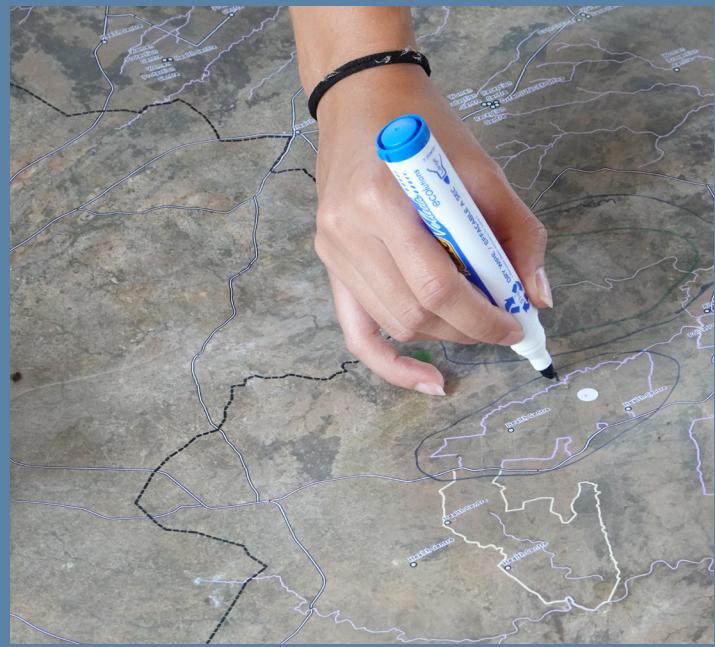


# Bidibidi Refugee Settlement: Environmental Scoping Report and Recommendations



**Uganda, September 2019**

*Prepared for Norwegian Refugee Council by Amanda George (UNEP / OCHA Joint Unit) and Theresa Dearden (UN Environment)*

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# Abbreviations

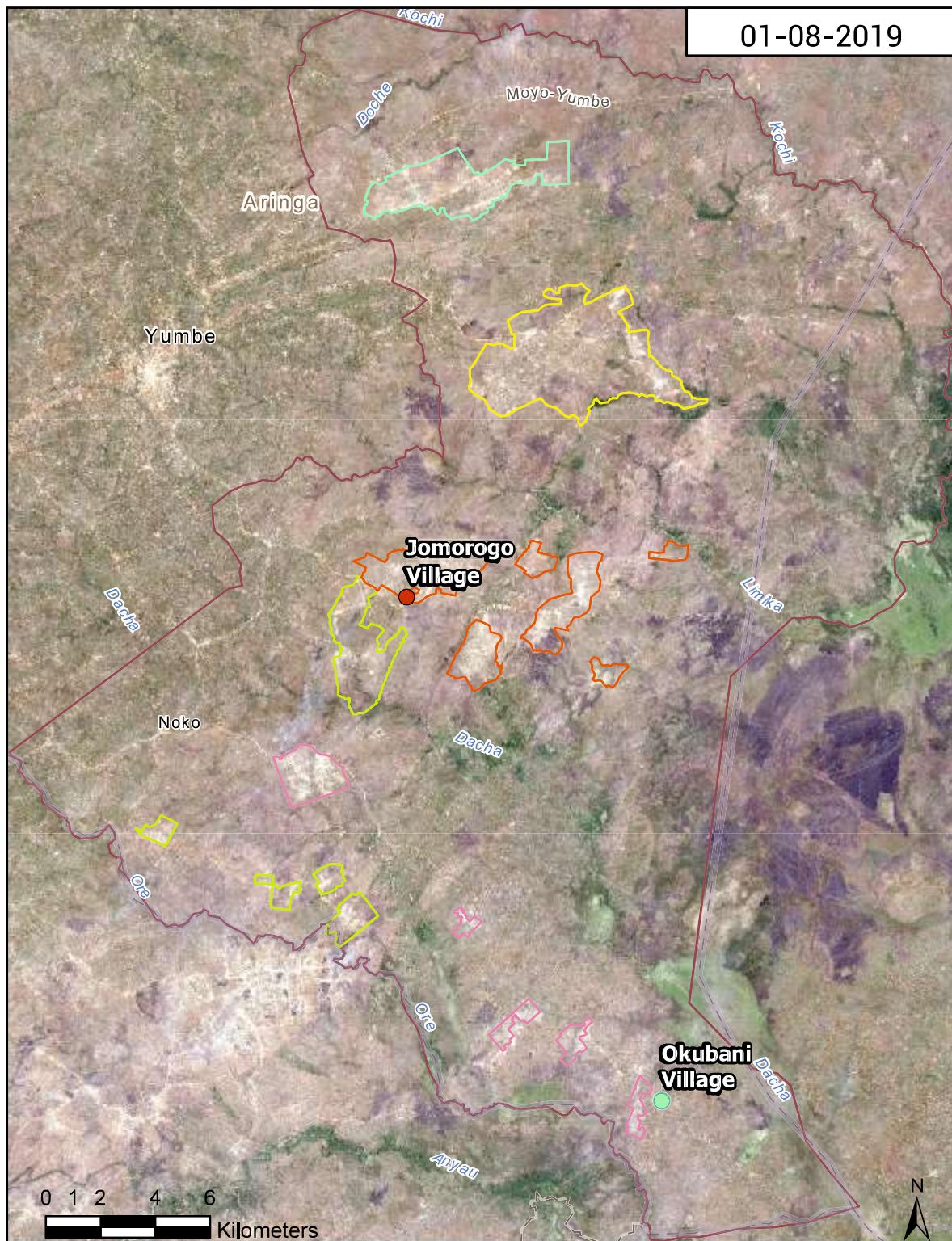
## Organizations

JEU	Joint Environment Unit <i>(of the United Nations Environment Programme and the United Nations Office for the Coordination of Humanitarian Affairs)</i>
EUTF	European Union Trust Fund
GoU	Government of Uganda
NRC	Norwegian Refugee Council
NEMA	National Environmental Protection Agency (Uganda)
OPM	Office of the Prime Minister (Uganda)
UBoS	Uganda Bureau of Statistics
UNEP	United Nations Environment Programme
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
UNHCR	United Nations High Commission for Refugees

## Thematic

FGD	Focus group discussion
FMNR	Farmer-managed natural regeneration
GIS	Geographic Information System
LFS	Livelihoods and Food Security
NEAT+	Nexus Environmental Assessment Tool
WASH	Water, Sanitation and Hygiene

# Bidibidi Refugee Settlement, January 2019



Data: Sentinel-2 satellite imagery downloaded from Copernicus Open Access Hub. Vector shapefiles provided by UNHCR. Map made for Joint Environment Unit following an environmental scoping mission of Bidibidi Refugee Settlement, September 2019.  
Date: 10-10-2019

# Executive Summary

This report presents the results of an environmental scoping mission by the UN Environment Programme / OCHA Joint Environment Unit (JEU) and Norwegian Refugee Council (NRC) to Bidibidi Refugee Settlement located in the West Nile Area of Uganda, home to over 270,000 South Sudanese refugees and the second largest refugee settlement in the world. The purpose of the mission was to highlight key areas of environmental risk in the NRC West Nile programme while using, testing and promoting the Nexus Environmental Assessment Tool (NEAT+). The mission was financially supported by NRC, UNEP and OCHA.

The scoping took place in Bidibidi Settlement Zones 3 and 5, locations of a future NRC and partner funded European Union Trust Fund (EUTF) programme with a strong emphasis on agriculture and food security. These zones were chosen in order to test the differences in environmental sensitivity between the newest established Zone 5 and the older Zone 3. Bidibidi Refugee Settlement was opened in August 2016 to accommodate a high influx of South Sudanese refugees.

