

Management Strategies of Tropical Savanna Ecosystem for Multiple Benefits of Community Livelihoods in Semiarid Region of Indonesia

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Abstract (300)

Tropical savannas are a complex landscape composed of grasses, bushes, shrubs, and trees. The tropical savannas play an essential role in maintaining multiple ecosystem services, biodiversity, carbon storage, and socio-economic and cultural values. However, sustainable land management practices are still the main challenges of managing the tropical savannas, especially for conservation practices and well-planned fire management. This study explored the level of knowledge, behaviours, and actions on managing savannas in a semi-arid region of the East Sumba Island of East Nusa Tenggara (in Bahasa Nusa Tenggara Timur - NTT) Province, which is considered as the largest savanna areas in Indonesia. The study conducted key informant interviews and household surveys among the target population in four villages of two districts in the East Sumba Island, i.e., Kanatang and Kota Waingapu Districts. The communities generally utilize the savanna ecosystems for crop cultivation, plantation farming, and livestock production. This utilization poses a great challenge to explore proper strategies for managing the savanna landscapes. The challenging demands on the savanna dynamics in the study area are due to land clearing for farming and livestock activities, low awareness of conservation practices, and long drought conditions. Learning from the interviews and surveys, management strategies to sustain savanna ecosystems should focus on: 1) improving knowledge and behaviour on sustainable farming and grazing practices, 2) establishing proper fire management system to sustain the savanna ecosystem functions and services, 3) designing policies or regulations on managing savanna ecosystems, 4) enhancing network and coordination for collective community actions. This study tries to fill the gaps in understanding challenging issues of managing tropical savanna ecosystems, which is rarely studied in Indonesia. Therefore, the identified management strategies are complemented with recommended actions to encourage proper management of savanna ecosystems that provide multiple benefits for the betterment of community livelihoods.

Keywords: tropical savannas; ecosystem services; community knowledge; fire management; semiarid climate; sustainable grazing

1. Introduction(1500)

Savannas are dynamic ecosystems [1] in the transition between grasslands and forests, characterized by the coexistence of trees, grasses, herbs, bushes, and shrubs [2,3]. The ecosystems cover about 15% of the Earth's land surface [2,3] and are generally found in many parts of the world, such as in western North America, western South America, South Africa and northern Africa, interior Asia, and western and interior Australia [4]. Tropical savannas contribute to the global carbon cycle, amounting to about 30% of Net Primary Production (NPP) produced by the savanna biomass [2]. The savannas also offer multiple benefits of ecosystem services, namely: food production, water supply and regulation, carbon storage and climate mitigation, pollination, cultural services [5–7], groundwater recharges, regulating soil erosion, provision of grass biomass for livestock production [8,9], holding floodwaters, and medicines [10]. Consequently, preserving savannas have been acknowledged and added as one of the focal ecosystems in the UN Decade on Ecosystem Restoration (2021–2030) [11]. This inclusion presents the need to devise a strategy for promoting sustainable land management practices [11,12] for managing savanna ecosystems for human well-being.

The global recognition of the savannas offers an opportunity to investigate the local responses in managing tropical savannas to sustain the ecosystem's multiple benefits for supporting human livelihoods. This case study explored the community's understandings and practices in managing savannas from a semi-arid area in Indonesia, which has been infrequently studied compared to savanna ecosystems from other parts of the world [13]. The focus on savanna landscapes is also timely as

knowledge of savanna management practices in Indonesia is still lacking. There is a limited understanding of savannas compared to forest ecosystems, which may cause improper management strategies for managing savanna ecosystems to benefit human well-being. The savannas are more tolerant of fires and high-light conditions, whereas the forests are favourable to shaded conditions and more intolerant of fires [14]. The savannas require frequent fires or periodic burnings to maintain the compositional mix of trees and grasses [14] and prevent the succession of perennial shrubs [15], which allows grasses to swell over the matrix of the savannah grasslands [16,17]. Fire is essential for savanna vegetation dynamics [8,18], as grasses recover faster than trees after a fire, which creates a positive feedback mechanism for savanna formation [8], [18–20].

Indonesia is a tropical country with a relatively large area of savannas in the Province of East Nusa Tenggara (named in Bahasa as Nusa Tenggara Timur - NTT). The NTT province has a climax of savannas that spread across all its big islands (i.e., Sumba, Flores, and Timor). The savanna area in NTT reached over 1,024 million hectares [21], covering about 22% of the province's land area. The climate of NTT province is categorized into a semi-arid region characterized by annual rainfall averages of 1000 - 1500 mm/year with shorter wet seasons (about 3-4 rainy months) and longer dry seasons. This semi-arid climate characteristic [22–24] suits the requirements of savanna formation [25–27]. Sutomo [17] summarized that the types of savanna origins are formed due to climatic conditions (i.e., the climatic savanna), soil conditions (i.e., the edaphic savanna), and forest removal (i.e., derived savanna). Even though it is not easy to determine the savanna origins, the savannas in NTT evolved from the monsoon forest resulting from frequently burnings [17] over longer time frames [28,29].

The province of NTT is located in the eastern part of Indonesia and is considered one of the poorest provinces [30]. The community livelihoods in the vast areas of savanna landscapes rely heavily on subsistence dryland agriculture and livestock [29]. For the province, the savanna landscapes offer multiple benefits to support the community's livelihoods. The Center for Research and Development on Environment and Forestry of the NTT Province justified that the savanna trees are utilized for: (1) woods and their derivative products (e.g., Ampupu (*Eucalyptus urophylla*, S.T. Blake), Lontar (*Borassus flabelifer*), Gewang (*Corypha utan* Lamk.)), (2) medicines (e.g., Faloak (*Sterculia quadrifida* R.Br.), Usakneo (*Helicteres isora* L)), (3) grasses for feeds (e.g., *Brachiaria mutica*, *Setaria spachelata*, *Kahirik*, *Panicum maximum*, *Euchlaena Mexicana*), and (4) carbon storage (e.g., *Casuarina jughuniana* Miq.). The savannas are also habitats for animals: Rusa Timor (*Rusa timorensis*, de Blainville 1822), Banteng (*Bos javanicus*), Komodo (*Varanus komodoensis*), various birds such as Cukukua Timor (*Philemon inornatus* G.R Gray, 1846), Cekakak kalung-coklat (*Todiramphus australasia*), Punai Sumba (*Treron teysmani*) and Walik rawamanu (*Ptilinopus dohertyi*) [31].

Since the early 2000s, land use in the NTT province was considerably migrated from less intensive uses (i.e., grassland and fallows) to more intensive and commercials (i.e., agriculture and woods), particularly in the wetter areas (western Sumba, Flores, and eastern Timor) and still less intensive in the drier regions (eastern Sumba) [32]. However, not all grassland areas in NTT are suitable for agricultural intensification, such as large areas of East Sumba District, because of poor soil, steep topography, and low rainfall [15]. This case study explored the challenges, understandings, and practices of the communities residing in East Sumba, i.e., the largest areas of savannas in the province of NTT. This case study investigated the responses of four communities in Kanatang and Kota Waingapu Districts of the East Sumba based on key informant interviews and household surveys. The exploration focused on the community's understandings and regular practices in utilizing and managing the savanna ecosystems, particularly on fire management and grazing practices, which determine the savanna ecosystems in eastern Indonesia [14,15,29]. The situational analysis provides a baseline information of the utilization of savanna resources by the local communities, which is then employed to develop strategies for adequately managing the savanna ecosystems [33]. The proposed strategies are also formulated by considering the potential benefits of savanna ecosystem services for climate change actions [34].

Furthermore, the local communities utilize savannas mainly for agriculture and animal husbandry opportunities. They usually do land clearing by burning the lands [16,34], which are not intended as prescribed fires [35,36], to maintain the savanna dynamics. Consequently, uncontrolled wildfires frequently occur in the study area, particularly under harsh, late dry season conditions or over a long drought condition [28,29]. These uncontrolled wildfires pollute the air with emissions harmful to human health, causing loss and damage to human well-being and cultivated land [28]. Concerning the harmful impacts, the provincial government enforces a fire suppression or zero burning policy. However, the policy is not entirely recommended for managing savannas in the study area [14,15,29,37]. The prescribed burning benefits the ecosystems by reducing fuel loads, limiting the enormous risks of uncontrolled wildfires during the dry season [39], and maintaining the grasslands [15]. An effective fire management and a supportive policy environment are essential for sustainable livelihood development in savanna landscapes of eastern Indonesia [29]. The government should work with the local stakeholders to manage fire risks and develop improved management approaches [15]. Hence, the local stakeholders' involvement ensures social acceptance and long-term sustainability [40]. This study hopes to enhance the knowledge and empower the capacity of the government and community to utilize and manage savanna landscapes from the semi-arid areas of Indonesia to endorse the need for a more comprehensive presentation of the ecosystems in the national and international policy framework and agenda.

With these ideas in mind, this case study explored the challenges, knowledge, and practices of the communities residing in East Sumba, the largest area of savanna in NTT; by investigating the responses of four communities in Kanatang and Kota Waingapu Districts based on key informant interviews and household surveys. [The exploration focused on the local communities and government capacity to understand the sustainable savanna management principal through regular practices in utilizing and managing the savanna ecosystems, particularly with respect to fire management and grazing practices](#) [14,15,29]. The situational analysis will provide baseline information for the utilization of savanna resources by the local communities, which can then be employed to develop strategies for adequately managing the savanna ecosystems [33]. The proposed strategies were also formulated by considering the potential benefits of savanna ecosystem services for climate change actions [34].

Agricultural activities also threaten the savanna ecosystems. The communities usually apply land clearing by burnings for land preparation. The use of fires for land preparation in the region East Sumba of NTT has been practised by the community for a long time [41]. In the farming tradition, fires are essential and are considered as one form of technology, energy, and material inputs in controlling savanna ecosystem dynamics [16]. However, the burning activities for the land clearing can trigger uncontrolled wildfires [41] as the community's knowledge and capacity in fire management, particularly prescribed fires/prescribed burning, are still limited. The uncontrolled wildfires have frequently occurred in savanna grassland areas of the eastern Sumba of NTT, particularly during the harsh and late dry season and have affected hundreds of hectares [28].

2. Material and Methods (2500)

2.1. Study Area (750)

a. Informasi mengenai lokasi studi dilengkapi dengan peta dan penggunaan lahan

This study was conducted in four villages of two districts in East Sumba, of NTT, i.e., Kanatang District (Ndapayami and Mondu Villages) and Kota Waingapu District (Mbatakapi and Pambotanjara Villages). Mondu and Mbatakapi are in lowland areas with topographic terrain near the coastline, while Ndapayami and Pambotanjara are situated in hilly areas with steep inclines (Fig. 1). The study area is dominated by four land cover types, i.e., grassland, shrubs, forest, and farmland. Grasslands and shrubs dominate the villages of Mondu, Ndapayami, and Mbatakapi. Meanwhile, Pambotanjara Village is dominated by grasslands, and scattered shrubs, forests, and farmland (Fig. 1B).

