Tanzania Journal of Forestry and Nature Conservation, Vol 90, No. 1 (2021) 30-40

THE EFFECT OF AGRICULTURAL INTENSIFICATION ON ECOSYSTEM SERVICES AROUND IHEMI CLUSTER

[1]Sirima, A., [1]Kashaigili, J.J. and [2]Kamau, F.

[1]College of Forestry, Wildlife and Tourism, Sokoine University of Agriculture, Tanzania
[2]The Nature Conservancy, Africa Regional Office, Nairobi, Kenya.

Corresponding author: agnes@sua.ac.tz

ABSTRACT

As the world population continue to increase, the demand for food also increases which necessitate the need for agricultural intensification. Agricultural intensification affects large parts of terrestrial area, therefore, assessment of its contribution to the decrease of ecosystem services is critical for successful conservation in the future. A study was conducted in five districts of Iringa and Njombe Regions, part of Ihemi cluster, to assess the effects of agricultural intensification on ecosystem services. A total of 607 household surveys and 19 Focus Groups discussions were conducted. Descriptive and cross tabulation were used for quantitative analysis while content analysis was used for qualitative data. Findings reveal that there are several benefits communities get from the ecosystem that play a great role on their livelihood. Across all villages, firewood is preferred due to its affordability and availability. Other ecosystems goods such as traditional medicine and mushrooms are hardly available due to clearing of land for agricultural activities, as well as settlement expansion. Community activities, such as valley bottom farming was mentioned as a practice that jeopardize the long-term sustainability of ecosystem resources within the Cluster. Agricultural intensification by investors was also mentioned as a sources of ecosystem depletion. Sustainable agricultural intensification, if adopted, might be one among the solutions to serve the ecosystem around the cluster.

Key words: ecosystem services, biodiversity loss, agricultural intensification, Ihemi cluster.

INTRODUCTION

Agriculture is one among the key sectors for economic growth, food security and poverty reduction (Lyatuu *et al.* 2015). As the world food demand rises, so too does the demand for agricultural land. The major pressure of agriculture on biodiversity is through forest clearance (Jenkins 2003). This is because the traditional and subsistence farming systems were intended to serve local market and provided resilience at a local scale (Tscharnke *et al.* 2005). However, as the demand for food increases worldwide, so is the demand for mechanizing agricultural activities to increase yield. The process of agricultural intensification is associated with an increase in labor inputs, increase use of natural and artificial fertilizer, use of improved seeds, change in technologies, change in agricultural mechanization and frequency of cultivation, changes to the landscape such as irrigation or soil conservation measures (Pretty and Brahucha 2014). Agricultural intensification in most cases involves (1) large scale changes on land cover due to amalgamation effect of fields to enhance farming efficiency (2) changes to landscape structure resulting into landscape homogeneity (3) changes to landscape management from traditional to mechanized (Tscharntke *et al.* 2005; Firbank *et al.* 2008). Since agricultural intensification affects large parts of land area, assessment of its contribution to biodiversity loss is necessary

for successfully future conservation efforts (Tscharntke *et al.* 2005). Theoretically, agricultural intensification sets in motion two countervailing forces, one that increases and another that reduces cultivated areas. Intensification policies have operated under two assumptions (1) the lowlands are resilient to intensification pressures and that they could sustain productivity growth indefinitely (2) that modern technology has provided a 'silver bullet' solution to food supply problems. Therefore, while there is little doubt that the agricultural intensification enables massive increase in agricultural yields in the cluster and beyond, negative environmental impacts cannot be ignored.

Agricultural intensification induces environmental degradation and ecosystem deterioration. Landscape perspective is important in understanding agricultural impacts in conservation of biological resources and provision of ecosystem services (Bennett *et al*. 2009). Agricultural intensification, through increasing inputs such as fertilizer, as well as expansion of farmland at landscape scales, is considered a key driver of biodiversity loss and the decline of ecosystem services (Zhao *et al.* 2013). Ecosystem goods and services are the benefits that people get from the ecosystems (MEA 2005). They are also referred to as the direct and indirect benefits of ecosystems to human-well-being (TEEB 2010, Burkhard *et al*. 2012; Burkhard & Maes 2017).

Agricultural intensification, dramatic land use changes, application of agrochemicals and intensification of resource utilization are among factors contributing towards biodiversity loss (Tilman *et al*. 2001, Firbank *et al*. 2008). This is because, the increase in use of fertilizers (on the upstream/catchment areas) to enhance crop yield can significantly impact on provision of clean water (Bennett *et al*. 2009). Similarly, agricultural intensification that involve use of genetically modified seeds/seedlings has more negative environmental impacts than the claimed increase in crop yield (Groot & Dicke 2002, Hails 2002). On the other hand, agriculture is claimed to have positive contribution towards conservation of diversified ecosystems and may contribute towards provision of ecosystem services such as pollination (Tscharntke *et al.* 2005). Therefore, to meet the growing demand of ecosystem services while increasing agricultural yield, an understanding of the relationship between ecosystem services and agricultural intensification is important.

