FS

Forest and Society
Vol. 5(1): 48-59, April 2021
http://dx.doi.org/10.24259/fs.v5i1.7389

Regular Research Article

Identifying Climate Change Adaptation Efforts in the Batutegi Forest Management Unit, Indonesia

Christine Wulandari [1,*]

[1] Graduate Program of Forestry, Lampung University, Indonesia
* Corresponding author: christine.wulandari@fp.unila.ac.id; chs.wulandari@gmail.com; Tel.: +62-812 82 09075

Abstract: The Batutegi Forest Management Unit (FMU) in Lampung Province, Indonesia is beginning to observe the consequences of climate change. Meanwhile, communities in Batutegi are also suggesting that effects of climate change are becoming more prominent in their region. Indicators include rising air temperature and the increasing regularity of extreme weather changes. Studies show that land cover has decreased by up to 95% in the region. As these trends intensify, predictions note that the Batutegi reservoir and the productivity of the surrounding protected forests will be affected. This research examines FMU efforts to adapt to vulnerabilities from environmental and climate change. The broader objective of this research is to determine the appropriate climate change adaptation efforts, specifically regarding the management of sustainable forest protection. The method is conducted through regression analysis to identify significant variables and applies the Analytic Hierarchy Process (AHP) to identify priorities for planned interventions for climate change adaptation by the FMU. Based on regression results there were four significant variables, i.e. appropriate agroforestry initiatives, non-timber forest products, community institutional support, and local policy engagement. This research also considers various kinds of technologies of adaptation applied by local communities. Examining community efforts also presents possibilities for improving FMU institutional planning that is locally responsive. This is done primarily through agroforestry techniques and other community conservation practices. Based on the result of the AHP analysis, the findings highlight various programs related to agroforestry technologies as the top priority. Thereafter, priorities point to institutional development policies. Together, these priorities can form the basic considerations for developing climate change adaptation policies in Batutegi. These policies can be applied with, and by communities in managing forests through agroforestry, beginning with support for high quality seed procurement that also supports all phases of cultivation and supply chain through final product marketing. As a result, forest productivity and support for local income can form a robust approach for fulfilling community needs despite the effects of environmental and climate change in Batutegi.

Keywords: Agroforestry; Climate Change; Community Institutions; Forest Policy

---

1. Introduction

Climate change poses increasingly serious threats to human life (Environmental Protection Agency, 2015), and international policy forums have begun supporting climate change adaptation interventions (Abid et al. 2016; Amamou, 2018). Adaptation strategies can be practiced both at group and individual levels. Herein, community based adaptation is defined as the capability for improving resilience, as well as reducing the vulnerability of communities against climatic changes and variability (Elum et al., 2017; Yohannes et al., 2017; Georgopoulou et al, 2017). Effective adaptation actions and strategies should therefore be aimed at securing the well-being of local communities in the face of climatic changes. The role of adaptation by the community (autonomous adaptation) plays a key role. For example, autonomous adaptation builds from diverse indigenous strategies that have long been practiced locally in selecting crop variety, such as agroforestry of mixed farming systems and sowing of early maturing crops in crops such as coffee, cacao, and others (Addis Ababa Ethiopia Climate Change Manifesto, 2012). Gedefaw et al. (2018) highlight that some adaptation strategies in Ethiopia measure crop rotations, early planting, mixed farming, minimum tillage practices, and crop diversification. Indonesia also faces similar effects from climate change and has similar opportunities to support non timber forest products.

Received: 2019-08-20; Accepted: 2021-02-15

This study focuses on a forerst management unit scale in Batutegi, a site in Lampung Province, Indonesia. The effects of climate change has been observed in the Batutegi Forest Management Unit (FMU) jurisdictional areas. Indications of climate change can be seen from changes in temperature and rainfall (Supriyadi et al., 2018). Climate change in the Batutegi FMU is based on indications of significant changes in the volume and timing of rainfall in the past decade. In 2005, the highest rainfall occurred in January (428.85 mm) and the lowest occurred in December at 39.70 mm. Ten years later, in 2015, the highest rainfall was 326.65 mm in January and the lowest was 11.25 mm in October. The total amount of rain in 2005 was 2,303.85 mm and 1,512.93 mm in 2015 (Supriyadi et al., 2018). While these changes are also influence by other climate variability patterns like El Niño, nevertheless, the scale of the differences have a significant effect on local ecological and livelihood conditions.

The FMU consists of a total of 58,162 ha, and is one among several FMUs in Lampung Province. There has been a decline in land cover around this reservoir over time as the a Batutegi FMU study (2017) shows that 76% of the FMU area is used as agricultural land. Julijanti et al. (2015) also shows that the Batutegi FMU area had been managed as agroforestry in the past, but that a high percentage of tree cover had declined, namely by 95%. Agroforestry products is the main food source for the community in Batutegi, and therefore these changes have had a corresponding impact on local food security. Cases from Africa are already showing that production crop yield has depleted by up to 50% due to climate change (Gedefaw et al., 2018), and similar effects are likely to influence communities in these tropical regions as well.

Of the total area, 34,746 ha is part of the Way Sekampung watershed, which is under the management of KPH Batutegi. An area of 74.33% of the watershed area has suffered damage due to cultivation from the dominant coffee plant species (Ruchyansyah et al., 2018). Based on these conditions, the Sekampung Hulu (upstream of Way Sekampung Watershed) is one of the priority watersheds for immediate recovery from 8 major watersheds in Lampung Province.

