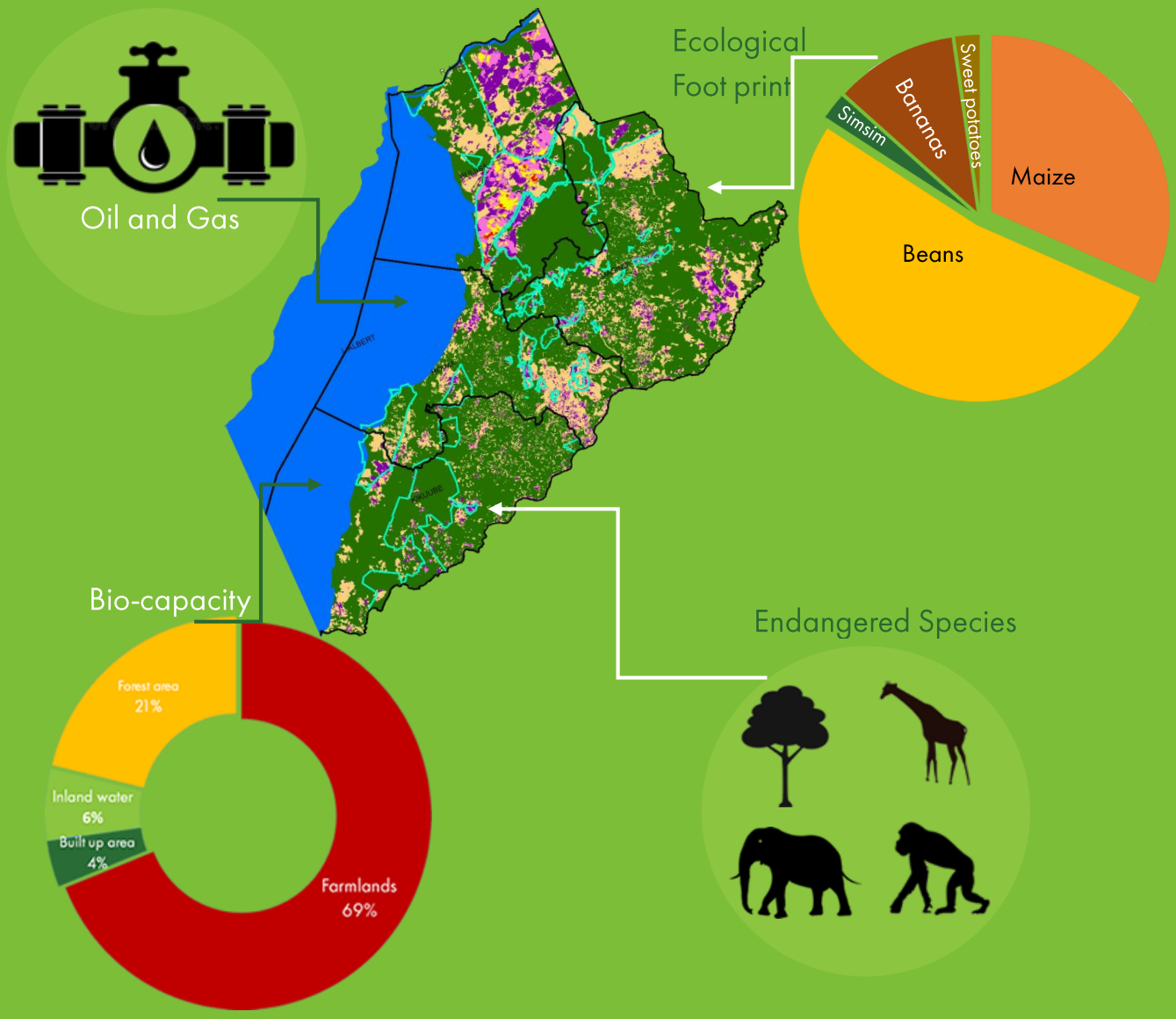


Ecological Footprint of Oil and Gas Industry

Implications for the Indigenous People and Local Communities (IPLCs) and ecosystems in the Bugoma Landscape

Contents

Executive summary

The Bugoma landscape lies in the Albertine rift, one of the most biodiversity areas in Africa and the world. The Murchison Falls National Park is the largest and leading nature-based tourism area in Uganda while Budongo and Bugoma Central Forest Reserve are among the most important conservation areas in the country contributing to both the biodiversity of flora and fauna and the wildlife corridor alongside other smaller forest reserves and community forests.