The Southern Agricultural Growth Corridor of Tanzania (SAGCOT) initiative was launched by the Government of Tanzania in 2010 as a Public-Private Partnership (PPP) dedicated to ensuring food security, reducing poverty, and spurring economic development in Tanzania's Southern Corridor. Further, the Green Growth Investment Framework (the - SAGCOT Green print) was launched with the purpose of refining the SAGCOT strategy to ensure that development in the Corridor is environmentally sustainable, socially equitable, and economically feasible. It is claimed that agriculture in the Southern Corridor is developed in harmony with the natural environment, and maintains the benefits that ecosystems provide to farmers, communities, and the nation as a whole. It is against the above background the paper aim to assess the common ecosystem services that communities within Ihemi Cluster depend on, in relation to the increasing agricultural intensification in the area. Specifically, the paper assesses (1) common ecosystem services communities receive from the cluster (2) challenges brought by agricultural intensification in relation to availability of ecosystem services

MATERIALS AND METHODS

The study area

Ihemi Cluster is located in the eastern-most part of the southern highlands. The cluster comprise of two regions of Iringa and Njombe. These regions form part of the Southern Highlands Zone of Tanzania Mainland which comprises of Ruvuma,

Iringa, Njombe, Mbeya, Katavi, Rukwa Regions and part of Morogoro Region. The regions are located between latitudes 6°30' and 11°0' south of the Equator, and between longitudes 33°30' and 37°0' east of the Greenwich (Figure 1).

Njombe Region borders Iringa Region in the North, Morogoro Region in the East and Ruvuma region in the South. It also borders Republic of Malawi via Lake Nyasa and part of Mbeya Region in the North-West and West. The Region has the total surface area of 24,994 sq. km out of which 21,172 sq. km is covered by land (84.7 percent) and 3,822 sq. km is covered by water (15.3 percent). To the North, Iringa Region shares borders with Singida and Dodoma Regions; Morogoro Region to the East, Mbeya Region to the West while Njombe Region lies on the South. Iringa Region covers an area of 35,743 sq. km out of which 2,704.2 sq km. or 7.6 percent is covered by water bodies of Mtera Dam, the little and Great Ruaha Rivers. The remaining area of 33,038.8 sq km. is land area (URT-PMORALG 2015).