The runoff coefficient of the watershed in Batutegi FMU in 2005 was 0.23 and increased to 0.34 in 2015. According to Asdak (2010), if the coefficient increases more than 30%, it can indicate that the watershed condition must be restored immediately. The greater the runoff coefficient, the lower the watershed's ability to retain and store rainwater. Thus the soil surface will dry out faster in the dry season, and on the other hand, floods will occur in the rainy season. Such conditions greatly affect the availability of water in the Batutegi Reservoir which irrigates 108,553 hectares of rice fields and is a source of water for the Hydroelectric Power Center to support electricity supply in Lampung Province (Supriyadi et al., 2018). Thus this reservoir is an important structure for the region, of which the Batutegi FMU holds the most important role in perserving.

In the Batutegi FMU, the increase in the runoff coefficient is accompanied by a decrease in the average monthly rainfall, namely 191.99 mm in 2005 and 126.08 mm / month in 2015 (Supriyadi et al., 2018). Thes conditions indicates that forest land cover in this FMU is very minimal. If the condition of forest land cover is not rehabilitated immediately, it will endanger the sustainability of the function of the reservoir and affect the availability of water for lands managed by the community in KPH Batutegi. In general, the people of Lampung Province will also have their lives disturbed because the sustainability of their electricity depends on the sustainability of this reservoir's functions.

The most prominent evidence of environmental and climate change is evident from natural conditions affecting the Batutegi reservoir, especially concerning the availability of water for the surrounding community (Supriyadi et al., 2018). Meanwhile, water availability in the Batutegi reservoir inflow has dropped from 7,229.92 m^3/sec in 2005 to 6,846.82 m^3/sec in 2015 highlighting the severe extent of climate and environmental impacts. Based on these conditions, it is timely to begin researching areas that can support climate change adaptation efforts in the Batutegi FMU. The research objective of this paper is thus to analyze efforts that have had real effects in achieving climate change adaptation goals, also ranking efforts according to community expectations based on priority rankings. The method uses the Analytic Hierarchy Process (AHP). This research also has a high-strategic value for supporting sustainable forest management (SFM) of the FMU, assisting in legalized means established by a Government Decree to spearhead SFM in 3 districts including West Lampung, Tanggamus, and Central Lampung.

The FMU is the smallest forest unit management in Indonesia and has a strategic position in SFM. The area of all FMU in Lampung is determined based on the Forestry Minister Regulation Number 68/Menhut-II/2010, which is then followed up by the establishment of an FMU as the Unit of Local Technical Organization through Governor Regulation Number 27 year 2010 and amended by Governor Regulation Number 3 year 2017, dividing all forest areas in the Province Lampung into 14 FMUs, consisting of six Production FMUs and eight Protection FMUs, of which Batutegi is among them. Since the FMU has a strategic position, the purpose of forest area management aims to be beneficial socially and economically for local communities in the region, providing ecological benefits such as the control of water yield in each watershed in every FMU area.

2. Materials and Methods

Research was conducted within the Batutegi FMU jurisdiction in Lampung Province (Figure 1.) between December 2016 - February 2017. According to Forestry Ministry Regulation No. 650/Menhut-II/2010 on 22 November 2010, the Batutegi FMU has 58,162 hectares of forest and is located at Sekampung Watershed. Geographically Batutegi FMU lies at 104°27’-104°54’ BT and 5°5’-5°22’ LS. The Batutegi FMU site is located in 4 administrative regencies, namely Pringsewu, Tanggamus, Central Lampung and West Lampung. The majority of the Batutegi FMU site is located in the catchment area of the Batutegi reservoir, which is one of the most important infrastructure features in Lampung Province. The boundaries of the Batutegi FMU are Way Waya-Tangkit Tebak FMU in the north, Protection Forest Register 32 Bukit Ridingan in the south, Kota Agung Utara FMU in the west, and Way Waya-Tangkit Tebak FMU in the east.

