adaptation options            | 16 5.9          | 36 70.6           |
| Climate supported policies               | 5 1.9           | 3 0.06            |

Source: Survey

2015) and in central provinces of Vietnam (Christoplos et al., 2017) found the availability of information is one of the barriers to the access and use of climate information by local people. However, many people in this study area indicated that availability of climate information is not the main issue, particularly through media and smartphone. Instead, the quality of information and language of information were the main barriers. More than 60% of people in A Lữ and 40% of people in Nam Đông districts use their own local language. It can therefore be extremely difficult for them to hear and understand information provided via mass media in Vietnamese. Direct communication with demonstration activities seems to be the most suitable approach for people in such communities (Harvey et al., 2009).

Use of climate information of surveyed households

Results from Table 5 show that the daily weather forecast is the main climate related information farmers access. A relatively low percentage of farmers have accessed formal and/or informal channels (21.9% and 29.8% of respondents respectively) for information regarding extreme events and associated damage. Informal channels such as neighbors, community key informants or successful farmers are important sources of information for raising awareness of successful adaptation options. More than 70% of respondents access these informal channels for information about other farmers’ successful adaptation strategies, while this figure is only 5.9% for formal channels. The results also show few respondents accessed information regarding governmental climate policies which support local people to adapt to climate change. Over 90% of respondents said that they do not know any support programs for climate change adaptation from the government. All respondents claimed they have responded to climate change impacts based on their local knowledge and community support networks.

The informal information channels (successful farmers, agricultural networks, market actors) provide local information that is practical, easily understood, allows for convenient information exchange, and some actors even provide demonstrations for farmers to follow. In contrast, the government departments have been largely inactive and absent from communities, with their communication activities dependent on the government budget. Overall, farmers want climate data that covers their local area to as fine a scale as possible, in formats that they can easily understand and incorporate into existing decision-making frameworks. In most cases, however, there is a gap between what is currently available and what they need (Bell-Pasth and Krechowicz, 2015). In addition, most government advice is related to advanced techniques that farmers are unable to implement due to the high cost and skills required. Farmers also reflected that because of a lack of frequent contact and communication, local people did not feel confident or disposed to communicate with the government staff.

Despite all respondents accessing climate information through either formal or informal channels, around 67.8% of Kinh respondents and 46.5% of ethnic minority respondents haven’t used the information for their livelihoods (Table 6). The results show the use of climate information for livelihood activities is significantly different between the two farmer groups. Ethnic minority farmers use more climate information than Kinh farmers (P < 0.001). They use information from weather forecasts and the media and smartphones for daily planning of their livelihood activities, particularly for non-timber forest product collection. The weather forecasts help farmers to avoid undertaking activities in difficult weather. Many respondents access climate information with the aim of sharing, chatting, or discussing with friends and neighbors. A relatively low number of respondents (15.5% and 17.2% ethnic minority and Kinh farmers respectively) accessed climate information for making decisions about long-term investments, such as planting perennial crops (fruits, rubber, acacia plantation) or annual crops (maize, upland rice, cassava), whether to increase their livestock production, or to diversify their income sources to avoid climate risks.

Many respondents stated that while they need climate information, i.e. regarding extreme events as well as information on appropriate adaptation strategies to suit their local conditions, they are unsure of where to access this information. As a culture, farmers in the study areas often collect information to share or discuss with others (P < 0.001), rather than to apply the information in their livelihood activities (Lam 1996). Most ethnic minority farmers depend on indigenous knowledge and experience for farming and are hesitant to apply techniques or advice recommended by relevant government departments (Dung 2018).

Therefore, to ensure farmers’ access and use of climate information in livelihood activities, information producers need to have a deep understanding of farmers’ production capacity and needs (Ziervogel and Opere, 2010). This suggests that farmers in the study location require local, context-specific information, delivered in their language and through informal channels such as neighboring farmers with demonstration plots.

Table 6
Farmers’ use of climate change information they received (% respondents)

| Use of climate change information | Kinh households (n = 87) | Minority households (n = 215) | χ² test |
|-----------------------------------|-------------------------|---------------------------|---------|
| To make plan for daily livelihood activities | 3.4 29.3 | 0.000 |
| For long term investment in livelihoods | 17.2 15.8 | 0.441 |
| To discuss and share with others | 28.7 51.7 | 0.000 |
| Do not use any climate information or not effectively use | 67.8 46.5 | 0.000 |

Source: Survey
This section analyses factors influencing the access to, and use of, climate information from formal channels (Table 7). The Chi square and Wald results with a probability of < 1% indicate that both models are appropriate and the results of the models are statistically significant. A correlation test for independence was done for all variables in Table 1, which are expected to have influence on farmers’ access to, and use of, climate change information. The results showed that farm size and household type (ethnic minority and Kinh) are strongly correlated (P < 0.001). Kinh households’ farm size is significantly lower than that of the ethnic households. Thus, only household type was selected as one of the dependent variables. Age and farming experience of household heads were expected to be correlated. However, they were not. One explanation for this is, that many people prior to 2005 were foresters rather than farmers and have since become farmers after the government started implementing the “closing forest policy”.