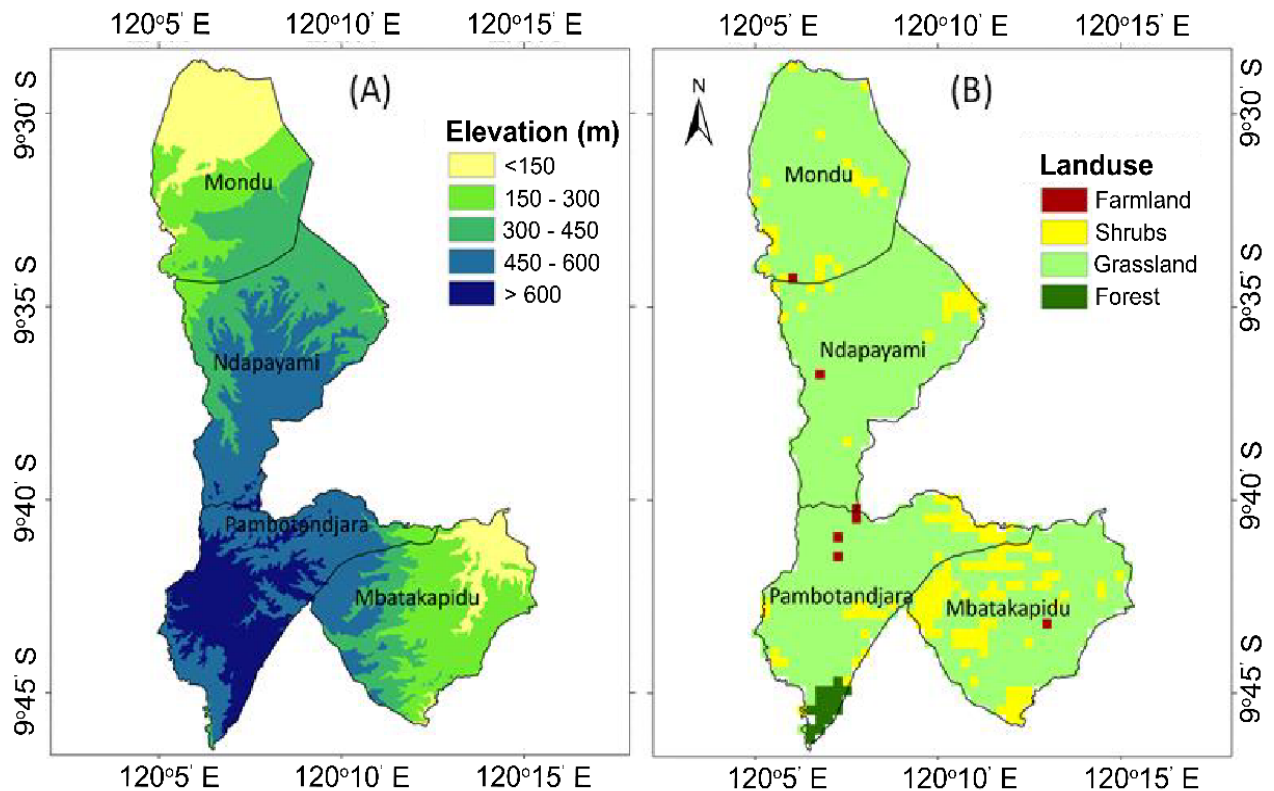


Fig.1. (A) Elevation and (B) land-use profile in the study area

b. Informasi mengenai karakteristik desa: demografi (liat BPS) dan mata pencaharian di wilayah studi

- tuliskan disini informasi mengenai demografi penduduk

Majority of the residents in the study villages are farmers. The total number of farmers in Pambotanjara, Ndapayami, and Mondu accounted for over 90% of the total households and over 40% of the families in Mbatakapi (Indonesia Statistical Bureau or Badan Pusat Statistik (BPS), [30]).

- informasi mengenai pekerjaan penduduk

In the four villages, the cultivated primary crop commodities are corn and cassava. Usually, the farmers also raise livestock, particularly horses and cattle (cow and buffaloes). The community places livestock as a source of income and provides it as a form of social prestige. Thus, it is an important socio-cultural component of the villager's lives [35].

- informasi mengenai sistem pertanian
- informasi mengenai sistem penggembalaan

The raising rating system is either by tying the animals or letting them roam freely in the grasslands. The farmers feed cattle in the parks during the dry season as they cannot do farming activities, e.g., cultivating corn.

2.2. Design Survey and Implementation (1000) (<https://www.mdpi.com/2071-1050/10/5/1360/htm>)

a. Rancangan survey

- Survey ini dilakukan untuk memahami interaksi masyarakat dengan savanna (pemanfaatan savanna), tantangan keberlanjutan ekosistem savanna, dan kapasitas masyarakat dalam pengelolaan savanna
- Survey dibagi menjadi 2 bagian, pertama target respinden household (rumah tangga), dan kedua target key informant interview
- Survey household diarahkan untuk mengeksplorasi dan mengidentifikasi interaksi masyarakat dengan savanna, aktivitas penggembalaan, dan kapasitas dalam pengelolaan savanna berkelanjutan
- Key informant interview diarahkan untuk mengeksplorasi kebijakan pemda, program pemerintah, kelembagaan dalam pengelolaan savanna

b. Rancangan kuisisioner

- Kuesioner disusun menjadi 2 tipe yaitu kuesioner household yang menjadi fokus utama dengan pertanyaan pilihan terhadap responden dan Key Informant Information (KII) yang berisi open question kepada stakeholders untuk mengkonfirmasi jawaban dari kuesioner household.
- Pertanyaan-pertanyaan dalam kuesioner household dan KII disusun berdasarkan 5 elemen konservasi savanna dan 6 elemen sustainable grazing
- Pertanyaan dirancang untuk memahami
- The survey questionnaires were designed for the targeted respondents with questions about existing conditions and issues related to agricultural/plantation/livestock activities, interactions with the savanna ecosystem, and community knowledge and practice on savanna conservation (Table 2). The questions are in Bahasa Indonesia.
- 1. Identifikasi pemanfaatan savana untuk mendukung kehidupan masyarakat di sumba timur (copas dari file seminar)
 - Potensi savanna yang besar harus dimanfaatkan secara bijaksana. Upaya tersebut dilakukan dengan mengoptimalkan penggunaan pengetahuan lokal masyarakat berkaitan dengan pengelolaan savanna, mengoptimalkan kapasitas stakeholder, dan mengoptimalkan kesesuaian lahan yang ada dan menerapkan pendekatan suksesi dalam upaya pemanfaatan dan rehabilitasi savanna
- 2. Explorasi tantangan atau praktik-praktik/fenomena yang mempengaruhi keberlanjutan padang savanna
- Tantangan: kebakaran lahan savanna, sustainable grazing, hilangnya native species, rendahnya kapasitas dan pengetahuan lokal komunitas (masyarakat dan pemerintah daerah) mengenai konservasi savanna
- 3. Memetakan kapasitas lokal (masyarakat dan pemerintah) dalam mengelola savanna dan praktek penggembalaan yang berkelanjutan (sustainable grazing)
- 4. perbedaan konservasi savanna dengan hutan: Manajemen pembakaran dalam suksesi rumput di wilayah savanna, menjaga kebakaran pepohonan asli savanna, dan afforestasi dalam peremajaan native trees
- Letakkan pertanyaan household disini

Table 2. Key research questions for the household surveys.

Key Research Question	
What are the general socio-economic conditions of community members?	
1.	What is the dominant average education level of the community?

2.	How What is the average household income of the community?
3.	What are the assets ownerships owned by the community?
4.	What is the current land use in the community?
What are the general conditions of the community?	
1.	How much is the number of How many Perdes (village regulations) are there regarding to forest management?
2.	How much What is the area of savanna burning per year in the last three years?
3.	How much is the number of How many hectares of burning savanna is reduced?
4.	How much is the number of many farmers have increasing their livestock raising practices?
5.	How much is the number of many farmers who have already trained in sustainable grazing practices?
6.	How much is the number of many hectares of managed savanna burning?
What are the current conditions of the community?	
1.	What is the current interaction between the community and the savanna?
a)	How does the community use savanna resources?
b)	What are their views and practices in savanna conservation?
c)	What are the incidents and causes of burning savannas in the community?
d)	What are the reasons for burning: social, cultural, behavioural, economic, technical?
2.	What arise the current capacity of the community to carry out savanna conservation activities?
a)	What are the local policies and structures which already established (if any)?
b)	What are the current knowledges, attitudes, practices of community members related to the savanna conservation?
c)	What is the agricultural profile and its opportunities for the community?
d)	What are their main crops and livestock? How does this affect good stewardship of the savanna lands?
e)	What are the opportunities for sustainable agriculture and livestock raising practices? Are there opportunities for animal feed production?

- pertanyaan kunci untuk KII

c. Target responden (jumlah responden, menggunakan metode apa untuk menentukan responden dan distribusi responden setiap desa dengan alasannya)

- jelaskan jumlah populasi penduduk atau Household di 4 desa

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- jelaskan metode untuk menentukan responden

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Determination of the number of respondents in the study area is using the Slovin approach with the following formula:

$$n = N / (1 + N e^2)$$

n = number of samples / number of respondents

N = total population

e = percentage of errors

Based on population data in target locations, it is estimated that the number of households (HH) is 1394 HH with errors used is 5%, the minimum number of household respondents to represent the population is 312 HH. To represent the conditions of each study location village, the number of respondents for each target location were obtained by dividing the percentage of population number of each location with total respondent so that each region has the representative number of respondents.

Sebaran jumlah responden ditentukan berdasarkan jumlah penduduk dan petani yang ada di desa tersebut.

Pambotanjara dan Mbatakpidu memiliki jumlah penduduk dan jumlah petani yang cenderung lebih banyak dibandingkan Mondu dan Ndayayami, sehingga mereka memiliki jumlah responden yang paling banyak. Ndayayami memiliki jumlah penduduk dan petani yang paling sedikit, sehingga jumlah responden dari desa tersebut merupakan yang paling sedikit juga.

Furthermore, the field surveys targeted 312 households (male = 176 persons, female = 136 persons). The total respondents for each village were 100, 113, 73, and 26 households for Mbatakpidu, Pambotanjara, Mondu, and Ndayayami, respectively.

- letakkan tabel sebaran responden

Table Responden Characteristics

Village	Demogprahy		Education				Farming Characteristics		Savanna Land Ownership			
	Household	Participated Respondent (Farmers)	No School	Elementary School	Middle School	High School and onwards	Crops	Animals	Governmen t	Privat e	Rent	Custom
Mbatakapidu	401	100 (84)	28	58	2	12	Corn/Maize	Pigs, cows, buffalo, sheep, goats, chickens and ducks	2	29	0	0
Pambotanjara	480	113 (85)	40	43	5	25			5	39	0	0
Mondu	345	73 (59)	25	29	8	11			2	65	0	0
Ndapayami	168	26 (19)	11	9	0	6			0	6	0	0

- jelaskan penentuan KII (beri tabel KII) bagaimana cara menentukan tiap orang KII

- sebaran dan karakteristik responden KII

Village	Demogprahy		Education				Farming Characteristics		Savanna Land Ownership			
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d. Pelaksanaan Survey (bagaimana survei dilakukan untuk KII dan household serta penanganan covid dalam pelaksanaan survey?)

This study explored challenges in managing the savanna ecosystem based on key informant interviews and household surveys. The exploration focussed on understanding the local situation and proposing proper strategies for managing savanna landscapes. The key informants interviewed were resource persons among the district officers, the village heads, extension officers, community members, and representatives of farmers' groups (Table 1). The interviews with the 27 resource persons were conducted from 22 April 2020 to 9 May 2020 via phone due to the pandemic COVID-19 situation. The interviews employed open questions on interactions between community and savannas, farming/livestock activities, fire occurrence and management, and policy implementation to control fires.

The study faced several obstacles: 1) survey delays due to the COVID-19 pandemic situation, 2) unavailability of compiled and digital information at the village level, 3) poor telephone signals when contacting the target key informants, and 4) difficulty of the household respondents in the Indonesian language. However, these obstacles were addressed as much as possible during the conduct of the case study through the following approaches: 1) rearranging the agenda for field surveys and coordination with the village head, 2) utilizing secondary data and information collected from the statistics bureau, 3) scheduling the key informant interviews conducted via telephone, and 4) hiring and training the local enumerators to conduct the field surveys.

The questions are in Bahasa Indonesia. However, the Well-trained local enumerators conducted the surveys in the local dialect rather than Indonesian. This approach allowed the respondents to communicate more freely as most of them did not speak Indonesian fluently and were more familiar with using local languages. The enumerators conducted the surveys from 8 – 22 July 2020. The study also undertook a literature review to recognise challenges and conservation practices for managing savanna landscapes. This review in combination with the results of interviews and surveys were then employed to identify proper strategies for managing savanna ecosystems that provide multiple benefits for the community livelihoods.

e. Kompilasi data survey KII maupun Household (bagaimana data hasil survey disiapkan untuk analisis)

- Jelaskan disini apa yang dilakukan untuk menyiapkan data dalam excel untuk analisis (flow di ppt)

- Data hasil survey dikelompokkan berdasarkan pertanyaan yang sesuai dari elemen-elemen konservasi savanna dan sustainable grazing management
- Dari setiap pertanyaan dan jawaban dari Household survey, akan dikompilasi berdasarkan desa

2.3. *Analisis data (Exploration Management Strategies (Analysis conservation & Sustainable Grazing), ini yang dilakukan dengan excel (750)*

a. Identification of challenges (metode yang dilakukan untuk mengidentifikasi tantangan savana di 4 desa, yang dilakukan:

1. Evaluasi global savanna ecosystem disturbances diantaranya drought, grass fires, Hunting to Extinction, logging, development conversion to agriculture, overgrazing by livestock, and introduction of non-native plant species (ref)

2. Mengevaluasi kegiatan yang dilakukan oleh masyarakat dalam menggunakan savanna berdasarkan kuesioner nomor ... dan hasil wawancara KII untuk pertanyaan ...