To support the needs of the South Sudanese refugees, who primarily come from the Equatoria region, and the host communities of Bidibidi refugee settlement, there are over 30 civil society and government organizations working within Bidibidi. Current environmental dialogue about Bidibidi is often focused on minimizing land degradation and deforestation, due to host and refugee community dependence on biomass for fuel. This concern is well documented by both government and civil society organizations, with several mitigation strategies already underway. The scoping mission additionally identified environmental concerns that seem under-defined by current programmes of work in Bidibidi. Of particular concern is the lack of waste management, leading to increased risks to human health, and lack of awareness about environmentally sustainable behaviours.

The findings of this report are based on a combination of a field test of the NEAT+, eight focus group discussions including participatory mapping with refugee and host community groups, and a secondary data review. Some key findings (and related recommendations) of the report include:

- While programmes in Bidibidi refugee settlement are often implemented at the settlement or zone level, the biophysical characteristics can vary widely between zones (there are 5 zones spread across 250 km<sup>2</sup>). Biophysical characteristics can vastly alter the context in which certain livelihood, shelter, and WASH activities are appropriate. Environmental sensitivities should be screened across the zone and cluster level during the planning process.
- Social conflicts between host and refugee communities are not homogenous across the Bidibidi settlement. In Zone 3, identified conflicts were concerned with competition over natural resources, while in Zone 5 conflicts were arising due to a mismatch of cultural beliefs and practices.

- Many refugees share land with hosts through informal land sharing agreements. Formalising this tenure system with humanitarian operations can mitigate conflict and disputes between communities.
- There is a strong need to sensitize and educate refugees about their surroundings and how to conduct their household and livelihood activities in a more sustainable manner. Furthermore, there is a strong need to educate hosts about how to adapt their traditional activities to increased pressures on the natural environment.
- Climate change is affecting the agricultural activities of the host and refugee communities. The host communities indicated that the rainy season is becoming hard to predict, often arriving later and shorter with each passing year. Education focused on adaptation and resilience is necessary to protect agricultural livelihoods.
- Data sharing between organizations and between organizations and government bodies, both within Bidibidi and across other humanitarian operations in Uganda, is not as prevalent as it could be. This can lead to a duplication of efforts or gaps in programming.
- Promoting the NEAT+ as a screening tool for environmental sensitivities on a national level could serve as a strategic, easily deployable first step in the national Uganda EIA process.
- The capacity for screening environmental risks in current humanitarian operations on an organizational level is low. No standard tools are widely deployed by organizations, however, UNHCR is developing guidance on mainstreaming environment in refugee settings alongside the Government of Uganda (GoU). This represents a key opportunity to share existing guidance, as well as the NEAT+, widely with organizations operating in Uganda.

This report is one of the main outputs of the visit and it is hoped that the results and environmental findings from this mission presented here will be used by NRC towards planning mitigation activities and/or environmentally sensitive project planning in both upcoming and existing refugee interventions. Lessons learnt from the NEAT+ pilot will also be captured and used for future updates of the tool.

# Introduction

## Objectives

From 28 August to 7 September 2019, Mandy George (Independent Consultant and Environmental Field Adviser, JEU) and Theresa Dearden (Project Support Analyst, UNEP) travelled to Uganda to conduct the second field pilot of the NEAT+ and to produce a series of recommendations for the Norwegian Refugee Council (NRC) to increase the environmental sustainability component of their programming. The overarching objectives of the field pilot and scoping mission were to:

1. Highlight the key areas of environmental risk in NRC's West Nile programme in Bidibidi to inform project design. Build capacity with local field staff to extend the pilot to other areas of interest. Explore how the NEAT+ can fit into NRC's systems and requirements at an organizational level.
2. Share and promote the tool with other in-country humanitarian/environmental organizations and Joint Initiative partners.
3. Test and document the use of the NEAT+ tool from a user perspective, with a view to further improve it

In this report, the results of the NEAT+ are analyzed in the context of the focus group discussions, secondary data review, and the NRC programme of work to provide tailored recommendations for mitigating environmental risks in Bidibidi, and more broadly on a national level. Recommendations are thus presented at three levels:

1. Programmatic: Project Implementation (Zones 3 & 5)
2. Organizational strategy: Mainstreaming NEAT in NRC
3. External advocacy and capacity building: With GoU and other partners

## NEAT+ Background

The NEAT+ was developed by the Coordination of Assessments for Environment in Humanitarian Action "Joint Initiative", in partnership with NRC and other partners (see below). The tool builds on a previous version ("NEAT") designed by NRC. It was updated and further developed by the Joint Initiative and overseen by a working group of over 25 organizations. For more information on the NEAT+, including the tool and guidance notes, visit the EHA Connect website: <https://ehaconnect.org/resources/neat>.

The NEAT+ is an open source, simple and pragmatic project-level environmental assessment tool that assesses a snapshot of the current sensitivity of the local environment, highlighting any underlying vulnerabilities. The tool then overlays activity-specific information to identify potential exacerbating risks posed by a project. The tool is intended to enhance project quality and improve the accountability of humanitarian programming. The NEAT+ is a targeted response to an identified need for a tool that allows an effortless and rapid identification of key

environmental issues by users with limited or no environmental expertise. It consists of various technical modules including environmental sensitivity, WASH, Shelter and Food Security and Livelihoods. Data is collected in Kobo Toolbox or in Excel.

The Joint Initiative ran from January 2017 to January 2019 and aimed to improve coordination between environment and humanitarian actors both before and after disasters, with a focus on updating and improving key humanitarian environmental assessment tools. It was a collaborative effort between USAID, UNHCR, WWF, the JEU, NRC and the Swedish Civil Contingencies Agency (MSB). The project, through better dissemination of tools, resources and environmental data, supported efficient consideration of environment and climate knowledge in humanitarian assistance. The Joint Initiative produced various deliverables working towards the improved integration of environment in humanitarian action, including the NEAT+. The JEU is now the custodian of the NEAT+.

## Bidibidi Background

According to [UNHCR statistics](#), as of August 2019 Uganda was hosting over 1.3 million refugees, making it the largest host country in Africa. Uganda is known for its progressive refugee policy which focuses on refugee integration and promotion of self-reliance and livelihood activities, and aid distribution to both refugee and host communities. Uganda hosts refugees and asylum seekers from South Sudan, Burundi, and the Democratic Republic of Congo (DRC).

South Sudanese refugees make up the majority of refugees in Uganda (>60% as of August 2019). Violent conflict in South Sudan forced almost 2.1 million refugees to flee into neighbouring countries since the end of 2013, with a little over 1 million migrating to Uganda.<sup>1</sup> Most of these South Sudanese refugees were settled in the West Nile region of northwestern Uganda, which is bordered by South Sudan to the north and DRC to the west. Between January and October 2016, 350,000 South Sudanese refugees crossed the border into the West Nile.<sup>2</sup> Due to this unanticipated influx, nine new settlements were opened in the region, with Bidibidi as the largest, currently hosting over 220,000 refugees in an area stretching over 250 square kilometers. Due to a challenging peace process and ongoing insurgencies, civil society organizations predict a protracted refugee presence in Uganda, with some estimating the displacement will last until 2025.<sup>3</sup>

Bidibidi officially stopped accepting new refugees in December 2016,<sup>4</sup> although new people may still be arriving to join family members on established plots. Bidibidi is divided into five zones

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<sup>1</sup> FAO (2018) 'Food security, resilience and well-being analysis of refugees and host communities in northern Uganda.' Available at: <http://www.fao.org/3/i9708en/I9708EN.pdf>

<sup>2</sup> Inter-Agency Regional Analysts Network (2017) 'Bridging the Gap: Long-term Implications for South Sudanese Refugees in West Nile, Uganda', Available at:

[https://www.actionagainsthunger.org.uk/sites/default/files/publications/bridging\\_the\\_gap\\_-\\_final.pdf](https://www.actionagainsthunger.org.uk/sites/default/files/publications/bridging_the_gap_-_final.pdf)

<sup>3</sup> Ibid.