The Bugoma landscape (Bunyoro sub-region) of Uganda covering Buliisa, Hoima, Kikuube and Masindi Districts is the centre of oil and gas development in the country. Oil and gas production and development in the landscape includes the Tilenga and Kingfisher projects that comprise central processing facilities (CPFs) for extracted crude oil, wells, which are planned to be drilled on well pads over 220 kilometres of flow lines which will transport crude oil within the oil fields, over 100 km of feeder pipeline which will transport the processed crude oil from the CPF to the delivery point in Kabaale, Hoima district. The landscape is the starting point for East African Crude Oil Pipeline (EACOP), the planned refinery and supporting infrastructure that includes the Kabaale Industrial Park (hosts refinery, an international airport, crude oil and products storage/ transmission hub, logistics, warehousing, offices, petrochemical industry, and associated facilities, among others), among others. The oil and gas only compound ecological pressure from commercial sugarcane, maize and increasingly paddy and upland rice production as well as several food crops.

As the economic development and the population grows in the Bugoma landscape, the consumption of ecosystem services particularly provisioning and regulating services increases. With an area of only 839,152, the landscape is expected to produce food, safe water, biomass energy, and provide ecosystem services to manage wastewater, solid waste and other wastes to the atmosphere, land, and water. Whereas environmental and social impact assessments (ESIAs) were conducted, and environmental and social management plans (ESMPs) developed there was no effort to determine whether the landscape has adequate biocapacity to manage the ecological footprint from the consumption of ecosystem services in the landscape.

The Bunyoro sub-region has a bio capacity of 1.38 million ha under the four main land use types of farmlands, inland water, forest areas, built up areas, despite an estimated ecological footprint of 3.3 million ha. The ecological footprint is at least 2.4-times higher than the biological capacity of the sub-region. Some decisions must be made to ensure that the current sustainability imbalance in the sub-region does not spiral out of control and lead to degradation of the ecosystems within the landscape.

Some of the proposed priority actions to counter the current unsustainable consumption of ecosystem services in the sub-region include:

- Revisiting the current methodology on environmental and social impact assessment (ESIA) to consider inclusion of the ecological footprint and to show who is responsible both for the unsustainable consumption as well as for actions to mitigate and/or offset the ecological footprint.

- Address the ecological footprint by undertaking actions to enhance the biocapacity within the Bugoma landscape and the Albertine Graben. This would involve restoration of natural forests, agroforestry on farmlands. Concurrently, action can be undertaken to avoid, minimise and mitigate actions that increase the ecological footprint. These actions need to be retrospectively included in the environmental and social management plans for the projects undertaken within the landscape.

- Develop both policy and economic instruments to enable the actors responsible for the ecological footprint to pay for actions that will lead to mitigation actions and offsetting for the ecological footprint within the Bugoma landscape and the Albertine graben.

- Sensitisation, awareness creation, and training for all the key stakeholders to understand the importance of reporting the ecological footprint and use of the ecological footprint and related instruments to ensure that unsustainable consumption and production is avoided, minimised and/or mitigated within the landscape.

Introduction

1.1 Background

Uganda's oil and gas sector has transitioned to the development and production phase, new exploration, and preparation of the discovered oil fields for production (development). The developments comprise putting in place infrastructure for both commercialization of the discovered 6.5 billion barrels of oil and gas resources (with 1.4 billion barrels recoverable and over 500 billion cubic feet of gas) and facilitating the developments in the sector (PAU 2022).

