Provisioning ecosystem services-sharing as a coping and adaptation strategy among rural communities in Ghana's semi-arid ecosystem

Yaw Agyeman Boafo^{a*}, Osamu Saito^b, Godfred Seidu Jasaw^b, Kei Otsuki^c, Kazuhiko Takeuchi^{ab}

^aIntegrated Research System for Sustainability Science (IR3S), The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8654, Japan.

^bUnited Nations University Institute for the Advanced Study of Sustainability (UNU-IAS), 5-53-70 Jingumae, Shibuya-ku, Tokyo, 150-8925, Japan

^cDepartment of Human Geography and Spatial Planning, Utrecht University, Heidelberglaan 2, 3584 CS, Utrecht, The Netherlands

*Corresponding author

Email: yboafo@gmail.com; Mobile: +81 8050108592

Abstract

As complex challenges linked to changing socio-economic, environmental, political, and cultural conditions continually hamper the delivery of ecosystem services to natural resource dependent communities, local level adaptation needs attention. This paper presents the findings of an empirical survey in rural semi-arid Ghana investigating how households are employing communal sharing as a strategy to enhance access and management of nine provisioning ecosystem services (**provisioning ES**) namely crops and vegetables, livestock and poultry, bushmeat, freshwater, wild plants, fodder and forage, traditional medicine, fuelwood, and building materials. The results indicate that the variations in the sharing patterns of the nine provisioning ES can be linked to a mix of closely-linked socioeconomic, cultural, and environmental factors. Traditional medicine is the most commonly shared, whilst building materials are the least commonly shared. Sharing intensifies during the long dry season for majority of the provisioning ES. Logistic regression modeling indicates annual household income to be the most significant socio-demographic variable influencing participation in sharing. A greater proportion of interviewed household heads (64%) perceive sharing to be on the decline. These findings provide important baseline data for further quantitative and qualitative research exploring sharing's potential contribution to rural households' livelihoods sustenance and ecosystem sustainability under changing conditions.

Keywords: adaptation, households, provisioning ecosystem services, resources, semi-arid Ghana, sharing

1. Introduction

Historically, communities in semi-arid dryland ecosystems have adapted to chronic environmental stresses, such as drought and floods (Smit et al. 1999, 2000, Hammill 2007). However, well-established evidence has shown that the increasing adverse effects of climate variability and change, coupled with socioeconomic, cultural, and political changes over the last few decades, have heightened community vulnerabilities and undermined the supply, utilization, and management of ecosystem services. This implies the weakening of local adaptive capacities (Fisher et al. 2005, Thornton et al. 2006).

The situation is highly precarious in Sub-Saharan Africa because of its geographical location (IPCC 2007), widespread poverty, and the extensive dependence of individuals and communities on ecosystem services (Cavendish 2000, Shackleton and Shackleton 2006, Boko et al. 2007, Paumgarten and Shackleton 2011, Fagerholmet al. 2012, Egoh et al. 2012). By ecosystem services, we reference the Millennium Ecosystem Assessment (MA) definition, which refers to ecosystem services as “benefits people obtain from ecosystems” (MA 2005: 5). These benefits are further classified into four categories: provisioning, regulating, cultural, and supporting services. Of these four categories, this study emphasizes provisioning ecosystem services (hereafter provisioning ES) which are the material goods or benefits that can be harvested and easily quantified and are derived from the ecosystem to be directly used by local people. Examples of such provisioning ES include food, fuelwood, water, timber, and fiber (Maass et al. 2005).

Climate change and unsustainable human actions are exacerbating the pressure on various ecosystems to supply critical provisioning ES, thus posing a major challenge for ecosystem sustainability and human livelihood sustenance. Across global ecological regions, semi-arid ecosystems have been found to be among the most vulnerable to these challenges (MA 2005, Thomas 2008). In order to face this challenge, researchers and development agencies

1 recommend community-based, natural resource utilization and management strategies
2 underpinned by reciprocal relationships and social capital. Ayers and Huq (2006) argued
3 that community-based adaptation strategies offer at least a more sustainable and participatory
4 avenue to strengthening the adaptive capacity of vulnerable communities in the face of current
5 and future stresses associated with climate change although it is often difficult to measure. In the
6 case of rural natural resource-dependent semi-arid communities of Sub-Saharan Africa, the
7 existence of strong communal relationships means that households with limited income may be
8 able to cope with food shortages caused by droughts by actively participating in the non-market
9 “gift economy”. This is made possible through social relationships and networks that value
10 reciprocity (Bugra 2002). Common-pool resource management suggests that resources are
11 managed through community-based rules (Agrawal and Gibson 1999, Agrawal 2002, Gibson and
12 Koontz 1998, Armitage 2005, Conrad and Hilchey 2011) and through the use of social capital
13 (Ostrom 1990, 2000, Ostrom and Ahn 2003, Ostrom et al. 1994, Pretty 2003, Adger 2003,
14 Poteete and Ostrom 2004). These authors contend that, because vulnerability and adaptive
15 capacities are location-specific, it can be more effective to employ community-level adaptation
16 strategies with an emphasis on place-based knowledge, technology, social structures, and
17 institutions.

18 In semi-arid developing tropics, community-based coping and adaptive strategies,
19 including the sale of productive and non-productive assets, out-migration, petty trading, wage
20 labour, and changes in diet, among others are well acknowledged (Chirwa et al. 2008, Kalaba et
21 al. 2010, Paumgarten and Shackleton 2011). However, little is known about the practice of
22 communal sharing in the context of provisioning ES, especially in places where biodiversity
23 decline and ecosystem degradation is evident. This collective action has been overlooked in the
24 conventional ecosystem assessment discourses and is yet to be documented.

