TRADEOFFS BETWEEN LAND USES IN THE SOUTHERN HIGHLANDS OF TANZANIA

An Economic Evaluation of the Impacts to Ecosystem Services and Livelihoods in the Southern Highlands

Report for the UNEP Project TEEBAgriFood, 2019 – 2022

Institute for Resource Assessment

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EXECUTIVE SUMMARY

Introduction

The study was carried out to understand the potential impact of rapid transformation of land uses to the functioning of the Southern Highlands (SHL) natural system and mainstream them in decision-making by highlighting several trade-offs made in land-use decisions. Southern Highlands are characterized by temperatures averaging around 23^{o}C and rainfall ranging from 250 mm in lowland to over 1,800mm in highland areas, a climatic condition that make much of SHL suitable for production of temperate crops like tea, fruits and vegetables and attractive for investment in commercial production of the crops. In addition, SHL is favourable for exotic timber production, and the communities living in the area have highly motivated to engage in exotic trees forest plantation at an unprecedented rate. Most tree species planted are pines and eucalyptus, mainly for commercial purposes such as timber and building poles production. Exotic forest plantations are now competing with other land uses such as agriculture and conservation of water resources. Much of the mountain grasslands and woodlands are being converted for crop and exotic timber production.

Equally important, low evapotranspiration make Southern Highlands to have abundant water resource compared to other areas of the country. Most streams originating from SHL combine to form many major rivers draining to the East to the Indian Ocean and Southwest to Lake Nyasa. To the East they form the Great Ruaha River (GRR), Kihansi and Ruhudji Rivers which then join to form the Rufiji River. This attracts investment in hydropower generation downstream, and water abstraction for domestic, irrigation and industrial use in the surrounding urban centers and lowlands. Investment in any of these alternative uses tends to affect the biodiversity and functioning of the SHL natural systems.

Realizing the challenges that may arise if land uses trade-offs are not well understood, TEEB project designed this study to investigate the following:

- Identify the impacts of various land uses on the functioning of the Southern Highlands natural system in the mid and long term;
- Conduct economic valuation to establish the opportunity costs society is likely to incur if various policy decisions are made.

To achieve this, two major investigations were done:

1. The analysis of the physical impacts of the anticipated management policy scenarios on crop, natural vegetation cover, exotic timber production, flow and quality of ecosystem services; and
2. The analysis of the economic impacts of anticipated management policy scenarios.

Study methodology

In analyzing the implications of the selected scenarios on the flow of ecosystem services and the economy of communities living in the area, the study employed a system approach which was implemented using the STELLA model. Results from the model were then used to estimate the economic impacts. The analysis was done in three stages: firstly, the study began by estimating the marginal changes caused as a result of the hypothetical policy scenarios in the mid-term and long-term; and secondly, estimating the economic values of the supporting, provisioning and regulating ecosystems services. Thirdly, the study estimates the economic impacts of different anticipated management policy scenarios on the supporting, provisioning and regulating ecosystem services.

To establish the economic value, we categorized ecosystem services into seven categories: (i) Agricultural supporting, (ii) Extracted forest products, (iii) Standing timber (iv) Water resources (v) Biodiversity, (vi) Carbon sequestration, and (vii) Bequest value or value of existence. In order to take into account, the effect of period on values estimated, the values were discounted basing on a discount rate of 6% which is the average of the lending (12%) and saving (0.003%) interest rate as derived from Bank of Tanzania (BOT) and commercial banks in Tanzania. We discounted the values at two periods of time i.e. 15 years-between 2021 and 2036 being the mid-term and 30 years-between 2021 and 2051 being the long-term. The study used exchange rate of 1USD=TZS 2,307.00 throughout that was prevailing during the field survey in 2020.

SHL management policy scenarios tested by the study

Seven possible management policy scenarios for SHL were considered and evaluated: Three scenarios in the upland zone, and two in the midland and lowland zones.

For the upland zone, the study evaluated (i) Business as Usual (BAU) whereby regulation of land use is not observed instead communities living in the area continue with conversion of mountain grassland to exotic forest plantations and agricultural settlements, (ii) discontinue conversion of mountain grasslands to agricultural settlement and preserve whatever is remaining, and (iii) implement Big Results Now (BRN) policy including expansion of dairy farming, horticultural farming etc.