The development of the oil and gas industry in the Albertine Graben and specifically the Bugoma landscape (Buliisa, Hoima, Kikuube and Masindi districts) is expected to be substantial on the environmental resources within the landscape. As part of the feasibility and detailed design for oil and gas development, Environment and Social Impact Assessments (ESIAs) were for the Tilenga, Kingfisher and Kabalega airport development, among others. These ESIAs identified among key impacts, physical environment impacts related to the non-living environment, including air quality and climate; noise and vibration; geology and soils, hydrogeology; surface water; landscape and visual, and waste, ecological/ biodiversity impacts related to relevant sensitive receptors within the project's area, social impacts, unplanned events, and potential cumulative effects and transboundary impacts.

The ESIAs conducted did not indicate whether the Bugoma landscape has adequate biocapacity to manage the existing and future ecological pressures that are associated impacts of the oil and gas, and agricultural production. Currently, stakeholders are not aware if there are ways of ensuring that the impacts of oil and gas development can be sustainably integrated within the landscape and/or the national context.

The ecological footprint measures human resource consumption against our stocks of natural capital – and answers the most basic question for sustainable development: 'How much nature have we got, compared with how much we use?' (Hopton and White, 2011). Ecological footprint is a method of gauging humans' dependence on natural resources by calculating how much of the environment is needed to sustain a particular lifestyle. In other words, it measures the demand versus the supply of nature (Bon, 2002). The Ecological Footprint is an environmental accounting tool that identifies the extent to which human activities exceed two types of environmental limits: (i) resource production and (ii) waste absorption.

1.2 Approach

The ecological footprint is defined as the total area required to indefinitely sustain a given population at the current standard of living and at an average per capita consumption rate (Atkinson et al., 2006). The Ecological Footprint (EF) of a population is the area of land and water ecosystems needed to provide the resources and assimilate the waste of the population being studied. The population can be a person, product, firm, region, or country. Since the area of land owned or controlled by the population is usually a finite and identifiable quantity, it can be compared to the EF. The rationale for representing impacts upon the environment in units of area is that biologically productive land area produces or absorbs flows of many of the materials utilised by our society. Uses are often mutually exclusive are therefore in competition for the finite area of productive land in the world.

To calculate the ecological footprint, you would use the equation by Tiezzi et al. (2008):

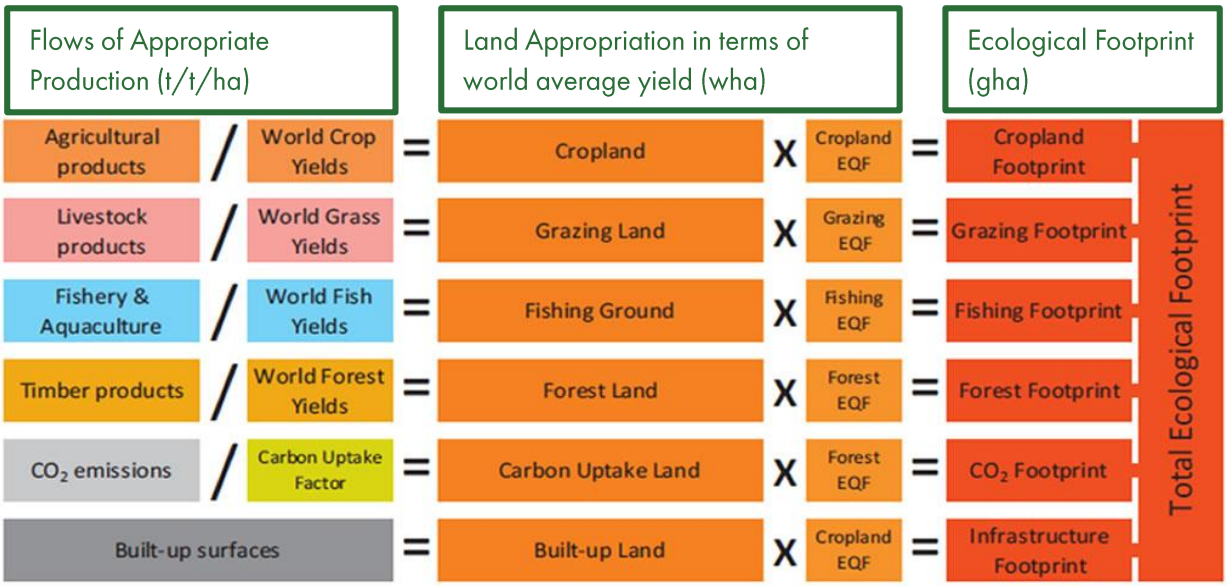
$$EF = \sum {}^{T_i}/_{Y_w} * EQF_i \quad \text{(i)}$$

Where T_i is the annual number of tons of each product I that are consumed in the nation, Y_w is the yearly world-average yield for producing each product i, and EQF_i is the equivalence factor for each product i.