25 As a practice for redistributing essential resources among social groups, sharing has long
26 been regarded as an important and effective mechanism for addressing the problem of scarcity

(Polyani 1958, Arrow 1975, Becker 1974, Lee 1979, Gould 1981, Kitahara-Frisch 1982). It has been considered as essential attempt to meet or fulfill social, economic, political or cultural needs or obligations through a social interaction system (Sherry 1983). In modern societies, evidence points to the use of sharing or resource gifting by communities and households in both rural and urban economies towards meeting the needs of vulnerable groups or to overcome resource stress (Polyani 1944, Speth 1990, Mingione 1991, Chakraborty 2007, Morton et al. 2008). Befu's (1968) study describes gift-giving in Japanese society as a minor institution guarded by complex rules of engagement. More recently, Kamiyama et al. (2016) found that the sharing of non-market food provisioning services was still prevalent in rural and semi-rural Japan. It is important to note that sharing as applied in this study is not limited to the reciprocal exchange of provisioning ES that occur at household or community levels. Sharing is used to encompass gifting or giving away provisioning ES over time and place in response to environmental stresses (drought, flood, and bushfires) or in fulfillment of socioeconomic and cultural obligations.

The literature has identified a number of factors and conditions that motivate people or communities to participate in resource exchange or gift-giving: in response to hazards or disasters (Dei 1988, Franzen 2006), support for family members (Palmer 1991), reciprocity (Gurven *et al.* 2000, Gurven 2004), network or alliance building (Adger 2003, Patton 2005), and risk reduction (Franzen and Eaves 2006). Compared to other community-based strategies for natural resource management, sharing may occur without any enforceable rules or regulations at the community level (Morton et al. 2008). In this sense, Morton et al. (2004) referred to sharing as voluntary "personal exchanges", presumably because sharing happens in communities that are naturally diverse owing to structural differences, including economic status, occupation, education, and religious affiliations. These factors are known to significantly influence community members' access to resources, knowledge, and perception of community-based practices, thus subsequently influencing their participation.

The objective of this study is to investigate how the communal practice of sharing is being used by poor rural communities as a coping and adaptation strategy in semi-arid landscape of Ghana in West Africa. We explore this through the lens of nine provisioning ES that are considered by community members to be critical for livelihood and ecosystem sustenance (Boafo et al. 2014). The provisioning ES include, crops and vegetables, livestock and poultry, bushmeat, fresh water, wild plants/food, fodder and forage traditional medicine, fuelwood, and building materials. Specifically, this paper investigates: (a) the sharing patterns and network structure of the nine provisioning ES; (b) the effect of seasonality, selected demographic variables and other factors influencing sharing of provisioning ES; and (c) household perceptions on the changing trends of the practice over the past 30 years. Our conclusion is based on examining the practical and theoretical implications of provisioning ES sharing under limited resources and competing needs.

2. Material and Methods

2.1 Location and description of study area

Semi-arid Ghana consists of three autonomous administrative regions located in the northern-most extent of Ghana; namely, Northern, Upper East, and Upper West. Lying within the Guinea and Sudan Savanna agroecological zones of Ghana, they are known to be highly vulnerable to climate and ecosystem changes, owing mainly to their semi-arid climate and physical conditions (Dietz et al. 2004). The semi-arid region of Ghana is highly rural and inhabited by smallholder farmers (Ghana Statistical Service 2013), whose poverty levels range between 68% and 88% (Canagaraah et al. 200; **Figure 1**). For many years, the cumulative effects of environmental and socioeconomic factors, such as climate change and variability, extreme disaster events like drought, floods, and bushfires, overexploitation of natural resources (Armah et al. 2011, Acheampong et al. 2014), disregard for traditional ecological knowledge (Boafo et al. 2015), and inter-tribal conflicts have been found to undermine the supply and management

1 ofecosystem services especiallyprovisioning ES needed to improve livelihood sustenance and
 2 security.

3
 4 **Figure 1.** Map showing the study communities in relation to Tolon district in Semi-arid Ghana

5 This study selected two rural communities, Yoggū (9°28'N, 1°5'W) and Kpalgun (9°30'N,
 6 1°4' W) as case study sites for in-depth survey. The selected communities are located within the
 7 Tolon district, which is to the west of Tamale, the capital city of the Northern region of
 8 Ghana (**Figure 1**). A district represents a second-level administrative sub-division below the level
 9 of region in Ghana (Institute of Local Government Studies and Friedrich-Ebert-Stiftung Ghana
 10 2010). The sites were selected on the basis of: (i) the fact that they are part of six communities that
 11 have been purposely identified and used as focal areas for the international interdisciplinary

project on climate and ecosystem changes, called ‘Enhancing Resilience to Climate and Ecosystem Changes in Semi-arid Africa: An Integrated Approach (CECAR Africa)’; and (ii) their proneness and high vulnerability to episodic drought conditions during the long dry season (Antwi et al. 2014). The Yoggu and Kpalgun communities are located approximately five kilometres apart and are accessible by gravel road from Tolon, the district capital. Based on a detail community survey in August 2013, Yoggu’s population density can be estimated at 457 people per square kilometres whilst Kpalgun is estimated at 904 people per square kilometres (Boafo et al. 2015). Yoggu and Kpalgun can be considered as ethnically homogenous, with the majority of people being members of the Dagomba ethnic group. Political authority rests with the local or elder (‘Na’ in local Dagbani).

Average temperatures range from 15°C at night to 40°C during the day. Annual rainfall averages between 750 mm to 1000 mm. The communities, like others in the Tolon district and the rest of semi-arid Ghana, are impacted more severely by the north-east trade winds (Harmattan dry winds). Under prevailing climatic conditions, livelihood activities are significantly influenced by the two main seasons: the wet season (usually between May and October) and the dry season (between November and April). Because of the relatively short unimodal rainy season, farmers have only one major cropping season. The dry season, which is much longer, is often characterized by longer periods of drought and low yields from the staple crops and vegetables. In this semi-arid ecosystem, drought-resistant plant species, most notably the *Adansonia digitata* (baobab), *Khaya senegalensis* (mahogany), *Vitellaria paradoxa* (shea), and *Parkia biglobosa* (locust tree) (dawadawa in local Dagbani), dominate the landscape. These wild tree species, along with other provisioning ES, provide critical social, economic, and cultural benefits for households and communities (Table 1).