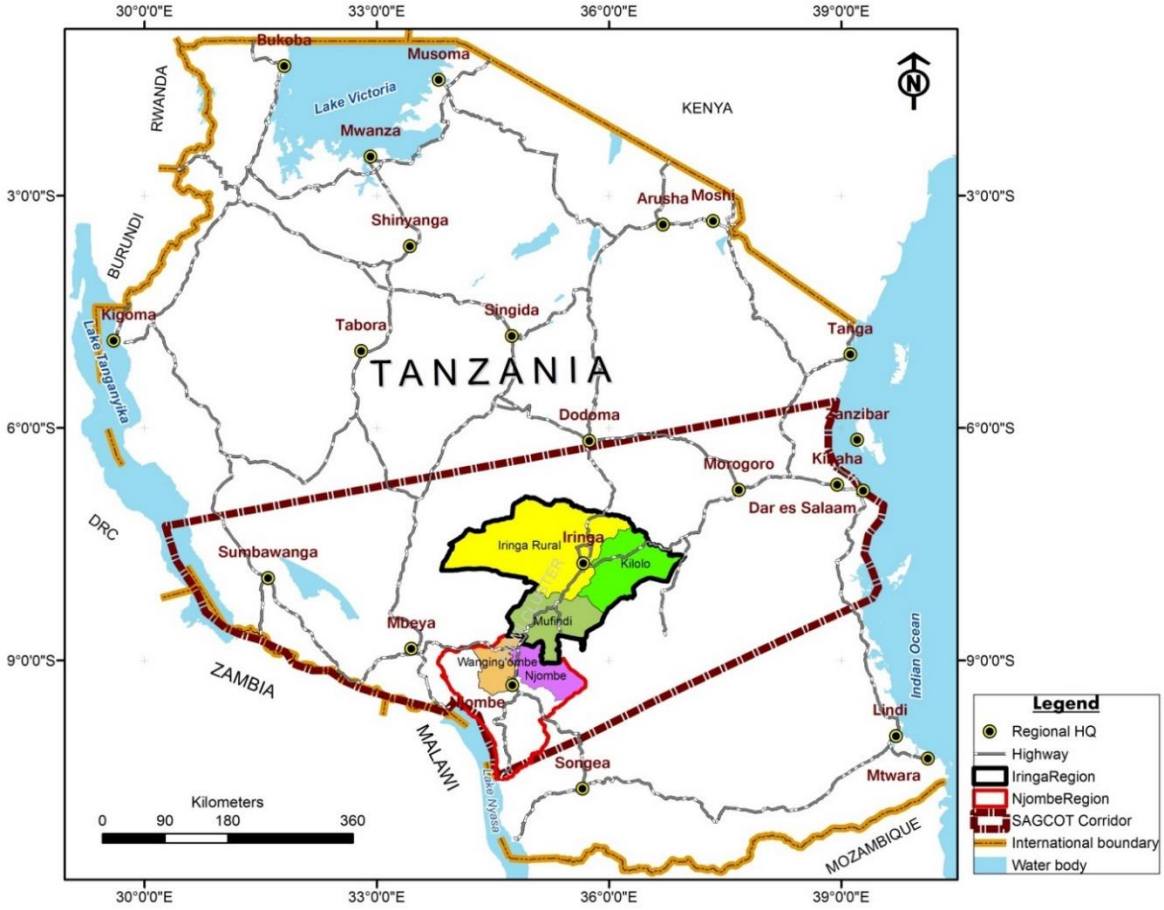

Figure 1: Location of the study area

Methods

A total of 607 households' surveys (376 in Iringa & 231 in Njombe) were conducted in five districts of Iringa DC (n=167), Kilolo (n=119) and Mufindi (n=90) in Iringa Region; Wanging'ombe (n=120) and Njombe (n=111) in Njombe Region. Respondents were categorized into three groups based on their wealth rank as assigned by village leaders. Ten households were randomly selected from each wealth category making a total of 30 households per village. In each household selected for the survey, head of household was considered the key respondent.

A face-to-face paper questionnaire was administered at a respondent's home. In case the head of household was not home, a replacement from the same wealth category was selected. In addition, 19 Focus Group Discussions were carried out. Focus group discussants comprised of about 6-16 local/village government leaders and representatives from communities according to their gender groups. The discussion to include the socio-economic profile and ecosystem services available in the area. Content analysis of the transcribed data was carried out using Excel spreadsheet. Using Excel, data were first sorted into themes and later pattern was generated across themes to show relationships across key issues such as gender groups, farm size, village etc. Two researchers coded the data independently and compared their themes to come up with agreed themes and relationships. The survey was pre-coded prior to data collection. For open ended questions, codes were generated after compiling a list of all responses to ensure that a single code is applied to each response without repetition. Descriptive data analysis, cross-tabulation were conducted to draw inferences on the collected data in response to the study goals.

RESULTS

Ecosystem services

Majority (>80%) mentioned variety of goods and provisioning services received from the ecosystem such as water, wild fruits and vegetables, honey, building poles, traditional medicines and thatch grasses. In terms of energy, the ecosystem provides raw materials for fuel including firewood, charcoal, plant oils and biofuels. Household energy consumption vary based on the distance the household is from the resource. For instance, over 95% of households prefer firewood because it is found within their residential areas as opposed to charcoal where the nearest charcoal supplier is found within 1-5 km. In terms of energy source, results indicate differences in rural household energy consumption based on their availability, accessibility, and level of infrastructure development in the area (Table 1). Similarly, types of energy vary depending on the function and use. For instance, communities mentioned to use charcoal for boiling drinking water while firewood is mainly for cooking (Table 3). Several reasons were given for the choice of energy for cooking and lighting as narrated in Table 1.

Energy for lighting

Regardless of the location, solar and kerosene were the most dominant form of energy source for lighting (Table 2). For example, 49% of respondents in Wanging'ombe state that solar is mostly used for lighting. Solar is preferred because it is affordable/cheap and easily available. During focus group discussions, respondents also added that solar is more reliable, and once installed, has no additional/recurring costs like electricity.

Table 1: Reason for the choice of lighting and cooking main, second & third fuel

PARAMETER	CHARACTERISTICS	IRINGA REGION			NJOMBE REGION	
		Iringa V	Kilolo	Mufindi	Njombe	Wanging'ombe
Lighting Main Fuel	Safe	12 (7.2)	9 (7.6)	9 (10.0)	7 (6.3)	2 (1.7)
	Affordable/Cheap	89 (53.3)	82 (68.9)	59 (65.6)	54 (48.6)	83 (69.2)
	Easily available	30 (18.0)	9 (7.6)	8 (8.9)	15 (13.5)	2 (1.7)
	Bright light	17 (10.2)	6 (5.0)	7 (7.8)	7 (6.3)	8 (6.7)
	Easy to use	6 (3.6)	11 (9.2)	4 (4.4)	8 (7.2)	8 (6.7)
	Affordable and Easily	12 (7.2)	1 (0.8)	1 (1.1)	18 (16.2)	14 (11.7)
	available	1 (0.6)	-	1 (1.1)	-	2 (1.7)
	Bright light and Easy to use	-	1 (0.8)	1 (1.1)	2 (1.8)	1 (0.8)
	None					
	Subtotal	**167 (100)**	**119 (100)**	**90 (100)**	**111 (100.0)**	**120 (100)**
Lighting Second Fuel	Safe	1 (0.6)	1 (0.8)	-	3 (2.7)	-
	Affordable/Cheap	16 (9.6)	5 (4.2)	3 (3.3)	15 (13.5)	3 (2.5)
	Easily available	38 (22.8)	25 (21.0)	22 (24.4)	17 (15.3)	19 (15.8)
	Bright light	4 (2.4)	1 (0.8)	3 (3.3)	3 (2.7)	2 (1.7)