3. Mengidentifikasi tantangan pengelolaan savanna sebagai akibat dari aktivitas yang dilakukan manusia dan kejadian alam dengan menganalisis pertanyaan kuesioner atau pertanyaan yang terkait dengan lokasi tempat tinggal dengan jarak ke savanna, seberapa sering ke savanna, aktivitas di savanna

- table list pertanyaan kegiatan/interaksi yang dilakukan masyarakat terhadap savanna yang dikelompokkan berdasarkan identifikasi tantangan (Tabel bagian identification challenges di matriks summary)

- Evaluasi penerapan sustainable grazing (berdasarkan 6 prinsip sustainable grazing, bagaimana grazing dilakukan di wilayah studi desa Pambotanjara, Ndapayami, Mondu, Mbatakpidu berdasarkan jawaban household dan diperkuat dengan KII)

- Evaluasi penerapan manajemen konservasi savanna (berdasarkan 5 prinsip savanna konservasi manajemen, bagaimana konservasi savanna dilakukan di wilayah studi desa Pambotanjara, Ndapayami, Mondu, Mbatakpidu berdasarkan jawaban household dan diperkuat dengan KII)

- evaluasi penerapan sustainable grazing dan savanna conservation dilakukan dengan identifikasi prinsip sustainable grazing dan savanna conservation melalui literature review

- didapat 6 prinsip sustainable grazing: 1. increasing grazing system productivity and profitability, 2. managing the risk of water shortage/drought, 3. protecting the on-farm assets and resources, 4. maintain savanna biodiversity, 5. reducing off-site impacts from the grazing system, 6. Participation and the opportunity to make changes

- dan didapat 5 prinsip savanna conservation: 1. Maintaining savanna ecosystem services, 2. Control of overgrowth with prescribed fire (i.e., trees, woody shrubs, and invasive species) to keep grasslands healthy, 3. Maintaining agricultural land area and not expanding land to savanna, 4. Knowledge and Participation in conservation activity, 5. Proper conservation management policies

- evaluasi dilakukan dengan pertanyaan pertanyaan kunci pada kuisisioner household yang diperkuat dengan kunci pertanyaan KII untuk menentukan apakah lokasi studi menerapkan sustainable grazing dan savanna conservation

- jawaban pertanyaan kunci kuisisioner dalam bentuk total responden direpresentasikan dalam presentase sesuai expected result dari tiap jawaban terhadap jumlah responden di tiap desa

- apabila dalam satu elemen terdapat lebih dari 1 pertanyaan maka presentase jawaban expected results dilakukan composite menggunakan rata-rata

- presentase jawaban dikategorikan kedalam 3 kategori yaitu follow (>70%), partially follow (40-70%) dan Unfollow (<40%)

- interpretasi presentase jawaban diverifikasi melalui jawaban KII dan status desa direpresentasikan menjadi Not follow SG and savanna conservation (unfollow Savanna Conservation); Follow savanna conservation without sustainable grazing practices (Partially follow savanna conservation); Follow SG but no savanna conservation (Partially follow savanna conservation); Ideal Condition (Follow Savanna Conservation)

-Letakkan table list pertanyaan berdasarkan 6 prinsip sustainable grazing practices dan 5 prinsip savanna konservasi manajemen HH Quisisionaire dan KII

- d. Perumusan rekomendasi manajemen savanna (pemetaan gaps dari prinsip dasar konservasi dan sustainable grazing yang menunjukkan permasalahan dan kapasitas masyarakat serta pemerintah daerah dalam pengelolaan savanna diperkuat dengan literature review terkait)
- perumusan rekomendasi manajemen savanna dilakukan dengan identifikasi aksi berdasarkan 6 prinsip sustainable grazing dan 5 prinsip konservasi savanna
 - aksi diidentifikasi dari pertanyaan pertanyaan yang mengindikasikan aktivitas pengelolaan savanna terkait 6 prinsip sustainable grazing dan 5 prinsip konservasi savanna
 - aksi teridentifikasi dikelompokkan menjadi 3 yaitu knowledge, attitude, dan practices
 - hasil identifikasi aksi merupakan jawaban total responden sesuai expected results di tiap desa
 - letakkan list pertanyaan identifikasi aksi berdasarkan prinsip sustainable grazing dan savanna conservation
 - hasil identifikasi aksi digunakan sebagai enebling condition atas rekomendasi yang dibangun dari gaps evaluasi penerapan prinsip sustainable grazing dan savanna conservation

3. Results (1500)

3.1. Utilization

In the study areas, the savannas provide multiple ecosystem services to support the community's well-being. Generally, the communities utilized the ecosystem for fuel wood gathering, herding cattle, agriculture farming, and hunting animals, with some variations (Fig. 2).

1. Savanna Utilization (Community Interaction caused savanna challenges (Fig 2. Updated))

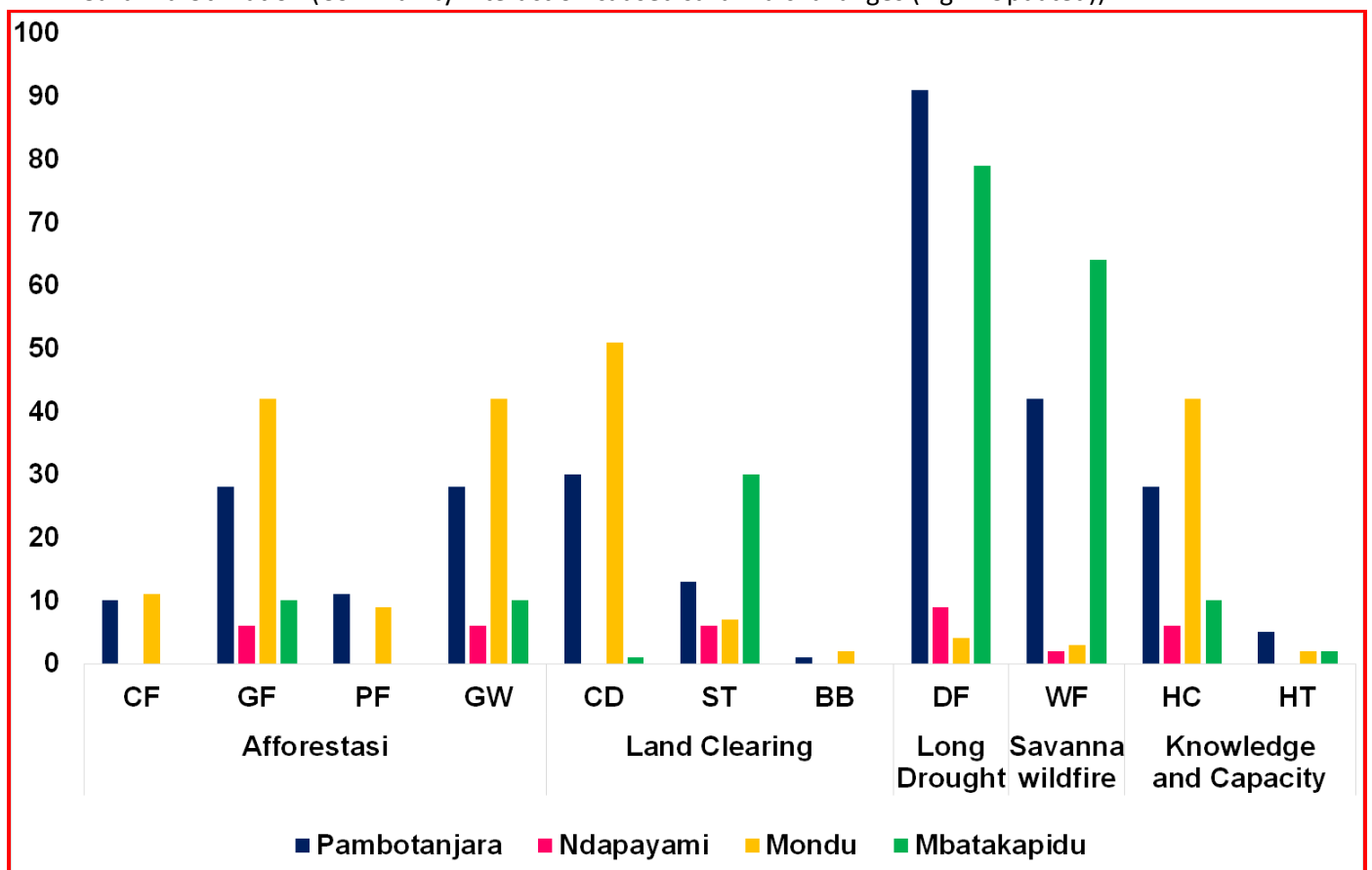
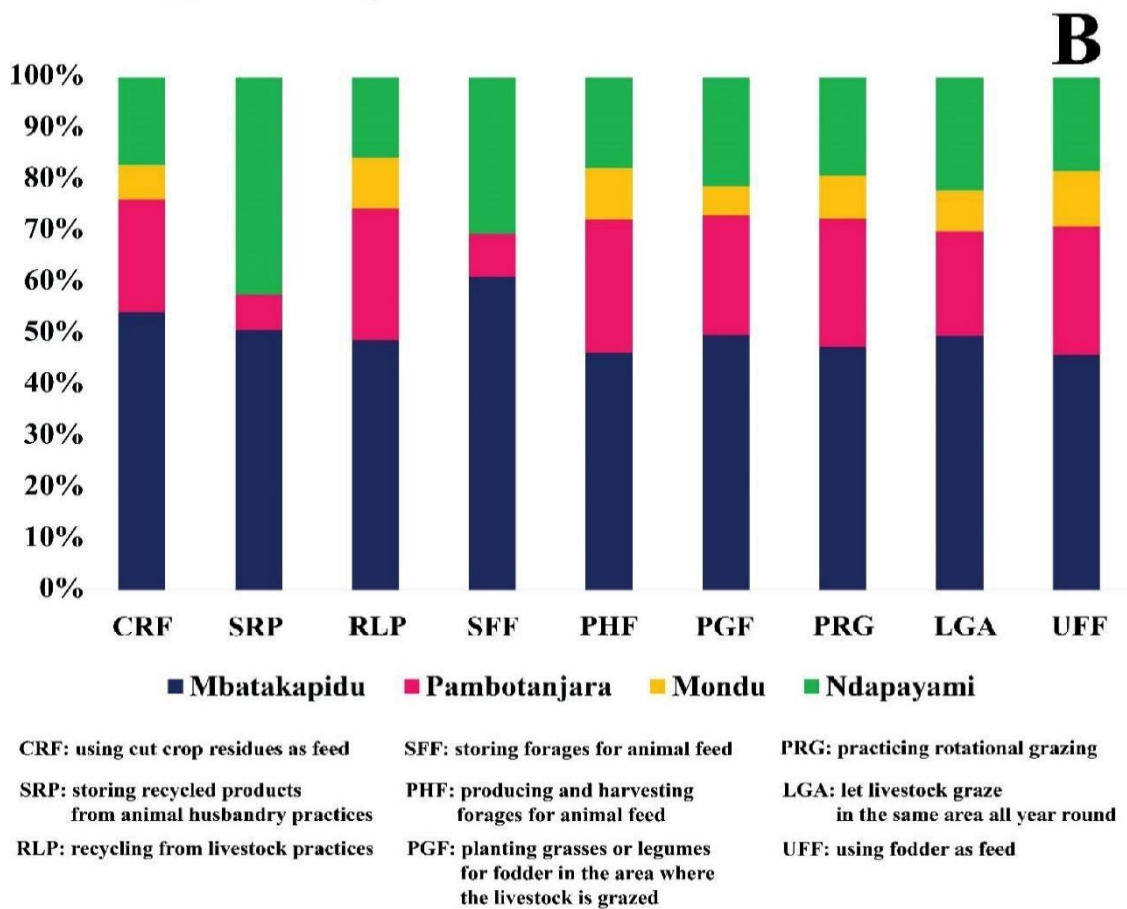
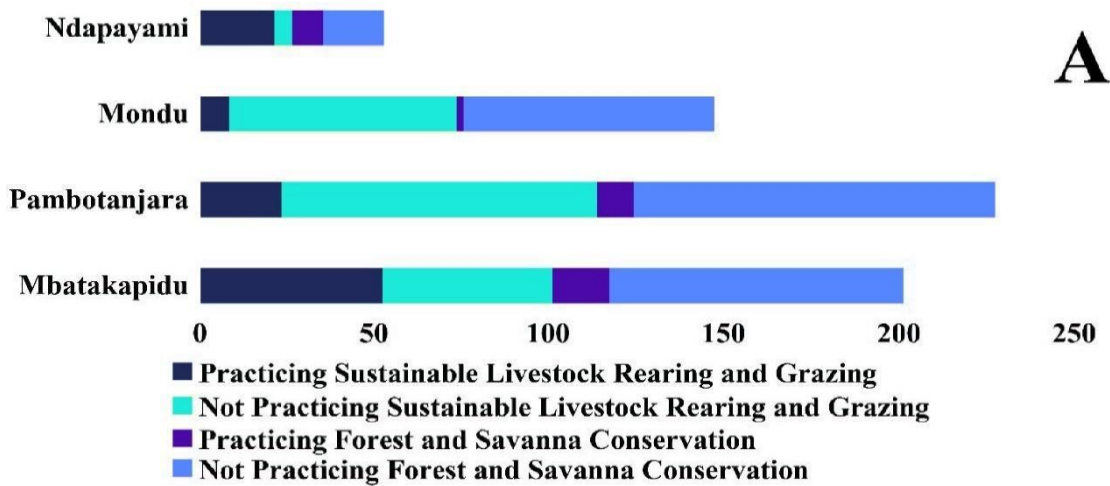


Fig.2. Community interaction with the savannas (left) and land clearing activities (right) in the study area presented in percent total answers. Note: Traditional cutting means the use of grass cutter or chopper to clear the land. (ganti gambar sesuai hasil excel, output per desa, untuk pemanfaatan savanna)

Whether by burning or cutting down, land clearing activities are traditionally practised to prepare land for agricultural production. The survey showed that about 67% of household respondents applied the land clearing by burning for cost-effectiveness and about 33% for time efficiency.