The majority of livelihood sustenance strategies in this region are built around the provisions of the local ecosystem primarily through small-scale agricultural

economy. Agriculture is composed of crop raising (mainly staple crops) and animal (livestock and poultry) production. The farming system is mainly traditional, with most food crops being intercropped. Most farming activities are undertaken during the wet season, as farmers predominantly rely on rainwater. Water shortage and scarcity in the area greatly impact crop cultivation and productivity as well as domestic activities. Off-farm activities, such as small-scale trading, perennial migration to urban centers, firewood sales, livestock sales, as well as shea and locust bean collection and butter processing, contribute significantly to meeting household needs. Like most communities of the **northern region of Ghana**, rural food insecurity is perennial and remains a major challenge (World Food Programme 2009).

2.2 Research Design

2.2.1 Data Collection

Data for this study were collected between August 2013 and August 2014, following a pilot survey (March 2013). The secondary data was collected from published and unpublished sources. The primary data was collected through the use of participatory field work methods, including key informant interviews, observations, household questionnaire interviews and focus group discussions (Patton 2002, Gray 2004). The inhabitants of Yoggu and Kpalgun communities constituted our survey population.

Estimation of household wealth status: This study categorized households according to wealth classes recognizing that even in the same social and ecological context, a household's capacity to access resources or cope with stresses varies. Following Garenne and Hohmann-Garenne (2003) and Shackleton and Shackleton (2006), we categorized households into wealth index classes by using ownership of physical household assets and diversity in sources of income as proxy indicators. This exercise was undertaken with the active participation of the local assemblymen (formal government representatives) and two village-based research assistants because of their relatively high level of literacy and previous involvement in field-based research in the

communities in March 2013. Dummy variables were created for information collected on ownership of physical assets (mobile phone, bicycle, motorbike, tricycle (*motoking*), plows, fertilizers, hunting tools, and donkey cart) and diversity in income sources (on-farm and off-farm). For example, a zero index score meant that a household had none of the listed household assets. Scores for each household were summed to form a final representation of the proxy household wealth index. The wealth index varied from 0 to 20. Households with a wealth index score of 0–12 were ranked as *low*, whereas those with a score of 13–20 were ranked as *high*.

Key informant interviews: In August 2013, twelve key informants were sampled and interviewed in Yoggu (seven) and Kpalgun (four) communities. These key informants were aged between 53 and 85 years old and comprised three women (two from Yoggu and one from Kpalgun) and nine men. Apart from the community head (chief) and opinion leaders (recommended by chief), the other key informants (landowners, clan heads, and traditional healers) were sampled by means of snowball sampling after the study objective had been discussed. Discussions focused on their understanding and application of the term sharing, effects of seasonality on the practice, and perceptions on changes in the trends of sharing as a communal practice.

Household questionnaires survey: Overall, 160 face-to-face interviews were conducted with household heads in the two study communities. Prior to administering the survey questionnaires (**Appendix 1**), each community was divided into four clusters based on location. During the main survey, random samples of 20 households from each of the four clusters were selected and interviewed, making up a total sample size of 80 households per community. The questionnaires were initially developed and tested in collaboration with eight household heads (five in Yoggu and three in Kpalgun). The targeted respondents for the interviews were household heads, meaning that they were all part of the adult segment of the community population. Household heads are the principal decision-makers when it comes to resource allocation, control, and general management within their households. When the household head was unavailable, the

next-in-line, as informed by members of that particular household, was identified and interviewed. When the research team noted that household heads were predominately men in the study communities, largely due to socio-cultural customs, we used a snowball sampling technique to identify and interview other households with female heads. This resulted in 22% sample size (Appendix 2). Since all interviews were pre-arranged (meeting date and time) with respondents, this study's response rate was 100%.

Focus group discussions: Following the household questionnaires, two focus groups (mixed gender) were held in each village in August 2014. Focus group discussions involved between ten and 15 household heads, drawn from the four clusters in each village. We ensured that all households with female heads from the household surveys also participated in the group discussions. Thus, we had 100% participation of households with female heads, which brought some balance overall. Discussions included motives behind provisioning ES sharing, relevance to livelihood sustenance, and perceptions of changing trends. The discussions were audio-recorded and transcribed for further analysis.

Table 1. Types of provisioning ecosystem services, sources and specific examples from the semi-arid ecosystem

No	Type of provisioning ecosystem service	Sources and/or specific examples
1	Crops and vegetables	Maize, millet, yam, cowpea, rice, sorghum, groundnut, tomatoes, chili pepper, tobacco, okra, tobacco
2	Livestock and poultry	Cattle, goat, sheep, pig, guinea fowl
3	Bushmeat	Birds, primates, invertebrates (<i>Chelonia spp.</i> , <i>Scuiridae</i> , <i>Tragelapus scriptus</i> , <i>Thryonomys swinderianus</i> , <i>Cephalophus maxwellii</i> , <i>Myosciurus spp.</i> , <i>Cricotomys gambianus</i>)
4	Freshwater	Ground and underground water used in households and on farms (Borehole, dugout wells, dams, rainwater)
5	Wildplants	Edible and non-edible plants, fruits, seeds, (<i>Khaya senegalensis</i> , <i>Parkia biglobosa</i> , <i>Vitellaria paradoxa</i> , <i>Solanum torvum</i> , <i>Rubus ssp</i>)
6	Fodder and forage	Leaves, pods, fruits, bark of trees and shrubs (<i>Acacia albida</i> , <i>Mangifera indica</i> , <i>Leucaena leucocephala</i> , <i>Moringa oleifera</i> , <i>Carica papaya</i> , <i>Vigna</i>