PARAMETER	CHARACTERISTICS	IRINGA REGION			NJOMBE REGION	
		Iringa V	Kilolo	Mufindi	Njombe	Wanging'ombe
	Easy to use	16 (9.6)	1 (0.8)	3 (3.3)	5 (4.5)	7 (5.8)
	Affordable and Easily available	1 (0.6)	-	-	-	-
	Bright light and Easy to use	8 (4.8)	2 (1.7)	1 (1.1)	1 (0.9)	2 (1.7)
	None	83 (49.7)	84 (70.6)	58 (64.4)	67 (60.4)	87 (72.5)
	Subtotal	**167 (100)**	**119 (100)**	**90 (100)**	**111 (100)**	**120 (100)**
Lighting Third Fuel	Safe	1 (0.6)	-	-	1 (0.9)	1 (0.8)
	Affordable/Cheap	5 (3.0)	-	3 (3.3)	-	-
	Easily available	5 (3.0)	1 (0.8)	-	5 (4.5)	-
	Bright light	3 (1.8)	2 (1.7)	1 (1.1)	2 (1.8)	1 (0.8)
	Easy to use	3 (1.8)	5 (4.2)	2 (2.2)	2 (1.8)	1 (0.8)
	Bright light and Easy to use	3 (1.8)	-	-	-	-
	None	147 (88.0)	111 (93.3)	84 (93.3)	101 (91.0)	117 (97.5)
	Subtotal	**167 (100)**	**119 (100)**	**90 (100)**	**111 (100)**	**120 (100)**
Cooking Main Fuel	Safe	1 (0.6)	-	-	-	-
	Affordable/Cheap	74 (44.3)	71 (59.7)	44 (48.9)	49 (44.1)	78 (65.0)
	Easily available	65 (38.9)	31 (26.1)	31 (34.4)	41 (36.9)	25 (20.8)
	Easy to use	6 (3.6)	2 (1.7)	2 (2.2)	2 (1.8)	1 (0.8)
	Affordable and Easily available	20 (12.0)	13 (10.9)	13 (14.4)	19 (17.1)	15 (12.5)
	None	1 (0.6)	2 (1.7)	-	-	1 (0.8)
	Subtotal	**167 (100)**	**119 (100)**	**90 (100)**	**111 (100)**	**120 (100)**
Cooking Second Fuel	Safe	-	1 (0.8)	-	1 (0.9)	-
	Affordable/Cheap	5 (3.0)	2 (1.7)	5 (5.6)	5 (4.5)	1 (0.8)
	Easily available	28 (16.8)	12 (10.1)	4 (4.4)	9 (8.1)	3 (2.5)
	Easy to use	2 (1.2)	1 (0.8)	-	1 (0.9)	-
	None	132 (79.0)	103 (86.6)	81 (90.0)	95 (85.6)	116 (96.7)
	Subtotal	**167 (100)**	**119 (100)**	**90 (100)**	**111 (100)**	**120 (100)**
Cooking Third Fuel	Easily available	-	-	1 (1.1)	-	-
	Easy to use	-	2 (1.7)	1 (1.1)	-	-
	None	167 (100.0)	117 (98.3)	88 (97.8)	111 (100.0)	120 (100.0)
	Subtotal	**167 (100)**	**119 (100)**	**90 (100)**	**111 (100)**	**120 (100)**

Table 2: Energy source for lighting

	Iringa Region			Njombe Region	
	Iringa DC	Kilolo DC	Mufindi DC	Njombe DC	Wanging'ombe DC
Energy source for lighting					
Generator	2 (1.2)	-	-	-	-
Electricity	15 (9.0)	11 (9.2)	8 (8.9)	6 (5.4)	6 (5.0)
Candles	1 (0.6)	-	1 (1.1)	1 (0.9)	-
Kerosene	29 (17.4)	44 (37.0)	25 (27.8)	33 (29.7)	27 (22.5)
Firewood	2 (1.2)	-	-	-	-
Charcoal	3 (1.8)	-	-	-	-
Solar	59 (35.3)	49 (41.2)	36 (40.0)	48 (43.2)	59 (49.2)
Dry Battery	1 (0.6)	-	1 (1.1)	1 (0.9)	1 (0.8)
Torch	47 (28.1)	6 (5.0)	7 (7.8)	10 (9.0)	10 (8.3)
Chinese Solar Light	8 (4.8)	9 (7.6)	11 (12.2)	10 (9.0)	16 (13.3)
None	-	-	1 (1.1)	2 (1.8)	1 (0.8)
Total	**167 (100)**	**119 (100)**	**90 (100)**	**111 (100)**	**120 (100)**

Kerosene is the second energy source for lighting and highly dominant in Kilolo District (37%). Similar to solar, kerosene is easily available and relatively affordable. However, in some of the areas like Makifu village in Iringa DC, the demand for kerosene is very low (17%). The majority use Chinese solar lamps and battery torches. During focus group discussions, discussants at Makifu village reported that some of the shops do not sell kerosene anymore because no one buys it.

