Smallholder livelihood adaptation capacity to the risk of climate change disasters in the buffer area of Bantimurung Bulusaraung National Park (TN BABUL) South Sulawesi

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Abstract. The number of smallholders’ farmer around the forest areas in Indonesia are about fifteen million households, and facing the risk of climate change disaster in their activities on the various national park area in Indonesia. This paper discussed about the role of management decentralization of National Park Zonation toward enhancement livelihood adaptation strategy of smallholder farmers, facing the risk of climate change disaster using spatial analysis (GIS) and content analysis. The result describing proprietor’s devolution at the resort level in the management of special zone and traditional zone that is a basic strategy to provide access to smallholders manages the land to develop agroforestry patterns that are resistant to climate variability. While in the jungle zone and utilization zone, devolution is only authorized user rights until the claimant right to collect non-timber forest products grown naturally to ensure resource sustainability. Pseudo de-concentration by the SPTN is required to monitor and ensure proprietors devolution rights, authorized user right, or claimant right in the management of traditional zone, special zone, jungle zone, and utilization zone between resort institution, the village head, and smallholders’ farmers. The implementation of devolution that produces anonymous adaptation supported by planned adaptation from village institutions and government can enhance the adaptation capacity of smallholder farmers in managing rice fields and their PLKCS land or in conservation forest areas with the availability of irrigation water sources.

1. Introduction

The number of poor farmers household in Indonesia are 26.14 million households and 14.62 million households (about 56.12%) are smallholder farmers around the forest with land property under 0.4 hectare [1], this as impacts of policy past that does not provide access to manage forest areas causing structural poverty [2] and agrarian conflicts [3, 4] to (a) less involvement of local communities in policy planning and management of forest area and (b) local community needs on forest land for agroforestry and farming, residence area, pastures, firewood, construction materials, hydro-micro power turbines, drinking water sources and irrigation water for rice fields [5, 6].

Conservation forest area that are managed in the form of National Park, are about 16,067,212 ha, and spread into 50 National Park in Indonesia. Bantimurung Bulusaraung National Park (TN BABUL) is...
one of the conservation forest areas in Eastern Indonesia, where most of smallholder farmers do their activity in 43,750 ha of conservation forest area, which is designated under Decree of Minister of Forestry Number: SK SK.398/Menhut-II/2004, 18 October 2004.

Data result of actual rainfall analysis (period 2004-2013) using Global Weather data and CSIRO Climate Projection Data (Climate Model CSIRO MK3.5), showed information that rainfall in TN BABUL will be increase in the future (period 2020 – 2040) in the rainy season and in the dry season there will be deficit about 21%. Climate variability that occurred, and supported by the landscape character of National Park, causing high potential of landslide, flood, and drought in some areas around TN BABUL. And the potential occurrence of that natural disaster will be very possibly causing environmental disaster [7].

The adaptation of climate change can be interpreted as an adaptation response made to resolve the impact of climate change [7]. Adaptation can be doing by autonomous adaptation and planned adaptation [8]. While adaptation capacity according to is determined by economic resources (including finance, human), technology, information and skills, infrastructure, institution (including regulation) and equity, where limitation on one of these elements may limit the adaptation capacity.

This paper aims to explain the role of management decentralization of TN BABUL and utilization forest area for smallholder farmers, which is the basic need for smallholder farmers to develop livelihood strategy and to enhancement the livelihood adaptation capacity of smallholder farmers facing the risk of climate change disaster.

The number of poor farmers household in Indonesia are 26.14 million households and 14.62 million households (about 56.12%) are smallholder farmers around the forest with land property under 0.4 hectare [1], this as impacts of policy past that does not provide access to manage forest areas causing structural poverty [2], and agrarian conflicts [3, 4], related to (a) less involvement of local communities in policy planning and management of forest area and (b) local community needs on forest land for agroforestry and farming, residence area, pastures, firewood, construction materials, hydro-micro power turbines, drinking water sources and irrigation water for rice fields [5, 6].

