Research Terms of Reference
Land Use and Land Cover Dynamics in Refugee Settlements: A Case Study of Uganda
UGA2307
Uganda

August 2023
1.0

REACH Informing
more effective
humanitarian action

1. Executive Summary

Country of intervention	*Uganda*					
Type of Emergency	□	Natural disaster	**X**	**Conflict**	□	Other *(specify)*
Type of Crisis	□	Sudden onset	□	Slow onset	**X**	**Protracted**
Mandating Body/ Agency	*European Union Civil Protection and Humanitarian Aid (ECHO)*					
IMPACT Project Code	*25AZV*					
Overall Research Timeframe *(from research design to final outputs / M&E)*	03/07/2023 to 08/12/2023					

Research Timeframe *Add planned deadlines (for first cycle if more than 1)*	1. Pilot/ training: N/A	6. Preliminary presentation: 27/11/2023
	2. Start collect data: 14/08/2023	7. Outputs sent for validation: 20/11/2023
	3. Data collected: 21/08/2023	8. Outputs published: 04/12/2023
	4. Data analysed: 13/10/2023	9. Final presentation: Upon request.
	5. Data sent for validation: N/A	

Number of assessments	**X**	**Single assessment (one cycle)**
	□	Multi assessment (more than one cycle) *[Describe here the frequency of the cycle]*

Humanitarian milestones *Specify **what** will the assessment inform and **when*** *e.g. The shelter cluster will use this data to draft its Revised Flash Appeal;*	**Milestone**		**Deadline (can be tentative)**
	X	**Donor plan/strategy** (ECHO)	26/03/2024
	□	Inter-cluster plan/strategy	_ _/_ _/_ _ _ _
	□	Cluster plan/strategy	_ _/_ _/_ _ _ _
	X	**NGO platform plan/strategy**	26/03/2024
	X	**Inter-Agency Refugee Response Plan (RRP)**	2026 - 2029

Audience Type & Dissemination *Specify **who** will the assessment inform and **how** you will disseminate to inform the audience*	**Audience type**	**Dissemination**
	X Strategic	**X General Product Mailing (using the IMPACT Uganda mailing list)**
	X Programmatic	**X Cluster/WG Mailing (Education, Shelter and WASH) and presentation of findings at next cluster/WG meeting**
	□ Operational	
	□ [Other, Specify]	**X Presentation of findings (to donors and relevant stakeholders)**
		X Website Dissemination (Relief Web & REACH Resource Centre)

		□	[Other, Specify]
Stakeholder mapping *Has a detailed stakeholder mapping been conducted during research design to identify all actors that could **contribute** to and/or **benefit from** the research?*	**X**	**Yes**	□ No
General Objective	*To inform the humanitarian and development actors in the refugee response about the magnitude of vegetation degradation and land use and land cover changes in refugee settlements and host communities in Uganda.*		
Specific Objective(s)	• To understand the extent and magnitude of vegetation degradation in refugee settlements and host communities, and their surroundings, using remote sensing analysis • To determine the trend of past and current land use and land cover changes in refugee settlements and host communities, and their surroundings using remote sensing analysis • To model future land use and land cover changes in refugee settlements and host communities using remote sensing analysis and historical refugee population growth data/trends.		
Research Questions	1. *What is the extent and magnitude of vegetation degradation in refugee settlements and host communities?* 2. *What are the historical land use and land cover changes in refugee settlements and host communities over the past 10 years?* 3. *What are the likely future land cover changes in refugee settlements and host communities over the next 10 years based on historical land cover data?*		
Geographic Coverage	*All 13 refugee settlements with a buffer of 15km: Adjumani, Bidibidi, Imvepi, Kiryandongo, Kyaka II, Kyangwali, Lobule, Nakivale, Oruchinga, Palabek, Palorinya, Rhino, and Rwamwanja.*		
Secondary data sources	*1. Rapid Assessment of Natural Resource Degradation in Refugee-Impacted Areas in Northern Uganda (Second edition based on April 2019 refugee statistics - FAO).* *2. The impact of refugee settlements on land use changes and vegetation degradation in West Nile Sub-region, Uganda - Geocarto International.* *3. Landsat satellite imagery.* *4. Maxar very high resolution (sub-meter) satellite imagery, where available.*		

Population(s) *Select all that apply*	□	IDPs in camp	□	IDPs in informal sites
	□	IDPs in host communities	□	IDPs [Other, Specify]
	X	**Refugees in camp**	□	Refugees in informal sites
	□	Refugees in host communities	□	Refugees [Other, Specify]