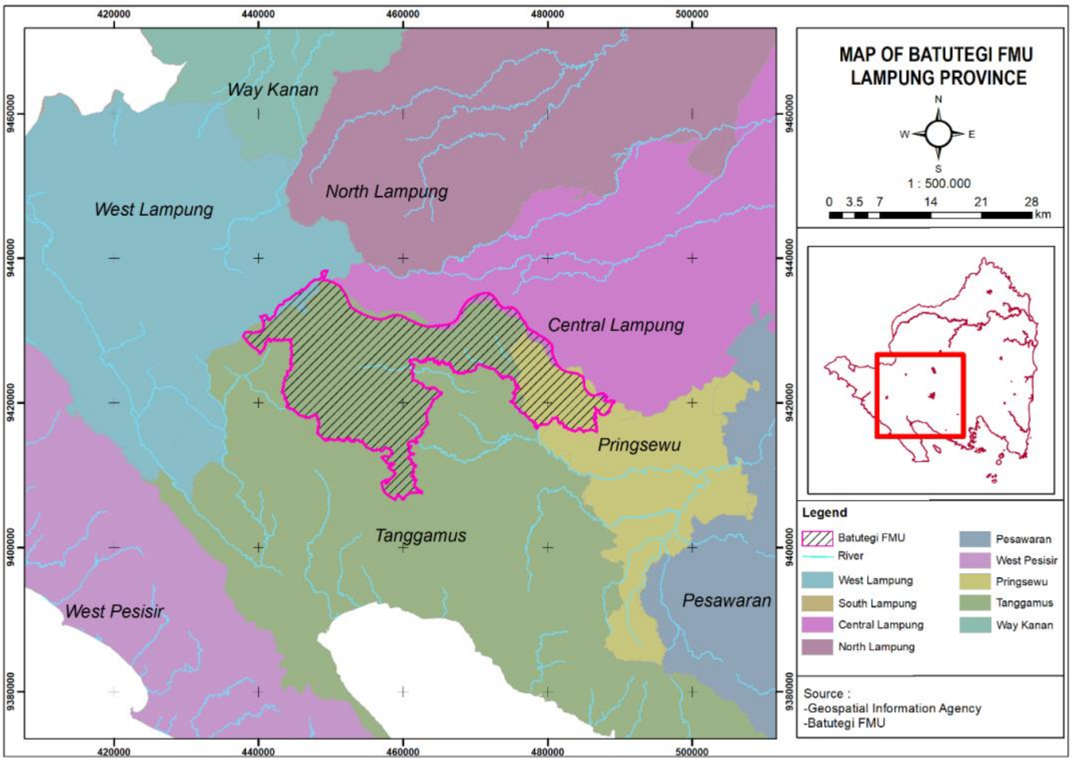

Figure 1. Map of Batutegi FMU as a research location [1]

[1] The map is drawn based on data provided by the Ministry of Environment and Forestry

The research approach is carried out through a compilation of several variables that draw from Rahayu et al. (2019), which also incorporates aspects of water conservation, soil conservation, soil fertility, agroforestry, Non Timber Forest Products (NTFP), product marketing, community institutions, and policy (Petrie et al., 2007, Crane et al., 2011; Teklewolda et al., 2019) (see figure 2 and 3). The methods applied in this study are mixed methods that combine qualitative and quantitative approaches in the data collection stage, and applied to modelling stages of the research process (Tashakkori and Teddlie, 2010).

The beginning of the research was preceded by a validity test and a reliability test of the questionnaire, while the reliability test used Cronbanch's Alpha formula (Sugiyono, 2012). After 3 field-tests, finally a correlation index (r) was established at 0.645, meaning all questions were valid and had a high reliability. Primary data was obtained through questionnaires given to 41 respondents selected through purposive sampling, namely people who manage forests based on social forestry schemes, i.e. community forestry (*Hutan Kemasyarakatan* (HKm)).

A field survey was then conducted to inquire whether the respondents would be able to fill out the questionnaire, by first determining their knowledge about efforts in climate change adaptation. Based on the results of the questionnaire, there were 8 appropriate efforts proposed by respondents in adapting to climate change, namely: soil conservation, soil fertility, water conservation, agroforestry, NTFP, community institution, products marketing and policy. Then the results of their entries were analyzed by regression (Confidence interval = 90%) in order to obtain 4 significantly different efforts to adapt to climate change in the Batutegi FMU, namely: agroforestry, NTFP, community institution and policy.

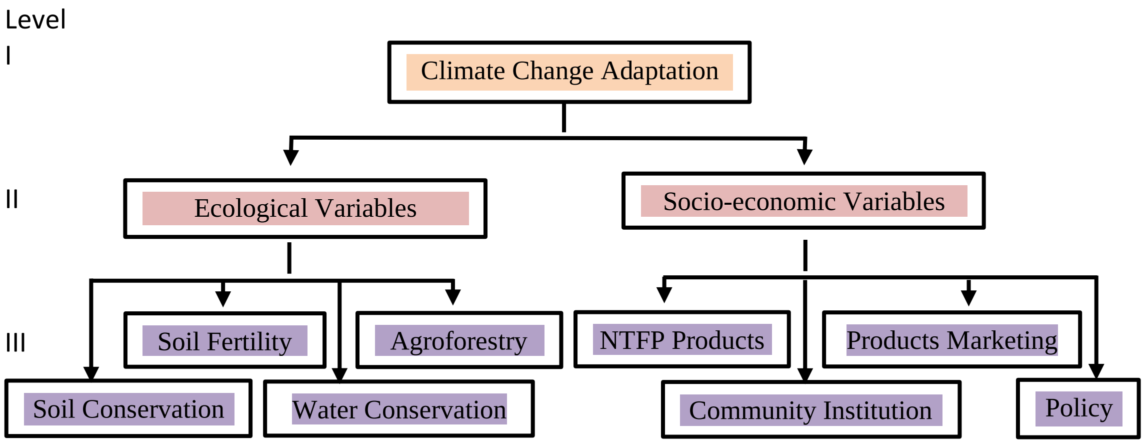

Figure 2. Climate Change Adaptation Variables

Furthermore, the 8 appropriate efforts were tested through AHP to determine the priority ranking of efforts that should be carried out by Batutegi FMU in adapting to climate change. There were 41 respondents who filled out the questionnaire, including 2 climate change experts, 2 traditional leaders , 2 women leaders, 2 religious leaders, 2 youth leaders, 2 village government officials, 2 Batutegi FMU staff, and 2 extension workers.

The collected data was then grouped based on variables as levels 1, 2 and 3 and processed with the AHP approach as shown in Figure 2. At level 2 of the questionnaire, this research differentiated ecological and socio-economic variables. Then, at level 3, it differentiated between soil conservation, soil fertility, water conservation, agroforestry, NTFP products, community institutions, products marketing, and policy.

The AHP model is called an additive weighting approach because the arithmetic operation to obtain the total weight is based on the sum (Saaty, 2008). There are three main principles in AHP, namely: 1. Principles for preparing hierarchy 2. Principles for determining priorities 3. Principles for logical consistency.