2. Research methods

This research was conducted multi years, from 2014 until 2020 in several study villages in TN BABUL Indonesia (figure 1), a research collaboration between TN BABUL and Hasanuddin University (UNHAS) using Focus Group Discussion (FGD) method to obtain agreement about the form of agreed zone management. In 2015, action participatory research (PAR) was conducted, collaboration between RECOFTC with UNHAS, to see the role of palm forest management to smallholder farmers livelihood in Tallasa village of TN BABUL. In 2016, a vulnerability analysis of climate change mitigation was conducted in 43 villages in two districts (Maros and Pangkep) collaboration with UNDP, KLHK and UNHAS, through workshops who involving district stakeholders related to the vulnerability of climate change in TN BABUL area. Surveys of land cover and land use, interviews and FGDs. In 2017, the research on adaptation strategy to face climate change, conducted in five villages selected purposively, i.e. dominant village of paddy field farming with available water potential, dominant village of rain fed rice field and limited water potential, dominant village of dry land and non-timber forest product, paddy field with the availability of adequate water resources and potential NTFPs, and paddy field with the availability of adequate water resources and potential NTFPs. The research was conducted through interview, observation, and FGD. Target group; (a) smallholder farmers who have activities within TN BABUL area, (b) village officials and community leaders, (c) Formal institutions related to the management of TN BABUL. Data obtained from 2014 to 2017 are then analysed using (a) spatial analysis (GIS) to determine the condition of land cover / use of TN BABUL area, (b) Analysis of policy narrative [9] for explores the role of decentralization policy of TN BABUL management toward livelihood adaptation capacity of smallholder farmers. As well as content analysis methods through document analysis, reports, interview transcript [4, 7, 10] to explore the decentralization policies that necessary for the fair utilization of TN BABUL zone [3, 10].
Figure 1. Layout of TN BABUL area.

3. Result and discussion

3.1. Results

3.1.1. Tenure conflict on land utilization of national park area by smallholder farmers toward national park management institutions. The result of spatial analysis (GIS) showed about 12,147 ha non-forested area of TN BABUL consist of grasslands, scrub, dry land agriculture, dry land farming mixed bushes (PLKCS), and rice fields. While, just 31,268.14 ha areas are forested areas. Dry land agriculture mix bush spread in all the villages in the area of TN BABUL (figure 2). The farmers using about 11,778 ha of TN BABUL land area, in the form of rice field lands, plantations, the beef grazing cattle, honey bee hunting, residential areas, picked of palm juice, and moor. While the benefits of environmental services obtained from the existence of TN BABUL, such as water source (catchment area) for hydro-micro power plant, drinking water source, and irrigation water source for rice field. Various activity of local population in TN BABUL area causing conflict between TN BABUL institutions and local population who need conflict resolution through collaboration management of TN BABUL zone.

| Closure / Land use                  | Color | Area (ha) |
|-------------------------------------|-------|-----------|
| Secondary Dryland Forest            | Green | 30,950.38 |
| Plantation Forest                   | Gray  | 336.12    |
| Meadow                              | Yellow| 148.50    |
| Resident Area                       | Red   | 17.56     |
| Dryland Farming                     | Light Blue | 535.04 |
| Dryland Farms Mixed Bushes          | Olive | 5,769.55  |
| Rice Fields                         | Orange| 1,034.51  |
| Shrubs                              | Light Green | 4,423.68 |
| Open Ground                         | Magenta | 218.51   |
| Water Body                          | Light Pink | 0.00    |
| **Total**                           |       | **43,433.85** |

Figure 2. Layout of TN BABUL land lover or land use.
3.1.2. The risk of climate change disaster. The result of survey and interviews on samples about 639 people in eight sub-districts within TN BABUL, to see the impact of climate change on the occurrence of floods, landslides and drought, showed the most widely and most frequently experienced by respondents was the impact of drought (table 1).

Table 1. Impacts of climate change on TN BABUL area

| No  | Districts         | Climate Change Impacts on Local Residents in Bantimurung Bulusaraung National Park Area (people) | Amount (people) |
|-----|-------------------|-----------------------------------------------------------------------------------------------|-----------------|
|     |                   | Flood | Drought | Landslide | Tornado | Flood | Drought | Landslide | Tornado | Flood | Drought | Landslide | Tornado | Flood | Drought | Landslide | Tornado | Flood | Drought | Landslide | Tornado |
| 1   | Cenrana           | 43    | 44      | 10        | 8        | 3     | 3       | 10        | 10      | 61    | 88      | 46        | 88      | 105   | 120     | 105        | 120     |
| 2   | Camba/Tompobulu   | 41    | 68      | 10        | 1        | 18    | 23      | 30        | 15      | 40    | 40      | 20        | 40      | 80    | 100     | 80         | 100     |
| 3   | Pangkajene/Minasate’ne | 61    | 37      | 0         | 2        | 10    | 5       | 10        | 15      | 17    | 17      | 17        | 17      | 100   | 100     | 100        | 100     |
| 4   | Todong Tallasa    | 0     | 30      | 10        | 15       | 20    | 20      | 20        | 30      | 9     | 9       | 9         | 9       | 45    | 75      | 45         | 75      |
| 5   | Mallawa           | 8     | 38      | 17        | 27       | 23    | 23      | 23        | 27      | 14    | 14      | 14        | 14      | 55    | 55      | 55         | 55      |
| 6   | Bantimurung       | 18    | 33      | 4         | 14       | 10    | 10      | 10        | 14      | 10    | 10      | 10        | 10      | 69    | 69      | 69         | 69      |
| 7   | Bone              | 5     | 40      | 0         | 5        | 2     | 2       | 2         | 5       | 10    | 10      | 10        | 10      | 50    | 50      | 50         | 50      |
| 8   | Balocci           | 14    | 26      | 10        | 20       | 12    | 12      | 12        | 20      | 20    | 20      | 20        | 20      | 70    | 70      | 70         | 70      |
|     | Total             | 190   | 316     | 61        | 92       | 92    | 92      | 92        | 92      | 659   | 659     | 659       | 659     |