	X	Host communities	□	[Other, Specify]		
Data management platform(s)	X	**IMPACT**	□	UNHCR		
	□	[Other, Specify]				
Expected ouput type(s)	□	Situation overview #: _ _	X	**Report #: 1**	□	Profile #: _ _
	□	Presentation (Preliminary findings) #: _ _	X	**Presentation (Final) #: 1**	□	Factsheet #:
	□	Interactive dashboard #:_	□	Webmap #: _ _	X	**Map #: 12**
	□	[Other, Specify] #: _ _				
Access	X	**Public (available on REACH resource center and other humanitarian platforms)**				
	□	Restricted (bilateral dissemination only upon agreed dissemination list, no publication on REACH or other platforms)				
Visibility *Specify which logos should be on outputs*	*REACH / ECHO*					
	Donor: ECHO					
	Coordination Framework: N/A					
	Partners: N/A					

2. Rationale

2.1 Background

Uganda has had a long history of hosting refugees from neighboring conflict-affected countries mainly from South Sudan and the Democratic Republic of Congo. The progressive refugee policies in Uganda have greatly contributed to the substantial influx of refugees over the years.[1] This has subsequently had detrimental impacts on the environment including land degradation and forest depletion due to the increasing demand for agricultural land and reliance on biomass fuels such as firewood and charcoal in refugee-hosting districts.[2] According to the World Bank Environment and Social Framework Report 2020, the total net loss of Uganda's forests between the years 2000 - 2015 was estimated at 1.8 million ha, making an average annual loss rate of 4%. This was mainly attributed to agricultural expansion and wood extraction for energy.[3]

The establishment of refugee settlements in Uganda has also necessitated the development of infrastructure such as housing, schools, health centers, and administrative buildings thereby resulting in the conversion of natural land cover into built-up areas, leading to changes in the overall land use pattern.[4] This has further affected the access to land for all because in some cases, land may have been commandeered from the local population to accommodate the settlement, potentially reducing their access to agricultural land or grazing areas.[5] This inevitable need to share limited resources has created tensions between the host community and the refugees. The refugees themselves also face challenges in accessing land for livelihood activities, as they are confined to designated areas within the settlement.[6] With the advent of General Food Assistance cuts and reprioritization in recent years, including in recent months (July 2023), demand for land is expected to increase according to relevant actors, aside from demand spurred by an ever-increasing refugee caseload in Uganda.[7]

The changes in land use and land cover have had implications for access to energy. Prior to the establishment of the settlements, local communities relied on traditional energy sources such as firewood and charcoal for cooking and heating. However, with the influx of refugees and the increased demand for energy within the settlements, there is additional pressure on the surrounding natural resources.[8] This has increased rates of deforestation and degradation of the land, impacting the

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[1] *Uganda's Refugee Management Approach within the EAC Policy Framework – Konrad Adenauer Stiftung 2017.*

[2] *Research Terms of Reference: Knowledge, Attitudes and Practices (KAP) on Energy, Environment and Climate Change – REACH Initiative*

[3] *Environment and Social Management Framework – The World Bank 2020.*

[4] *Spatial assessment of urban sprawl in Arua Municipality, Uganda, The Egyptian Journal of Remote Sensing and Space Science.*

[5] *Survey Highlights on Self-Settled Refugees in Koboko Municipal Council Empowering Refugee Hosting Districts in Uganda: Making the Nexus Work,2018 - VNG International.*

[6] *Using Land to Promote Refugee Self-Reliance in Uganda - Land journal 2022.*

[7] *Uganda's Refugee Management Approach within the EAC Policy Framework – Konrad Adenauer Stiftung 2017.*

[8] *The Energy Potential of Harvested Wood Fuel by Refugees in Northern Uganda - The Scientific World Journal.*

availability of firewood and other biomass fuels. Consequently, both the host community and the refugees face challenges in accessing reliable and sustainable sources of energy.[9]

To address these challenges, it is crucial to implement sustainable land management practices in refugee settlements and surrounding host communities. This includes promoting efficient land use planning, reforestation efforts, and alternative energy sources such as clean cookstoves or renewable energy technologies. Additionally, efforts should be made to foster collaboration and dialogue between the host community and the refugees, ensuring equitable access to land and resources while minimizing environmental impacts.

Intended impact

This study will seek to understand the dynamics of land use and land cover in refugee settlements and host communities. The study will analyze changes in land use and land cover and predict future changes to help humanitarian organizations, policymakers, and stakeholders in the Uganda refugee response make informed decisions concerning sustainable land management practices and improved livelihoods.

Overall, this work will aim to:

- Improve Information on land use and land cover changes in all refugee settlements in Uganda
- Create time series analysis to show how the changes vary across settlements
- Compare changes with increase in population for selected/hotspot refugee settlements
- Create a prediction for future changes in land use and land cover change

3. Methodology

3.1 Methodology overview

Remote sensing analysis will be conducted across the 13 refugee settlements in Uganda to understand the extent and magnitude of vegetation degradation, trend of past and current land use types, and prediction of future land use and land cover changes. The study will use Google Earth Engine platform and use supervised classification (Random Forest Classifier machine learning algorithm) to classify selected satellite imagery, use appropriate functions to determine the changes in land use and land cover change, and then use the CA Markov model to model potential future land cover change.