		<i>unguiculata, Azadirachta indica, Lannea acida</i>)
7	Traditional medicine	Whole plant, roots, bark, fruits, leaves, seeds (<i>Securitaca longepedunculata, Ceiba pentandra, Vitellaria paradoxa, Eucalyptus spp., Crescentia cujete, Adansonia digitata, Parkia biglobosa, Ficus gnaphalocarpa, Tapinanthus bangwensis, Azadirachta indica</i>)
8	Fuelwood	Dried and dead stems, branches, charcoal burning (<i>Prosopis africana, Khaya senegalensis, Detarium microcarpum, Vitellaria paradoxa, Psedocedrela kotschi</i>)
9	Building materials	Mud, thatch, dried grass (<i>Pennisetum purpureum</i>), cow dung, neem (<i>Azadirachta indica</i>), sticks and branches (<i>Parkia biglobosa</i>)

Source: Modified from Boafo et al. 2014

2.2.2 Data Analysis

Quantitative data (provisioning ES sharing patterns and network structure, seasonality effects, and determining factors of sharing) were analyzed using descriptive statistics (frequencies, percentages, and mean) with IBM SPSS Statistics version 20. Categorical variables were analyzed using cross tabulations to calculate Pearson's chi-square (X^2) statistics. In order to understand and appreciate the influence of selected socio-demographic variables on provisioning ES sharing across households (binary dependent variables; 0, 1; **Table 1**), we performed a regression analysis. The logistic regression model used to estimate household sharing abilities for particular provisioning ES is shown below:

$$Y_i = \alpha + \beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 + \beta_6 + \text{error}$$

Y_i is the dependent variable and represents whether a household head shares a particular provisioning ES or not, α is a constant and the β_s are the explanatory variables (β_1 = education: non-formal, primary and junior high, secondary or others, β_2 = religion: muslim, christian or traditionalist, β_3 = marital status: married, never married, divorced or co-habiting, β_4 = residency status: native or migrant, β_5 = annual household income: below GHS 1000, GHS 1000–2,999, GHS 3000–5,999, and over GHS 6000, and β_6 = household size: 1–3, 4–6, 7–10 or more than 10).

Qualitative data collected from the different field survey activities were analyzed using the inductive grounded theory approach (Strauss and Corbin 1998). The transcribed data were categorized into themes and sub-themes. Quotes from the transcripts that addressed critical questions in the study were noted to support quantitative responses.

3. Results

3.1 Provisioning ecosystem services-sharing patterns and network structures

From the survey results, traditional medicine is the most commonly shared of the nine provisioning ES as indicated by the largest proportion of household heads (86.2%). Building materials are the least shared (23.1%). Other provisioning ES including bushmeat, wildplants, fuelwood, and crops and vegetables can be considered as being moderately shared by households across the study communities (**Table 2**).

Table 2. Provisioning ecosystem services-sharing pattern stratified by community and household wealth rank

Type of provisioning ecosystem service	Overall (n=160)	Sharing patterns across communities and wealth ranks (%)					
		Yoggu		X ²	Kpalgun		
		Wealth rank			Wealth rank		
		Low (n=52)	High (n=28)		Low (n=61)	High (n=19)	
Crops and vegetables	50.6	53.8	60.7		36.8	47.5	*
Livestock and poultry	48.8	50.0	35.7	*	50.8	57.9	
Bushmeat	58.8	57.7	71.4	*	54.1	57.9	
Fresh water	50.6	46.2	64.3	*	45.9	57.9	*
Wild plants	58.1	61.5	50.0	*	60.7	52.6	
Fodder and forage	37.0	36.5	35.7		34.4	47.4	*
Traditional medicine	86.2	92.3	85.7		80.3	89.5	
Fuelwood	54.4	48.1	60.7	*	47.5	52.6	
Building materials	23.1	17.3	25.0		32.8	5.3	**

n = number of observations, χ^2 = chi square (Pearson's) test of significance, *: p < 0.05, **: p < 0.01

When sharing pattern is stratified across household wealth ranks, we observe a significant difference across the study communities. At Yoggu, high-wealth ranked households are more likely to share bushmeat, fresh water, and fuelwood (all at a 0.05 significance level), whereas low wealth-ranked households tend to better at sharing livestock and poultry and wildplants. Similar to Yoggu, high-wealth ranked households at Kpalgun appear to be more active in the

sharing of fresh water in addition to crops and vegetables. On the other hand, low-wealth-ranked households at Kpalgun are the more active when it comes to sharing fodder and forage and building materials (**Table 2**).

Sharing network examines household heads perception of the most important spatial direction — (i) within community, (ii) outside community or (iii) both,—for gifting or exchanging each of the nine provisioning ES as illustrated in **Table 3**. The results generally indicate that the majority of sharing takes place within community for all but two of the nine provisioning ES, traditional medicine and wildplants. With traditional medicine, sharing appears spread nearly evenly across the three network structures, although both are slightly higher. In the case of wildplants, sharing is fairly balanced between within community and outside community in Yoggu, but is variable in Kpalgun. The statement by a traditional healer from Kpalgun may be corroborating the above:

‘Our ancestors have taught us that we must share medicine from plants free of charge irrespective of where one comes from. We believe that if you take money, the medicine will lose its efficacy. You can only take kola as a token of appreciation. I have known this practice since I was born. However, this practice is changing as some herbalists’ charge money, and I blame all this on increased poverty’.