The savanna ecosystem in the study area is considerably fire-prone, so uncontrolled wildfires often occur, particularly under harsh, late dry season conditions or over a long period of drought condition. This situation confirms the claims of Accordingly, about 60% of respondents who agreed that a long dry season contributed to uncontrolled wildfires in the study area.

3.2. Local Capacity



Tuliskan hasil pertanyaan kunci “apakah mengikuti sustainable grazing dan konservasi savanna?” apa jawaban dari pertanyaan diatas

- jelaskan/validasi atas jawaban diatas menggunakan tabel dibawah dalam bentuk gambar

Conservation/ Sustainable Grazing	1) maintaining savanna ecosystem services	2) control of overgrowth with prescribed fire (i.e., trees, woody shrubs, and invasive species) to	3) Maintaining agricultural land area and not expanding land to savanna	4) Knowledge and Participation in conservation activity	5) Proper conservation management policies
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		keep grasslands healthy;			
1) increasing grazing system productivity and profitability;	SC: 12% (9%, 35%, 3%, 16%) SG: 18% (7%,54%,2%,31%)	SC: 17% (14%,33%,1%,33%) SG: 18% (7%,54%,2%,31%)	SC: 64% (70%,56%,32%,60%) SG: 18% (7%,54%,2%,31%)	SC: 8% (4%,14%,2%,15%) SG: 18% (7%,54%,2%,31%)	SC: 12% (9%,38%,1%,16%) SG: 18% (7%,54%,2%,31%)
2) increasing water use in the grazing system; Mengelola risiko kekurangan air/kekeringan	SC: 12% (9%, 35%, 3%, 16%) SG: 42% (35%,42%,68%,31%)	SC: 17% (14%,33%,1%,33%) SG: 42% (35%,42%,68%,31%)	SC: 64% (70%,56%,32%,60%) SG: 42% (35%,42%,68%,31%)	SC: 8% (4%,14%,2%,15%) SG: 42% (35%,42%,68%,31%)	SC: 12% (9%,38%,1%,16%) SG: 42% (35%,42%,68%,31%)
3) protecting the on-farm assets and resources;	SC: 12% (9%, 35%, 3%, 16%) SG: 85% (83%,98%,82%,87%)	SC: 17% (14%,33%,1%,33%) SG: 85% (83%,98%,82%,87%)	SC: 64% (70%,56%,32%,60%) SG: 85% (83%,98%,82%,87%)	SC: 8% (4%,14%,2%,15%) SG: 85% (83%,98%,82%,87%)	SC: 12% (9%,38%,1%,16%) SG: 85% (83%,98%,82%,87%)
4) creating more opportunities for biodiversity; Menjaga keanekaragaman hayati savanna	SC: 12% (9%, 35%, 3%, 16%) SG: 95% (97%,97%,99%,89%)	SC: 17% (14%,33%,1%,33%) SG: 95% (97%,97%,99%,89%)	SC: 64% (70%,56%,32%,60%) SG: 95% (97%,97%,99%,89%)	SC: 8% (4%,14%,2%,15%) SG: 95% (97%,97%,99%,89%)	SC: 12% (9%,38%,1%,16%) SG: 95% (97%,97%,99%,89%)
5) reducing off-site impacts from the grazing system; and	SC: 12% (9%, 35%, 3%, 16%) SG: 59% (57%,69%,47%,67%)	SC: 17% (14%,33%,1%,33%) SG: 59% (57%,69%,47%,67%)	SC: 64% (70%,56%,32%,60%) SG: 59% (57%,69%,47%,67%)	SC: 8% (4%,14%,2%,15%) SG: 59% (57%,69%,47%,67%)	SC: 12% (9%,38%,1%,16%) SG: 59% (57%,69%,47%,67%)
6) improving producer satisfaction, motivation and capacity to implement change Partisipasi dan kesempatan untuk melakukan perubahan	SC: 12% (9%, 35%, 3%, 16%) SG: 21% (27%,36%,11%,18%)	SC: 17% (14%,33%,1%,33%) SG: 21% (27%,36%,11%,18%)	SC: 64% (70%,56%,32%,60%) SG: 21% (27%,36%,11%,18%)	SC: 8% (4%,14%,2%,15%) SG: 21% (27%,36%,11%,18%)	SC: 12% (9%,38%,1%,16%) SG: 21% (27%,36%,11%,18%)

Note :

SC: Savanna Conservation

SG: Sustainable Grazing

Nilai merupakan total responden menjawab sesuai expected result dengan urutan

Initial Component: Total Responden (312) (Number of Respondent in Pambotanjara (113); Number of Respondent in Ndapayami (26); Number of Respondent in Mondu (73); Number of Respondent in Mbatakapidu (100)

3.3. Identified Actions

The surveys then identified the level to which the community applied regular practices for grazing and identified nine activities, namely: 1) using cut crop residues as feed, 2) storing recycled products from animal husbandry practices, 3) waste recycling from livestock practices (e.g., processing animal waste into fertilizer), 4) forage storage practices for animal feed, 5) producing and harvesting forages for animal feed, 6) planting grasses or legumes for fodder in the area where the livestock is grazed, 7) practising rotational grazing, 8) allowing the livestock to graze in the same area all year round, and 9) using fodder as feed (e.g., hay, straw, silage, compressed and pelleted feeds, oils and mixed rations, and sprouted grains and legumes) (Fig. 4). Of these, three were mainly practised by the four villages, namely; 1) planting grasses or legumes for fodder in the area where the livestock is grazed (197 respondents), 2) letting livestock graze in the same area (190 respondents), and 3) rotational grazing (177 respondents) (Fig. 4). Generally, the sustainable grazing practices for savanna conservation have not been implemented by villagers in Mbatakapidu, Ndapayami, Pambotanjara, and Mondu. This finding reveals that further actions are needed to advocate good grazing practices to the local government and communities for sustaining the ecosystem functions and services of the savannas to support their community livelihoods.

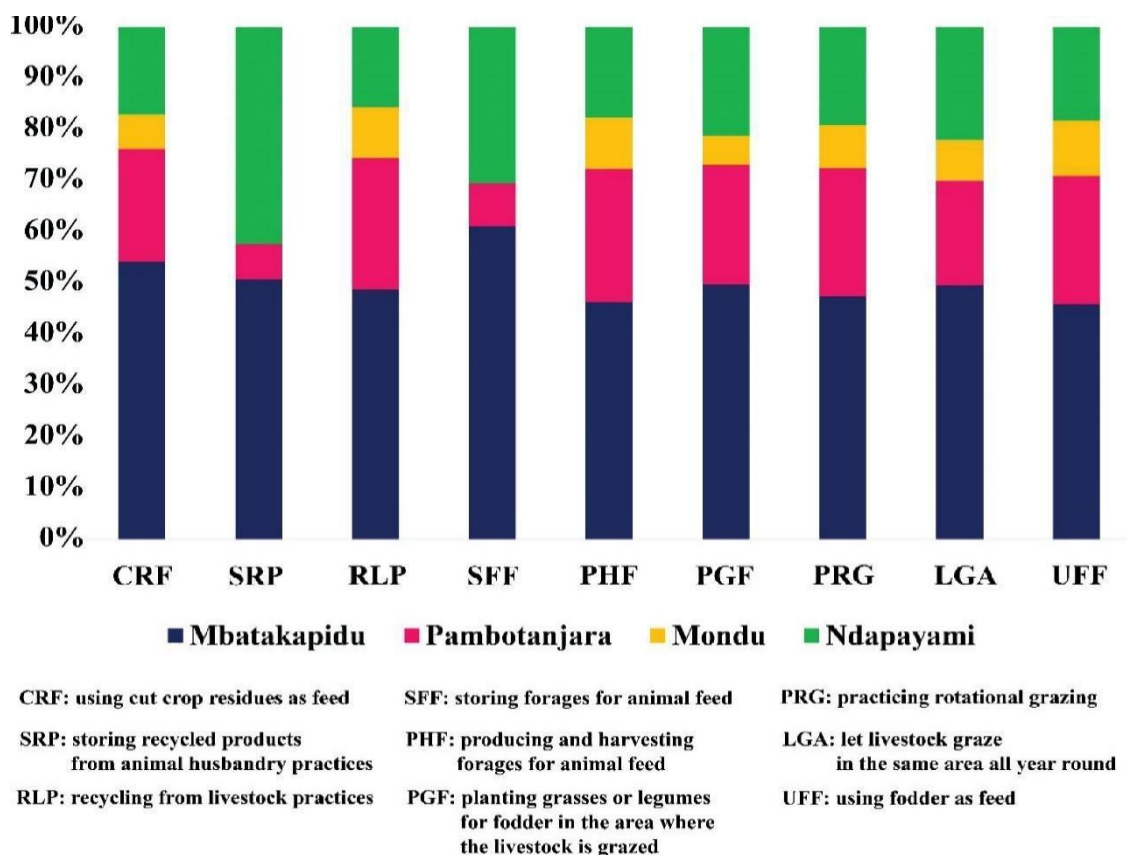
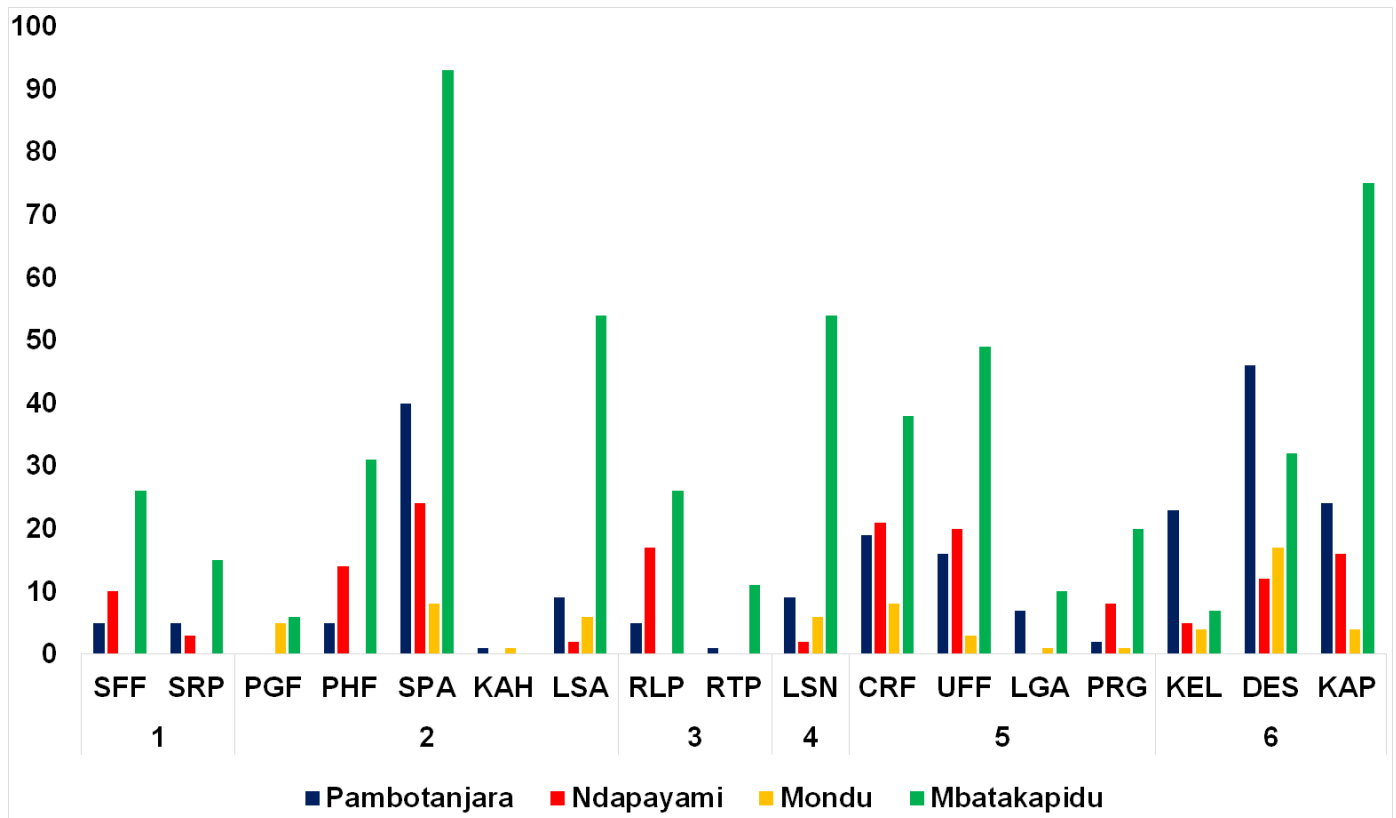


Fig.4. Sustainable grazing practices and savanna conservation (A) and the identified practices applied by the community (B) in the case study area. Note: The three letters in the x-axis are abbreviations corresponding to the identified grazing practices.