Relevant key definitions

Remote sensing. The science of acquiring information about an object or area from a distance. This could be from aerial cameras or sensors attached to drones, aircraft or satellites. This information is analyzed to determine the properties of these objects or areas.

Image classification. Image classification is the categorizing or labelling of pixels or groups of pixels from remotely sensed images into different categories or classes based on their spectral values.

Change detection. This is the process of finding differences between scenes of the same location or geographic objects at different times. An example is detecting changes in two satellite images of the same location captured at different dates.

Land use Land Cover Change Prediction. This involves using known changes to land use and land cover change to estimate future changes.

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[9] *Wood fuel Consumption in Refugee Hosting Areas and Its Impact on the Surrounding Forests - The Case of Uganda.*

3.2 Population of interest

The study will cover all the 13 refugee settlements together with host communities in two regions of Uganda. The South-Western region consists of Kyaka II, Kyangwali, Nakivale, Oruchinga, Rwamwanja, Kiryandongo refugee settlements and the West-Nile region consists of refugee settlements of Adjumani, Bidibidi, Imvepi, Lobule, Palabek, Palorinya, Rhino Camp.

3.3 Data and Tools

3.3.1 Tools

ArcGIS PRO. We will use ArcGIS Pro to prepare the datasets and for presentation resulting mapping products from the analysis.

Google Earth Engine. We will leverage the processing power of Google Earth Engine to analyze satellite imagery for the different years of interest, classify the images and detect past changes in the area of interest.

QGIS. We will use the MOLUSCE plugin QGIS to predict future changes in land use and land cover change.

3.3.2 Data

The following summary contains the datasets that will be used in this study together with some of their metadata.

Data	Format	Scale/Resolution	Date	Source
Multi-spectral image Landsat 8 Collection 2 Tier 1	Raster	30m	2013 - 2023	USGS
Multi-spectral image WorldView – 3	Raster	31 cm	2014 - 2023	MAXAR
Multi-spectral image WorldView – 2	Raster	46 cm	2009 - 2023	MAXAR
Multi-spectral image GEOEYE - 1	Raster	41 cm	2008 - 2023	MAXAR
Multi-spectral image Sentinel-2	Raster	10m	2015 - 2023	ESA
Space Shuttle Radar Topography Mission DEM	Raster	30m	-	USGS
Roads	Vector	-	-	HDX
Rivers	Vector	-	-	HDX

3.4 Data Processing & Analysis

3.4.1   Remote sensing analysis

Remote sensing analysis of land use and land cover changes over the last decade will be conducted across the 13 refugee settlements and host communities within a buffer of 15 km from the settlements using Google Earth Engine (GEE) integrated with Geographical Information System (GIS). Satellite imagery analysis will be conducted in Google Earth Engine to understand the extent and magnitude of vegetation degradation, trend of past and current land use types and prediction of future land use and land cover changes. Data processing will be done in ArcGIS PRO, Google Earth Engine (GEE) platform and QGIS.

Data Acquisition:

-   Access and acquire high-resolution satellite imagery for the refugee hosting districts in Uganda from Google Earth Engine.
-   Retrieve the relevant multispectral bands (e.g., visible, near-infrared, shortwave infrared) required for land use and land cover classification.

Pre-processing of Remote Sensing Data:

-   Remove atmospheric effects, such as haze and cloud cover, from the satellite imagery.
-   Apply radiometric and geometric corrections to ensure consistency and accuracy in the data.

Image Processing and Classification:

-   Perform image classification techniques to identify land use and land cover categories in refugee settlements and host communities within a buffer of 15 km.
-   Utilize machine learning algorithms (e.g., Random Forest, Support Vector Machines) to classify the satellite imagery based on training samples.
-   Assign classes such as housing, agriculture, built-up areas, water bodies, and vegetation.

Accuracy Assessment:

-   Collect ground truth data through field surveys or use existing ground reference data to assess the accuracy of the classification results.
-   Conduct statistical analysis to determine the accuracy metrics (e.g., overall accuracy, kappa coefficient) and validate the land use and land cover maps.

Change Detection and Projection Analysis:

-   Change detection is the process of finding the differences in the land features by observing them at different time periods.
-   Utilize multi-temporal satellite imagery to analyze land use and land cover changes over time within the refugee settlements.
-   Perform change detection algorithms (e.g., post-classification comparison, image differencing) to identify and quantify the extent of land cover changes.
-   To look into the future of how the current land use/cover types will look in 2033, a change projection will be done using the CA Markov Model.