Table 3. Provisioning ecosystem services-sharing network structure

Type of provisioning ecosystem service	Sharing network structure (%)							
	Yoggu				Kpalgun			
	Within community	Outside community	Both	X ²	Within community	Outside community	Both	X ²
Crops and vegetables	75.6	4.4	20.0	**	66.6	16.7	27.8	*
Livestock and poultry	64.0	14.0	22.2	*	57.1	14.3	28.6	*
Bushmeat	70.0	14.0	16.0	*	79.5	13.6	6.8	**
Freshwater	59.5	23.8	16.7	*	55.3	21.1	23.7	*
Wildplants	43.5	45.7	10.9	*	53.2	29.8	17.0	*
Fodder and forage	79.3	6.9	13.8	**	71.0	9.7	19.4	**
Traditional medicine	26.4	33.3	40.3		21.2	36.4	42.4	
Fuelwood	71.4	4.4	14.3	**	51.3	16.7	10.3	*
Building materials	80.0	6.7	13.3	**	71.4	14.3	14.3	*

χ^2 = chi square (Pearson’s) test of significance, *: $p < 0.05$, **: $p < 0.01$

3.2 Effects of seasonality on provisioning ecosystem services-sharing

A statistically significant relationship is observed between seasonality and provisioning ES sharing across the study communities (**Table 4**). According to a large proportion of survey respondents, bushmeat, fresh water, wild plants, fodder and forage, and fuelwood sharing is at its peak during the dry season. Distinctly, traditional medicine and building materials sharing is done all year round according to the overwhelming proportion of respondents in both Yoggu (76.4% and 60%) and Kpalgun (65.2% and 62%) respectively.

Table 4. Effects of seasonality on provisioning ecosystem services-sharing pattern

Type of provisioning ecosystem service	Period of the year (season) (%)							X ²
	Yoggu			X ²	Kpalgun			
	Wet (farming)	Dry (Drought)	All year		Wet (farming)	Dry (Drought)	All year	
Crops and vegetables	57.8	35.6	6.7	**	61.1	33.3	5.6	**
Livestock and poultry	25.0	30.6	44.4	*	16.7	52.6	31.0	*
Bushmeat	20.0	70.0	10.0	**	25.0	61.4	13.6	*
Fresh water	19.0	64.3	16.7	*	18.4	71.1	10.5	**
Wild plants	26.1	52.2	21.7	*	21.3	66.0	12.7	*
Fodder and forage	20.7	69.0	10.3	*	29.0	58.1	12.9	*
Traditional medicine	8.3	15.3	76.4	**	7.6	27.3	65.2	**
Fuelwood	23.8	57.1	19.0	*	17.9	74.4	7.7	**
Building materials	20.0	20.0	60.0	*	28.6	9.4	62.0	**

χ^2 = chi square (Pearson's) test of significance, *: p < 0.05, **: p < 0.01

3.3 Determinants of participation in provisioning ecosystem services-sharing

3.3.1 Influence of socio-demographic variables

The results of the logistic regression analysis show a considerable variation in the effect of the selected variables on the household sharing of each of the nine provisioning ES (**Table 5, Appendix 2**). Annual household income has the most significant influence on sharing, where higher income households are more likely to share provisioning ES. This is reflected in the significant relationship between income and the sharing of bushmeat, freshwater, wild plants, fodder and forage, traditional medicine, and livestock and poultry (all at 0.05 significance level). With regards to education, non-formally educated households are more likely

to share traditional medicine ($p < 0.05$). Muslim households are more likely to share livestock and poultry ($p < 0.05$) compared to Christian or Traditionalist households. Furthermore, married households are the most likely to share bushmeat, as the regression model showed a significantly greater relationship ($p < 0.01$). Natives compared to migrants appear to be more active when it comes to livestock and poultry sharing ($p < 0.05$).

Table 5. Logistic regression results showing the influence of selected socio-demographic variables on provisioning ecosystem services-sharing, N = 160

Independent variables	Dependent variables (Do you share ? 0= No, 1=Yes)								
	CV	LP	BM	FW	WP	FF	TM	F	B
1= Education	-0.043	0.392	-0.223	-0.033	0.289	-0.356	0.696*	0.082	0.361
2= Religion	-0.124	-0.656*	0.283	-0.339	0.990	-0.165	0.526	-0.222	0.445
3= Marital status	-0.254	0.300	-0.951*	-0.278	0.036	0.346	-0.045	0.097	-0.032
4= Residency status	0.123	-1.213*	0.086	0.107	0.214	0.495	-0.451	0.015	0.186
5= Annual household income	0.004	0.000*	0.000*	0.000	0.000*	0.000*	0.001*	0.000*	8.570
6= Family size	0.050	0.111	-0.183	0.131	-0.086	-0.119	0.133	-0.015	0.162
Constant	0.635	0.982	1.203	0.636	-0.981	-1.685*	-0.151	-0.290	-2.299

N= number of observations, *: $p < 0.05$, **: $p < 0.01$,

(CV: Crops and vegetables; LP: Livestock and poultry; BM: Bushmeat; FW: Fresh water; WP: Wild plants; FF: Fodder and forage; TM: Traditional medicine; F: Fuelwood; B: Building material)

4.3.2 Influence of socioeconomic, cultural, and environmental factors

Beyond the effect of socio-demographic variables (**Table 5**), sharing is influenced by a number of closely linked environmental, cultural, and socioeconomic factors according to household heads interviewed (**Appendix 3**). As an example of environmental drivers, the most frequently cited reason by respondents was to 'reduce pressure on endangered plant and animal species,' with a score of 90%; the least cited reason in the same category was to 'help address overharvesting and wastefulness,' which received a score of 85%. Among the cultural drivers, the most frequently cited reason was 'an important religious duty as a muslim,' which was mentioned by 77% of respondents; the least cited reason was the 'expectation of a reward in the next world,' mentioned by 46% of respondents. The most frequently cited socioeconomic motivation was to 'show unity, love, and togetherness,' which was mentioned by 89% of

respondents; the least frequently cited reason for sharing was ‘just reward for labour in the farm,’ which was mentioned by 45% of respondents.