The Ecological Footprint measures the amount of biologically productive land and water (fishing grounds) area required to: (i) produce all the resources an individual, population or activity consumed, and (ii) to absorb the wastes they generated, given prevailing technology and resources management practices. The final Ecological Footprint of an individual or a country is the sum of all these different types of land, irrespective of where they are located.

The approach used in this study is drawn from Lin *et al.* (2019). Essentially the ecological footprint for oil and gas in the Bunyoro sub-region (UBOS 2018) was developed based on worksheets that compare the total ecological footprint (TEF) or EF with the Total Biocapacity. The components of the footprint are the consumption flows for agricultural products, livestock products, fisheries and aquaculture, wood (timber and fuel), carbon emissions and built-up area (Figure 1)

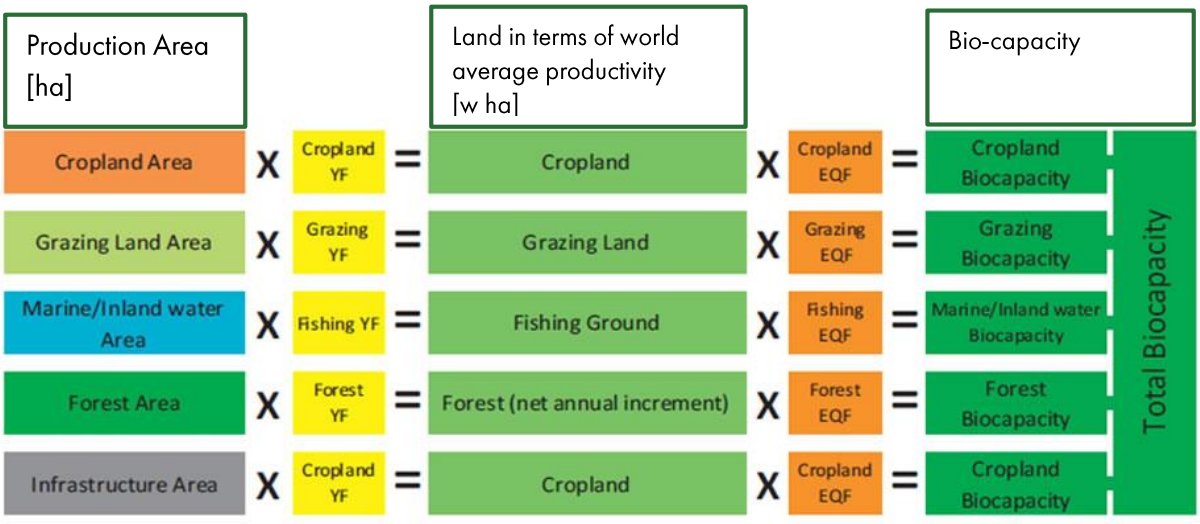
Figure 1: Illustration of the calculation for the Total Ecological Footprint



Source: Lin et al. 2019

The biocapacity comprises crop area, grazing land, inland water, forest area and infrastructure area available as the biocapacity for the Albertine Graben, specifically the Bunyoro sub-region (Figure 2).

Figure 2: illustration of the calculation for the Total Ecological Footprint



Source: Lin et al. 2019

The activity on flows of production was adapted from statistics collected in the Annual Agricultural Survey Reports (UBOS 2018; 2019; 2020). There was additional information also drawn from other documents such as the Wood Assets and Forest Resources Accounts (UBOS 2020), and the Land Improvement Ecosystem Accounts (NEMA, 2021), among others. The world yield averages, yield factors and equivalent factors were collated from published works including work done by the FAO and individual authors (Borucke *et al.,* 2013; Hopton and White, 2011).