<sup>4</sup> Relief Web (June 2018) 'Uganda Refugee Response Monitoring Settlement Fact Sheet: Bidi Bidi (June 2018)'. Available at: <https://reliefweb.int/report/uganda/uganda-refugee-response-monitoring-settlement-fact-sheet-bidi-bidi-june-2018>

(see Figure 1), settled sequentially (from Zones 1-5) by time of refugee arrival, and each of these zones is divided into clusters, which are further divided into individual villages surrounded by host community settlements. The Bidibidi land was chosen so that it fell in between existing host communities, and generally consists of under-utilized "hunting grounds" considered by the host community as unsuitable for agriculture.<sup>5</sup> The settlement comprises an area of 798 km<sup>2</sup>, within which the five zones cover a total of 250 km<sup>2</sup>.

*Alongside UNHCR there are over 30 organizations working within Bidibidi.<sup>6</sup> Organizations follow a loose "30% soft law" when working in Bidibidi, in which 30% of the aid coming into Bidibidi is allocated to the host community.<sup>7</sup>* This rule is not clearly defined and is interpreted differently by different agencies, local government and the Office of the Prime Minister. This is one source of grievance in the conflict dynamics between host and refugee communities. In some cases, there are refugees who seem better off than the host community, with a greater diversity of livelihood opportunities and higher levels of education than nearby host community members.

Environmental issues of concern in Bidibidi are generally well documented, in particular the overdependence on biomass for energy by both host and refugee communities. This is another source of conflict and competition between host and refugee communities due to dwindling supply.

## Uganda EIA regulatory context

The key regulations for environmental and social assessment in Uganda include the National Environment Act Cap 153, and the National Environment (Environmental Impact Assessment) Regulations, 1998. There are different categories for ESIsAs which indicate the level of envisaged risk based on the sensitivity of the setting and the nature and scope of planned activities.

Screening is identified by the government as a vital first step in the project cycle, to rule out those projects with little or no environmental and social impact so that they can move to approval and implementation immediately. Screening is the most important process to distinguish if an EIA is required, however there is no standard template or tool used for screening for environmental risk in Uganda. There are some examples of environmental and social safeguard screening forms (paper checklists)<sup>8</sup> but no one template. The NEAT+ was therefore of interest to the National Environmental Management Authority (NEMA)<sup>9</sup> as a possible screening tool to recommend for refugee programming.<sup>10</sup>

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<sup>5</sup> Alan Boswell, EU (2018) 'Contested Refuge: The Political Economy and Conflict Dynamics in Uganda's Bidibidi Refugee Settlements'. Accessible from: <https://data2.unhcr.org/en/documents/download/66344>

<sup>6</sup> UNHCR (2019) 'Performance Snapshot: Uganda Refugee Response Plan 2019-2020, Quarter 2.' Accessible from: <https://data2.unhcr.org/en/documents/download/71035>

<sup>7</sup> Alan Boswell, EU (2018) 'Contested Refuge: The Political Economy and Conflict Dynamics in Uganda's Bidibidi Refugee Settlements'.

<sup>8</sup> For example, DRDIP Environmental & Social Safeguards Screening Form (Annex 2) of OPM's Uganda Development Response to Displacement Project (DRDIP).

<sup>9</sup> Who attended the NEAT+ workshop in Kampala.

<sup>10</sup> See "Recommendations" section (external advocacy and capacity building).

## Methodology

The methodology followed for the field pilot of the NEAT+ tool in Bidibidi Refugee Settlement involved conducting a three-day field test of the NEAT+ with NRC field and office staff in various locations, facilitating focus group discussions with host and refugee communities and holding a half day multi-stakeholder workshop presenting preliminary results and discussing the NEAT+. These data collection methods are expanded on below.

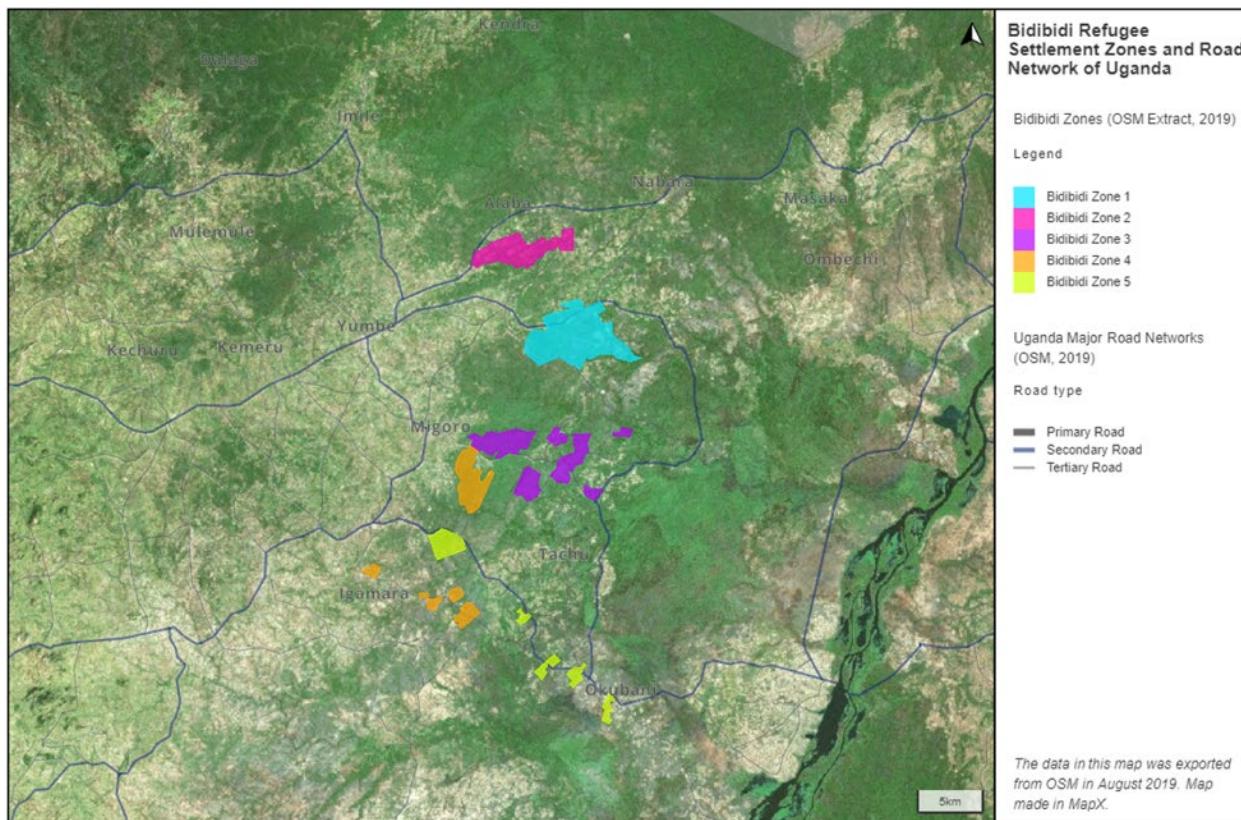


Figure 1. Map of Bidibidi Settlement Zones, major roads and surrounding towns.