Work disturbance experienced by villagers who are located within the supporting villages of National Park in eight districts in National Park areal surveyed as the impact of climate change, such as changing of planting season time, and PLKCS area due to the rainy season that coming fast or vice versa. The conditions interfere the working time and the allocation of farmers labors in one growing season. The length of the dry season caused a lot of rain-fed lowland (rice field and garden) may not be planted; causing many farmers lost their livelihoods during the dry season (table 2).

Table 2. The impact of the risk of climate change disaster on the people livelihoods in the Bantimurung Bulusaraung National Park area.

| No  | Supporting District of National Park | Loss of livelihood | Reduced duration / farming system | Disturbed Work | Work migration | Works elsewhere | Lack of water | Amount (people) |
|-----|------------------------------------|--------------------|----------------------------------|----------------|---------------|-----------------|--------------|-----------------|
| 1   | Cenrana                            | 9                  | 3                               | 53             | 1             | 0              | 11           | 77             |
| 2   | Camba/Tompobulu                    | 64                 | 42                              | 4              | 8             | 3              | 7            | 128            |
| 3   | Pangkajene/Minasate’ne             | 10                 | 68                              | 74             | 4             | 1              | 21           | 178            |
| 4   | Todong Tallasa                     | 0                  | 0                               | 10             | 0             | 0              | 30           | 40             |
| 5   | Mallawa                            | 28                 | 5                               | 29             | 0             | 0              | 8            | 70             |
| 6   | Bantimurung                        | 12                 | 25                              | 27             | 2             | 15             | 12           | 93             |
| 7   | Bone                               | 28                 | 3                               | 20             | 4             | 5              | 1            | 61             |
| 8   | Balocci                            | 8                  | 0                               | 34             | 0             | 0              | 10           | 52             |
|     | Total                              | 159                | 146                             | 251            | 19            | 24             | 100          | 699            |

3.1.3. Farmers adaptation strategy facing the climate change in Bantimurung Bulusaraung National Park area

a. The government's programs (plan adaptation) for mitigation and drought risk reduction

Local government programs in order to resolve drought disaster and ensure the availability of drinking water and water requirements for the cultivation of seasonal crops in the rice fields, and / or PLKCS, encompass (a) The program of building check dam on the flow of the river that many of them found in the Bantimurung Bulusaraung National Park area (b) Development of piped drinking water in the residential area and rice field area (c) Development of irrigation pipeline (d) Create of water ponds (table 3). The roles of plan adaptation program are in addition to increasing the availability of water for agricultural areas as well as to overcome the risk of flooding during the rainy season. Similarly, the creations of water ponds are also beneficial for water reservoirs for flood prevention.
Table 3. Local government programs reducing drought risk in Bantimurung Blusaraung National Park area.

| No | Districts             | Pipeline for drinking water | Check dam development | Irrigation line development | Public Bath, wash, and toilet (MCK) | PDAM water supply | Water bag | Making water ponds | Amount (people) |
|----|-----------------------|-----------------------------|-----------------------|-----------------------------|-------------------------------------|--------------------|-----------|-------------------|-----------------|
| 1  | Cenrana               | 5                           | 2                     | 4                           | 2                                  | 0                  | 0         | 3                 | 16              |
| 2  | Camba/Tompobulu       | 9                           | 6                     | 10                          | 4                                  | 1                  | 0         | 4                 | 34              |
| 3  | Pangkajene/Minasate’ne | 3                           | 2                     | 4                           | 3                                  | 4                  | 1         | 1                 | 18              |
| 4  | Tondong Tallasa       | 50                          | 50                    | 10                          | 10                                 | 10                 | 0         | 4                 | 170             |
| 5  | Mallawa               | 7                           | 1                     | 6                           | 1                                  | 0                  | 0         | 2                 | 17              |
| 6  | Bantimurung           | 3                           | 4                     | 5                           | 5                                  | 2                  | 0         | 3                 | 22              |
| 7  | Bone                  | 0                           | 0                     | 4                           | 3                                  | 0                  | 0         | 0                 | 7               |
| 8  | Balocci               | 4                           | 3                     | 5                           | 3                                  | 1                  | 0         | 3                 | 19              |
|    | Amount                | 81                          | 68                    | 48                          | 31                                 | 18                 | 1         | 56                | 303             |