"Timber activities drive commerce but also contribute to deforestation, leaving a lasting ecological footprint"

Findings

2.1 Ecological footprint

The ecological footprint was estimated 3.3 million global hectares (gha). This highest footprint is associated with carbon uptake from the greenhouse gas (GHG) emissions from cropland, followed by the land required to offset for GHG emissions from oil and gas mining, and footprint associated with inland water capture fisheries at 1.17 million ha, 1.09 million ha and 951,268 ha, respectively. The ecological footprint of the crop and livestock production was based on the Annual Statistical Abstract 2020 (UBOS 2022), global yield estimated for crops FAO 2020 and the equivalence factors (Lin et al., 2019).

Uganda's oil projects were designed for relatively low carbon footprint and carbon dioxide equivalent (CO_2e) emission per barrel of oil for Uganda's upstream and midstream projects is estimated to be in the range of 20-45 $kgCO_2e$. This is well below the global average of 70-100 $kgCO_2e$. (PAU, 2023). This carbon footprint only considers the 1.4 billion barrels of commercial production project and may increase as more reserves are identified. It also does not address the risk of inefficiency of the technology used in the oil production and development. Global arable cultivated soils have a carbon stock of 27.5-88.2 tonnes of C per ha in the top 30cm (not including deep peat soils) (FAO, 2020). Therefore, the ecological footprint of the oil and gas GHG capture.

The ecological footprint for the fisheries was based on fish production in 46% of the Lake Albert located in the Albertine Graben, the global inland fish production of 63.3 million tons against a global inland water cover of 1,125.3 million ha (FAO 2020). The other considerations for ecological footprint were forest areas based on timber and wood fuel production (UBOS 2020), and the associated equivalence factors.

Table 1: Results of the preliminary ecological footprint analysis

Land use / Cover Cropland	Flows of appropriate Agricultural production (t)	World crop yield(t/ha)	Land appropriation in terms of world average yield (ha)	EQF	Ecological footprint by category (gha)
Maize	656,285	5.8	113,152.59	2.52	285,144.52
finger millet	2,383	0.6	3,971.67	2.52	10,008.60
sorghum	3,261	2.5	1,304.40	2.52	3,287.09
Rice	18,919	4.66	4,059.87	2.52	10,230.88
Beans	134,364	0.715	187,921.68	2.52	473,562.63
G. nuts	34,877	1.69	20,637.28	2.52	52,005.94
Sim sim	5,086	0.578	8,799.31	2.52	22,174.26
Soybean	248	2.79	88.89	2.52	224.00
All bananas	649,988	16.46	39,488.94	2.52	99,512.14
Cassava	602,450	12.8	47,066.41	2.52	118,607.34
Sweet potatoes	95,465	11.8	8,090.25	2.52	20,387.44
Irish potato	17,028	17.4	978.62	2.52	2,466.12
Coffee	82,656	2.85	29,002.11	2.52	73,085.31
Sub-total					**1,170,696.26**
Grazing land (livestock units/ha)					
Cattle	126,377	3	42,126	0.48	20,220.24
Goats	354,156	15	23,610	0.48	11,332.98
Sheep	34,032	15	2,269	0.48	1,089.04
Sub-total					**32,642.26**
Forest land	23,084	0.79	29,220	1.38	40,324
Carbon Uptake Land (for oil & gas mining)	45,500,000	57.75	787,879	1.38	1,087,272.73
Fishing Land (million tons/ million ha)	148,640	0.056251666	2,642,411	0.36	951,267.82
Built up Land	21,038	1	21,038.49	2.52	21,038.49
Total					**3,303,241.53**

2.2 Biocapacity Results

The biocapacity was estimated at 1.38 million gha, with a global high yield factor of 1 t/ha. Biocapacity represents the available ecological resources to support the consumptive demands of the population within the Bunyoro Landscape. The biocapacity is at least 2.4 times less than ecological footprint.

Whereas the Bunyoro area has an area of 839,152 ha with a bio capacity of 1.38 million ha under the four main land use types of farmlands, inland water, forest areas, built up areas, the ecological footprint based on the projected medium term economic activities largely associated with oil gas production is 3.3 million ha i.e. equivalent to an actual area of at least 2.01 million ha.