Energy for cooking

Firewood is the main source of energy for cooking across the five study districts. Majority of respondents (over 95%) reported using firewood for cooking (Table 3). Since Njombe is often very cold, firewood is used for warming homes and heating water. Similar to solar, firewood is preferred due to

its affordability and availability. In Njombe for instance, most of the firewood comes from the remains of the Wattle trees stems after extracting the bark. Over 90% of communities mentioned gas to be slightly expensive and not readily available in some areas, making it difficult to rely on.

In Wanging'ombe District for instance, 100% of respondents reported to use firewood daily. Similar percentages can be observed in Iringa DC (94.6%), Kilolo (99.2%), Mufindi (98.9%) and Njombe (97.3%) on the same, indicating high rate of forest dependence for firewood.

Like other rural areas of Tanzania, charcoal is not widely used across the study villages. It is occasionally being used for ironing and boiling drinking water, probably the reason why its consumption is low compared to firewood. Households that use charcoal, buy it from nearby areas within their villages. Only 5% of respondents in Njombe District claim to be making charcoal for their own consumption.

Firewood collection

More often women and female children in the family are responsible for firewood collection. Over half of respondents (55.7% in Iringa, 54.4% in Mufindi, 61.3% in Njombe and 55.8% in Wanging'ombe) reported that women are responsible for firewood collection in the households (Table 4). This is common especially in rural African societies where most of the household chores are handled by women. One to two head-loads of firewood are collected weekly from nearby forests. Very few households buy firewood for household use. Since the collection of firewood is not regulated, measures need to be taken to ensure that the forests are not depleted by over consumption.

Table 3: Energy source for cooking

	Iringa Region			Njombe Region	
	Iringa DC	Kilolo DC	Mufindi DC	Njombe DC	Wanging'ombe DC
Energy source for cooking					
Gas	3 (1.8)	-	-	1 (0.9)	-
Firewood	158 (94.6)	118 (99.2)	89 (98.9)	108 (97.3)	120 (100)
Charcoal	6 (3.6)	1 (0.8)	1 (1.1)	2 (1.8)	-
Total	**167 (100)**	**119 (100)**	**90 (100)**	**111 (100)**	**120 (100)**

Table 4: Means of obtaining and responsibility for firewood collection

	Iringa Region			Njombe Region	
	Iringa DC	Kilolo DC	Mufindi DC	Njombe DC	Wanging'ombe DC
Means of obtaining firewood					
Collect and Buy	18 (10.8)	5 (4.2)	6 (6.7)	2 (1.8)	7 (5.8)
Collect	124 (74.3)	91 (76.5)	73 (81.1)	102(91.9)	102 (85.0)
Buy	20 (12.0)	23 (19.3)	10 (11.1)	7 (6.3)	11 (9.2)
None	5 (3.0)	-	1 (1.1)	-	-
Total	**167 (100)**	**119 (100)**	**90 (100)**	**111 (100)**	**120 (100)**
Responsibility for firewood collection					
Male children	1 (0.6)	-	-	-	-
Women and female children	16 (9.6)	24 (20.2)	16(17.8)	17 (15.3)	17 (14.2)
Women	93 (55.7)	48 (40.3)	49(54.4)	68 (61.3)	67 (55.8)
Men	6 (3.6)	8 (6.7)	5 (5.6)	5 (4.5)	7 (5.8)
All household members	8 (4.8)	8 (6.7)	4 (4.4)	6 (5.4)	9 (7.5)
Female children	10 (6.0)	8 (6.7)	5 (5.6)	2 (1.8)	6 (5.0)
Women and male children	9 (5.4)	-	-	6 (5.4)	3 (2.5)
None	24 (14.4)	23 (19.3)	11(12.2)	7 (6.3)	11 (9.2)
Total	**167 (100)**	**119 (100)**	**90 (100)**	**111 (100)**	**120 (100)**

Preferred energy for different uses

Communities were also requested to state their energy choice preference, if all sources (i.e., electricity, gas, firewood, charcoal, solar) are available in the area. Over 70% of respondents across the five study districts prefer electricity Table 5). During focus group discussions, majority mentioned high

service cost (connection & monthly fees) and unavailability of the service in the area as key reasons hindering electricity use in most of the households. However, given the recent developments in rural electrification projects, some of the villages have started receiving electricity installation at village level. For example, some areas in Makifu Village (Iringa Rural District) and Matembwe and Iyembela Villages (Njombe District) have electricity poles close to their households, with few houses already connected.