The Cellular Automata (CA) Markov model will be used for predicting future land cover types and will involve a combination of spatial analysis, transition modeling and simulation base on historical data and observed trends.

4. Key ethical considerations and related risks

The proposed research design meets / does not meet the following criteria:

The proposed research design…	*Yes/ No*	*Details if no (including mitigation)*
… Has been coordinated with relevant stakeholders to **avoid unnecessary duplication** of data collection efforts?	Yes	Consultation with the WorkGreen working group and FAO.
… **Respects respondents, their rights and dignity** (*specifically by: seeking informed consent, designing length of survey/ discussion while being considerate of participants' time, ensuring accurate reporting of information provided*)?	Yes	Will seek consent for participation
… Does not **expose data collectors to any risks as a direct result** of participation in data collection?	Yes	Data collectors will not be recruited for this study
… Does not **expose respondents / their communities to any risks as a direct result** of participation in data collection?	Yes	
… Does not involve **collecting information on specific topics which may be stressful and/ or re-traumatising** for research participants (both respondents and data collectors)?	Yes	
… Does not involve **data collection with minors** i.e. anyone less than 18 years old?	Yes	
… Does not involve **data collection with other vulnerable groups** e.g. persons with disabilities, victims/ survivors of protection incidents, etc.?	Yes	
… Follows IMPACT SOPs for management of **personally identifiable information**?	Yes	

5. Roles and responsibilities

Task Description	Responsible	Accountable	Consulted	Informed
Research design	GIS Officer	Research Manager, GIS/Data Manager	HQ-Senior Manager GIS/Remote sensing	CC
Supervising data collection	-	-	-	-
Data processing (checking, cleaning)	GIS Officer	Research Manager, GIS/ Data Manager	Senior Manager GIS and Remote sensing, RDDU	CC
Data analysis	GIS Officer	GIS/Data manager	HQ - Senior Manager GIS and Remote sensing, RDDU	
Output production	GIS Officer	GIS/Data manager	Research manager	Country Coordinator
Dissemination	GIS Officer	GIS/Data manager	Research manager	Country Coordinator
Monitoring & Evaluation	GIS Officer, GIS/Data Manager	Research Manager		Country Coordinator
Lessons learned	GIS Officer	Research Manager		Country Coordinator

Responsible: *the person(s) who executes the task*

Accountable: *the person who validates the completion of the task and is accountable of the final output or milestone*

Consulted: *the person(s) who must be consulted when the task is implemented*

Informed: *the person(s) who need to be informed when the task is completed*

6. Monitoring & Evaluation Plan

IMPACT Objective	External M&E Indicator	Internal M&E Indicator	Focal point	Tool	Will indicator be tracked?
Humanitarian stakeholders are accessing IMPACT products	Number of humanitarian organisations accessing IMPACT services/products Number of individuals accessing IMPACT services/products	# of downloads of x product from Resource Center	Country request to HQ	User_log	X Yes
		# of downloads of x product from Relief Web	Country request to HQ		X Yes
		# of downloads of x product from Country level platforms	Country team		X Yes
		# of page clicks on x product from REACH global newsletter	Country request to HQ		X Yes
		# of page clicks on x product from country newsletter, sendingBlue, bit.ly	Country team		X Yes
		# of visits to x webmap/x dashboard	Country request to HQ		□ Yes
IMPACT activities contribute to better program implementation and coordination of the humanitarian response	Number of humanitarian organisations utilizing IMPACT services/products	# references in HPC documents (HNO, SRP, Flash appeals, Cluster/sector strategies)	Country team	Reference_log	□ Yes
		# references in single agency documents			□ Yes
Humanitarian stakeholders are using IMPACT products	Humanitarian actors use IMPACT evidence/products as a basis for decision making, aid planning and delivery Number of humanitarian documents (HNO, HRP, cluster/agency strategic plans, etc.) directly informed by IMPACT products	Perceived relevance of IMPACT country-programs	Country team	Usage_ Feedback *and* Usage_ Survey template	□ Yes
		Perceived usefulness and influence of IMPACT outputs			□ Yes
		Recommendations to strengthen IMPACT programs			
		Perceived capacity of IMPACT staff			
		Perceived quality of outputs/programs			
		Recommendations to strengthen IMPACT programs			□ Yes □ Yes
Humanitarian	Number and/or percentage of	# of organisations providing resources (i.e.staff, vehicles,	Country team		□ Yes

stakeholders are engaged in IMPACT programs throughout the research cycle	humanitarian organizations directly contributing to IMPACT programs *(providing resources, participating to presentations, etc.)*	meeting space, budget, etc.) for activity implementation		Engagement_log	
		# of organisations/clusters inputting in research design and joint analysis			□ Yes
		# of organisations/clusters attending briefings on findings;			□ Yes