### 1. Secondary data review pre-field test

Before arrival in Uganda, the JEU team completed a secondary data review of open spatial and non-spatial data available on a national level and for Bidibidi. Non-spatial data was mostly reviewed through reports and studies done in Uganda by civil society organizations. Over 100 spatial datasets were compiled into a geodatabase, collected from sources such as [Open Street Map](#), [HDX](#), and the Uganda Bureau of Statistics [geoportal](#). In addition, UNHCR focal points provided spatial datasets related to refugee settlements around Uganda via email. Relevant datasets pertaining to the Bidibidi refugee settlement and environment and administration in Uganda were uploaded to a MapX [data project](#), which is open to the public. [MapX](#) is an open-source, cloud-based geospatial mapping platform managed by UN Environment and GRID-Geneva. Once the open geospatial data had been uploaded to MapX, the national level data could be compared to global datasets to conduct a preliminary study on the biophysical conditions of Bidibidi. Optical satellite imagery was obtained from the Copernicus Open Data Hub to assess

ground conditions before and after the settlement. The results of this can be seen in the section below regarding land use and land change.

## 2. NEAT+ field test

The tool was tested over three days with various users from NRC, including field staff, community volunteers, sector experts and the Livelihoods and Food Security regional advisor for East Africa. The NEAT+ field test took place in Zones 3 and 5 of Bidibidi and was tested at different scales - from the Cluster to the Zone level. It was completed in three different ways:

- a. *Environmental Sensitivity Zone 3*: Two groups consisting of a mix of field staff, community volunteers and technical experts completed the environmental sensitivity module for Zone 3.
- b. *Environmental Sensitivity Zone 5*: Two field staff who are familiar with the area conducted the environmental sensitivity module for Zone 5.
- c. *Activity modules*: FSL experts (3) and WASH experts (2) conducted the activity modules for Zones 3 and 5. Note: WASH was conducted for Zone 3, and FSL for the planned activities in Zone 5 and for the ongoing activities in Zone 3. The FSL modules were completed by two different users on mobile devices in the field, while the WASH and Shelter modules were completed on mobile devices in the field office.

NRC already has an organizational Kobo account in Uganda, which was utilized for the tests and many field staff were already familiar with Kobo mobile data collection. Furthermore, there was an M&E specialist in the field office who manages the Kobo account, mobile devices, and data aggregation for the entire office.

### Test in 2 zones for comparison

Bidibidi is split into five zones (see Figure 1), which are further split into clusters. The zones were gazetted and settled sequentially, beginning in 2016. To test the difference between a well-established and a newer zone, the NEAT+ tests were conducted in Zones 3 and 5, both of which have NRC activities either planned or ongoing. The clusters tested are over 20 km apart and also have different biophysical characteristics, for example in terms of agricultural suitability and water availability.

### Test at different geographic scales (Cluster, Zone)

Each zone in Bidibidi is split into clusters, which are further delineated into smaller villages within the cluster. The NEAT+ environmental sensitivity module was tested at two geographic scales: the entire zone, and the specific cluster where focus group discussions took place. The activity modules were tested at the zone level, as activities are often planned and implemented at the zone level by organizations.

Tests conducted by field officers, technical staff, and community volunteers

Tests were completed by different NRC staff at different locations. In Zone 3, the environmental sensitivity module was completed with the help of the community volunteers.

Technical modules tested by sector specific staff

Sector specific staff conducted tests of the NEAT+ activity modules based on their knowledge of NRC activities in Zones 3 and 5. In some cases, the activities in Zones 3 and 5 were the same.

### 3. Focus Group Discussions and Participatory Mapping

Focus group discussions (FGDs) and participatory mapping exercises were conducted for more detailed contextual information and to validate the results of the NEAT+.<sup>11</sup> Focus group discussions were held with the refugee and host communities of villages/areas in Zones 3 and 5. Eight discussions were held in total, in which the participants were divided by gender and host or refugee status. FGDs were organized by NRC field staff, who also provided translation assistance. The questions followed a similar line of enquiry to the NEAT+ environmental sensitivity module, with some additional questions related to Shelter, WASH and FSL. A participatory mapping element was included so that participants could indicate where they were collecting natural resources, disposing of waste, and collecting water. The results of the participatory mapping exercises are available on the MapX data project but are viewable only by approved members<sup>12</sup> of the project to protect participant anonymity.

In Zone 3, the closest village to the cluster was Jomorogo Village. Focus group discussions were held in Mengo Primary School with the host community, and the Methodist church inside Zone 3, village 3 with the refugee community. In Zone 5, the closest village to the selected cluster was Okubani village.

### 4. Kampala workshop

On 6 September 2019, a workshop was held by the JEU and NRC at the Silver Springs Hotel in Kampala to present the NEAT+ and preliminary findings from the Bidibidi field test, and to engage participants in broader discussions about different aspects of screening and assessing environmental risk in humanitarian settings. Twenty-five representatives from the government, civil society organizations and UN agencies attended the half-day workshop (see participant list in Annex B). The aim of the workshop was to promote the use of the NEAT+ and to have a broader discussion on screening for environmental risk and the use of environmental data in humanitarian action. These discussions have informed the recommendations for NRC, particularly the section on advocacy and support to Government.<sup>13</sup>

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<sup>11</sup> Note: FGDs are not necessary for the completion of the NEAT+.

<sup>12</sup> To request access to the MapX “NEAT+ Uganda” data project as a member, contact [theresa.dearden@un.org](mailto:theresa.dearden@un.org)

<sup>13</sup> See “Recommendations” section.

See Annex B for a full workshop report.

## NEAT+ usability learning

Key findings related to the usability and functionalities of the NEAT+ arising from the pilot include:

- **Useful precursor to EIA:** In a country context where EIAs are mandatory but where there is little guidance on how humanitarian agencies should conduct them or select the expertise necessary to conduct them, the NEAT+ can play an important role in prioritizing which sector experts should be recruited for the EIA.
- **It is as much about the process as the results:** The NEAT+ can act as a useful checklist of ideas and information that is a useful process to go through, not only for the results generated but to stimulate discussion (if answered in a group). The prompts and hints are particularly useful for this.
- **Easy to use:** The NRC team was already familiar with using Kobo for data collection, and they found the process of data collection and download straightforward. This was the same for field and technical staff. The process of explaining the NEAT+ can make it appear more complicated than it actually is, and efforts should be made to explain it as simply as possible, preferably using demonstrations. Completing the collection, download, and analysis processes with the field staff during the test eased the friction between user and tool.
- **New mitigation tips feature is a highly practical addition:** The latest revision of the NEAT+ added in mitigation tips for each area of environmental concern that was well received as one of the most practically useful aspects of the tool.
- **Accurate results:** Enquiry into Zones 3 and 5 via FGDs revealed quite different scenarios, that were accurately reflected in the results of the NEAT+ for both zones, including differences in cultural conflict. When more than one group completed the environmental sensitivity module for the same areas, the results were almost identical. The only main difference came from a misunderstanding of what disaster waste is and from some of the environmental questions (see next point).
- **Need for further clarification on how to respond to certain questions:** There was some difference in how respondents classified the area as highly/mediumly/sparsely populated; slope; soil type; and type of environment (i.e., savannah, forest, etc.). There was some confusion over whether this question referred to how it was before the refugees arrived or how it appears now. To address this, edits to the questions will be made, and additional guidance added to these specific questions in the next update of the tool.
- **Area-specific results are useful even when large amounts of settlement data exist:** During the pre-pilot there was a concern that the NEAT+ might not be as useful in Bidibidi as in other contexts where less environmental data and information is available. However, the pilot revealed that despite the large amount of existing data, programme staff did not necessarily know about it or how to access it, and often the data is for the entire settlement and therefore not as accurate as NEAT+ as a project planning tool. Furthermore, the data available could not be exclusively used to accurately complete the environmental sensitivity module of the NEAT+ remotely - some level of field knowledge

or validation would have been required. Thus, the ideal scenario is to use secondary data for the overall context and to verify the NEAT results, and the NEAT+ results for more detailed project planning.