If all choices were available, electricity, gas, firewood and charcoal were indicated as energy of choice at household level for cooking. However, electricity was the most preferred (43.7 % in Iringa, 56.3% in Kilolo, 53.3% in Mufindi, 45.9% in Njombe and 52.5% in Wanging'ombe) followed by gas (Table 6). High cost (connection and service), availability of the service in the area, lack of appliances and lack of electricity in the house were reported as reasons hindering current use of electricity and gas for cooking.

Table 5: Preferred energy for lighting and ironing

	Iringa Region			Njombe Region	
	Iringa DC	Kilolo DC	Mufindi DC	Njombe DC	Wanging'ombe DC
Preferred energy for Lighting					
Electricity	123(73.7)	96(80.7)	75(83.3)	93(83.8)	95 (79.2)
Biogas	-	-	1 (1.1)	-	-
Solar	42(25.1)	22(18.5)	14(15.6)	18(16.2)	25 (20.8)
None	2(1.2)	1 (0.8)	-	-	-
Total	**167 (100)**	**119(100)**	**90 (100)**	**111(100)**	**120 (100)**
Preferred energy for Ironing					
Electricity	143(85.6)	98(82.4)	76(84.4)	80(72.1)	98 (81.7)
Firewood	3 (1.8)	3 (2.5)	1 (1.1)	1 (0.9)	-
Coal	-	-	-	-	1 (0.8)
Charcoal	8 (4.8)	15(12.6)	9 (10.0)	10 (9.0)	9 (7.5)
Solar	3 (1.8)	3 (2.5)	4 (4.4)	8 (7.2)	6 (5.0)
None	10 (6.0)	-	-	12(10.8)	6 (5.0)
Total	**167 (100)**	**119(100)**	**90 (100)**	**111(100)**	**120 (100)**

Table 6: Preferred energy for cooking

	Iringa Region			Njombe Region	
	Iringa DC	Kilolo DC	Mufindi DC	Njombe DC	Wanging'ombe DC
Preferred energy for Cooking					
Electricity	73 (43.7)	67 (56.3)	48 (53.3)	51 (45.9)	63 (52.5)
Kerosene	5 (3.0)	1 (0.8)	1 (1.1)	-	-
Gas	41 (24.6)	32 (26.9)	28 (31.1)	30 (27.0)	30
Biogas	-	-	1 (1.1)	-	-
Firewood	29 (17.4)	7 (5.9)	2 (2.2)	16 (14.4)	6 (5.0)
Charcoal	14 (8.4)	11 (9.2)	8 (8.9)	11 (9.9)	17 (14.2)
Solar	5 (3.0)	1 (0.8)	2 (2.2)	3 (2.7)	4 (3.3)
Total	**167 (100)**	**119 (100)**	**90 (100)**	**111 (100)**	**120 (100)**

Other ecosystem services

Other ecosystem products identified include wild fruits, mushroom, vegetables, thatch grasses, building poles, honey, and traditional medicines. Some of these ecosystem products are seasonal e.g., mushrooms, while others are available throughout e.g., firewood. Common ecosystem services utilized by majority of households by their local names are found in Appendix 1.

During discussion, community members indicated that most of ecosystem resources are currently not readily available or have become seasonal. For example, mushrooms are usually available during the rainy season around February and March, annually. Its scarcity is also exacerbated by reduction land

parcels due to agricultural expansion by investors who clear and cultivate large chunk of land. Mushrooms are used as food or sold to earn income. Dried mushrooms are sold for about Tsh. 2000 (1 USD) per can of 20 kg while fresh mushroom goes for about Tsh. 5000 (USD 2) per 20 kgs.

DISCUSSION

Communities in Ihemi cluster use ecosystem services for different purposes, most of them for subsistence use. Results indicate that, across all villages a combination of energy sources was used. The use of more than one energy source is a common feature in many low-income households (SPARKNET 2004). Energy used for cooking and heating, both of which are required for basic survival, accounted for most of the energy consumption in the Cluster. This is similar to the 2007/08 National Sample Census of Agriculture results which show that in Njombe DC for instance, 96% of residents use firewood for cooking (Njombe DC Investment Profile 2013).

The trend of energy used for cooking and for lighting depicted by community members in Ihemi cluster is similar to what has been observed elsewhere around the world. For instance, DFIF (2002) observed that majority of rural communities depend on fuel wood, dung and crop residues as source of fuel. Further, results indicated that charcoal has mostly been used for business purposes. This energy source has contributed to the negative impact on the environment by cutting down trees which in turn may leads to decreasing other ecosystem service availability. Although the area is dominantly covered by both planted and natural forest, the rate of consumption may surpass the natural regeneration capacity if measures are not taken, hence resulting in the depletion of these important ecosystem resources.