Farmers’ perceptions of climate risk and their trust of climate information channels are the two main factors shaping farmers’ access to, and use of, climate information from formal channels for their livelihood activities. The logit analysis showed that for farmers who perceive climate change as a risk (climate change perception) and trust formal climate information services, this positively influences their access and use of climate information. The values of the odds ratio for climate change perception, Exp(B) = 6.750 for access and Exp(B) = 54.674 for use of information (Table 7) can be explained that holding other variables constant, the probability that farmers’ access to and use of climate information is 6.750 and 54.674 times higher for farmers who perceive climate change as a risk than those who do not, respectively, confirming previous studies (Mandieni and Amin, 2011; Lemos et al., 2012).

Climate risk perception is an important driver for farmers’ decision-making in response to climate change impacts (Carr et al., 2016; Cherotich et al., 2012) and remains the main barrier to both the access to, and use of, climate information services (Hedges et al., 2006), since more than 45% of farmers in the area believe climate change is due to God.

Ethnic minority farmers’ lack of awareness of climate risk, and attribution of climate change to God or nature, shows that these perceptions do not influence farmers’ access to climate information but significantly influences the use of that climate information. Ethnic minority farmers are less likely to use formal channels for accessing climate information, preferring informal channels due to them being convenient, practical, low cost and culturally appropriate. Further, this climate information is used for discussions rather than for planning their livelihoods. These findings emphasize the role of indigenous knowledge in ethnic minority farmer climate adaptation, which other studies have shown to be significant (Sen and Bond, 2017) and necessary for integration with other forms of knowledge for robust adaptation (Makondo and Thomas, 2018). These findings show that any future climate information activities undertaken in the study area should incorporate not only indigenous knowledge, but indigenous pathways for creating knowledge (such as collaborative activities between farmers with demonstration plots).

For the trust of climate information services, the probability that farmers’ access to and use of climate information is 8.018 and 8.331 times higher for farmers who trust the services than those do not, respectively. Such quantitative results imply that farmers who perceive climate change as a risk are likely to devote more effort to seek out climate change information and use it as an input for livelihood planning, than those who do not. Farmers who trust the formal information channels are more likely to access and use climate information than those who do not. As farmers trust the channels, they often pay more attention, are more supportive of the information, and are more motivated to access and use the information, despite any previous failures or poor results. This is in line with the findings from Lemos et al., (2012) and Muema et al., (2018). Most farmers in this study expressed a lack of trust in the formal climate information services, except for the daily weather forecast. Two main reasons for this lack of trust include the usefulness or ‘fit’ of information to the locality and the lack of frequent and direct communication. It was expressed that except for the weather forecast, climate information from the formal information channels is very general, often does not fit the local conditions and does not build farmers’ capacity to understand and apply the information to their practice. The lack of detailed guidance and communication with farmers created many difficulties for them to access, understand and use the information.

Ownership of communication assets such as television, radio, or smartphone is also a determining factor for both access to and use of climate information by farmers, with significance levels of 5% and 10%, respectively. Farmers who own such communication assets show greater propensity to access and use climate information. The level of significance of 5% for access and 10% for use, indicates that still many farmers own televisions but do not use them for accessing climate information,

### Table 7
Factors effecting access and use of climate information from formal channels

| Factors                                      | Access to information | Use of information |
|----------------------------------------------|-----------------------|--------------------|
|                                              | Coefficient (B)       | Exp (B)            | Coefficient (B)       | Exp (B)            |
| Constant                                    | -3.785* (1.732)       | 0.023              | -8.687*** (2.877)     | 0.000              |
| Age (years) of household head                | -0.052 (0.034)        | 0.494              | 0.079 (0.049)         | 1.083              |
| Sex of household head                       | -0.355 (0.451)        | 0.701              | -0.390 (0.7070)       | 0.677              |
| Education (grade)                           | 0.066 (0.060)         | 1.068              | -0.042 (0.101)        | 0.959              |
| Farming experience (years)                  | 0.028 (0.036)         | 1.029              | -0.099* (0.050)       | 0.906              |
| Household economic classification (non- poor = 1) | -0.191(0.468)       | 0.826              | 0.350 (0.836)         | 1.419              |
| Ethnic (Ethnic household = 1)                | -0.386 (0.514)        | 0.679              | -0.546 (0.736)        | 0.579              |
| TV (1 – having at least 01 TV)              | 2.728** (0.928)       | 15.296             | 2.694* (1.471)        | 14.784             |
| Radio (1 – having at least 01 radio)        | 1.188* (0.583)        | 3.281              | -1.277 (0.890)        | 0.279              |
| Smartphone or computer (1 – having at least 01) | 0.795* (0.378)      | 2.215              | 1.114* (0.595)        | 3.046              |
| Number of social groups being member        | -0.357 (0.256)        | 1.430              | 0.390 (0.377)         | 1.447              |
| Income sources                              | 0.045 (0.229)         | 1.046              | 0.197 (0.365)         | 1.218              |
| Climate information availability (1 – available) | 2.136*** (0.861)    | 8.467              | 2.291* (1.023)        | 9.880              |
| Relationship with market actors (number of actors being connected) | -0.047 (0.080)  | 0.954              | 0.017 (0.134)         | 1.017              |
| Perceive climate change as a risk (1 – agree) | 1.910*** (0.661)  | 6.750              | 4.001*** (0.862)      | 54.674             |
| Trust on the formal information services (1 – trust) | 2.082*** (0.593) | 8.018              | 2.120** (0.815)       | 8.331              |
| Chi-square                                  | 164.562               | 210.977            |                      |                    |
| Log likelihood                              | 206.155               | 102.128            |                      |                    |
| $R^2$                                       | 0.423                 | 0.506              |                      |                    |