Table 1. Scales in Pairwise Comparative Assessment in AHP

Interest Intensity	Information
1	Both elements are equally important
3	One element is slightly more important than the other
5	One element is more important than the other
7	One element is clearly more important than other
9	One element is absolutely more important than the other
2,4,6,8	Values between two adjacent value considerations
Reciprocals	Reciprocals for Inverse Comparison

The consistency index (CI) is a random matrix with a rating scale of 9 (1 to 9) and the inverse is called the Random Index (RI). Based on calculations by using 41 samples, if numerical "judgement" is taken randomly from scales of 1/9, 1/8, ..., 1, 2, ..., 9, a consistent average for different matrices is obtained (Table 1.). The comparison between CI and RI for a matrix is defined as the consistency ratio, CR = CI / RI. A comparative matrix can be accepted if the consistency ratio (CR) ≤ 0.1 (Saaty 2008, Wulandari and Kurniasih 2019).

3. Results

3.1. Regression Analysis Result

The data analysis used is multiple linear regression analysis using a 90% confidence interval, meaning that the error can be tolerated by 10%. The P-Value generated by 4 adaptation efforts shows a value of <0.1, which means that the four have a significant effect in achieving the goals of climate change adaptation efforts in Batutegi FMU. The four distinctly different appropriate efforts are: agroforestry, NTFP, community institutions and policy. Based on the results of the R-square, all efforts can be explained through the existing model at 83.2%, and the remaining 16.8% is influenced by other factors. It can be said that the statistical model used is acceptable and valid for testing 8 climate change adaptation efforts in Batutegi FMU as written by the respondents.

Table 2. Regression Analysis Results

Independent Variables	P Value
Soil conservation	0.1586
Soil fertility	0.2357
Water conservation	0.1291
Agroforestry	0.0882*)
NTFP	0.0918*)
Community institutions	0.0779*)
Products marketing	0.3065
Policy	0.0474*)

Remarks: R-sq = 83.2%
*) significant (CI=90%)

According to 78% of respondents, it is logical that 2 efforts, namely the technical adjustment of agroforestry and the use of NTFP, have a significant effect. In the field, there are still many people who tend to grow coffee and cocoa as the dominant types on their lands (Bakri et al., 2018). This reduces agroforestry areas. Therefore, agroforestry cropping patterns with plant species suitable for climate change must be implemented in the field immediately.

There are 53.66% of respondents who stated that community institutions really need to be strengthened and provided with updating their knowledge about climate change adaptation. This is important to fulfill their family's subsistence needs as well as to sustain family income. Up to 87% of respondents stated the need for an appropriate local policy on climate change adaptation. According to them, the government has issued many policies mostly related to licensing in obtaining forest management rights with an umbrella program in the form of a social forestry scheme. Local policies as an umbrella for climate change adaptation programs are needed because there are still gaps in policies related to group facilitation after obtaining permits. Policies like this are needed so that community groups can be sustainable even though environmental conditions have changed due to environmental and climate change. This means that there is still a need for the development of new policies that support the sustainability of a collective economy. It is hoped that the new policy can ensure that forest resource conservation efforts can also be implemented sustainably by community groups even during times experiencing the negative effects of climate change.

Policy discrepancies such as these condition actually occur in the field because the Indonesian government, namely the Ministry of Environment and Forestry (MOEF), has a program to accelerate the achievement of social forestry areas. On the MOEF website, it is written that the total target for expansion of social forestry is 12.7 million hectares, achieving an area of 4.38 million hectares by 2019. However, in October 2020, only 4.21 million hectares had been achieved.

3.2. Eigen Vectors of Ecological and Socio-economic Variables

All variables were then further tested. The importance of one variable to another variable is analyzed based on the comparison of eigen vector numbers. The results of using AHP presents a variable that will be said to have a higher priority ranking if the variable has an eigenvector value higher than the other variables.

Table 3 lists the results of the eigen vector of AHP analysis. Based on the analysis, we known that the community in Batutegi FMU has an understanding that in climate change adaptation programming, the following 3 variables from 8 variables that must be considered in the most important order (Table 3.), are as follows: (1.) appropriate agroforestry systems (0.529392381), (2.) support for community institutions (0.501347792), and (3.) appropriate local policy development (0.498638714).

Table 3. Eigen Vector results of AHP analysis

Variables	Eigen Vector
Soil conservation	0.115786323
Soil fertility	0.103957845
Water conservation	0.123998797
Agroforestry	0.529392381
NTFP	0.209135878
Community institutions	0.501347792
Product marketing	0.347649751
Policy	0.498638714

3.3. Three Variables Most Prioritized for Climate Change Adaptation in the Batutegi FMU

The results of the regression analysis found that there were four efforts that had a real impact in achieving the goals of climate change adaptation in the Batutegi FMU area. The four appropriate efforts are agroforestry, NTFP, community institutional support, and appropriate policy. The three efforts that have a significant impact are to obtain eigenvector values of rank 1, 2, and 3 (out of 8 attempts tested), and namely resulted in agroforestry, community institution, and policy. These three efforts will be described in detail because they are the three efforts that have a real impact and also have priority rankings of 1, 2, and 3 in the consideration of preparing climate change adaptation efforts in Batutegi FMU. Especially for non-timber forest products (NTFP), the priority ranked as fifth, with an eigenvector value of 0.20913587. The NTFP effort can be logically accepted as an effort that has a real impact in achieving climate change adaptation goals because the research location is a protected forest area. In Law number 41/1999 on Forestry, it is stated in article 26 that protected forests can only be used for NTFPs.