Table 2: Results of the preliminary biocapacity analysis

Land use	Land area (ha)	Yield factors (t/ha)	Land in terms of average world productivity	EQF	Biocapacity (gha)
Farmlands	377,588	1	3,775,880	2.52	951,522
Inland water	228,271	1	2,282,710	0.36	82,178
Forest area	212,255	1	2,122,550	1.38	292,912
Built up area	21,038	1	210,385	2.52	53,017
Total	839,152				1,379,628

The ecological footprint from the oil and gas development cannot be achieved through the biocapacity within the Bugoma landscape alone. The ecological footprint of the oil and gas industry extends to the national and global scale. Therefore, the mitigation actions to reduce, minimise, mitigate, and offset the ecological footprint will be expected to extend beyond the landscape. Similarly, the ecological footprint from the wood demand is also higher than the biocapacity. These are preliminary assessment results than need to be interrogated further to ensure that appropriate ecological investments are made in the landscape to limit the large ecological footprint.

Main outcomes and key lessons

3.1 Conclusions

- The Bugoma landscape is important to the future economic growth prospects of Uganda particularly regarding the oil and gas industry and the commercial farming activities. At the same time, due its location in the Albertine rift and the important biodiversity in the area, the landscape is an important base for the country's sustainability as it helps to balance environmental sustainability alongside the economic and social needs.

- The economic activities from oil and gas development and agricultural production prospects are attracting more and more people to the landscape to engage in economic activities, while the number of tourists is also expected to increase. At risk is the capacity of the ecological system within the landscape to support the consumptive needs of the increasing population of inhabitants and visitors to the landscape.

- The consumptive needs that create added demand of ecological resources relate to increased demand for food and energy to meet the needs of an increasing population, ability of the ecosystem to manage the added waste including emissions of GHGs, solid waste, and other wastes. To ensure continued sustainability in the landscape it is important to establish if there is adequate biocapacity at a regional level to manage the ecological pressures from the developments.

- An ecological accounting methodology was adapted using secondary data from the Annual Agricultural Survey 2020 (UBOS 2022), the Wood Assets and Forest Resources Accounts (UBOS 2020) and the Land and Soil Improvement Accounts (NEMA, 2021), and other data sets. The methodology developed from adapted the annual inventories approach for the ecological footprint that was adapted at the regional level (Lin et al., 2019; Tiezzi et al., 2008).

- The results of the ecological footprint analysis show that the human consumption in the Bugoma landscape, represents by the Bunyoro sub-region is unsustainable. The ecological footprint at a preliminary analysis is 2.4-times higher than the biocapacity.

- The Bugoma landscape does not have adequate biocapacity to address the needs to limit and/or sequester the GHG emissions from the oil and gas sector, and the timber and wood fuel demands that growth with the population increase. There may be need for specific interventions to address the large shortfall in the biocapacity of the landscape. Some of the possible interventions.

3.2 Recommendations

1. There is need for a wider strategy to address the ecological footprint for the Albertine Graben and the Bugoma Landscape in particular. The results above indicate that several activities impose a large burden on the biocapacity of the landscape; however, no provisions have been out in place that the residual impact of ecological footprint is offset. To avoid a downward spiral of the ecological footprint the actors responsible for the ecological footprint must undertake actions to offset it.

2. One of the immediate ways of addressing the ecological footprint is to undertake actions to enhance the biocapacity within the Bugoma landscape and the Albertine Graben. This would involve restoration of natural forests, agroforestry on farmlands. Concurrently, action can be undertaken to avoid, minimise and mitigate actions that increase the ecological footprint. These actions need to be retrospectively included in the environmental and social management plans for the projects undertaken within the landscape.

3. There is need to develop both policy and economic instruments to enable the actors responsible for the ecological footprint to pay for actions that will lead to mitigation actions and offsetting for the ecological footprint within the Bugoma landscape and the Albertine graben.

4. There is need to revisit the current methodology on environmental and social impact assessment (ESIA) to consider inclusion of the ecological footprint and to show who is responsible both for the unsustainable consumption as well as for actions to mitigate and/or offset the ecological footprint.