- **Can be used both to modify existing activities (M&E) or plan new ones:** The NEAT+ test on Zone 3 provided ideas for mitigation that could be incorporated into existing implementation plans to increase sustainability. The NEAT+ test on Zone 5 with the future EUTF FSL programme in mind will be used to plan new activities. Both were considered equally useful by the NRC team.
- **Highlights areas that need more research:** Some mitigation activities may seem quite broad as the tool can be used anywhere in the world. However, even for the mitigation measures or environmental concerns that are not specific to the local context, they still can highlight areas that need further research before programme implementation. As mentioned above, even the process of going through the mitigation tips and determining whether they are applicable to the local context can be a useful starting point for dialogue and planning.
- **Agile first step without environmental expertise which frames technical concepts within humanitarian jargon and priorities:** Almost all the questions were answered easily without environmental expertise and the level of questioning worked well for all types of users. The only questions where there was some debate or confusion were on soil types, gradient and topography.
- **Can be used as a predictive tool:** One suggestion for use of the tool by a workshop participant was to use it as a predictive tool to see the differing impacts of alternative sets of activities during the planning stage.
- **Links to MapX data sets from the hints and prompts would help users answer questions:** In particular those that they might not know, such as climate type or proximity to water bodies or international borders
- **Answering the environmental sensitivity module as a group exercise worked well.** This allowed for discussion on each question and increased the collective understanding of the issues.

## Environmental concerns

### Findings from the NEAT+

This report focuses primarily on the results of Zone 5, as this is where there is less knowledge of environmental sensitivities and where the new FSL activities of the EUTF programme will take place. It is however expected that the results and recommendations will be applicable to the other zones where NRC is working and will be considered for both adapting existing programming and planning new interventions.

## Environmental sensitivity module

Overall there were limited issues of concern in Zone 3 (Figure 2) which can be attributed to the level of services already provided in this area, including mostly sufficient access to water and permanent or semi-permanent shelters, due to the fact that the refugee community has been living there for approximately three years. As of August 2019, Zone 3 is the most populated settlement of Bidibidi - with 53,760 residents (comprising 11,489 households) over 16 square kilometres.

<b>Environmental Sensitivity Analysis</b>		<b>NEAT +</b> Nexus Environmental Assessment Tool
Assessment of: Bidibidi, zone 3, Village 3, Group 1	Date of Assessment: 02-Sep-19	
Assessment completed by: Group 1	Location: Bidibidi zone3 village 3	
Organisation completing assessment: NRC	Country: Uganda	
Issues of High Concern	Issues of Medium Concern	Issues of Low Concern
There is a high concentration and/or number of people. The potential environmental impact is greater.	The community may not be socially cohesive. This can prevent collective action and lead to social conflict.	The community may have low self-sufficiency. There may be a greater demand (and impact) on the local environment.
	The environment has fragile ecosystems. Loss of biodiversity may be an issue.	The displaced population may have a poor understanding of local ecosystems. This makes it difficult to manage the environment effectively.  There may be a weakened or poor governance system. There may be low capacity for environmental management.

Figure 2: Environmental Sensitivity Analysis, Zone 3

Although Zone 5 was also gazetted and settled in late 2016, it is considered the newest zone with the least amount of established services and programmes. As of August 2019, Zone 5 had 49,493 residents (comprising 9,715 households) over 7.5 square kilometres. The result of the environmental sensitivity analysis (Fig 3) for Zone 5 returned more risks on all themes compared to Zone 3, most of which were confirmed by focus group discussions (for example, the propensity of the area to flooding and social conflict over area of cultural significance).

# Environmental Sensitivity Analysis



Nexus Environmental  
Assessment Tool

Assessment of: Bidibidi Zone 5	Date of Assessment: 04-Sep-19	
Assessment completed by: Team	Location: Zone 5	
Organisation completing assessment: NRC	Country: Uganda	
Issues of High Concern	Issues of Medium Concern	Issues of Low Concern
The displaced population may have a poor understanding of local ecosystems. This makes it difficult to manage the environment effectively.	The environment has fragile ecosystems. Loss of biodiversity may be an issue.	There is a high concentration and/or number of people. The potential environmental impact is greater.
There is low capacity to manage wastewater. Environmental sanitation and disease transmission may be an issue.	There are areas of high cultural significance. This can threaten social cohesion.	The community may have low self-sufficiency. There may be a greater demand (and impact) on the local environment.
The area may have heightened exposure to climate-related risks and extreme weather events.	Indoor air pollution, caused by poor ventilation and cooking/heating, may be an issue.	The displaced population may be in a state of high uncertainty. There may be a lack of incentive to practice sustainable behavior.
Natural resource availability/accessibility may be affected by changing climatic conditions.	The water sources may be vulnerable to contamination. Water quality may be an issue.	There may be a weakened or poor governance system. There may be low capacity for environmental management.
	There is low capacity to manage solid waste. Environmental sanitation and disease transmission may be an issue.	The environment has high biodiversity value. Vulnerable and/or rare flora and fauna may be at risk.
	Disaster waste may be an issue. Disaster waste can pose public health risks, and impede relief or recovery activities.	The community may have a high dependency on the natural environment. This can threaten livelihoods and social cohesion.
	This area may be at risk of soil erosion from wind.	Rates of deforestation may exceed regeneration capabilities. Deforestation may be a risk.
	This area may be at risk of flooding.	The environment has a low regenerative capacity. The effects of land and soil degradation are more significant.
		The water resources may have a low regenerative capacity. Water scarcity may be an issue.
		The area may have poor slope stability. Landslides or mudslides may be a risk.
		This area may be at risk of soil erosion from water.

Figure 3: Environmental Sensitivity Analysis, Zone 5

## Activity Modules

### Food Security Livelihoods

Three of the four FSL submodules were completed for the planned Zone 5 activities.<sup>14</sup> Activities planned for EUTF in Zone 5 are predicted to be very similar to those ongoing in Zone 3.

Of particular interest to the sector experts who completed the FSL assessment was the irrigation submodule. One person noted that although NRC does include irrigated crops in farmer training programmes, there is usually little previous knowledge about where the water is coming from and what the recharge rates of the water source might be.

<sup>14</sup> Note: for the full reports, including mitigation tips and further resources, see separate PDFs of results.

The overall potential environmental risk highlighted for FSL activities in Zone 5 is predicted to be low. However, it is important to highlight that low risk does not mean no risk, and that the aggregate of low risks across all zones can combine to form a medium to high risk and therefore low risks should also have mitigation tips in place. As of September 2019, the NEAT+ tool has already been updated to reflect this.

#### Livestock

Environmental Concerns	Environmental Sensitivity	Potential Activity Impact	Potential Environmental Risk
<b>Key environmental concerns</b>			
The environment has fragile ecosystems. Loss of biodiversity may be an issue.	Medium	Null	Low
The environment has a low regenerative capacity. The effects of land and soil degradation are more significant.	Low	Medium	Low
<b>Other environmental concerns</b>			
The environment has high biodiversity value. Vulnerable and/or rare flora and fauna may be at risk.	Low	Low	Low
The water resources may have a low regenerative capacity. Water scarcity may be an issue.	Low	Null	Null
The water sources may be vulnerable to contamination. Water quality may be an issue.	Medium	Null	Low
Natural resources may be scarce and in high demand. This can lead to social conflict.	Null	Low	Null
<b>Mitigation Tips</b>			