An appropriate agroforestry system effort is the highest priority variable and can be logically accepted based on the conditions in the field. Currently, there is 92% of the area in Batutegi that has been changed into more intensive agriculture areas from agroforestry. Agricultural areas are a land classification with crops that have short life cycles ranging from 3 months to a year such as corn, rice, wheat, sugar cane, soybeans, and potatoes. The meaning of agroforestry is optimizing land use by simultaneously planting trees and agricultural crops, which are sometimes accompanied by livestock, fisheries and honey bees (Ruchyansyah et al. 2018). In agroforestry there is a mixture of plants from short cycles to long cycles (more than 3 years).

Coffee and cocoa are the majority cash crops, which are closely connected with the government's programs for climate change adaptation. These plants require shade trees. In addition, because both coffee and cocoa can only be harvested during one period per year, people will grow plantation and agricultural crops that are placed between coffee and cocoa. At the research location, these two types of plants are planted in protected forests, and therefore planting must comply with Indonesian legal designations applies to protected forests. Article 26 of Law 41/1999 states that protected forests can only be used for areas with environmental services and for NTFPs. This means that the research location, which is in a protected forest where there is a lot of coffee and cocoa growing, must continue to be maintained as a protected forest, whereby the diversity of plant species including the trees must reflect an agroforestry system. Crucially, there is no felling of trees allowed in a protected forest.

This situation needs to be addressed because 66.67% of the 41 respondents have coffee as the majority of their plants in the forest that they manage (62.05% up to 64.01% of the total area). Respondents want restrictions on the types of trees that grow around their coffee so that there is sufficient shade but also enough sunlight to produce quality beans for the harvest season. Based on forest management principles from the FMU perspective, such conditions should not occur in the field however, because it will make the ecosystem vulnerable. Therefore, with these conditions, the existence of appropriate agroforestry systems becomes an urgent compromise in climate change adaptation programs, as should be followed in land management designated as the Green Belt of North Sumatra (Rahmawaty el al., 2017).

The existence of an appropriate agroforestry system as the first variable is important to support adaptation programs (Butar-Butar, 2012). Research results of Teklewolda et al. (2019) show that agricultural production can be characterized by complementarities between climate change adaption practices. Agroforestry effects due to a) mixing wood-producing tree species, fruits, etc., because mixed species are better for ecosystem services than monoculture; b) mixing species based on the nature of tolerance to utilize all the light for photosynthesis; c) mixing age differences; d) mixing based on different harvesting times; e) merging economic, social and cultural values of vegetation changes can gradually suit social and cultural changes that can be adapted to climate change; and f) being a model to facilitate changes in vegetation groups into new adaptation groups.

The second variable is an appropriate community institution which has an influence on climate change adaptation programs. Among the 41 respondents, 19.51% of them stated that they will have rights or freedom to cut down the trees after having the permission as their community forestry (*Hutan Kemasyarakatan* / HKm) and 26.83% of them said that they can benefit from all kinds of forest products.

The responses that do not align with existing regulations indicate the absence of community institution to protect potential agroforestry zones in the area (Gupta et al., 2010; Wulandari and Inoue, 2018). There are respondents who still think they can use all types of forest products and even cut trees because their HKm group has not enforced government regulations regarding protected forests. As an institution, the HKm group does not yet have a clear program in accordance with the Five-Year Work Plan and Annual Work Plan. In addition, the group's organizational mechanisms have not worked well. They have group meetings only if needed and furthermore, the existing HKm group has not been able to address challenges for the group related to climate-driven concerns. The ineffectiveness of the group in enforcing regulations on the prohibition of logging and the arbitrary use of forest products will result in deteriorated condition of forests. Moreover, the production of plants to meet their daily needs will decrease as a function of climate drivers so that people will increasingly exploit forest products. This kind of situation will only worsen the current condition of the forest, and will further be exacerbated by climate change as has happened elsewhere in North Sumatera, Indonesia (Rahmawaty et al., 2017).

From various analysis of agroforestry and climate change adaptation, agroforestry is influenced by community institutions (Wulandari and Inoue, 2018; Wulandari and Kurniasih 2019). According to Gupta et al. (2010), adaptive capacity is a characteristic inherent in institutions that empower social actors to take short and long terms for anticipating climate change through their group's short-term and long-term plans. Anticipation of climate change can be carried out based on group characteristics through group strengthening and increasing the capacity of group members in carrying out programs adapted to climate change in the research location.

The characteristics of the institution meant here are: (1) institutional characteristics (formal and informal rules; norms and beliefs) that enable communities (individuals, organizations and networks) on climate change adaptation; and (2) the degree to which these institutions are possible and encourage actors to change institutions as climate change adaptation efforts. This result is supported by Adger (2000); Droogers (2004); Naess et al. (2005); Ziervogel and Calder (2003) which all stated the key role that local institutions play in implementing climate change adaptation programs.

A similar condition was found by Eakin (2005) in Mexico and Agrawal (2008) in Tanzania that many climate adaptation practices were carried out with institutional support at the local level, with integration of forest and carbon product markets, as well as other institutional relations at a higher level. In general, it can be said that local institutions that influence climate change are formed through the following three processes: they determine how households as members of community institutions are affected by climate impacts; they form or support the ability of households to respond to detrimental climate impacts and then they pursue different adaptation practices and mediate external flows in intervening variables for climate change adaptation program.