For the midland zone the study evaluated (i) BAU whereby management is not observed and communities in the area continue with conversion of natural woodlands/forests into tea and exotics forest plantations and (ii) implement BRN initiatives by enhancing cultivation crops such as paddy, maize, fruits including avocado, dairy farming, and free ranging livestock keeping.

And for the lowland zone the study evaluated (i) BAU as upholding planned development of all irrigation schemes as they come without stringent screening

for sustainability and (ii) undertake irrigation projects including those under different stages of development after strict screening for sustainability.

These management policy scenarios were evaluated to understand their probable effects on nature and human livelihoods in the mid and long term periods. The study used crop and timber production as indicators for the impact on SHL land holders' economy, carbon storage capacity/carbon sequestration as an indicator for the impact on the capacity of SHL to regulate atmosphere, water flow rates in the streams and rivers draining the area as indicator of the capacity of SHL to regulate run-off, and water quality (i.e. turbidity) as indicators for the impact on water quality. The study did not use other measures of social welfare such as health and education because of data limitation. Water quantity and quality was also used as a measure of social welfare as it cut across social and commercial uses.

Results and discussion

a) Upland zone

Scenario 1: Business as usual (BAU); continue conversion of mountain grasslands to forest and agricultural settlements

Economic valuation results show that BAU policy will lead to net benefits of about 5,201 million USD (net present value[1]) between 2021 and 2036 and 7,122 million USD net present values between 2021 and 2051 in the upland zone.

Specifically, the policy between 2021 and 2036 will increase benefits accrued to land holders in the uplands by 6,696 million USD net present values and between 2021 and 2051 the policy will increase benefits accrued to upstream land holders by 9,071 million USD net present values. On the other hand, the policy will also have negative effects; results show that between 2021 and 2036 the policy will lead to loss of about -1,496 million USD net present values and between 2021 and 2051, the policy will lead to loss of about -1,949 million USD net present values.

These benefits and costs are attributed to the fact that under current policies without any interference or regulation, agricultural land and exotic forest plantations are expected to continue to expand at the current rate. That expansion will increase benefits accrued to land holders from agriculture and exotic forest plantations in the upland zone between 2021 and 2036 as well as between 2021 and 2051. Such expansion will negatively affect natural vegetation cover i.e., bushland, woodlands and grass lands will decrease. Such a decrease in natural vegetation will reduce the capacity of uplands regulate the climate, and regulate water flows.

[1] Net present value is the sum of future benefits minus costs, discounted by 6% per year to account for the fact that distant future benefits matter less to people than current benefits.

Scenario 2: Discontinue conversion of mountain grasslands into agricultural settlements

The policy will lead to a decrease of agricultural land and forest plantations. A decrease in expansion of agricultural land and exotic tree plantations will improve re-growth of woodlands and grasslands which in turn will improve carbon storage, water flow regulation and hence water quantity and quality. This policy to a certain extent will affect negatively the benefits accrued to upland land holders and other actors along the value chain of products produced in Southern Highlands.

Economic valuation results show that between 2021 and 2036 the costs of this policy will outweigh the benefits in this zone. Between 2021 and 2036 the policy will lead to a net loss of about -5,628 million USD net present values, and between 2021 and 2056 the policy will lead to a net loss of about -7,954 million USD net present values.

Benefits accrued to upland land holders will increase by 1,347 million USD from 2021 to 2036, which is equivalent to 1,079 million USD present values, and between 2021 and 2051 the policy will increase the benefits accrued upland land holders by 1,392 million USD net present values. Conversely between 2021 and 2036 the policy will induce costs of about -9,772 million USD which is equivalent to -6,707million USD present values and between 2021 and 2051 the policy will of about -9,347 million USD net present values. Although the policy will have both benefits and costs, but the benefits are too small to outweigh costs.

Scenario 3: Implement BRN policy (expansion of diary faming, vegetable and fruit production)

The policy will limit conversion of mountain grassland and bushlands into agricultural and settlements which will minimize effects to other ecological functions of the SHL systems. Under this policy water sources will be protected and bare lands will be left to fallow instead of planting exotic trees. Farmers will be encouraged to practice vertical agriculture expansion instead of horizontal agriculture expansion which involves clearing of mountain grasslands and bushes for new farms. They will also be encouraged to grow high value crops that need less water and land and take short period to mature but with high yield and income for land holders. One way to support this is to provide farmers with high value crop inputs including seeds and to establish markets for the products.