In terms of energy source, it is important that gradual transfer to modern forms of energy that are environmentally clean is achieved to make sure that the cluster is conserved to continue providing other ecosystem resources. There is also a need to map and quantify ecosystem services demand and supply at the cluster level. Overall, results show that the structure of rural household energy consumption is undergoing a transformation from traditional low-efficiency biomass domination to integrated consumption of traditional and renewable energies. Renewable energy consumption is expected to significantly contribute to the sustainable development of rural households.

Similar to energy sources, other ecosystem services is traditional medicine that used to be the go-to prescription for most of Ihemi communities either due to lack of modern health care facilities and/or lack of its awareness. However, the traditional medicines are currently hard to find due to increased deforestation, as well as due to the negligence of the young generation to continue using this kind of treatment. Similar to DFID (2002) observation, the burden is proportionally higher on women who are the main collector and user of ecosystem resources at household level.

Although benefits that communities obtain from ecosystems are essential to livelihood, the demands for such services often surpass the capacity of ecosystems to provide them (Bennett *et al*. 2005). Kubiszewski *et al*. (2017) argued that, changes to land cover in the past twenty years have reduced the value of the annual flow of ecosystem services by USD 4–20 trillion/yr^2. It is therefore suggested that, for communities to continue benefiting from using specific services that the environment provide, a transaction need to be arranged within which user will pay for a specific service or revel their willingness to pay for a given service (Kronenberg 2014). This is because, in the absence of market value for these services, there is a tendency to over exploit the resources especially when the long-term sustainability of land tenure where these resources are found is not sustainable. Furthermore, given that these ecosystem services are finite and, in most

cases, non-renewable, there is usually a cost associated with their overexploitation.

Ihemi cluster is pressured by a growing demand for land to increase agricultural production through investments, tree planting and clearing of natural forest for different uses such as agriculture, urbanization and the draining of natural wetlands (valley bottoms for agriculture popularly locally known as *vinyungu*[1] farming). Most of the *vinyungu* areas exist as shallow subsurface water, thus drainage of them has been a common practice, converting to agriculture or urban development, but this has detrimental effects as it can result in decreased recharge to groundwater and increased flooding in the developed area. Generally, if wetlands are drained, biological impacts may be substantial because wetlands are some of the most biologically productive ecosystems on Earth. For instance, most of the wetlands (*vinyungu*) are water sources for the most rivers in the cluster. Their conversion to agriculture has impacted on the water resources by causing some rivers to dry-out or becoming seasonal. The sustainability of water supply as a key ecosystem resource in the Ihemi cluster is jeopardized by the human actions.

CONCLUSION

Although the area is dominantly covered by forest both planted and natural forest, the rate of ecosystem services uses if not regulated may surpass the natural regeneration capacity resulting in the depletion of these important ecosystem resources. Although most of the firewood used especially in Njombe is from the remains of the wattle trees, the consumption rate is not equivalent to the regeneration or planting capacity. To continue enjoying the ecosystem benefits, measure need to be put in place to facilitate tree planting, introducing the use of improved energy stoves, and sustainable farming, to mention but few. Further, communities need to be empowered to understand and practice sustainable natural resources management. Responsible authorities need to ensure that the National Environmental Management Act of 2004 that oversees all issues on environment is enforced.

Acknowledgements

The authors highly acknowledge the financial support from a research program on Water Land and Ecosystem (WLE), an ambitious 12 years CGIAR's Research Program led by the International Water Management Institute (IWMI) and all people consulted.

REFERENCES

Kubiszewski, I. Costanza, R., Anderson, S. & Sutton, P. 2017. The future of ecosystem services: Impacts on ecosystem service values, and global and national scenarios. Ecosystem Services 26: 289-301.

Bennett, E.M., Peterson, G.D. & Gordon, L.J. 2009. Understanding relationships among multiple ecosystem services. Ecology letters 12 (12):1394-1404.

Bennett, E.M., Peterson, G.D. & Levitt, E.A. 2005. Looking to the Future of Ecosystem Services. Ecosystems 8 (2): 125-132.

DFID. 2002. Energy for the poor: Underpinning the Millennium Goals. London, UK

Firbank, L.G., Petit, S., Smart, S., Blain, A. & Fuller, R.J. 2008. Assessing the impacts of agricultural intensification on biodiversity: a British perspective. Philosophical Transactions of the Royal Society 363(1492): 777-787.

[1] Valley bottom farming

Groot, A.T. & Dicke, M. 2002. Insect-resistant transgenic plants in a multi-trophic context. Plant Journal 31: 387-406.

Hails, R.S. 2002. Assessing the risks associated with new agricultural practices. Nature 418, 685-688.

Jenkins M. 2003. Prospects for biodiversity. Science 302: 1175-1177.

Kronenberg, J. 2014. Environmental Impacts of the Use of Ecosystem Services: Case Study of Birdwatching. Environmental Management 54: 617-630.

Lee, D.R & Barrett, C.B., 2001. Trade-offs or Synergies? Agricultural intensification, economic development and the environment. CABI publishing, UK, 538p.