- Local communities should be engaged from the project's conception to ensure that interventions are culturally appropriate, meet communities' needs and leverage traditional knowledge of the local environment. Engaging with local communities also reduces the likelihood of potential future conflict; this is particularly important in a humanitarian emergency as social fabrics can be significantly strained.
- Beginning new livestock activities requires additional assessments to better understand provisioning capacities of the local environment and the suitability of planned species, given the absence of existing knowledge about livestock and local environment. Comprehensive training for communities is also recommended given potential unfamiliarities.
- Different species or breeds of livestock have different foraging preferences. Investing in only a single breed can lead to an over-consumption of certain vegetation, significantly altering the mix of plants and ecosystem dynamics in the area. Single specie herds also have lower overall resilience to seasonal and climatic patterns. Therefore, investment should be made in multiple breeds.
- Larger livestock species, such as cattle or buffalo, have a greater environmental footprint. These species are resource intensive in terms of food and water requirements, and also produce significantly more greenhouse gas emissions. Where appropriate, diversify herd species with smaller species to strengthen resilience and also reduce environmental impacts.
- The introduction of non-native or non-locally adapted species can negatively affect biodiversity. Some newly introduced species may be poorly adapted to the climate, environment or local diseases. In other instances, cross-breeding can threaten genetic diversity reducing herd resilience. A comprehensive risk assessment should be undertaken and regulatory approval should be sought when introducing non-native species.
- Local wildlife can prey on livestock or compete for food. This may encourage livestock managers to kill wildlife to prevent wildlife-livestock contact or to reduce food competition. Wildlife-livestock contact can also lead to the spread of diseases. Herding and livestock management strategies should be developed to minimize potential conflict with wildlife.
- Maintaining livestock numbers (and species) outside of a sustainable level can lead to long-term land, soil degradation and competition for resource. The local carrying and regenerative capacities of the area should be identified. Traditional local knowledge and local experts are often useful sources of information.
- Inadequate land availability can lead to conflict, overgrazing or the conversion of natural areas for livestock usage. Land use requirements for livestock should be identified and compared to the available area as well as the carrying or regenerative capacity of the local environment. Customary governance structures of pastoralists must be understood to support culturally-sensitive land stewardship.
- Tenure security (land ownership or access rights) provides certainty for the user, encouraging a long-term outlook thus improving sustainability of practices. Humanitarian emergencies can hamper access to legal documents on tenure. Consider tenure rights and access regimes in order to preempt potential social conflict or future legal concerns. Local authorities should be consulted as they can be a source of information for tenure rights, especially among agro-pastoralists.
- Look for synergies in different uses of land. For example, livestock activities can enhance and restore grazing and agricultural land through rotational land use activities.
- Livestock use of shared water sources can lead to decreased availability or quality of water. This can cause social conflict. Water needs of livestock should be estimated, and assessed against water availability after considering the existing needs of existing users. Rules and access agreements for water usage should be devised collaboratively and enforced accordingly.
- Shared-used water points can contaminate water sources and can also increase risk of human-animal disease transmission. Downstream aquatic ecosystems can also be negatively impacted. Identify sensitive receptors, and site watering points away and downstream from these receptors. Protect water sources from contamination by livestock manure.
- Construction of water provisioning infrastructure can lead to the depletion of water sources or increase the risk of contamination. The recharge capacity of the water source should be assessed, and appropriate protective strategies and infrastructure should be put in place to minimize the risk of water contamination.
- Slaughter sites should be collaboratively identified with community members. Slaughter should be carried out away or downstream from water courses to minimize contamination risk, as well as away from residential areas due to strong odors. Ensure that livestock managers have an appropriate strategy for the disposal or usage of livestock carcass remnants.
- Veterinary pharmaceuticals can remain active in livestock manure or urine, leading to soil and/or water contamination. Imprudent usage of antibiotics or other medicines also lead to microbial resistance. Practice integrated pest management, using pharmaceuticals and chemicals as a last resort. Select species adapted to local conditions to reduce the need for medicines. Animal pharmaceuticals should be properly sourced, stored and disposed of.

<b>Additional Resources</b>	
<b>Sector Environmental Guidelines: Livestock</b>	<a href="#">Link</a>
USAID's Sector Environmental Guidelines aim to support environmentally sound design and management of humanitarian and development projects. These guidelines provide concise, plain-language information regarding potential environmental impacts, and prevention and mitigation strategies.	
<b>Sector Environmental Guidelines: Integrated Pest Management</b>	<a href="#">Link</a>
USAID's Sector Environmental Guidelines aim to support environmentally sound design and management of humanitarian and development projects. These guidelines provide concise, plain-language information regarding potential environmental impacts, and prevention and mitigation strategies.	
<b>Additional Details/Comments</b>	

## Agriculture

Environmental Environmental Concerns	Environmental Sensitivity	Potential Activity Impact	Potential Environmental Risk			
<b>Key environmental concerns</b>						
The environment has fragile ecosystems. Loss of biodiversity may be an issue.	Medium	Null	Low			
The environment has a low regenerative capacity. The effects of land and soil degradation are more significant.	Low	Null	Null			
<b>Other environmental concerns</b>						
The environment has high biodiversity value. Vulnerable and/or rare flora and fauna may be at risk.	Low	Null	Null			
The water resources may have a low regenerative capacity. Water scarcity may be an issue.	Low	Null	Null			
The water sources may be vulnerable to contamination. Water quality may be an issue.	Medium	Null	Low			
Natural resources may be scarce and in high demand. This can lead to social conflict.	Null	Null	Null			
<b>Mitigation Tips</b>						
<ul style="list-style-type: none"> <li>Utilize and preserve traditional knowledge. Traditional knowledge and practices have evolved over time based on an understanding of the local environment. Their practices are often sustainable, as they have been employed over generations. Disturbing traditional practices can lead to a loss of knowledge resulting in future unsustainable practices. Traditional knowledge can be a valuable source of information - consult locally when designing the project.</li> <li>Protected areas and existing forests can contain fertile soils, but are often exploited for short-term agricultural benefits leading to long-term land degradation. Clearing these areas also destroys ecosystems, reducing natural services such as runoff, flooding and erosion protection. Avoid devegetation, prioritizing the rehabilitation of existing vegetated areas where possible.</li> <li>Tenure security (land ownership or access rights) provides certainty for the user, encouraging a long-term outlook thus improving sustainability of practices. Humanitarian emergencies can hamper access to legal documents on tenure. Consider tenure rights and access regimes in order to preempt potential social conflict or future legal concerns. Local authorities should be consulted as they can be a source of information for tenure rights, especially among agro-pastoralists.</li> <li>Look for synergies in different uses of land. For example, livestock activities can enhance and restore grazing and agricultural land through rotational land use activities.</li> <li>Irrigation requirements should be calculated and assessed against the water source recharge capacities to ensure sustainability of the interventions. Needs of other users (e.g. for drinking, livestock or other agriculture) should be considered, as well as seasonal/climatic variations. Rules and access agreements for water usage should be devised collaboratively, with monitoring and enforcement mechanisms.</li> <li>Water runoff can cause soil erosion and also transport contaminants into water bodies. An absence of drainage infrastructure can also lead to salt accumulations or waterlogged soils. Drainage systems improve agricultural productivity and minimize environmental risks. Systems should be designed considering local topography, soil and water conditions, and climate.</li> </ul>						
<b>Additional Resources</b>						
<b>Sector Environmental Guidelines: Agriculture</b>	<a href="#">Link</a>					
USAID's Sector Environmental Guidelines aim to support environmentally sound design and management of humanitarian and development projects. These guidelines provide concise, plain-language information regarding potential environmental impacts, and prevention and mitigation strategies.						
<b>Sector Environmental Guidelines: Integrated Pest Management</b>	<a href="#">Link</a>					
USAID's Sector Environmental Guidelines aim to support environmentally sound design and management of humanitarian and development projects. These guidelines provide concise, plain-language information regarding potential environmental impacts, and prevention and mitigation strategies.						
<b>Sector Environmental Guidelines: Safer Use Pesticides</b>	<a href="#">Link</a>					
USAID's Sector Environmental Guidelines aim to support environmentally sound design and management of humanitarian and development projects. These guidelines provide concise, plain-language information regarding potential environmental impacts, and prevention and mitigation strategies.						
<b>Additional Details/Comments</b>						