Economic valuation shows that the policy will lead to both benefits and costs accrued in the uplands. Results indicate this policy will lead to net costs of about - 6,527 million USD net present values, and between 2021 and 2051 the policy will lead to net costs of about - 8,931 million USD net present values.

Results show that between 2021 and 2036 the policy will lead to benefits accrued to the uplands of about 168 million USD net present values, and between 2021 and 2051 the policy will lead to positive benefits accrued of about 234 million USD net present values. On the other hand, between 2021 and 2036 the policy will lead to costs of about -6,695 million USD net present values. And between 2021 and 2051 the policy will lead to costs of about 9,165 million USD net present values.

b) Midland zone

Scenario 1: Business as usual (BAU); Continue with conversion of natural woodlands/forests into tea and exotics forest plantations.

Similarly, to the upland zone, current policies and practices will increase benefits accrued to land holders in both the short and long term. However, this will happen at the expense of water quantity and quality flowing in streams and rivers draining SHL. This will reduce income from livestock due to reduced water for livestock, and will increase cost for cleaning water for domestic and industrial use in the zone.

Model results show that business-as-usual will lead to net benefits accrued to midland land holder of about 13,373 million USD net present values between 2021 and 2036, and 18,756 million USD net present values between 2021 and 2051.

Economic valuation shows that between 2021 and 2036 the policy will lead to benefits accrued to midland land holders of about 14,581 million USD net present values, and 20,321 million USD present values between 2021 and 2051. On the other hand, the policy will lead to a cost of about 1,208 million USD net present values, and 1,566 million USD net present values between 2021 and 2051.

Scenario 2: Implement BRN - enhance crop production mainly maize, beans, avocado, dairy farming and free ranging cattle farming agricultural settlements

Implementation of BRN in the midland will lead to a relatively small increase in agricultural land, bare soil and built up areas compared to BAU in both short and long term. Since the increase will be small it will increase the benefits accrued to land holders at lower margins compared to BAU in midland zone. Under this policy the areas of grasslands and bush lands converted to agriculture will be small compared to that under BAU in both between.

Model results show that implementing BRN will lead to net costs of about -8,667 million USD present values between 2021 and 2036, and -11,945 million USD present values between 2021 and 2051.

Economic valuation shows that the policy will lead to benefits accrued to midland land holders of about 251 million USD net present values between 2021 and 2036,

and 334 million USD net present values between 2021 and 2051. Since the benefits accrued are much lower than in BAU the policy will lead to higher costs accrued to land holders in this zone. Results show that between 2021 and 2036 the policy will lead to a loss of about -8,918 million USD net present values, and -12,279 million USD net present values between 2021 and 2051.

c) Low land zone

Scenario 1: Under BAU: Uphold all the existing irrigation schemes at the current development rate.

Upholding all the existing irrigation schemes at the current development rate will result in continued expansion of irrigation schemes in the lowlands. Irrigation schemes in the lowlands receive water from upland and midland zones where water sources are highly affected by land uses, potentially limiting the water available downstream. Equally important, such increased irrigated lands will reduce flow in the streams and rivers and increase erosion that will increase siltation in the rivers and reservoirs. Poor quality and reduced flow volume will lead to higher costs of producing water for domestic and industrial use, and this will affect both rural and urban water users in the area.

Business as usual policies will cause a net loss of about -1,667 million USD present values between 2021 and 2036, and 2,147 million USD present value between 2021 and 2051.

Economic valuation results show that the policy will increase a relatively lower benefits accrued to land holders compared to BAU in upland and midlands. Between 2021 and 2036 the policy will increase benefits 598 million USD net present values and 834 million USD net present values between 2021 and 2051. Conversely, between 2021 and 2036 the policy will lead to a loss of about 2,266 million USD net present values, and 2,980 million USD net present values between 2021 and 2051.

Scenario 2: Undertake development of irrigation schemes after strict screening of sustainability

Undertaking development of irrigation schemes after strict screening of sustainability reduces damage on natural vegetation by reducing land converted to irrigation agriculture and reduces water resource abstraction compared to the current rate i.e. BAU. With this policy agricultural land, bare land, and built up land will increase in a relatively low percentage. Such a relatively small increase in agricultural land will result into a relatively small increase in crop production in low land zone. Such a small increase on agricultural and built up lands will result in a relatively small decrease in natural vegetation cover that will relatively reduce carbon regulation capacity by a relatively small percentage compared to BAU. The

reduced area covered by natural vegetation will affect the regulation of water flowing in the streams and rivers draining the SHL by relatively low percentage compared to BAU.