Lyatuu, E.T., Nie, F. & Fang, C. 2015. The Role of Agriculture in the Economic Growth and Poverty Reduction in Tanzania. Journal of Economics and Sustainable Development 6(14): 154-165.

Pretty, J. and Bharucha, Z.P. 2014. Sustainable intensification in agricultural systems. Annals of Botany 1-26.

SPARKNET. 2004. South Africa Country Report Synthesis.

Tilman, D., Fargione, J., Wolff, B., D'Antonio, C., Dobson, A. & Howarth, R. 2001. Forecasting agriculturally driven global environmental change. Science 292:281–284.

Tscharntke, T., Klein, A.M., Kruess, A., Steffan-Dewenter, I. & Thies, C. 2005. Landscape perspectives on agricultural intensification and biodiversity – ecosystem service management. Ecology letters 8(8): 857-874.

Burkhard, B., Maes, J. (Eds.). 2017. Mapping Ecosystem Services. Pensoft Publishers, Sofia, 374 pp. Available at: http://ab.pensoft.net/articles.php?id=12837.

TEEB. 2010. The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB. p. 36.

Millennium Ecosystem Assessment. 2005. Ecosystems and Human Wellbeing: Synthesis. Island Press. Washington, DC, p. 137.

Burkhard, B., Kroll, F., Nedkov, S. & Müller, F. 2012. Mapping supply, demand and budgets of ecosystem services. Ecological Indicators 21: 17-29.

Zhao, Z.H., Hui, C., Ouyang, F., Liu, J.H., Guan, X. Q., He, D. H. & Ge, F. 2013. Effects of inter-annual landscape change on interactions between cereal aphids and their natural enemies. Basic Applied Ecology. 14: 472–479.

Appendix 1: Ecosystem products/resources in the Ihemi Cluster

Grass and tree products	Vegetables	Fruits	Traditional Medicines	Wild-animals
Boriti Kuni Majani ya kusukia vilago na vikapu/vilago /nyungo Mawe ya kujengea Mazinga ya nyuki Mbao Mianzi. Mkaa Nguzo	msuga nyahedai nyangelesa nyangololo sakulwihe ukalfya mdoda Umpasenga Unyafigulu Unyafikwe unyahipo, unyanyongo, unadagata, Unyamgulu, Unyikolo, Nyamalagata,	Magola, Mapinkipinki, Masaula Matangadasi, Mduma, Mgolo, Mibuyu miduwa Mifudio (fuvu) Mifudu, Migora, Mijombe, Mikusu, Misada, Misambarawe Misasati,	Disowi degedege majani Kimakosa vidonda (mizizi) Lipase dawa ya tumbo la kusokota Lisoiwi –degedege Litenganiko (jatropha)-tezi, Lugohomolo – kikohozi luhahii tumbo la kuhara watoto - mizizi Lusasa macho kuwasha -mizizi Lusenyi - Degedege Lutona dawa ya tumbo -mzizi Lwenyi – degedege Madihanyi – degedege kwa watoto. Magugu- minyoo - majani Maholohodzi – inashusha BP -majani	Kumbikumbi Ndezi Nguruwe-pori Njiwa pori

Grass and tree products	Vegetables	Fruits	Traditional Medicines	Wild-animals
	Ulyafini, Wilundasa, Wilulu. Wihongole Wikulwe, Wilelema Wisogolo Wiwalagata Wizimba	Misaula, Misombe Mitowo, Mitundwa, Mivengi, Miwewe, Mkusu, Mlubaya, Msasita Msaula, Mtafutwa Mutowo Ngaluunyi, Mlambanusi, Mindokoli, Nyafiguru Nyanya songwe, Passion mwitu Sada Ubaswa, Ubuyu Udagala. Udavi, Ukolekole, Unyali (Ukwaju) Unyamala, Welefu,	Matembetembwe – kideli cha kuku, vidonda vya tumbo, upele usoni. Mavi ya tembo mtoto – degedege Mbelebele – kutibu jipu linalotembea Mchechefu –rangi kwenye vyungu kuimarisha chungu\ Mdetele - degedege, kideri Mdudu – Tumbo typhoid Mdudwe – kutibu misuli. Mfakigulu, mdaa- kung'arisha meno - mizizi Mhemi – upele – magome Mhunza mwelu - kifua -mzizi Minyanga –surua Miulungu- tumbo kama lina gas – mizizi Mkomanga - + Msaula – Ugiri Mmulimuli – kifua Mnong'anongwa – degedege Mtawala – degedege -majani na mizizi ngiri. Mvambaravidundu dawa ya tumbo kusokota - majani na mizizi Mwalobaini pori majani Mwekele kupata choo mizizi Mwilitu –magome BP na ngozi Ndula jino tunda na hata mizizi ngiri Nsyoye degedege mizizi Nyalabafi viti na dawa, neumonia Rauti-kichomi (mizizi) (macho kufukiza)	