b. Farmer's adaptation strategy (autonomous adaptation) facing climate change
The most common forms of adaptation used by respondents to resolve and reduce drought risk in the eight districts surveyed and interviewed, are the adaptation of planting pattern arrangements, planting rice in rice fields along with planting peanuts. Or vegetables on the PLKCS area following the climate change of rainy season and crop selection adaptation based on drought resistant types of plant, like nuts plants (soybeans, green beans), water melon, in area that are difficult to reach irrigation using water pumps machine technology, and or irrigation pipe from irrigation or check dam (table 4). Farmer’s cost of farming is also increased to fund the irrigation of drought-affected agricultural area through the use of water pumps. Adaptation of the use of pumping machine is mostly done by farmers who the land near the water sources such as the river, check dam or dam.

Table 4. Adaptation of drought risk by residents in the eight supporting districts of national park.

| No | Districts             | Settings of plant pattern | Planting of drought resistant species | Use of pump / water pipe machine | Building Water reservoir | Provision of drinking water | Government assistance | Amount (people) |
|----|-----------------------|---------------------------|--------------------------------------|---------------------------------|--------------------------|-----------------------------|------------------------|-----------------|
| 1  | Cenrana               | 2                         | 7                                    | 7                               | 11                       | 27                          | 9                      | 63              |
| 2  | Camba/Tompobulu       | 73                        | 64                                   | 42                              | 4                        | 3                           | 7                      | 193             |
| 3  | Pangkajene/Minasate’ne | 8                         | 19                                   | 23                              | 17                       | 1                           | 5                      | 73              |
| 4  | Tondong Tallasa       | 23                        | 3                                    | 24                              | 4                        | 24                          | 3                      | 81              |
| 5  | Mallawa               | 36                        | 35                                   | 34                              | 5                        | 0                           | 8                      | 118             |
| 6  | Bantimurung           | 17                        | 8                                    | 17                              | 4                        | 0                           | 7                      | 53              |
| 7  | Bone                  | 7                         | 20                                   | 6                               | 22                       | 0                           | 4                      | 59              |
| 8  | Balocci               | 0                         | 2                                    | 21                              | 7                        | 4                           | 7                      | 41              |
|    | Amount                | 166                       | 158                                  | 174                             | 74                       | 59                          | 50                     | 681             |

Anonymous adaptation through the use of water pumping machine, water reservoir building supported by plan adaptation through construction of check dam, irrigation channel and pipeline, strongly support farmers in increasing farmer’s adaptation capacity by arranging planting pattern in dry season. The procurement of infrastructure that strongly supports the adaptation capacity of farmers has also been successful in Nepal and Madagascar [11].
3.1.4. Livelihood adaptation capacity of smallholder farmer to climate change. Variety of livelihood adaptation capacity of smallholder farmer to climatic change, was observed in five village that have livelihood asset (resources, physic, human, social capital and financial) and different dominant agriculture system between villages.

a. Village dominant with rice field with water supply available

Adaptation strategy of villager that have rice field in facing climate variability that (a) to do cultivate pattern arrangement by cultivating dry resistant crop in dry season i.e. peanut, chili or ginger in rice field that far from water source by using water pump, (b) by using tenure “paje” (to lease the land in one dry season) in chili cultivated that the management need labour intensive and high cost, compared to peanut. Reward to land owner from “paje” that in rainy season, smallholder farmer have to process the land until ready to paddy cultivate (c) using the technology equipment (tractor, water pump, grass cutting machine and paddy harvester) in land working and pesticide and herbicide to shorten land preparation time and to decrease manpower in crop tending. Using the technology significantly increase farm expenditure, (d) honey bee harvesting in vacant time in the peak of dry season, (e) cattle sighting maximum for two cattle with hay and silage from peanut harvest waste, rice straw and grass in rice field. Agriculture intensification in wet and dry land, so smallholder farmer didn’t have farm activity in Bantimurung Bulusaraung National Park and land conflict is low, although many smallholder farmer have candle nut in the area vegetable in dry land before established as conservation forest. Most of the agriculture system in the village was commercial oriented and was supported by village infrastructure like village road, checkdam and pipeline.