3.4 Perceptions on changing trends in provisioning ecosystem services-sharing

Based on memories and experience of the 1981-1983 drought across Ghana (Ofori-Sarpong 1986) as an example extreme disaster event and how it impact of livelihood systems, respondents’ were asked to evaluate their perception on how sharing as a communal practice has been changing since. A higher proportion of respondents (64%) are of the opinion that provisioning ES sharing is decreasing over the stated timeline. Approximately 27% say that the practice has been increasing, whereas the remaining 9% answered ‘I do not know’ to the question citing the difficulty in measuring such changes (Appendix 4). According to respondents, the decreasing trends in sharing should be blamed on persistent poverty in their region (92%), increasing disregard for traditional values on resource management (88%), weakening extended family systems (83%), and emergence of larger family sizes (65%). A statement by a focus group discussant at Yoggu best summarizes the above:

‘Before the big and extensive drought and subsequent bushfires of 1983, there was so much food and even water in this village. My father used to share his catch from hunting with most of our neighbors and our relatives who live in the next village. However, nowadays we experience a lot of shortages especially during the dry season, the land is infertile so we cannot access or cultivate enough yam and maize for our household, although sharing has decreased in recent years, it has helped us survive famine in times past.’

Conversely, respondents who perceive sharing to be increasing described interrelated reasons, including the increasing loss of biodiversity leading to scarcity of provisioning ES (96%), persistent poverty among households (90%), proliferation of social and cultural factors (85%), and increase in the frequency of natural disasters (81%), among others.

4. Discussion

4.1 Provisioning ecosystem services-sharing patterns and network structures

Our survey results show that sharing is a widely recognized community-based practice that affects the utilization and redistribution of critical provisioning ES (Boafo *et al.* 2014) among

1 rural households in semi-arid Ghana. Generally, the observed patterns of sharing can be directly
2 linked to their fundamental utilization forms and management systems, which according to locals
3 continually being shaped by changing socioeconomic, cultural and environmental conditions.

4 We explore two practical factors in the study sites to plausibly explain why traditional
5 medicine is the most commonly shared of the nine provisioning ES by households as other
6 studies have found (Buchmann 2009). First, local beliefs and customs at both Yoggu and
7 Kpalgun maintain that it is a taboo for traditional healers (main suppliers of herbal medicine) to
8 collect money from community members who seek their service because ‘the gods have given it
9 freely.’ Typically, payment is expected in the form of kola nuts (*Cola acuminata*). Traditional
10 medicine is perceived to lose its efficacy if one charges money. **Second, the increasing scarcity**
11 **of medicinal plant species as has been reported across Ghana’s semi-arid ecosystem (O’Higgins**
12 **2007) negatively impacts the ability of individuals to collect their own plants for medicine.**
13 **People are therefore being forced to look for herbal medicine beyond their household or**
14 **community.** During several direct field observational walks with a traditional healer at Kpalgun,
15 he emphasized on the challenges in his profession due to the impacts of biodiversity species loss
16 and scarcity.

17 From the questionnaire surveys, we notice more than half of respondents’ claiming to
18 share bushmeat, wildplants, fuelwood, livestock and poultry as well as crops and vegetables
19 (**Table 2**). This result may be re-emphasizing the safety net function of provisioning ES for
20 majority of rural households and communities in semi-arid regions (Fafchamps 1998, Dercon
21 1998, 2002, McSweeney 2004, Moll 2005, Akter et al. 2007, Wouterse and Taylor 2008,
22 Paumgarten and Shackleton 2011, Fagerholm et al. 2012). From our participant observations
23 survey, livestock and poultry in addition to being a source of food is sold to generate income to
24 cope with low crop yield, a form of insurance, a source of manure or traction, and a symbol of
25 wealth in the community. Fundamentally, households are likely to share all of the above
26 provisioning ES in order to fulfill daily and seasonal livelihood needs and obligations although

1 they are all widely collected and used (Boafo et al. 2014). At both study communities it is not
2 uncommon for hunters to give away some of bushmeat catch after hunting. Building materials
3 and fodder and forage low sharing pattern as our survey results (**Table 2**) show, can be attributed
4 to their innate characteristics as provisioning ES. First, building materials are among the most
5 sparingly used provisioning ES despite the critical nature. For example, thatch roofs, according
6 to a number of interviewees, are often replaced once a year and that according to most household
7 heads is considered as an ‘individual’s own task’. Observed fluctuations in quantity and quality
8 of fodder and forage at different times of the year best explains its sharing pattern as our survey
9 results show. In dry season, when the rainfall that is needed to enhance natural fodder growth is
10 inadequate and irregular, shortage and scarcity arises. Conversely, forage is often in ample
11 supply in the wet season, thus allowing individual households to collect as much as needed
12 without relying on others.

13 The analysis of sharing patterns according to wealth ranks shows differentiation in
14 sharing of the nine provisioning ES between high-wealth ranked and low-wealth ranked
15 households (**Table 2**). The most plausible explanation for the observed variation is in locals’
16 ability to access and produce physical or technical capital. High-wealth ranked households being
17 the most active in sharing bushmeat, fuelwood, crops and vegetables, and freshwater can be linked
18 these particular provisioning ES often requiring additional technical input or capital in order
19 to access or produce them. Known for possessing multiple physical assets and income sources,
20 high-wealth ranked households may be able to buy ancillary assets such as guns to hunt
21 bushmeat, fertilisers to improve crop yields, and materials to construct more wells or buy water
22 tank to store water (Shackleton and Shackleton 2006, Chirwa et al. 2008, Kalaba et al. 2010,
23 Paumgarten and Shackleton 2011). Low-wealth ranked household high propensity to share
24 livestock and poultry, wildplants, building materials, as well as fodder and forage can best be
25 explained by the limitation of substitutes. Thus, even though livestock’s contribution to the
26 household’s asset base is well-acknowledged by all, for most low-ranking households in terms of

wealth giving away livestock, usually in the form of goats and sheep, is necessary in case of crises or in fulfillment of social obligations, like marriage. This finding gives credence to the old adage which says, '*you cannot give what you don't have*'.