### Irrigation

Environmental Environmental Concerns	Environmental Sensitivity	Potential Activity Impact	Potential Environmental Risk
<b>Key environmental concerns</b>			
The water resources may have a low regenerative capacity. Water scarcity may be an issue.	Low	Low	Low
The environment has fragile ecosystems. Loss of biodiversity may be an issue.	Medium	Null	Low
<b>Other environmental concerns</b>			
The environment has high biodiversity value. Vulnerable and/or rare flora and fauna may be at risk.	Low	Null	Null
The environment has a low regenerative capacity. The effects of land and soil degradation are more significant.	Low	Null	Low
The water source may be vulnerable to contamination. Water quality may be an issue.	Medium	Low	Medium
Natural resources may be scarce and in high demand. This can lead to social conflict.	Null	Null	Null
<b>Mitigation Tips</b>			
<ul style="list-style-type: none"> <li>Inadequate irrigation water quality can degrade irrigated lands over time. Salts, minerals and ions in irrigation water accumulates in irrigated soils, reducing fertility and crop outputs. Consult national or local standards for irrigation water quality where they exist; where this is not the case, international standards (e.g. FAO) can be a substitute.</li> <li>Irrigation activities can generate contaminants in drained or discharged water, affecting downstream users. Typical concerns include nutrients from fertilizers, chemicals from pesticides or salts from saline soils. Water quality should be monitored and referenced against national or international standards, with treatments (low-cost nature-based options exist) if necessary.</li> <li>Understanding recharge/flow/yield rates is necessary to properly estimate sustainable irrigation water usage rates. Short-term (seasonal) and long-term (climatic) variations should also be considered. Extracting water unsustainably can alter hydrologies, negatively affect ecosystems and be a catalyst for social conflict.</li> <li>Upstream or downstream users or uses can be threatened or can threaten the quality and quantity of shared water resources. Downstream users and/or ecosystems are particularly vulnerable to the effects of unsustainable water usage practices. Consider the water needs (both quantity and quality) downstream as part of project planning, particularly the farmers whose fields are furthest from the source.</li> <li>Inequitable access to irrigation water or lands can lead to increased inequality and social tensions, especially in a humanitarian context where social fabrics are under stress. This is exacerbated by climate change. Irrigation activities should benefit all actors. Consider the needs of all actors during planning.</li> <li>Dams can significantly alter hydrologies and aquatic hydrologies. Inappropriately designed, maintained and operated dams can also affect water quality, with concerns such as anoxic conditions, siltation or hosting disease vectors. Water loss through evaporation and socio-economic impacts should also be considered. Dams are high risk, and a full environmental impact assessment must be considered for dams larger than 2m.</li> <li>Water runoff can cause soil erosion and can also cause transport contaminants to enter into water bodies. An absence of drainage infrastructure can also lead to salt accumulations or waterlogged soils. Drainage systems improve agricultural productivity and minimize environmental risks. Systems should be designed considering local topography, soil and water conditions, and climate.</li> <li>Ecosystems that are sensitive are more likely to be adversely impacted by irrigation activities. Where possible, construction in these areas should be avoided or expert local advice sought to minimize potential impacts if otherwise not possible.</li> <li>An integrated water management strategy should be developed, in close collaboration with stakeholders including downstream users. This strategy should ensure that water used for irrigation does not negatively affect adequate access for other users. Stakeholders should be assigned responsibilities, with mechanisms for monitoring and accountability also in place.</li> </ul>			
<b>Additional Resources</b>			
Sector Environmental Guidelines: Construction	<a href="#">Link</a>		
USAID's Sector Environmental Guidelines aim to support environmentally sound design and management of humanitarian and development projects. These guidelines provide concise, plain-language information regarding potential environmental impacts, and prevention and mitigation strategies.			
Sector Environmental Guidelines: Agriculture	<a href="#">Link</a>		

Figure 4: FSL NEAT results

### WASH

The WASH module was conducted for ongoing activities in Zone 3. Levels of potential environmental risk were in general higher than for FSL.<sup>15</sup> Although the below is for Zone 3, the same WASH results can be used with Zone 5 environmental sensitivity data for predicting levels of environmental risk in Zone 5, if the EUTF programme will implement WASH activities.

#### Distribution of WASH and/or hygiene kits

Environmental Environmental Concerns	Environmental Sensitivity	Potential Activity Impact	Potential Environmental Risk
<b>Key environmental concerns</b>			
There is low capacity to manage solid waste. Environmental sanitation and disease transmission may be an issue.	High	Medium	Medium
<b>Solid waste management</b>			
Environmental Environmental Concerns	Environmental Sensitivity	Potential Activity Impact	Potential Environmental Risk
<b>Key environmental concerns</b>			
There is low capacity to manage solid waste. Environmental sanitation and disease transmission may be an issue.	High	Null	Low
The water sources may be vulnerable to contamination. Water quality may be an issue.	Low	Null	Low
<b>Other environmental concerns</b>			
The environment has fragile ecosystems. Loss of biodiversity may be an issue.	Medium	Null	Low
The environment has a low regenerative capacity. The effects of land and soil degradation are more significant.	Low	Null	Low

<sup>15</sup> Note: the updated NEAT+ template based on user feedback in Uganda to change the green low risk colour to yellow is used in this example.

### Construction and material sourcing (for all infrastructure projects)

Environmental Environmental Concerns	Environmental Sensitivity	Potential Activity Impact	Potential Environmental Risk
<b>Other environmental concerns</b>			
The environment has a low regenerative capacity. The effects of land and soil degradation are more significant.	Low	Low	Low
There is a risk of air pollution from nearby activities.	Null	Medium	Low
The water sources may be vulnerable to contamination. Water quality may be an issue.	Low	Medium	Low
There is low capacity to manage solid waste. Environmental sanitation and disease transmission may be an issue.	High	Low	Medium
There is low capacity to manage wastewater. Environmental sanitation and disease transmission may be an issue.	Low	Medium	Low

### Wastewater management and drainage network design

Environmental Environmental Concerns	Environmental Sensitivity	Potential Activity Impact	Potential Environmental Risk
<b>Key environmental concerns</b>			
The water sources may be vulnerable to contamination. Water quality may be an issue.	Low	Null	Null
There is low capacity to manage wastewater. Environmental sanitation and disease transmission may be an issue.	Low	Null	Null
<b>Other environmental concerns</b>			
The water resources may have a low regenerative capacity. Water scarcity may be an issue.	Low	Null	Null
The environment has fragile ecosystems. Loss of biodiversity may be an issue.	Medium	Null	Null
The environment has a low regenerative capacity. The effects of land and soil degradation are more significant.	Low	Null	Null

### Operation and maintenance of water systems

Environmental Environmental Concerns	Environmental Sensitivity	Potential Activity Impact	Potential Environmental Risk
<b>Key environmental concerns</b>			
The water resources may have a low regenerative capacity. Water scarcity may be an issue.	Low	Medium	Medium
The water sources may be vulnerable to contamination. Water quality may be an issue.	Low	High	Medium
<b>Other environmental concerns</b>			
There is low capacity to manage wastewater. Environmental sanitation and disease transmission may be an issue.	Low	High	Medium
Natural resources may be scarce and in high demand. This can lead to social conflict.	Low	High	Medium