The third variable that supports adaptation programs is appropriate local policy development. Moeliono et al. (2017) as well as Cummins and Yamaji (2019) stated community empowerment need to respect local people and structural reforms for providing clear rights based on their local policy. That statement is relevant because climate change adaptation efforts in Batutegi FMU are essentially community empowerment efforts. In order for the content of local policies to be prepared according to what is needed in the field, there is a corresponding need to review the existing climate change adaptation policies or identify necessary policies towards suitability of recent conditions (Tumiwa et al. 2011).

This research result is relevant with current conditions in the field because it says that 87% of the respondents stated that regulations do not have much impact because they only discuss bureaucracy to obtain permits, without key follow up aspects such as how to market forest products. According to Wulandari et al. (2019) and Tajuddin et al. (2019), FMUs also have other operational and policy issues related to the weaknesses of their institutions and strong central and provincial bureaucracy. Thus, a holistic regulation is necessary for climate change adaptation programming.

Ecosystem-based local regulations are needed in climate change adaptation. Regulations support the community in the research location in managing the HKm area so that they can still meet their daily needs even. According to Schram-Bijkerk et al. (2013), climate change adaptation policy for supporting economic aspects should be designed through the adequate cooperation among local authorities and citizens and/or private-sector parties. Gebreyes (2018) stated that effectiveness of adaptation strategies have a correlation to multi-stakeholder involvement, which include farmers, community, researchers, extension agents, donors, NGOs, and policymakers.

The partnership between Batutegi FMU and community groups has already occurred in the field but it still needs further attention in terms of the suitability of operational cooperation that follows established agreements. The continuity of cooperation must be based on agreements by stakeholders in terms of rights and obligations as well as benefit sharing and cost sharing mechanisms. Apart from considering economic sustainability, the formulated local policy must also regulate forest management towards the preservation of its ecosystem. This is in accordance with the Regulation of the Director General of Climate Change Control of the Ministry of Environment and Forestry No. P.4 /PPI/SET/Kum.1/11/2019 concerning Guidelines for the Identification of Ecosystem-Based Climate Change Adaptation. This consideration is important because the protected forest as a research location also has a protection function for water management through the Batutegi Reservoir in that location. Thus, the development of adaptation policies in this location must be made specific considering the existing landscape, which means it must be different from climate change adaptation policies in protected forests in general. This statement is supported by Tajuddin et al. (2018), whereby forest policy development on climate change adaptation policy should considerably impact lifescape conditions. Crane et al. (2011) also highlighted that development policies are important and must be based on unique approaches to the action and position of community in climate change adaptation implementation.

The development of local policies in this research location which also had problems in terms of the decreasing area of agroforestry must be very specific and formulated based on community perceptions. Problems arose in the research locations due to the desire of the community to change the areas managed through agroforestry into areas with majority coffee and cacao. Arsiso et al. (2017) found that the perception of local community is a key aspect for successful implementation of adaptation policy strategies to mitigate climate change impacts particularly on agricultural practices.

With these results, it is expected that this study can serve as the basis for considerations in arranging or making annual work planning and implementation arrangements for the Batutegi FMU to support climate change adaptation. The current obtained results can be considered in developing regional climate change adaptation policies, particularly at the province level. There needs to be development policies that can function in maintaining existing agroforestry areas and support increasing such land use types where possible. In addition, local policies should also be able to support strengthening of community forestry institutions in dealing with climate change.

4. Conclusion

The negative impacts of decreasing environmental quality and forest cover in the Batutegi FMU area can be minimized by climate change adaptation programming. With the existence of variables supporting climate change adaptation initiatives based on the research results, namely appropriate agroforestry systems, support for community institutions, and assistance in local policy development will greatly assist the government in preparing applicable adaptation climate change programs. It is expected that focusing on these areas as the core adaptation program will help the Batutegi FMU to successfully achieve its objectives towards efforts on climate change adaptation.

Despite this strong recommendation, however, this research has limitations because of limited variables analyzed with the AHP approach, hence there is no detailed explanation yet regarding a specific and appropriate agroforestry system in the area. Institutional development also requires further attention relative to the ways that the Batutegi FMU can support communities. Gap analysis in policies is also pending and also contingent on future developments. This research has not yet analyzed the applicability of the existing policies in the Batutegi FMU and their relation to climate change program adaptation.

References

Abid, M., Schneider, U. A., & Scheffran, J. (2016). Adaptation to climate change and its impacts on food productivity and crop income: Perspectives of farmers in rural Pakistan. *Journal of Rural Studies*, *47*, 254-266. https://doi.org/10.1016/j.jrurstud.2016.08.005

Adger, W. N. (2000). Institutional adaptation to environmental risk under the transition in Vietnam. *Annals of the Association of American Geographers*, *90*(4), 738-758. https://doi.org/10.1111/0004-5608.00220

Addis Ababa Ethiopia Climate Change Manifesto. (2012). *A Time Series Analysis of Climate Variability and Its Impacts on Food Production in North Shewa Zone in Ethiopia Climate Change (CC) Manifest in the Form of Temperature Increases, Changes in Precipitation and Sea Level Rise, and the Intensification*, *20,* 261-274.

Agrawal, A. (2008). The Role of Local Governance and Institutions in Livelihoods Adaptation to Climate Change. Paper Prepared For the Social Dimensions of Climate Change, Social Development Department, the World Bank, Washington DC, March 5-6.