The information on sharing network structure suggests that majority of households share all but two provisioning ES, traditional medicine and wildplants within their community (**Table 3**). This result may be indicative of the existence of greater connectivity, social capital, and interactions within and across households and communities. From our observations however, geographical proximity (Conley and Udry 2010) may be the most plausible explanation for this network structure. Traditional medicine and wildplants distinctiveness as earlier discussed is evidence of the strong influence of socio-cultural beliefs and norms as well as local environmental conditions impacting of their use and management. We will provide two illustrative examples to explain this pattern. First, beyond the inherent socio-cultural values linked to traditional medicine's use, households here have limited access to and cannot afford modern or western health services, hence their reliance on it all year round. Second, communal collection and processing of wildplants like *vitellaria paradoxa* (shea) by women outside communities for home consumption and income generation is widely undertaken (Jasaw et al. 2015).

4.2 Effects of seasonality on provisioning ecosystem services-sharing.

Our survey found that bushmeat, fresh water, wild plants, fodder and forage, and fuelwood sharing increases in the dry season across both communities. The upsurge in sharing during this time of high dependence can be linked directly to shortage and scarcity of these goods. Studies in other semi-arid regions of Africa provide evidence increased dependence on nature-based resources needed for livelihood sustenance (Dei 1998, Shackleton and Shackleton 2006, Thornton et al. 2006, Boko et al. 2007). From our field survey, we found that the above provisioning ES are not necessarily considered by locals to contribute greatly to the erosion of household asset bases compared to other provisioning ESs like livestock and poultry, and crops

1 and vegetables. Comments, such as the following were widely expressed by participants during
2 focus group meetings in both study communities: "...even common grasscutter (*thryonomys*
3 *swinderianus*) has become scarce so we have to share as much as possible."; "...the dua
4 (*vitellaria paradoxa*) fruiting is very poor in recent years and most of them are being cut down."; "
5 "...water shortage is our biggest problem in this community, especially in the drought prolongs
6 that normal."

7 Local farming practices coupled with the highly communalistic relationships in the study
8 sites can best explain why majority of interviewees say crops and vegetables are shared the
9 most during the wet season. In the early part of the wet season as we found during our field
10 survey, seeds or seedlings sharing is common while land preparation and planting is taking place.
11 In the late wet season, when harvesting begins and ends, farmers share a percentage of their
12 yields with land tenants in fulfillment of agreements over the use of a plot of land, a practice
13 known as share-cropping. At times, farmers give away some of their yields to needy community
14 members (vulnerable groups: the elderly, sick, those affected by disaster) or institutions
15 (religious leaders and chiefs) within or outside the community as a form of thanks to the gods for
16 a good harvest. Lastly, sharing also occurs if farmers pay hired labor (who help with the harvest)
17 with farm output (for example, dry maize and groundnut).

18 Considering that traditional is the most shared provisioning ES among households and
19 communities, it does not come as a surprise that majority of locals claim to share it all year round.
20 The dominantly all year round sharing characteristic of traditional medicine can practically be
21 explained by households' limited access to and inability to afford modern or western health
22 services (Boafo et al. 2014). This was succinctly stated by the community head and herbalists at
23 Yoggu community:

24 'People fall sick every day, get bitten by snakes, give birth and so I am regularly called upon to prepare
25 medicine. As you can see now, I am preparing this medicine for my neighbor whose child has convulsion.

Even when people are not sick, I still prepare medicine as some diseases are recurring and people prefer to keep it in case of emergency’.

4.3 Determinants of participation in provisioning ecosystem services-sharing

Households’ ability or willingness to share a particular provisioning ES is influenced by a mix of demographic, socioeconomic, environmental, and cultural variables (**Table 5, Appendix 3**). The significant relationship between annual household income and sharing patterns of majority of provisioning ES as results (Table 5) show is not surprising. This finding reinforces earlier discussions in this study which states that households with better financial and physical capital as well as assets are typically expected produce more or access variety of provisioning ES compared with those with limited assets. This plausibly explains why higher income households are better at sharing more diverse provisioning ES. Lino et al.’s (1998) study conducted in the United States similarly found that income status significantly influenced the exchange ability of household goods. Hofferth and Iceland (1998) have also reported similar evidence in their comparison of social capital in rural and urban communities of the United States of America.

Our survey results indicating Muslim-headed households to be more likely to share livestock and poultry be explained using two empirical outcomes. Firstly, Muslims form the largest cohort of the religious groups (57%) in the study communities (**Appendix 2**). By the local sociocultural customs, cattle, sheep, and goats are to be presented as part of the dowry during marriage ceremonies to the bride’s family. Secondly, during annual religious festivals and celebrations, such as *Eid-al-Fitr* (Breaking the Fast Feast), *Eid-al-Adha* (Sacrifice Feast) and *Bugum Chugu* (Fire Festival), livestock and poultry are slaughtered to provide meat for sharing among friends, relatives or neighbors and guests.

One plausible explanation for married households being the more likely to share bushmeat relates to the highly polygamous nature of the study communities. Polygamous

household heads may be required to give some of their catches to their wives, who may or may not live in the same compound house. Although we found little evidence to explain why migrant household heads are less likely to share livestock and poultry compared to natives, we hypothesize that migrants may have less social interaction and connectivity with other members of the community, and therefore less sharing partners. The survey finding showing non-formally educated households to be the more likely to share traditional medicine may be corroborating existing studies (Alilio et al. 1998, Fawole and Onadeko 2001) which have all reported that uneducated compared to educated households have more knowledge of and use traditional medicine and also the more likely to consult a traditional healer. In the context of our study communities, this result buttresses earlier discussions on the wide use of traditional medicine in the absence of western medicine (Boafo et al. 2014).