- Adopsi aksi yang telah dilakukan masyarakat

- Identifikasi aksi yang telah dilakukan oleh masyarakat untuk sustainable grazing dan konservasi (pastikan sumbu x dan y jelas unit dan variabelnya)



Community practices based on sustainable grazing practices for recommendation enabling conditions

4. Discussion (2000)

4.1. Challenges

- Jelaskan mengenai faktor yang mengontrol kebakaran savanna wildfire di studi area

The application of fires for land preparation may trigger uncontrolled wildfires in the savanna ecosystem [16]. According to the Village Head of Mondu, the wildfires in Mondu were generally caused by uncontrolled fires in neighbouring villages that spread to the savanna area near the village border. The local Forestry Service of East Sumba - NTT reported that uncontrolled wildfires generally occurred due to human activities such as clearing activities for agricultural land, animal hunting, and savannah burning to grow new grass shoots for animal feed [42].

A long-dry season may affect the fire severity [43]. In addition, prevailing weather conditions (e.g., high wind speeds and temperatures) may dictate the fuel moistures and flammability of the fuels [44–46], leading to uncontrolled firestorms [47]. Thus, climate seasonality, soil properties, and natural disturbances primarily affects savanna ecosystems [48], [49]. The climate condition may also affect the dryness level of surface fuels (i.e., dead grass leading to fuel fires), the amount of oxygen available, and the speed of the fire spreads [50].

In the study area, uncontrolled wildfires frequently occurred in the middle of grasslands with difficult access to paved roads and settlements. Hence, if a fire burns a tall grassy savanna area, the community cannot see the source of the fire and cannot extinguish it. As fire equipment is also limited in the villages, villagers traditionally try to extinguish the fire by dumping soil and leaves or trampling on the fires. The East Sumba District Environmental Service established the Fire Care Community called *Masyarakat Peduli Api* (MPA) to protect the savanna areas from fires. MPA has to patrol and extinguish fires in forest and savanna areas. However, communication and coordination among MPA personnel is often challenging due to lack of village

facilities (e.g., poor phone signals). The wildfires that cause loss of vegetation and trees pose a challenge for sustaining community livelihoods dependent on agriculture or livestock activities. The cleared areas may also pose issues on the available water supply, particularly during the dry season. The local governments have undertaken activities to overcome this issue of water availability by planting trees near springs. In the 1990s, the provincial government provided Banyan tree seedlings and involved the community in planting. In 2002, the government promoted planting Mahogany and Gamalilo trees on the farm's edge for easier maintenance.

Also challenging are the unsustainable grazing practices and inadequate community knowledge on savanna conservation. Combined grazing and fire had much more significant effects on tree density than either acting alone [51]. Only a combined effect of fire and grazing was able to prevent increases in tree density. This interplay between fire and grazing may lead to the phenomena of retreat and advance of the savanna ecosystem over time, especially in movements of the often sharp boundaries between savanna and forest area [52]. The feedback loop between fire and grazing shows their combined effect on grasses (fuel load) and woody biomass [39]. The field surveys found that sustainable grazing and savanna conservation are not generally implemented in the study areas. In short, the challenges to the existence of the savanna ecosystem are identified below (Fig. 3).

- The utilization of savannas for crop and plantation farming will require expansion of agricultural lands as demand for foods increases due to population growth,
- The conversion of savannas to agricultural lands using land clearing activities contributes to eliminating native vegetation and degrading the pastures,
- Uncontrolled burning for the land clearing in combination with the prolonged drought condition, soil water deficits, and the abundance of combustible material loads create favourable conditions for the uncontrolled wildfires spreading to a large area,
- Extensive grazing activities due to inadequate knowledge on sustainable grazing practices threatens the existence of healthy grasses,
- Lack of knowledge and capacity in understanding the use of climate information, such as seasonal rainfall and wind direction, has hindered the conduct of proper fire management or controlled burning practices at the transition periods from the rainy to the dry season,
- Currently, the policies are more leaning towards forest management, thus the policy or regulation to protect the savanna ecosystems are lacking at the national and provincial levels.

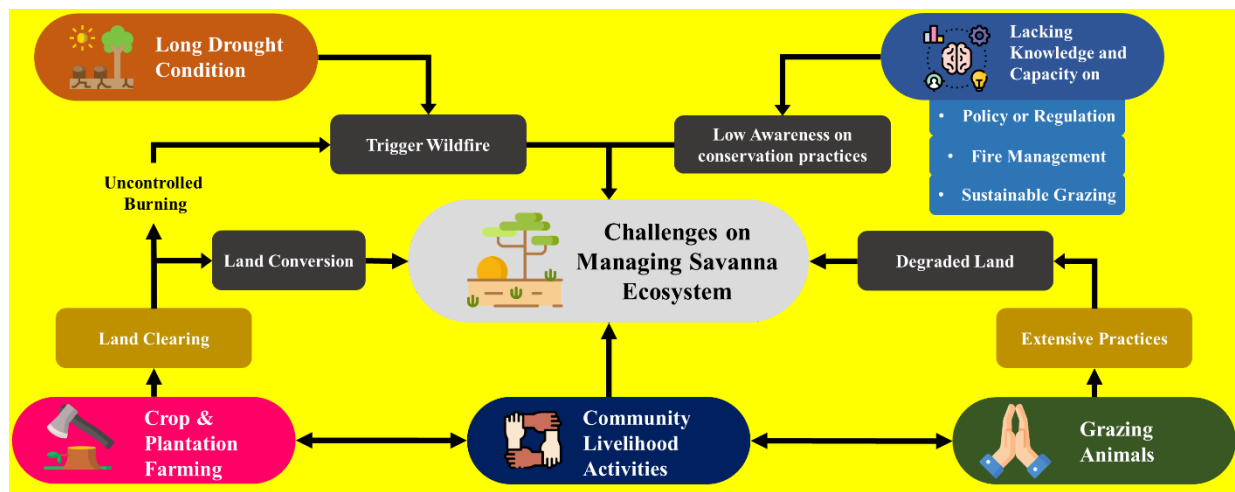


Fig.3. Identified challenges to savanna ecosystem at the study area

4.2. Management Knowledge

jelaskan paragram pembuka dibagian ini mengenai pemahaman manajemen hutan dan savanna yang kurang di tingkat masyarakat

- Fire management: Prescribed fire yang belum dipahami dan pentingnya api untuk suksesi savanna

Fire plays an essential role in maintaining the stability and diversity of savannas. Fires warm the soil and reduce the accumulated litter, allowing sunlight penetration, creating a favourable condition for growing new grasses and flowers [53]. Prescribed fires are beneficial in maintaining the savanna structure and biodiversity [35,36]. However, controlled burns such as prescribed fires must be appropriately managed [36]. The improper actions may produce uncontrolled wildfires affecting large areas and destroying natural resources and biodiversity [54]. The savannas in the study areas are considered fire-prone landscapes, yet without any applied prescribed fire management. Consequently, uncontrolled wildfires frequently occur, particularly during the long drought conditions when the accumulated fuel materials (e.g., grass, shrubs and dry branches) are readily available, and thus, fire can quickly start and spread in the study area.

Understanding the role of fires in controlling savanna dynamics, knowledge and awareness on the proper use of fire control management for the savanna ecosystem are an essential aspect of savanna conservation. Low awareness on managing savannas as opposed to forests has contributed to misapplied conservation practices. The typical techniques applied to forest conservation and restoration (e.g., fire exclusion and planting trees) are inappropriate for managing savanna ecosystems. Currently, the prescribed policy of the NTT Provincial Government which was formulated from national perspectives and guidelines, is to curb the burning practice. The probably insufficient information regarding the best time or frequency to burn, has resulted in this government policy to curb burning practices in the study area. Moreover, the local actions on afforestation or agroforestry are not appropriate for savanna conservation. Afforestation of open ecosystems will increase density of non-native trees and destroy savanna biodiversity [37]. Nevertheless, periodic well-planned fire management may avoid uncontrolled wildfires and maintain open vegetation types and their biodiversity [36].

Furthermore, despite the community's limited knowledge on savanna conservation in the study areas, they already have basic knowledge on the importance of protecting savannas from uncontrolled wildfires. Farmers make a ditch when burning grass for land clearing to create a barrier, so the burning does not spread to other areas. Other farmers do not burn and only apply traditional land clearing by using grass cutter or chopper (Fig. 2). The community engagement level on fire management is necessary as the savannas occupy relatively large areas in the case study communities (Fig. 1). The community involvement is needed in proper fire management, such as applying prescribed fires, using climate and weather information for the well-planned burning activities, early detection and surveillance of fire incidents, routine patrols, and fire suppression. Their involvement is crucial as they are best knowledgeable of the bio-geographical characteristics of their place and social conditions [55,56].

Several other issues are also related to the lack of fire management practices of the NTT community members [29]. Based on the key informants' declaration, conflicts over land ownership both within and between village communities are common; manifested in open disagreements on overutilization and management of resources. As a result, there is no fire management undertaken on contested lands. Occasionally, claimants deliberately set fire on the contested land. Examples of social conflicts over land and resultant uncontrolled wildfire problems were evident in all the study locations. Such conflicts were exacerbated by increasing population pressures, given finite arable and forested land resources. Land tenure conflicts were also considered a significant factor contributing to destructive wildfire activities in Indonesia [57]. These potential land conflicts may be minimized when the community is involved and agrees that efforts from all stakeholders are required. Therefore, the establishment of Community Based Fire Management (CBFM), which emphasizes the active participation of local communities in fire management practices, is a recommended option to manage the savanna ecosystem in the study area.

b. Grazing Practices: Afforestasi tidak boleh dilakukan disavanna, tetapi suksesi rumput alami dengan cara membakar

Management of grazing animals in the savanna ecosystem must also apply sustainable practices. The fundamental strategy of good grazing practice is to balance the quantity of pasture biomass and livestock numbers and to avoid over-grazing or prolonged grazing. However, this continuous practice can reduce grass biomass resulting in patchy vegetation with bare soil. Grazing management strategies are then directed to restore soil function and increase the efficiency of nutrient cycling. Sustainable grazing management considers six (6) elements that include: 1) increasing grazing system productivity and profitability; 2) increasing water use in the grazing system; 3) protecting the on-farm assets and resources; 4) creating more opportunities for biodiversity; 5) reducing off-site impacts from the grazing system; and 6) improving producer satisfaction, motivation and capacity to implement change [58].

Furthermore, the grazing management plan may include: 1) the growth cycle of pasture and its response to grazing intensities; 2) the amount of optimum stocking rate piles, 3) the application of rotational grazing and rainfall information to avoid over-grazing, 4) the existing populations of native grasses. Examples are short grazing periods of rotational grazing that will benefit from retaining the litter and plant cover to protect soils and allow rapid plant regrowth [59]. Unfortunately, the household surveys found that most respondents who were agricultural and livestock farmers generally did not practice sustainable grazing or conserve the savannas (Fig. 4). The local animal husbandry department disseminates knowledge on preserving animal feed (e.g., green fodder) to improve alternative animal feed from agricultural products cultivated in the garden. Unfortunately, knowledge sharing during local training has limited coverage, with a target of 20-30 farmers each year. Based on the surveys, only representatives from Pambotanjara Village had participated in the training.