Arsiso, B. K., Tsidu, G. M., Stoffberg, G. H., & Tadesse, T. (2017). Climate change and population growth impacts on surface water supply and demand of Addis Ababa, Ethiopia. *Climate Risk Management*, *18*, 21-33. https://doi.org/10.1016/j.crm.2017.08.004

Asdak, C. (2010). *Hidrologi dan Pengelolaan Daerah Aliran Sungai*. Gadjah Mada University Press. Yogyakarta. Indonesia. Pp 653.

Amamou, H. (2018). Climate Risk Management Climate Change-related Risks and Adaptation Strategies as Perceived in Dairy Cattle Farming Systems in Tunisia. *Climate Risk Management*, *20,* 38-49. https://doi.org/10.1016/j.crm.2018.03.004

Bakri, S., Setiawan, A., and Nurhaida, I. (2018) .Coffee bean physical quality: The effect of climate change adaptation behavior of shifting up cultivation area to a higher elevation. *Biodiversitas Journal of Biological Diversity*, *19*(2), 413-420. https://doi.org/10.13057/biodiv/d190208

Batutegi FMU. (2017). *Rencana Pengelolaan Hutan Jangka Panjang*. Batutegi FMU, Lampung Provincial Forestry Office. Bandarlampung.

Butar-butar, T. (2012). Agroforestri untuk Adaptasi dan Mitigasi Perubahan Iklim. *Jurnal Analisis Kebijakan Kehutanan*, *9* (1), 1 – 10. https://doi.org/10.20886/jakk.2012.9.1.1-10

Crane, T. A., Roncoli, C., & Hoogenboom, G. (2011). Adaptation to climate change and climate variability: The importance of understanding agriculture as performance. *NJAS-Wageningen Journal of Life Sciences*, *57*(3-4), 179-185. https://doi.org/10.1016/j.njas.2010.11.002

Cummins, A., & Yamaji, E. (2019). To See Invisible Rights: Quantifying Araman informal tenure and its immediate relationship with Social Forestry in Central Java, Indonesia. *Forest and Society, 3*(2), 193-201. http://dx.doi.org/10.24259/fs.v3i2.6289

Droogers, P. (2004). Adaptation to Climate Change to Enhance Food Security and Preserve Environmental Quality: Example for Southern Sri Lanka. *Agricultural Water Management*, *66*(1), 15–33. https://doi.org/10.1016/j.agwat.2003.09.005

Eakin, H. (2005) Institutional Change, Climate Risk, and Rural Vulnerability: Cases from Central Mexico. *World Development*, *33(*11), 1923-1938. https://doi.org/10.1016/j.worlddev.2005.06.005

Elum, Z. A., Modise, D. M., & Marr, A. (2017). Farmer's perception of climate change and responsive strategies in three selected provinces of South Africa. *Climate Risk Management*, *16*, 246-257. https://doi.org/10.1016/j.crm.2016.11.001

Environmental Protection Agency. (2015). U.S. EPA. Report on the 2015 U.S. *International Decontamination Research and Development Conference*. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-15/283.

Fisher, M., A. Maryudi and M.A.K. Sahide. (2017). Forest and Society: Initiating a Southeast Asia Journal for Theoretical, Empirical, and Regional Scholarship. *Forest and Society*, *1(*1), 1-6. http://dx.doi.org/10.24259/fs.v1i1.1369

Gedefaw, M., Girma. A., Denghua, Y., Hao, W., and Agitew, G. (2018) Farmer's Perceptions and Adaptation Strategies to Climate Change, Its Determinants and Impacts in Ethiopia: Evidence from Qwara District. *J Earth Sci Clim Change*, 9, 1-10.

Gebreyes, M. (2018). 'Producing'institutions of climate change adaptation and food security in north eastern Ethiopia. *NJAS-Wageningen Journal of Life Sciences*, *84*, 123-132. https://doi.org/10.1016/j.njas.2017.10.007

Georgopoulou, E., Mirasgedis, S., Sarafidis, Y., Vitaliotou, M., Lalas, D. P., Theloudis, I., ... & Zavras, V. (2017). Climate change impacts and adaptation options for the Greek agriculture in 2021–2050: A monetary assessment. *Climate Risk Management*, *16*, 164-182. https://doi.org/10.1016/j.crm.2017.02.002

Gupta, J., Termeer, C., Klostermann, J., Meijerink, S., van den Brink, M., Jong, P., ... & Bergsma, E. (2010). The adaptive capacity wheel: a method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. *Environmental Science & Policy*, *13*(6), 459-471. https://doi.org/10.1016/j.envsci.2010.05.006

Julijanti, J., Nugroho, B., Kartodihardjo, H., & Nurrochmat, D. R. (2015). Proses Operasionalisasi Kebijakan Kesatuan Pengelolaan Hutan: Perspektif Teori Difusi Inovasi. *Jurnal Analisis Kebijakan Kehutanan*, *12*(1), 67-88.

Moeliono, M., Thuy, P., Waty Bong, I., Wong, G., & Brockhaus, M. (2017). Social Forestry - why and for whom? A comparison of policies in Vietnam and Indonesia. *Forest and Society, 1*(2), 78-97. http://dx.doi.org/10.24259/fs.v1i2.2484

Ministry of Environment and Forestry. 2019. *Map of Batutegi FMU*. Planning of Longterm Forest Management of Batutegi Forest Management Unit (FMU).