5. Some of the commercial production of crops and subsequently oil and gas benefits actors in the value chain who do not necessarily live within the landscape. The economic instruments or price mechanisms can be designed to make sure that their consumption supports actions to enhance the biocapacity within the Albertine Graben and the Bugoma landscape.

6. Considerable effort is required in sensitisation, awareness creation, training for all the key stakeholders to understand the importance of reporting the ecological footprint and use of the ecological footprint and related instruments to ensure that unsustainable consumption and production is avoided, minimised and/or mitigated within the landscape.

7. There may be need for a more detailed study to provide more detailed on the ecological footprint and environmental burden or damage associated with unsustainable consumption within the landscape. There are several constituencies of ecological footprint that cannot be assessed due to a lack of data. These include transport systems, solid waste, and sanitation as well as all wastewater, and the construction industry, hotels, and accommodation, among others.

Pull out Quotes

- Uganda's oil and gas sector has transitioned to the development and production phase, new exploration, and preparation of the discovered oil fields for production (development). The environmental and social Impact Assessments (ESIAs) conducted did not indicate whether the Bugoma landscape has adequate biocapacity to manage the existing and future ecological pressures that are associated impacts of the oil and gas, and agricultural production. Currently, stakeholders are not aware if there are ways of ensuring that the impacts of oil and gas development can be sustainably integrated within the landscape and/or the national context.

- The ecological footprint is defined as the total area required to indefinitely sustain a given population at the current standard of living and at an average per capita consumption rate. The Ecological Footprint (EF) of a population is the area of land and water ecosystems needed to provide the resources and assimilate the waste of the population being studied.

- Whereas the Bunyoro area has an area of 839,152 ha with a bio capacity of 1.38 million ha under the four main land use types of farmlands, inland water, forest areas, built up areas, the ecological footprint based on the projected medium term economic activities largely associated with oil gas production is 3.3 million ha i.e. equivalent to an actual area of at least 2.01 million ha.

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References

1. Atkinson, G., Dietz, S., Neumayer, S. 2006. ***Handbook of sustainable development***/edited by Edward Elgar Publishing Limited, Cheltenham, UK.

2. Bond, S. 2002 ***Ecological footprints A guide for local authorities***, WWF-UK Panda House, Weyside Park, Godalming, Surrey GU7 1X

3. Borucke, M.; Moore, D.; Cranston, G.; Gracey, K.; Iha, K.; Larson, J.; Lazarus, E.; Morales, J.C.; Wackernagel, M.; Galli, ***A. Accounting for demand and supply of the biosphere's regenerative capacity: The National Footprint Accounts' underlying methodology and framework***. Ecol. Indic. 2013, 24, 518–533

4. FAO 2020 ***The State of World Fisheries and Aquaculture 2020. Sustainability in Action***. FAO, Rome

5. Hopton, M.E., White, D., ***A simplified ecological footprint at a regional scale, Journal of Environmental Management (2011),*** doi:10.1016/j.jenvman.2011.07.005

6. Lin, D., L. Hanscom, J. Martindill, M. Borucke, L. Cohen, A. Galli, E. Lazarus, G. Zokai, K. Iha, D. Eaton, M. Wackernagel. 2019. ***Working Guidebook to the National Footprint and Biocapacity Accounts***. Oakland: ***Global Footprint Network.***

7. NEMA 2021: ***Land and Soil Improvement Ecosystem Accounts for Uganda Annual Agricultural Survey 2020 for Uganda***, Uganda Bureau of Statistics, Kampala. http://www.ubos.org

8. Tiezzi, E.; Bastianoni, S. ***Sustainability of the Siena Province through ecodynamic indicators.*** *J. Environ. Manag.* 2008, *86*, 329–331.

9. UBOS 2020 ***Wood Assets and Forest Resources Accounts for Uganda, Uganda Bureau of Statistics***, Kampala. http://www.ubos.org

10. UBOS 2022 ***Annual Agricultural Survey 2020 for Uganda, Uganda Bureau of Statistics***, Kampala. http://www.ubos.org

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