4.3. Recommended Strategies

In this study, the savannas occupied relatively large areas and provided multiple benefits to the communities in supporting their livelihoods, particularly agriculture and livestock production (Fig. 1). However, the demand for savanna resources (Fig. 2), and the long drought conditions, and the low awareness level on savanna conservation pose challenges to savanna dynamics preservation (Fig. 3). Moreover, the communities have relatively inadequate fire management knowledge on fire management and a general lack of understanding on sustainable grazing and savanna conservation practices (Fig. 4A). Therefore, savanna ecosystem management should consider enhancing the community's ecological knowledge [53], particularly on with respect to: 1) control of woodlands overgrowth (i.e., trees, woody shrubs, and invasive species) to keep grasslands healthy; 2) capacity building on regarding the application of climate and weather information for to undertake proper fire management by regularly applying controlled prescribed fires to reduce accumulated fuel materials to and thus decrease severe wildfires, by reducing the accumulated leaf litter and other fuel materials by applying regularly controlled prescribed fires; 3) creating healthy grasslands

by providing sufficient native foods for wildlife and nutritious forage for cattle, 4) maintaining vigorous food chains (such as the wildflower diversity in grasslands) that create favourable conditions for pollinators throughout the growing season, 5) maintaining native tree species and avoiding afforestation or agroforestry that is detrimental to savanna biodiversity.

These lessons obtained from the surveys and interviews were employed to propose strategies to enhance the community's capacity to manage savanna ecosystems. The local government and communities have been encouraged to address the challenges by minimizing land conversion (i.e., protection), proper livestock raising (sustainable grazing practices and animal feed production), well-planned fire management (e.g., prescribed fires), and by anticipating drought conditions or water shortages associated with the long-dry season. Below are the identified options proposed to empower the local government and community (Fig. 5).

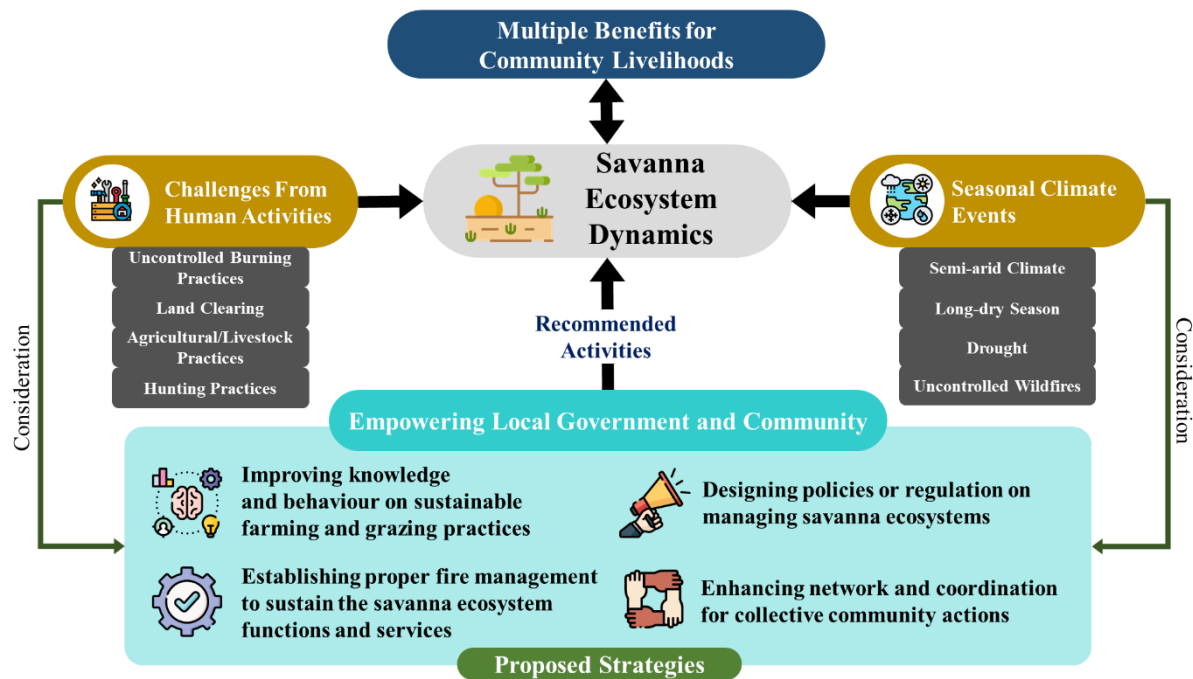


Fig.5. Identified strategies to empower communities in implementing recommended activities to manage tropical savanna ecosystem dynamics for multiple benefits.

The identified options proposed to empower the local government and community are outlined in (Fig. 5). On With respect to improving knowledge and behaviour on sustainable farming and grazing practices, the proposed actions are:

1. Capacity building on the principles and examples of sustainable grazing practices.
2. Use of sustainable animal feed and waste management through modification of the composition of fodder plants.
3. Training: on improved agricultural practices; on using commodity crops to conserve savanna areas; and land preparation without burning or using selective cutting and crop rotation.
4. Application of intensified farming practices such as superior cultivar, drought-tolerant varieties, and adjustment of growing season and cropping patterns to prevent land conversion.

On With respect to establishing proper fire management to sustain the savanna ecosystem functions and services, the possible actions are:

1. Installing a small-scale burning schedule in the early dry season and rainy season.
2. Application of climate and weather information updates such as the number of dry days to avoid any uncontrolled burning activities for land clearing, particularly on during a long-dry season.
3. Controlling the burn sites using firebreaks and fire lines and establishing fire lookout towers to monitor and control fire spreads within the burn unit boundaries.
4. Establishing permanently cleared firebreaks (making ditches) inside several burning blocks, with a clearing strip or path and using the fire-back method back-burning to restrict the fire spreads.
5. Make Aavailability of emergency fire suppression equipment to quickly respond to fire events before reachbecoming uncontrolled wildfire condition events due to potential changes in weather.

On With respect to designing policies or regulations in managing savanna ecosystems, proposed actions are::

1. Raising awareness onabout savanna conservation practices that theyat are different from forest conservation practices.
2. Promoting savanna conservation practices and their benefits, such as:
 - Harvesting branches rather than whole trees to prevent deforestation, soil erosion, and desertification
 - Practising a well-managed controlled burning to avoid uncontrolled wildfires

- Crop rotation to keep the varied supply of nutrients in the soil to prevent soil erosion and desertification
- Sustainable grazeland management to avoid overgrazing, soil erosion and desertification
- 3. Government policy alignment and local actions for well-planned fire management and good grazing practices
- 4. Enhancing community knowledge and understanding of the savanna ecosystem by establishing a tropical savanna research and management centre of excellence
- 5. Encouraging local agreement on the restriction of converting savanna areas for other uses such as agricultural lands and human settlements as the population grows

On With respect to enhancing networks and coordination for collective community actions, the possibilities are;

1. Encouraging the MPA to conduct early detection and surveillance of fire occurrence, routine patrols, and fire suppression activities.
2. Improving coordination among members of the Fire Care Community (i.e., MPA) to patrol for and extinguish developing wildfires using proper communication technology (e.g., radio, sound or light signals, etc.).
3. Encouraging the MPA to conduct early detection and surveillance of fire occurrences, routine patrols, and fire suppression activities.
4. Establishing the Community Based Fire Management (CBFM) that involves surrounding communities around the neighbourhood areas to minimize conflicts in controlling the fires.

Syarat agar rekomendasi bisa berjalan : Enabling condition selalu berhubungan dengan:

- kebijakan: saat ini adanya pengelolaan hutan, maka perlu dibuat kebijakan dan regulasi pengelolaan savanna
- pengetahuan masyarakat termasuk adat istiadat dan budaya: masyarakat sudah menyadari pentingnya fungsi layanan savanna (maintaining savanna biodiversity) dan pembakaran untuk menumbuhkan rumput baru namun waktu pembakaran sering kali tidak tepat karena dipuncak musim kemarau yang mengakibatkan wildfire dan belum mengetahui mengenai savanna conservation
- kesiapan alat dan teknologi: belum mengadopsi teknologi untuk prescribe fire dan pemanfaatan informasi cuaca dan iklim
- alokasi pendanaan: perhatian lebih banyak pada pengelolaan hutan dibanding dengan savanna, sehingga perlu alokasi untuk ekosistem savanna baik dari lokal maupun internasional
- kelembagaan masyarakat dan partisipasinya: sudah ada MPA yang perlu diperkuat dengan pengakuan peran para pihak (insentif atas partisipasi mereka), menerapkan transparansi dan keterlibatan para pihak dalam monitoring dan evaluasi

5. Conclusion (500)

Sustaining ecosystem functions and services, which provide multiple benefits to human livelihoods, is a challenging issue as growing human population will demand for natural resources. This study focuses on savanna ecosystem in the tropical area of Indonesia. The savannas face challenging issues related to land clearance and uncontrolled wildfires due to human activities and climate events. On the other hand, the savannas play an essential role in maintaining multiple ecosystem services, biodiversity, carbon storage, socio-economic and cultural values.

This study explored challenges and strategies to manage tropical savannas, especially on conservation practices and well-planned fire management. The recommendations were drawn based on local-level findings of knowledge, behavior, and actions from interviews and surveys conducted in four villages of two districts in East Sumba of NTT Province, whose savanna landscapes occupied the largest areas. The community engagement and participation are critical parts to manage the ecosystem as the community understands well about the local situation and wisdoms. Low awareness on managing savannas as opposed to forests has contributed to misapplied conservation practices. The typical techniques applied to forest conservation and restoration (e.g., fire exclusion and planting trees) are inappropriate for managing savannas. This lesson contributes enhancing our understandings on required governance and multidisciplinary approaches for conservation strategies in the tropical landscape ecosystem.

Managing tropical savannas are a complex interplay that requires coordination among key stakeholders. This study identified four strategies complemented with recommended actions that are required to manage the savanna landscapes for multiple benefits of community livelihoods. The four strategies are 1) improving knowledge and behaviour on sustainable farming and grazing practices, 2) establishing proper fire management to sustain the savanna ecosystem functions and services, 3) designing policies or regulations in managing savanna ecosystems, and 4) enhancing network and coordination for collective community actions. The proposed strategies are directed mainly to enhance awareness among the local government and community in compliance with the principles of savanna conservation. Hopefully, this study offers and triggers intuitive ideas to sustainably

manage the tropical savannas in facing the current and future challenges, considering the multiple benefits of the savanna ecosystems functions and services for the betterment of human livelihoods.

6. Declaration of Competing Interest

Conflicts of Interest: SDP, SO and RFA are employed by PIAREA. DYDI and REPT are employed by KRESA. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

7. Acknowledgement

This article was made possible through the partnership and financial support from Lutheran World Relief (LWR) with partial support from the Evangelical Lutheran Church in America. Partial support was also provided by the Indonesian Ministry of Education and Culture under World Class University (WCU) Program managed by Institut Teknologi Bandung. Finally, the authors extend their appreciation to all stakeholders, i.e., key informants, respondents, local interviewer, and officers and partners of Center for Disaster Studies, i.e., PIAREA.co.id and KRESA.id. Their gratitude also goes to Luthfi Aditya Pangestu for enriching literatures and discussion, and to Evelyn Bigcas for the help in proofreading.

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Supplementary Materials

1. Table 1. Key Information Interview (KII) conducted in the study area. (supplementary matetrial

Regency/District/Village	Respondent Name	Position or Occupation	Interview Method	Subject Fields	Interview date
East Sumba Regency	Ida Bagus Punia	Head of the Environmental Service	Phone	Forest and Savannahs Lands	24 April 2020
East Sumba Regency	Oktavianus Mbaku Muku, SP, M.Si	Acting Head of the Agriculture and Food Service	Phone	Agriculture	23 April 2020
East Sumba Regency	Mikail Jaka Laki	Chief Executive of Regional Disaster Management Agency (BPBD)	Phone	Forest and Land Disasters and Fires	22 April 2020
East Sumba Regency	Andumila Kapita	Forestry Technical Implementation Unit	Phone	Forests and Savannahs	29 April 2020
East Sumba Regency	Yohanes Radamuri	Head of Animal Husbandry Service	Phone	Livestock	24 April 2020
Waingapu City District	Umbu Ngguti Ngadu	Gapoktan	Phone	Agriculture	5 May 2020
Mbatakapidu Village	Alexander Viktor Umbu Retang	Village head	Phone	Social Economy	28 April 2020
Mbatakapidu Village	Linus Luta Lappu	Agricultural Extension worker	Phone	Agriculture	28 April 2020
Waingapu City District	Umbu Nengirutung	Animal Husbandry Extension worker	Phone	Livestock	28 April 2020
Mbatakapidu Village	Samuel Hinggiranja	Fire Care Society / Masyarakat Peduli Api	Phone	Forest and Land Fires	6 May 2020
Mbatakapidu Village	Yohanes M. Lalupanda	Poktan	Phone	Agriculture	5 May 2020
Mbatakapidu Village	Wehelmina Tanandita	Farmer Women Group	Phone	Gender and Agriculture	5 May 2020
Pambotanjara Village	Anton Radandima	Village head	Phone	Social Economy	27 April 2020
Pambotanjara Village	Bertha	Agricultural Extension worker	Phone	Agriculture	4 May 2020
Pambotanjara Village	Damu Lodu	Fire Care Society / Masyarakat Peduli Api	Phone	Forest and Land Fires	4 May 2020
Pambotanjara Village	Martinus Rongga Yina	Poktan	Phone	Agriculture	27 April 2020