This policy of screening and restricting irrigation will lead to a net loss of about -774 million USD net present values between 2021 and 2036, and of -993 million USD net present values between 2021 and 2051.

Economic valuation results show that the policy will increase benefits accrued to land holders by small margins compared to the loss. Between 2021 and 2036 the policy will increase benefits by 116 million USD net present values, and by 162 million USD present values between 2021 and 2051. On the other hand, the policy will lead to a loss of about 891 million USD net present values between 2021 and 2036, and of about 1,154 million USD net present values between 2021 and 2051.

Table 1: Total differences (million USD) including ecosystem services between BAU, BRN, discontinue conversion of grassland and expansion of irrigation schemes after strict screening

S/N	ZONES	TIME PERIOD	SCENARIOS								
			Business as Usual (BAU)			Big Results Now (BRN)			Discontinue Conversion of mountain grasslands		
			Benefit	*Cost*	*Net value*	*Benefit*	*Cost*	*Net value*	*Benefit*	*Cost*	*Net value*
1	**Upland**	**15 years**	6,696.0	1,496.0	**5,200.0**	168.0	6,695.0	**-6,527.0**	1,079.0	6,707.0	**-5,628.0**
		30 years	9,071.0	1,949.0	**7,122.0**	234.0	9,165.0	**-8,931.0**	1,392.0	9,347.0	**-7,955.0**
2	**Midland**	**15 years**	14,581.0	1,208.0	**13,373.0**	251.0	8,918.0	**-8,667.0**			
		30 years	20,321.0	1,566.0	**18,755.0**	334.0	12,279.0	**-11,945.0**			
									Strict Irrigation Screening		
3	**Lowland**	**15 years**	598.0	2,266.0	**-1,668.0**				116.0	891.0	**-775.0**
		30 years	834.0	2,980.0	**-2,146.0**				162.0	1154.0	**-992.0**

Implication of Land use Changes on Products Value Chains

The value chain analysis (VCA) of the agricultural and forest plantation products from SHL show that the values accrued to farmers are relatively low compared to other actors in upper nodes in value chains. The results show that farmers were receiving less than 20% of the total value captured by all (4 to 5) actors/nodes covered by this study. On the other hand, the VCA for crops show that processors were leading in terms of the share of the value accrued to actors followed by retailers and wholesalers in value chains. It has been observed that low values accrued to farmers are attributed to high costs of inputs, low capacity to process for value addition, poor storage facilities, and low bargaining power in the markets, among other factors.

The results further show that under BAU the total annual benefit/value accrued to all actors in the agricultural value chain will increase from 452.8 million USD in 2021 to 543.9 million USD in 2051, equivalent to 20.1% increase. However, the annual benefit/value accrued to value chain actors in 2021 under BAU, i.e., 452.8 million USD, its future value in 2051 will be 2,600.7 million USD, an increase of 474% or about five-folds using a discount rate of 6%.

Generally, the observed impact of changes in land use in different policy scenarios in preceding sections will be equally translated into value chains of different products in SHL and beyond. The results reveal that the production of many crops and total annual values accrue to landholders and actors along the value chains will increase more under BAU than under implementation of BRN in all zones (upland, midland and lowland). Conversely, the implementation of a policy designed to discontinue conversion of mountain grasslands into agricultural settlements in upland will decrease the total annual output accrue to landholders and total value accrue to all actors for all crops with exception of avocado.

The results show that the total annual value that will accrue to actors in value chains will increase by 377.05, 49.76, 16.22 and 47.35 million USD for round potato, beans, avocado and tomato respectively under implementation of BAU in a long term (2021 – 2051). Similarly, the increase under BRN will be 118.92, 34.06, 38.51 and 70.24 million USD for round potato, beans, avocado and tomato respectively for the same period. However, the results imply that the increase of value accrued to actors from high value crops, i.e. avocado and tomato, is higher under BRN than BAU. Correspondingly, the results show that there will be increase in total annual value accrue to value chain actors by 143.50, 342.99 and 326.9 million USD for maize, sunflower and paddy respectively in midland in long term under BAU. For same value chain there will be increase of 245.55, 220.85 and 559.3 million USD for maize, sunflower and paddy respectively in midland in long term under BRN.