b. Dominantly village with dry paddy field, water source and limited NTFP

Smallholder farmer did livelihood adaptation strategy in facing water shortage, the shorter wet season in the last 3 years by (a) paddy cultivating at the same time with peanut and vegetable in dry land, (b) honey bee hunting in Bantimurung Bulusaraung National Park, beside farm labour and construction worker in village surrounding with funding from central government, (c) cattle grazing in meadow in Bantimurung Bulusaraung National Park that were cattle source for fattening for village with dominantly rice field, so livestock forage available, (d) as the farm labour in rice field in management and harvesting in neighbor village (e) the man migrating to Malaysia as palm oil worker or the woman migrating to Saudi Arabia as household assistant. Limited availability of the water resources like river or wellspring, causing the livelihood of smallholder farmer, dominantly from paddy field. Honey bee hunting and construction worker was side job in dry season. This kind of job for extra income to buy staple food when the production of paddy field has ran out.

c. Village with dominantly dry land and NTFP available

Land resources that available just dry land, community forest, and NTFP that all was Bantimurung Bulusaraung National Park, so livelihood adaptation strategy was (a) dry land extensification by cultivating legume plant (soybean, green pea, ginger) on one land partition or some land partition that located disperse. On rainy season, farmer cultivated corn to consume and storage as food reserve while out of food stock, (b) to harvest sugar palm and honey bee hunting that many available in sugar palm forest or natural forest in Bantimurung Bulusaraung National Park. Harvesting sugar palm and then to process to become alcholic drink for selling outside the village was main job in the village. The production of Palm sugar tree and honey bee eas high in dry season, but low in the rainy season. (c) Livestock tending by releasing cattle to fatten the cattle in neighbouring village (d) to become farm labour in paddy harvesting or construction worker in city regency and province. The other NTFP potency that didn’t processed like coffee and palm fruit because it need more more manpower and the income were less compared to construction worker or harvesting palm sugar and honey bee. Conflict potency in Bantimurung Bulusaraung National Park was highest compared to other village, because livelihood dependance in forest area was very high for NTFP and for farm areal, beside coffee agroforestry and wood that has cultivated before the areal set as national park.
d. Village with dominantly non irrigated rice field, mining and tourist
Smallholder farmer did the livelihood adaptation strategy in facing water shortage and climate variability that uncertain in the last 3 years by (a) to (a) to quicken cultivating paddy in the field in the beginning of rainy season so they can cultivate rice twice a year. In the dry season, they can cultivate crops that resistance to drought like soybean, green pea, and vegetable (b) to fatten the cattle with cattle forage source from straw and soybean harvest waste, (c) to become mining worker in mining company or mining themself (gravel and marble) to sell as construction material for local community or neighboring village while in leisure time. (d) Most of the housewife sell food to tourist in their village as extra income for the household.

e. Village with enough water availability and NTFP potency
Farmer did livelihood strategy by planting peanut and paddy simultaneously in different land when dry season. They used water source from water spring, irrigation, pipeline, checkdam without waterpump technology. In rainy season, they just plant paddy because palm tree and honey bee didn’t produce palm sugar and honey. Vacant time from activity in the paddy field when dry season, smallholder farmer hunt honey bee, beside harvesting palm sugar and process it to brown sugar. Firewood source to make brown sugar from coffea agroforestry outside of Bantimurung Bulusaraung National Park. Smallholder farmer take coffea and to process it to consume itself.

Cultivation technology and commodity was less intensive compared to village with paddy field dominant and water availability with limited land acreage, because paddy field still broad and it was not support by collector trader that make link the village with regency market or central market in the province. Nobody of smallholder farmer apply migration livelihood strategy or to become worker in abroad or between provinces because paddy field availability, dry land and agroforestry land to manage.

High adaptation capacity of farmer among the five villages was Village with paddy field with enough water resource and NTFP potency that have natural potency and village with infrastructure of water irrigation. Easyness to access water source, the simple way to access water source, facilitate the farmer to diversify crop in dry season on paddy field and dry land. Contrary, village with low adaptation capacity i.e village with unirrigated paddy field, water source and limited NTFP that just have cultivating activity in rainy season.

4. Conclusions
The development of drought-resistant agroforestry models by smallholders is an anonymous adaptation that supported by village institution with their planned adaptation, can enhancement adaptation capacity of smallholders in managing rice field and their PLKCS land, with the irrigation water source.

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