Pambotanjara Village	Kristina Banja Uru	Farmer Women Group	Phone	Gender and Agriculture	29 April 2020
Desa Ndapayami	Lodu Pirandawa	Village head	Phone	Social Economy	25 April 2020
Mondu Village	Umbu Tunggu Mbili	Village head	Phone	Social Economy	28 April 2020
Kanatang District	Diana Mariana Djati	Agricultural Extension worker	Phone	Agriculture	29 April 2020
Kanatang District	Robinson Delu Marau	Animal Husbandry Extension worker	Phone	Livestock	9 Mei 2020
Ndapayami Village	Ndawa Lu	Community Members	Phone	Forest and Land Fires	4 Mei 2020
Ndapayami Village	Dima Talu Marak	Poktan	Phone	Agriculture	7 Mei 2020
Ndapayami Village	Kristina Engga Ana Hamu	Farmer Women Group	Phone	Gender and Agriculture	30 April 2020
Mondu Village	Kabula Ana Awang	Community Members	Phone	Forest and Land Fires	1 Mei 2020
Mondu Village	Umbu Hitu	Poktan	Phone	Agriculture	4 Mei 2020
Mondu Village	Rambu Danga Lilla	Farmer Women Group	Phone	Gender and agriculture	4 Mei 2020

2. table list pertanyaan kegiatan/interaksi yang dilakukan masyarakat terhadap savanna yang dikelompokkan berdasarkan identifikasi tantangan (Tabel bagian identification challenges di matriks summary)

Community Interaction	Questions	Expected Results	KII Key Questions
Crop Farming and Plantation Farming (Afforestation)			Bagaimana interaksi masyarakat dengan wilayah hutan dan savana?
Crops Farming	Apakah Anda menggunakan savanna untuk bercocok tanam?	"Ya"	
Get Firewood	Apakah Anda menggunakan savanna untuk mendapatkan kayu bakar?	"Ya"	
Plantation Farming	Apakah Anda menggunakan savanna untuk pertanian perkebunan?	"Ya"	
Get wood for Building	Apakah Anda menggunakan savanna untuk mendapatkan kayu untuk bangunan?	"Ya"	
Land Clearing			Bagaimana kondisi penggunaan lahan dan perubahannya saat ini di masyarakat? Bagaimana interaksi masyarakat dengan wilayah hutan dan savana?
Cutting Down Traditionally	Bagaimana Anda membersihkan savanna saat pertama kali Anda menggunakannya?	"Menebang secara tradisional"	
Land Clearing by No Special Treatment	Bagaimana Anda membersihkan savanna saat pertama kali Anda menggunakannya?	"Tidak ada perlakuan khusus"	
Land Clearing By Burning	Bagaimana Anda membersihkan savanna saat pertama kali Anda menggunakannya?	"Dengan cara membakar"	
Long Drought			Bagaimana status ketahanan masyarakat saat ini? Serta sejauh mana hal tersebut dapat ditingkatkan? Apa saja kendala yang Saudara/instansi Saudara hadapi dalam mengimplementasikan

Drought Frequency	Apakah Anda mengetahui savanna mengalami kekeringan?	"Ya"	pengelolaan wilayah hutan dan savana tersebut? Apakah upaya yang Saudara lakukan untuk mengatasi kendala tersebut?
Savanna wildfire			Faktor apa saja yang menyebabkan kebakaran hutan atau savana di wilayah Saudara? Seberapa sering kejadian kebaran hutan atau savana terjadi di wilayah Saudara? Seberapa luas dan di mana lokasi wilayah yang terbakar tersebut?
Wildfire Frequency	Apakah pernah terjadi kebakaran di savanna?	"Ya"	
Community Knowledge and Capacity			Apakah masyarakat pernah mendapatkan pelatihan terkait konservasi hutan dan savana? Apakah masyarakat pernah mendapatkan pelatihan terkait praktik pemeliharaan dan penggembalaan ternak berkelanjutan?
Herding Cattle	Apakah Anda menggunakan savanna untuk menggembalakan ternak?	"Ya"	
Hunting	Apakah Anda menggunakan savanna untuk berburu?	"Ya"	

3. -Letakkan table list pertanyaan berdasarkan 6 prinsip sustainable grazing practices dan 5 prinsip savanna konservasi manajemen HH Quisonaire dan KII

Sustainability Grazing Management Elements	Quisonaire Code	Questions for household	Expected Answers	KII Key Questions
1. increasing grazing system productivity and profitability;	LI5	Apakah Anda mempraktikkan pemeliharaan dan penggembalaan ternak yang berkelanjutan?	Ya	Bagaimana interaksi masyarakat dengan wilayah hutan dan savana?
	LI12	Apakah Anda menyimpan tanaman hijauan untuk pakan ternak?	Ya	
2. managing the risk of water shortage/drought	PA 11	Apakah Anda mengalami kekeringan dalam kegiatan pemeliharaan ternak?	Tidak	Apa saja kendala yang Saudara/instansi Saudara hadapi dalam mengimplementasikan pengelolaan wilayah hutan dan savana tersebut? bagaimana upaya yang Saudara lakukan untuk mengatasi kendala tersebut? Bagaimana status ketahanan masyarakat saat ini? Serta sejauh mana hal tersebut dapat ditingkatkan?
	IF 41	Apakah Anda mengetahui savanna mengalami kekeringan?	Ya	

3. protecting the on-farm assets and resources	IF 43	Apakah terjadi serangan hewan ternak?	Tidak	Bagaimana kondisi penggunaan lahan dan perubahannya saat ini di masyarakat?
	IF 44	Apakah terjadi pencurian hewan ternak?	Tidak	Bisakah Saudara ceritakan bagaimana pelibatan masyarakat dalam melakukan pengelolaan wilayah hutan dan/atau savana yang terbakar?
4. maintain savanna biodiversity	CC3G	Apakah Satwa liar / keanekaragaman hayati penting/sangat penting?	Penting dan Sangat Penting	Apa saja yang menjadi alasan atau penyebab kebakaran hutan dan/atau savana di wilayah Sumba Timur?
	IF 46	Apakah Anda melakukan perburuan hewan?	Tidak	Apakah masyarakat melakukan pelestarian hutan (melindungi atau menanam kembali atau digunakan secara berkelanjutan)? Berapa persen jumlah masyarakat yang menerapkannya?
	IF 42	Apakah Anda menggunakan perangkat hewan ilegal?	Tidak	
	IF 7	Apakah Anda menggunakan [lahan] untuk berburu?	Tidak	
5. reducing off-site impacts from the grazing system; and	LI9	Apakah Anda melakukan rotasi penggembalaan?	Ya	Apakah Saudara/masyarakat pernah mengadakan pelatihan atau dilatih terkait praktik penggembalaan berkelanjutan? Berapa jumlah masyarakat yang mengikuti pelatihan tersebut? Apakah Saudara/masyarakat pernah mengadakan pelatihan atau dilatih terkait konservasi hutan dan savana? Berapa jumlah masyarakat yang mengikuti pelatihan tersebut?
	LI8	Apakah Anda membiarkan ternak merumput di daerah yang sama sepanjang tahun?	Tidak	
	IF 4	Apakah Anda menggunakan savanna untuk menggembalakan ternak?	Tidak	
6. Participation and the opportunity to make changes	GR 2 K	Apakah semua anggota keluarga memiliki akses/terlibat (tugas) dalam menyiapkan pakan ternak?	Semua Anggota	Bagaimana keputusan dibuat di masyarakat? Siapa yang mengambil keputusan? Apa peran gender dalam pengambilan keputusan masyarakat? Bisakah Saudara ceritakan bagaimana pelibatan masyarakat dalam melakukan pengelolaan wilayah hutan dan/atau savana yang terbakar?
	GR 2 M	Apakah semua anggota keluarga memiliki akses/terlibat (tugas) dalam penggembalaan ternak?	Semua Anggota	
	GR 2 S	Apakah semua anggota keluarga memiliki akses/terlibat (tugas) dalam Keanggotaan dalam kelompok masyarakat?	Ya	
	GR 7	Apakah Anda berpartisipasi dalam pengambilan keputusan desa?	Ya	
Savanna Conservation Management	Quisioaire Code	Questions	Expected Results	KII Key Questions

1. maintaining savanna ecosystem services	IF 22	Apakah anda melakukan peningkatan kawasan lindung savanna dan mengurangi pembakaran lahan yang tidak terkontrol?	Ya	Bagaimana tindakan Pemerintah Daerah dalam melakukan pengelolaan wilayah hutan atau savana yang terbakar? Bagaimana pelibatan masyarakat dalam pengelolaan tersebut?
	IF 21	Apakah Anda mempraktikkan konservasi savana?	Ya	Apakah masyarakat pernah mendapatkan pelatihan terkait konservasi hutan dan savana? Bisakah Saudara ceritakan bagaimana pelibatan masyarakat dalam melakukan pengelolaan wilayah hutan dan/atau savana yang terbakar?
2. control of overgrowth with prescribed fire (i.e., trees, woody shrubs, and invasive species) to keep grasslands healthy;	IF 20	Apakah anda mengetahui fire management?	Ya	Faktor apa saja yang menyebabkan kebakaran hutan atau savana di wilayah Saudara?
	IF 15	Apakah anda melakukan pembakaran lahan untuk pembentukan rumput baru setiap tahun?	Ya	Apa saja yang menjadi alasan atau penyebab kebakaran hutan dan/atau savana di wilayah Sumba Timur?
	CC26M	Apakah anda melakukan aksi untuk mencegah kebakaran savanna?	Ya	
3. Maintaining agricultural land area and not expanding land to savanna	AG 13	Apakah Anda membuka lahan baru musim tanam lalu? (melakukan ekspansi lahan pertanian)	Tidak	Faktor apa saja yang menyebabkan kebakaran hutan atau savana di wilayah Saudara?
	CC27A	Apakah Anda Menyiapkan lahan pertanian/penggembalaan tanpa membakar?	Ya	
	IF 13	Apakah Anda pernah membakar savanna untuk membuka lahan baru?	Tidak	
4. Knowledge and Participation in conservation activity	IF 16	Pernahkah Anda mendengar tentang konservasi savana?	Ya	Apakah masyarakat pernah mendapatkan pelatihan terkait konservasi hutan dan savana?
	IF 18	Apakah Anda tahu ada kegiatan konservasi savana yang terjadi di komunitas Anda?	Ya	Bisakah Saudara ceritakan bagaimana pelibatan masyarakat dalam melakukan pengelolaan wilayah hutan dan/atau savana yang terbakar?
	IF 19	Sudahkah Anda berpartisipasi dalam kegiatan konservasi savana dalam lima tahun terakhir?	Ya	Apakah Saudara/masyarakat pernah mengadakan pelatihan atau dilatih terkait konservasi hutan dan savana? Berapa jumlah masyarakat yang mengikuti pelatihan tersebut?
5. Proper conservation management policies	IF 30	Apakah Anda tahu aturan adat yang mengatur penggunaan dan pengelolaan savanna?	Ya	Apakah ada kebijakan(perdes)/aturan/panduan yang berlaku di wilayah Saudara terkait pengelolaan hutan? Jika ada, apakah kami boleh meminta sumbernya?