In addition to the above demographic variables, which our survey results show as weakly determining individual households participation in provisioning ES sharing, other variables linked to local beliefs, customs and rites as well as regulations were found to affect peoples' willingness or ability to participate in sharing. The results from the questionnaire point to a number of closely related factors, indicating households' positive perception of sharing as an action which contributes to safeguarding ecosystems. Among the socioeconomic, environmental, and cultural categorizations, further analysis shows that the environmental reasons are mentioned more frequently by a large proportion of the household heads interviewed (**Appendix 3**). This result provides further evidence of how environment-related changes and the resulting disasters, notably floods, bushfires, irregular rainfall, and droughts, are increasingly exposing the vulnerability of households in semi-arid Ghana.

4.4 Perceptions on changing trends in provisioning ecosystem services-sharing

The surveyed respondents' perceptions pertaining to the observed changes in trends in the sharing of provisioning ES with their communities is best understood through an analysis of changing local socioecological factors (**Appendix 4**). Interestingly, a significant proportion of

respondents from both groups mention poverty as a major driver of the observed changing trends in provisioning ES sharing. In our opinion, this reflects the broken relationships between ecosystem services and human well-being. Practically, we can analyze this from two perspectives. On the one hand, this result provides further evidence of persistent poverty in semi-arid Ghana compared to the rest of Ghana despite the progress made over the past two decades (Ghana Statistical Service 2014). In the event of hazards such as drought and floods, poor rural households provisioning ES, which are integral livelihood assets and source of food, are either lost or become scarce. On the other hand, this is ample evidence of how provisioning ES still provide a safety net function for the majority of households and communities that do not have the capacity to mobilize other assets beside what the local ecosystem provides. The perception that provisioning ES sharing is decreasing is a recognition of how ecosystem degradation is undermining not just the supply, access, and management of provisioning ES, but also people's ability to practice long-held social and cultural customs.

4.5. Theoretical and practical implications

This study has both practical and theoretical implications. The outcomes provide evidence on how sharing as a local level adaptation strategy in the utilization and management of provisioning ES applies in rural households in semi-arid ecosystems of Ghana. In a region where people are struggling to adapt to changes in their ecosystem due to persistent socioeconomic poverty coupled with climate variability and change effects, sharing readily allows individuals and households to gain access to critical and increasingly scarce provisioning ES. The fact that respondents surveyed perceive sharing as a useful and practical strategy for ensuring equitable access, and promoting sustainable harvesting among others (**Appendix 4**), provides a basis for policy makers and external interventionists to carefully consider local level knowledge and practices in natural resource management efforts. From the survey, a household's motivation for sharing points to a perception of the practice as serving both a reactive and proactive function. Given the limited adaptive capacity options and lack of social support systems for rural

households in semi-arid Ghana, sharing's reactive function may be critical in helping to redistribute resources in times of exposure and vulnerability to common extreme disasters, such as drought, bushfires, and floods. The perceived proactive function of sharing on the other hand indicates locals' appreciation of the long-term benefits for livelihood sustenance and ecosystem sustainability as a result of their participation in the practice.

Whereas high intra-community sharing as is the case of our studied communities, might be particularly significant for enhancing household social capital and cohesion or for reducing risk, its contribution to safeguarding ecosystems and the services they provide may be limited in the long term. The existing inequalities within each community present a major challenge for intra-community sharing. Our survey found that inherent differences in wealth (physical or economic endowments) meant that not all households would have the incentive, motivation, or capacity actively to participate in provisioning ES sharing (Varughese and Ostrom 2001). Considering that these inequities were not expected to be overcome in the short term, we suggest that communities improve their provisioning ES sharing to extend beyond household and communities, as a way to enjoy the collective benefits and risks. Increasing inter-community sharing will not only enhance household access to scarce provisioning ESs, but will also provide the opportunity for households to widen their social interactions and capital and improve their social capital, encourage the exchange of local knowledge and information for managing ecosystem services, as well as promote a sense of shared responsibility for sustainably using and managing ecosystem services. For example, the increased inter-community sharing of common-pool resources (Ostrom 1990), like water from small-scale dams in the study area, although driven largely by scarcity, could help in safeguarding the semi-arid ecosystem's water resources.

5. Conclusion

Climate change and environmental degradation are expected to significantly alter the supply of ecosystem services across all socio-ecological production landscapes of the world, and

1 semi-arid regions are known to be among the most vulnerable. Considering that ecosystem
2 services, especially provisioning ES, will remain part of the wider livelihood strategy portfolio of
3 natural resource-dependent communities, knowledge of practical and sustainable local level
4 responses and adaptations will be critical in framing external interventions. Our present work has
5 provided empirical evidence of how the traditional and communal practice of sharing is being
6 employed by climatically vulnerable rural households in semi-arid Ghana to enhance access and
7 redistribute provisioning ES including crops and vegetables, livestock and poultry, bushmeat,
8 freshwater, wild plants, fodder and forage, traditional medicine, fuelwood, and building materials.

9 No single coping or adaptation strategy can sufficiently enhance the resilience of
10 households and communities that are vulnerable to the effects of climate and ecosystem
11 changes. Moreover, resilience is based not only on one factor but also on the simultaneous
12 functioning of social, ecological, economic, and political factors. As a practice that is strongly
13 connected to the social elements of communities and involves local knowledge, values, and
14 practices, sharing can complement other forms of community-based coping and adaptation
15 strategies when considered as both a short term and long term adaptive strategy. The findings
16 from this research in many ways provides evidence of how collective action based on
17 reciprocity, trusts and networks can promote community resilience as several scholars have
18 discussed (Adger 2003, Ostrom and Ahn 2003, Pelling and High 2005). However, with the lack
19 of data to quantify and value the impacts of sharing on household and communities livelihood
20 sustenance, we recommend further studies to gain a deeper understanding of sharing's role in
21 enhancing resilience to climate and ecosystem changes.

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