Muttaqin, Z., Yulianti, A. and Karmanah. (2019). Climate village program (ProKlim) in Simurugul Sub-Village, Margawati Village, Garut Kota Sub-Regency, Garut Regency, West Java Province, Indonesia. *In the IOP Conference Series: Earth and Environmental Science 299*, 1-17. http://doi.org/10.1088/1755-1315/299/1/012046

Naess, L.O., G. Bang, S. Eriksen, and J. Vevatne. (2005). Institutional Adaptation to Climate Change: Flood Responses at The Municipal Level in Norway. *Global Environmental Change*, *15*(2), 125-138. https://doi.org/10.1016/j.gloenvcha.2004.10.003

Petrie, C. A., Singh, R. N., Bates, J., Dixit, Y., French, C. A., Hodell, D. A., ... & Singh, D. P. (2017). Adaptation to variable environments, resilience to climate change: Investigating land, water and settlement in Indus Northwest India. *Current Anthropology*, *58*(1), 1-30. https://doi.org/10.1086/690112

Rahayu, S., Laraswati, D., Pratama, A. A., Permadi, D. B., Sahide, M. A., & Maryudi, A. (2019). Research trend: Hidden diamonds–The values and risks of online repository documents for forest policy and governance analysis. *Forest Policy and Economics*, *100*, 254-257. https://doi.org/10.1016/j.forpol.2019.01.009

Rahmawaty, P. Patana and S. Latifah. (2017) Spatial Analysis on Distribution of Green Belt to Reduce

Impacts of Climate Change in Medan City, North Sumatra. Malays. *Appl. Biol. 46* (2), 67–76

Ruchyansyah Y., Wulandari, C., & Riniarti M. (2018). Pengaruh Pola Budidaya pada Hutan Kemasyarakatan di Areal Kelola KPHL VIII Batutegi terhadap Pendapatan Petani dan Kesuburan Tanah. Jurnal Sylva Lestari, *6*(1), 100-106

Saaty, T. L. (2008). Decision Making with the Analytic Hierarchy Process. Int. *J. Services Sciences*. 1(1): 83 – 98.

Schram-Bijkerk, D., Dirven-van Breemen, E.M. Otte, P.F. (2013). *Key factors for climate change adaptation: Successful green infrastructure policies in European Cities.* National Institute for Public Health and the Environment. The Netherlands. Pp 45

Sugiyono (2012) Memahami Penelitian Kualitatif. Alfabeta. Bandung. Pp380

Supriyadi, Banuwa I.S., & Yuwono, S.B. (2018). Pengaruh Perubahan Penggunaan Lahan terhadap Karakteristik Aliran Masuk (Inflow) Bendungan Batutegi. Jurnal Hutan Tropika. 6 (1) : 73-81

Tajuddin., Supratman., Salman, D., Yusran, Y., & Sahide, M. A. K. (2018). Integrated Analysis of Forest Policies and Their Impacts on Landscape and Lifescape Dynamics: A Case Study in The Walanae Forest Management Unit, Indonesia. *Journal of Landscape Ecology*, *11*(3), 155-174. http://dx.doi.org/10.2478/jlecol-2018-0017

Tajuddin, T., Supratman, S., Salman, D., & Yusran, Y. (2019). Bridging social forestry and forest management units: Juxtaposing policy imaginaries with implementation practices in a case from Sulawesi. *Forest and Society, 3*(1), 97-113. http://dx.doi.org/10.24259/fs.v3i1.6049

Tashakkori, A., and C. Teddlie. (2010). *Overview of Contemporary Issues in Mixed Methods Research.* 2nd edition. Sage Handbook.

Teklewolda, H., A. Mekonnenb, and G. Kohlinc. (2019). Climate Change Adaptation: A Study of Multiple Climate-Smart Practices in The Nile Basin of Ethiopia. *Climate and Development, 11*(2): 180–192. https://doi.org/10.1080/17565529.2018.1442801

Tumiwa, F., T. Laan, K. Lang and D.V. Dunbar. (2011). "*Citizen's Guide to Energy Subsidies in Indonesia*." Retrieved June 17, 2019, from http://www.iisd.org/pdf/2011/indonesia_czguide_eng.pdf

Wirjohamidjojo, S. and Y.S. Swarinoto. (2007). *Praktek Meteorologi Pertanian*. Jakarta: Badan Meteorologi dan Geofisika (BMG).

Wulandari, C. and M. Inoue. (2018). The Importance of Social Learning for the Development of Community Based Forest Management in Indonesia: The Case of Community Forestry in Lampung Province. *Small-scale Forestry, 17,* 361-376. https://doi.org/10.1007/s11842-018-9392-7

Wulandari, C., and Kurniasih, H. (2019). Community preferences for social forestry facilitation programming in Lampung, Indonesia. *Forest and Society, 3*(1), 114-132. http://dx.doi.org/10.24259/fs.v3i1.6026

Wulandari, C., Budiono, P., and Ekayani, M. (2019). Impacts of the New Decentralization Law 23/2014 to the implementation of Community Based Forest Management in Lampung Province, Indonesia. IOP Conf. Series: Earth and Environmental Science, 285, 012006. http://doi.org/10.1088/1755-1315/285/1/012006

Yohannes, D. F., Ritsema, C. J., Solomon, H., Froebrich, J., & Van Dam, J. C. (2017). Irrigation water management: Farmers' practices, perceptions and adaptations at Gumselassa irrigation scheme, North Ethiopia. *Agricultural Water Management*, *191*, 16-28. https://doi.org/10.1016/j.agwat.2017.05.009

Ziervogel, G. and R. Calder. (2003) Climate Variability and Rural livelihoods: *Assessing the Impact of Seasonal Climate Forecasts in Lesotho Area*, *35(*4): 403-17. https://doi.org/10.1111/j.0004-0894.2003.00190.x