Notes: ***, **, * presents 1%, 5% and 10% significant levels, respectively.

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1 Decision No 07/2012/QĐ-TTg dated 08/02/2012 signed by the Prime minister on policies restricting forest protection and management. This includes promoting socialization; attracting economic sectors, social organizations and local people to participate in forest protection; creating jobs, raising incomes, contributing to poverty reduction and ensuring living standards for forest-dependent communities.
and even when they do hear climate information from the television, they do not use it for livelihood decisions. Many farmers own a television or smartphone with the main purpose of entertainment (watch films or entertainment programs).

Farming experience does not show a significant influence on farmers’ access to information, but does show a negative influence on the use of climate information. This result indicates that older farmers are less likely to use climate information than younger farmers. The more experienced farmers are more likely to depend on their experience and indigenous knowledge for their livelihood activities rather than adopt new techniques or incorporate outside advice (Sen and Toan, 2013). The results also show no significant effect of household group on the access to, and use of, climate information from formal channels, however, it seems that ethnic minority farmers are less likely to access and use climate information from formal channels than Kinh people. Age, sex, education level, household types (ethnicity), and number of income sources do not show a significant influence on either access to, or use of, climate information by farm households for their livelihoods.

Conclusions and recommendations

This study was framed around three research questions, exploring farmers’ use and access of climate information. Our study found that climate information channels available at the community level in TTH province are both formal (TV, radio, governmental officers) and informal (the market, neighborhoods, friends, and networks), with farmers, particularly ethnic minority farmers, preferring informal channels (particularly best practice farmers and community groups), producing information based on indigenous knowledge and experience. Trust of information, climate risk perceptions and culture were key factors influencing farmers’ access to climate information, while additionally, farmers’ own experience influenced their use of climate information.

While other studies have highlighted the importance of information for smallholders’ climate adaptation, this study has interrogated the distinction between smallholders’ climate information access and use. The major contribution of this study is the understanding that information availability itself is not a limiting factor and does not necessarily correlate with information use in livelihood decisions. Cultural beliefs of ethnic minority farmers in Central Vietnam pose a barrier to their perception of climate as a risk, and therefore this hinders their use of climate information, rather than access to it. Similarly, trust of information sources is critical for farmers’ use of that climate information in their adaptation decision-making. While efforts should still be made to provide smallholders in the study site with climate information, greater focus should be put towards increasing the trustworthiness of the information. Greater focus on the fit of information (i.e. accuracy, relevance and reliability to the local area) would likely achieve this. Further research probing which of these two main findings (cultural beliefs of climate and lack of ‘fit’ of information) is more significant could provide critical insight.

The implications of this research are related to the integration of indigenous knowledge and activities into government or other formal activities. It is recommended that interactions between market actors and government staff with local people are improved through direct communication and demonstration of climate adaptation options. Interactions should be cognizant of ethnic minority farmers’ local languages, preferences for learning in social settings, and their attribution of climate change to God. This would enhance the reliability and real-world application, and therefore effectiveness, of the climate information provided to farmers, which requires a deep understanding of their local conditions and capacity. This improved network is needed to manage and enhance the incorporation of formal and informal climate information channels in the study areas to effectively combine local resources and indigenous knowledge with advanced technologies, to support farmers’ sustainable and robust climate adaptation responses.

Authors contributions

All authors contributed to the study conception and design. Questionnaire preparation, data collection and analysis were performed by L.T.H Sen, J. Bond, N.T Dung, H.G Hung, N.T. H. Mai and H.T.A Phuong. The first draft of the manuscript was written by L.T.H Sen and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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