Comparing the total values under different policy scenarios results in table 1 show that there will be an increase of about 508.56 million USD under BAU, an increase of about 113.12 million USD under BRN and a decrease of about -144.18 under

discontinue conversion natural vegetation to farm land in the upland zone. In the midland zone results show that there will be an increase of about 364.78 million USD under BAU and of about 248.93 million USD under BRN. While in the lowland there will be an increase of about 334.99 million USD under BAU and of about 564.51 million USD under screened expansion irrigation. This implies that implementation of BAU and strict screened expansion of irrigation schemes will give higher output and values accrue to actors along the value chain in the upper, mid and lowland.

Table 2: Total differences (Million USD) in crop values between BAU, BRN, discontinue conversion of grassland and expansion of irrigation schemes after strict screening

Zones		Crops							Timber		Total
	Scenarios	Maize	Round potato	Sunflower	Bean	Avocado	Paddy	Tomato	Pine	Eucalyptus	
Upland zone											
	BAU	143.5	377.05	-	49.76	16.22	-	47.35	242.05	9.68	508.56
	Discontinue conversion of mountain grasslands into agricultural settlements	245.55	-87.73	-	-57.41	12.16	-	-47.62	-198	-11.09	-144.18
	BRN	-	118.92	-	34.06	38.51	-	70.24	-140.1	-8.48	113.12
Midland zone											
	BAU,	4.17	6.94	342.99	3.91	6.77	-	-	-	-	364.78
	BRN	7.14	2.19	220.85	2.68	16.07	-	-	-	-	248.93
Lowland zone											
	BAU	-	-	8.09	-	-	326.9	-	-	-	334.99
	Undertake development of irrigation schemes after strict screening of sustainability	-	-	5.21	-	-	559.3	-			564.51

Study key findings of the study

The study found four key issues that need to be addressed as follows:

1. Water is becoming scarce in the Southern Highlands. Therefore, there will be increasing competition for water between food production, plantation forest production, plantation tea production, domestic uses, in stream flows that support wildlife and biodiversity, and downstream uses including paddy production and hydropower generation.
2. Current trends (Business as Usual) will lead to greater food crop and plantation forest production, and associated greater use of water. These changes to land and water use will likely benefit local populations, but will decrease downstream water availability and increase river turbidity, which will negatively impact downstream water users, downstream biodiversity, and downstream hydropower generation.
3. Conversely, restricting agricultural and plantation land uses can preserve downstream water flows and reduce turbidity, but at a cost upstream populations.
4. Policy makers must face the difficult tradeoffs between upstream and downstream benefits of water use. They must also consider tradeoffs between agriculture production and conservation of natural ecosystems and the services they support, such as carbon storage, water filtration, and biodiversity habitat.

Study recommendations

- The results of this TEEBAgriFood study suggest that in upland and midland regions of the Southern Highlands, policies directed toward land use, water smart agriculture, and irrigation should promote high-value crops that need less water and land to yield high income to land holders. The ministry of agriculture via Tanzania research institutes should conduct research on crops, vegetables and fruits which need less land and water but fetch high value in the markets. On the other hand, in the lowlands, irrigation technologies that reduce water loss and use less water should be emphasized; irrigation technologies such as System of Intensive Irrigation (SRI) should be emphasized to minimize water loss. Equally important, newly established and existing irrigation schemes should be improved by lining the streams to reduce water loss.
- Water use should be measured and monitored in order to manage uses for the greatest net benefit, accounting for the value of water downstream.

- Additionally, localized information about water abstraction costs is needed to understand who will be impacted by increased water scarcity and when. In the absence of this localized spatial modeling, the study can only make general recommendations. The Ministry of Water through Rufiji Basin water office should establish spatial database on water use and abstraction for the purpose of understanding the beneficiary segment that will be impacted by increased water scarcity.
- Simultaneously, policies should support the strengthening of farmers' groups and networks as well as cooperatives to increase their bargaining power in the agricultural value chain and marketing. Agricultural producers receive a small portion of the value of the products they produce because they compete with each other and because middlemen, distributors and processors hold greater market power.
- Policy makers must consider tradeoffs between agriculture production and conservation of natural ecosystems and the services they support, such as carbon storage, water filtration, and biodiversity habitat for any policy option for sustainable welfare of landholders and actors along the value chains and environment.