4. Supplementary Material Rekomendasi aksi yang diperoleh dari findings, gaps, dan adopsi aksi

Principal	Temuan (Findings)	Aksi yang sudah dilakukan	Gaps	Recommendation Strategy	Rekomendasi Aksi	Existing Situation
Sustainable Grazing						
1) increasing grazing system productivity and profitability;	Masyarakat belum meningkatkan produktivitas dan profitabilitas sistem penggembalaan karena masih menggunakan praktik penggembalaan tradisional (ternak dilepas dan dibiarkan merumput secara liar)	Practices: 1. Menyimpan tanaman hijauan untuk pakan ternak (41 orang melakukan) 2. Menyimpan hasil daur ulang dari praktik peternakan (23 orang melakukan)	1. Masyarakat belum mengadopsi praktik sistem penggembalaan yang mampu meningkatkan produktivitas dan profitabilitas akibat rendahnya tingkat pengetahuan masyarakat mengenai praktik baik sistem penggembalaan berkelanjutan	Improving knowledge and behaviour on sustainable farming and grazing practices	Capacity building on the principles and examples of sustainable grazing practices. Training: improved agricultural practices; using commodity crops to conserve savanna areas; land preparation without burning or using selective cutting and crop rotation. Use of sustainable animal feed and waste management through modification of the composition of fodder plants. Application of intensified farming practices such as superior cultivar, drought-tolerant varieties, and adjustment of growing season and cropping patterns to prevent land conversion.	Sudah ada sedikit pelaku untuk mengajar praktik penyimpanan tanaman hijauan dan hasil daur ulang praktik peternakan untuk pakan ternak di lokasi studi Kegiatan bimbingan teknis di fasilitasi oleh Pemda terkait yang melibatkan kelompok tani dan ternak di lokasi studi
2) managing the risk of water shortage/drought	Masyarakat mengutamakan air untuk pemenuhan kebutuhan pertanian dan rumah tangga akibat sering terjadinya kekeringan	Practices: 1. Menanam rumput atau kacang-kacangan untuk pakan ternak di daerah penggembalaan ternak (11 orang melakukan) 2. Memproduksi dan memanen tanaman hijauan untuk pakan ternak (50 orang melakukan) 3. Melakukan pengembangan sistem pengelolaan air (165 orang melakukan) 4. Melindungi sumber air (75 orang melakukan) Knowledge:	Masyarakat belum mampu mengelola risiko kekurangan air di savanna			Masyarakat sudah mampu menilai kondisi ketersediaan air baku untuk rumah tangga dan pertanian Sudah ada beberapa pelaku produksi pakan ternak alternatif selain dari padang rumput savanna di lokasi studi

		1. Pemahaman mengenai pengumpulan dan menggunakan air hujan (2 orang melakukan) 2. Pemahaman mengenai kondisi ketersediaan air baku (291 orang paham) 3. Pemahaman mengenai ancaman bahaya kekurangan air baku (234 orang paham)				
3) protecting the on-farm assets and resources;	Masyarakat cenderung menjaga aset pertanian dan peternakan mereka	Practices: 1. Melakukan proses daur ulang dari praktik peternakan (misal: pengolahan kotoran hewan menjadi pupuk) (48 orang melakukan) Knowledge: 1. Pemahaman mengenai rotasi tanaman pertanian (12 orang melakukan)	-			Sedikit masyarakat sudah mengetahui pentingnya rotasi pertanian namun belum memahami sepenuhnya fungsi dari rotasi tanaman pertanian Sedikit masyarakat di lokasi studi melakukan proses daur ulang dari praktik peternakan untuk mencukupi kebutuhan lahan pertaniannya
4) Maintain savanna biodiversity	Masyakat sudah menyadari bahwa keanekaragaman itu hayati itu penting	Practices: 1. Tidak melakukan perburuan hewan (301 orang melakukan) 2. melindungi sungai, danau, dan	-			Mayoritas masyarakat tidak melakukan perburuan hewan dan tidak menggunakan perangkap hewan illegal di lahan savanna Sebagian masyarakat melindungi sungai, danau dan sumber air

		sumber air lainnya (71 orang melakukan) Attitude: 2. Tidak menjadikan perangkap hewan illegal sebagai alat berburu (311 orang melakukan)				lainnya
5) reducing off-site impacts from the grazing system; and	Masyarakat masih sangat bergantung pada padang rumput savanna dan tidak memperhatikan dampak sistem penggembalaan terhadap kelangsung savanna	Practices: 1. Menggunakan sisa tanaman yang dipotong sebagai pakan (86 orang melakukan) 2. menggunakan pakan khusus ternak (88 orang melakukan) 3. Rotasi penggembalaan (31 orang melakukan) Attitude: 1. Membiarkan ternak merumput di daerah yang sama sepanjang tahun (86 orang melakukan) 2. Tidak menjadikan savanna untuk menggembala ternak (62 orang melakukan)	Rendahnya pengetahuan masyarakat akan dampak yang ditimbulkan dari aktivitas penggembalaan (heavy grazing) terhadap ekosistem savanna Praktik pengurangan dampak dari sistem penggembalaan seperti rotasi penggembalaan belum menjadi praktik baik			Sebagian masyarakat sudah menggunakan sisa tanaman yang dipotong sebagai pakan ternak Sebagian masyarakat sudah beralih ke pakan khusus ternak Sudah ada sedikit pelaku rotasi penggembalaan untuk mengajar di lokasi studi

6) Participation and the opportunity to make changes	Kesempatan dan partisipasi untuk mengadopsi perubahan sistem penggembalaan ternak belum merata	Attitude: 1. Kesempatan akses/terlibat (tugas) dalam Keanggotaan kelompok masyarakat (39 orang mengakui mendapat) 2. partisipasi dalam pengambilan keputusan desa (107 orang mengakui mendapat) 3. mengikuti kegiatan peningkatan kapasitas (119 orang mengakui mendapat)	Hanya sedikit rumah tangga yang memberi kesempatan kepada seluruh anggota keluarga untuk berpartisipasi dalam sistem penggembalaan			Sudah ada sedikit keluarga yang memberikan akses yang sama kepada semua anggota keluarganya untuk bergabung dalam keanggotaan kelompok masyarakat Sudah ada sedikit keluarga yang berpartisipasi dalam mengambil keputusan desa dan mengikuti kegiatan peningkatan kapasitas
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Savanna Conservation

1) maintaining native tree species and avoiding afforestation or agroforestry that is detrimental to savanna biodiversity	Tidak pernah dilakukan pengelolaan wilayah hutan savana setelah kejadian kebakaran. Dulu pernah ada satu yayasan tahun 90-an. Hanya itu yg menadampingi desa ini untuk menanam pohon di mata air, jenis pohonnya adalah pohon beringin. Pemerintah kasih anakan, jadi masyarakat tanam di pinggir-pinggir lahan, pohon mahoni, gamalilo tahun 2002. Pelaksanaan pelatihan	Practices: 1. Afforestation (23 orang melakukan) Knowledge: - Attitude: -	Practices: 1. Masyarakat masih belum menghindari afforestation di savanna Knowledge: 2. Pemahaman untuk tidak melakukan penanaman pohon di savanna karena dapat mengganggu habitat asli ekosistem savanna Attitude: -	establishing proper fire management to sustain the savanna ecosystem functions and services	Installing a small-scale burning schedule in the early dry season and rainy season. Application of climate and weather information updates such as the number of dry days to avoid any uncontrolled burning activities for land clearing, particularly during a long-dry season. Controlling the burn sites using firebreaks and fire lines and establishing fire lookout towers to monitor and	Sebagian masyarakat meningkatkan kawasan lindung untuk mempertahankan ekosistem savanna.
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	konservasi yang dilakukan adalah dengan mengurangi pembakaran, menjaga ternak, dan juga melakukan penanaman pohon Responden (12% dari total responden) melakukan konservasi savanna, dengan 0 responden tidak menjawab. Responden (11% dari total responden) meningkatkan kawan lindung dan mengurangi pembakaran, dengan 277 responden tidak menjawab.				control fire spread within the burn unit boundaries. Establishing permanently cleared firebreaks inside several burning blocks, and using back-burning to restrict fire spread. Make available emergency fire suppression equipment to quickly respond to fire events before becoming uncontrolled wildfire events due to potential changes in weather.	
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2) control of overgrowth with prescribed fire (i.e., trees, woody shrubs, and invasive species) to keep grasslands healthy;	Masyarakat melakukan pembakaran untuk membersihkan rumput lama dan menghasilkan tunas rumput baru sebagai pakan ternak. Sedangkan untuk pemotongan pohon, masyarakat tidak melakukannya di savanna, melainkan mengambilnya hanya dari lahan rumah. Desa Mondu setiap tahun diwajibkan membersihkan rumput-rumput sekitar permukiman jarak 100 meter supaya api tidak merembet. Karena lokasi di tengah padang, jadi tidak ada orang di sana. Responden (0% dari total responden) memahami fire management, dengan 288 responden tidak menjawab. Responden (1% dari total responden) melakukan pembakaran savanna untuk mendapatkan rumput baru, dengan 240 responden tidak menjawab. Responden (52% dari total	Practices: 1. Pembakaran lahan savanna sekali dalam setahun (2 orang melakukan) 2. Pengambilan kayu dari pepohonan (86 orang melakukan) Knowledge: 1. fire management untuk lahan savanna (0 orang memahami) Attitude: -	Practices: 1. Pembakaran lahan savanna untuk mengontrol pertumbuhan rumput cenderung sedikit dilakukan Knowledge: 2. Pemahaman dalam mengontrol pembakaran agar tidak terjadi wildfire ketika ingin membersihkan rumput Attitude: -			Masyarakat harus memahami fire management Masyarakat harus paham bahwa pembakaran di savanna dapat dilakukan tapi dengan terkontrol Masyarakat tidak melakukan penanaman pohon (afforestasi) di lahan savanna karena dapat mengganggu native species savanna
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	responden) mencegah pembakaran savanna, dengan 0 responden tidak menjawab.					
3) Maintaining agricultural land area and not expanding land to savanna	Pembukaan lahan pertanian sangat jarang terjadi. Petani semua menggarap lahan yang sudah ada dari dulu.	Practices: 1. Pembukaan lahan baru (2 orang melakukan) Knowledge: - Attitude: -	Practices: 1. Pembukaan lahan untuk pertanian cenderung dilakukan di lahan dekat rumah 2. Pembukaan lahan untuk pertanian di savanna belum dilakukan 3. Rotasi tanaman pertanian belum dilakukan Knowledge: 1. Kurangnya pemahaman bahwa melakukan proses pertanian di savanna dapat menjaga rumput savanna tetap sehat dengan rotasi pertanian yang benar Attitude: -			Masyarakat tidak membuka lahan pertanian di dalam savanna
4) Knowledge and Participation in conservation activity	Cukup sering pelatihan di lakukan kepada seluruh warga terkait menanam pohon kembali dan tidak boleh menebang/me mbakar. Sejak tahun 80an banyak LSM yang masuk dan mendorong warga untuk menanam pohon disekitar pemukiman sehingga saat ini warga sudah lebih dari cukup memanfaatkan hutan keluarga	Practices: 1. Partisipasi dalam konservasi savanna (24 orang) 2. Meningkatkan kawasan lindung dan mengurangi pembakaran (35 orang) Knowledge: 1. Memahami jenis kegiatan konservasi savanna (13 orang) Attitude: -	Practices: 1. Konservasi savanna yang dilakukan masih belum merupakan praktek dari sustainable savanna conservation 2. Praktek yang dilakukan cenderung merupakan praktek konservasi hutan dan bukan savanna Knowledge: 1. Kurangnya pemahaman mengenai savanna conservation 2. Cenderung menyamakan konservasi untuk hutan dan savanna	designing policies or regulations in managing savanna ecosystems enhancing networks and coordination for collective community actions	Raising awareness about savanna conservation practices as they are different from forest conservation practices. Promoting savanna conservation practices and their benefits, such; - Harvesting branches rather than whole trees to prevent deforestation, soil erosion, and	Masyarakat paham bahwa konservasi savanna dan hutan itu berbeda

	saja disekitar rumah. Lahan yang belum berupa hutan, ditanami pohon Gamal dan Lamtoro Responden (4% dari total responden) mengetahui adanya praktek konservasi savanna, dengan 0 responden tidak menjawab.		Attitude: -		desertification - Practising well-managed controlled burning to avoid uncontrolled wildfires - Crop rotation to keep a varied supply of nutrients in the soil to prevent soil erosion and desertification - Sustainable grazeland management to avoid overgrazing, soil erosion and desertification	
5) Proper conservation management policies	Belum ada Perdes hanya sebatas himbauan-himbauan. Hanya mengikuti peraturan pemerintah tentang konservasi hutan. Jadi menggunakan peraturan konservasi hutan untuk lahan savanna. Responden (12% dari total responden) telah mengetahui adanya aturan untuk pengelolaan savanna, dengan 0 responden tidak menjawab.	Practices: - Knowledge: 1. Keputusan dalam desa dibuat dari pemerintah dan ketua adat (200 orang) 2. Berpartisipasi dalam proses pengambilan keputusan (107 orang) Attitude: -	Practices: - Knowledge: 1. Belum adanya peraturan khusus untuk konservasi savanna 2. Cenderung masih memahami bahwa hutan dan savanna itu sama, sehingga pembuatan kebijakan akan terpengaruh Attitude: -		Government policy alignment and local actions for well-planned fire management and good grazing practices Enhancing community knowledge and understanding of the savanna ecosystem by establishing a tropical savanna research and management centre Encouraging the MPA to conduct early detection and surveillance of fire occurrence, routine patrols, and fire suppression activities. Improving coordination	Masyarakat paham bahwa konservasi savanna dan hutan itu berbeda

					among members of the Fire Care Community (i.e., MPA) to patrol for and extinguish developing wildfires using proper communication technology. Establish Community Based Fire Management (CBFM) involving surrounding communities to minimize conflicts in controlling fires.	
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