### Design of water distribution networks

Environmental Environmental Concerns	Environmental Sensitivity	Potential Activity Impact	Potential Environmental Risk
<b>Key environmental concerns</b>			
The water resources may have a low regenerative capacity. Water scarcity may be an issue.	Low	Medium	Low
The water sources may be vulnerable to contamination. Water quality may be an issue.	Low	High	Medium
<b>Other environmental concerns</b>			
The environment has fragile ecosystems. Loss of biodiversity may be an issue.	Medium	High	High
Rates of deforestation may exceed regeneration capabilities. Deforestation may be a risk.	Low	Null	Sub-module not selected
Indoor air pollution, caused by poor ventilation and cooking/heating, may be an issue.	Medium	Null	Sub-module not selected
There is a risk of air pollution from nearby activities.	Null	Low	Null
There is low capacity to manage wastewater. Environmental sanitation and disease transmission may be an issue.	Low	High	Medium
Natural resources may be scarce and in high demand. This can lead to social conflict.	Low	Medium	Medium

### Design of water abstraction/extraction systems

Environmental Environmental Concerns	Environmental Sensitivity	Potential Activity Impact	Potential Environmental Risk
<b>Key environmental concerns</b>			
The water resources may have a low regenerative capacity. Water scarcity may be an issue.	Low	Low	Low
The water sources may be vulnerable to contamination. Water quality may be an issue.	Low	High	Medium
<b>Other environmental concerns</b>			
The environment has fragile ecosystems. Loss of biodiversity may be an issue.	Medium	High	High
The community is close to an international border. Transboundary resource management and/or pollution may be a concern.	Null	Low	Low
There is a risk of air pollution from nearby activities.	Null	Null	Null
There is low capacity to manage wastewater. Environmental sanitation and disease transmission may be an issue.	Low	Medium	Low
Natural resources may be scarce and in high demand. This can lead to social conflict.	Low	Low	Low

Figure 5: NEAT+ WASH results

## Shelter

The Shelter module was conducted for ongoing activities in Zone 3. Five of the seven submodules were selected: Siting, design, materials, construction and household items. Overall risks were fairly low, with a few exceptions.

**Shelter (Siting)**

Environmental Concern	Environmental Sensitivity	Potential Activity Impact	Potential Environmental Risk
<b>Key environmental concerns</b>			
The environment has high biodiversity value. Vulnerable and/or rare flora and fauna may be at risk.	Low	Medium	Low
<b>Other environmental concerns</b>			
Rates of deforestation may exceed regeneration capabilities. Deforestation may be a risk.	Low	Null	Low
The environment has a low regenerative capacity. The effects of land and soil degradation are more significant.	Low	Low	Low
The water sources may be vulnerable to contamination. Water quality may be an issue.	Low	Null	Low
<b>Mitigation Tips</b>			
<ul style="list-style-type: none"> <li>Ensure that there is reliable access to a sustainable safe drinking water source. Ensure that human settlements do not have an adverse impacts on the quality and quantity of nearby water sources.</li> <li>Ensure that energy consumption does not deplete already scarce non-renewable resources and work to minimise the negative localized environmental concerns of energy consumption such as deforestation and indoor air pollution.</li> <li>The production of electricity, if from non-renewable sources, generates emissions and consumes natural resources. However, electricity provision decreases dependency on solid fuels for heating or cooking, and thus decreases the likelihood of local ecosystem degradation. Small-scale renewable energy systems should therefore be investigated.</li> <li>Unmanaged wastewater or bodily waste can lead to long-term contamination of water sources or the ground near the site, and also act as host for vectors-borne diseases. Put relevant measures in place to address these risks.</li> <li>Unmanaged wastewater or bodily waste can lead to long-term contamination of water sources or the ground near the site, and also act as host for vectors-borne diseases. Put relevant measures in place to address these risks.</li> <li>Incorporating green areas can provide natural protection against various natural hazards such as landslides, erosions and/or flooding. Green areas also improve inhabitant satisfaction and can provide a natural cooling effect. Native flora is preferable; the biodiversity impacts of foreign flora should be properly considered and assessed. A strategy for maintaining green areas should be in place post- implementation.</li> <li>Engage with local communities. Communities can provide local knowledge of key environmental concerns, potential hazards and natural resource availability in the area. Effective engagement with existing local communities can also minimize the likelihood of future social conflict and uncooperative behavior.</li> <li>Consult with local authorities as they are a key stakeholder and may be responsible for future environmental management and service provision. Consultations can provide insight into key concerns regarding environmental sensitivities, natural resources availability, environmental hazards and tenure rights of the site.</li> </ul>			
<b>Additional Resources</b>			
<b>Quantifying Sustainability in the Aftermath of Natural Disasters (QSAND) - Settlements Chapter</b>	<a href="#">Link</a>		
QSAND is a self-assessment tool to promote sustainable approaches to relief, recovery and reconstruction after a natural disaster. It consists of various checklists and benchmarks for achieving environmental sustainability. This resource covers many different types of humanitarian activities.			
<b>Green Recovery and Reconstruction Toolkit (GRRT) - Strategic Site Planning and Development (Module 4)</b>	<a href="#">Link</a>		
The GRRT is a toolkit that provides guidance and strategies for environmentally sustainable recovery efforts in a humanitarian context. It consists of numerous modules focused on different thematic areas of humanitarian programming.			

Siting issues are low given the large area designated for Bidibidi.

**Shelter (Design)**

Environmental Concern	Environmental Sensitivity	Potential Activity Impact	Potential Environmental Risk			
<b>Other environmental concerns</b>						
Rates of deforestation may exceed regeneration capabilities. Deforestation may be a risk.	Low	Null	Null			
Indoor air pollution, caused by poor ventilation and cooking/heating, may be an issue.	Medium	Null	Null			
There is a risk of air pollution from nearby activities.	Null	Null	Null			
There is low capacity to manage solid waste. Environmental sanitation and disease transmission may be an issue.	High	Low	Medium			
<b>Mitigation Tips</b>						
<ul style="list-style-type: none"> <li>The exhaust of stoves or heaters should not be in an enclosed shelter as this exacerbates indoor air pollution. Shelters should include a dedicated area with open ventilation or chimney structure to expel exhaust gases.</li> </ul>						
<b>Additional Resources</b>						
<b>Quantifying Sustainability in the Aftermath of Natural Disasters (QSAND) - Shelter and Community Chapter</b>	<a href="#">Link</a>					
QSAND is a self-assessment tool to promote sustainable approaches to relief, recovery and reconstruction after a natural disaster. It consists of various checklists and benchmarks for achieving environmental sustainability. This resource covers many different types of humanitarian activities.						
<b>Additional Details/Comments</b>						

**Shelter (Materials)**

Environmental Concern	Environmental Sensitivity	Potential Activity Impact	Potential Environmental Risk			
<b>Key environmental concerns</b>						
The environment has fragile ecosystems. Loss of biodiversity may be an issue.	Medium	Medium	Medium			
Rates of deforestation may exceed regeneration capabilities. Deforestation may be a risk.	Low	Low	Low			
<b>Other environmental concerns</b>						
Disaster waste may be an issue. Disaster waste can pose public health risks, and impede relief or recovery activities.	Low	Null	Null			
There may be high and/or unsustainable rates of extraction of resources from the local environment.	Low	Low	Low			
<b>Mitigation Tips</b>						
<ul style="list-style-type: none"> <li>Construction materials can consume non-renewable or low-regenerative capacity natural resources. Material lifecycle, from extraction to disposal, should be considered - the initial design should promote future recycling, reusing or repurposing. Materials selection could be diversified to minimize dependencies on a single source. Refer below for material specific considerations.</li> <li>Consider using similar materials as host communities. This leverages existing extraction, production and supply chain processes which, if previously well regulated, can have lower environmental impacts. However, bear in mind that these chains can be overwhelmed in cases of sudden increased demand, potentially leading to unsustainable practices.</li> </ul>						
<b>Additional Resources</b>						
<b>Quantifying Sustainability in the Aftermath of Natural Disasters (QSAND) - Materials and Waste Chapter</b>	<a href="#">Link</a>					
QSAND is a self-assessment tool to promote sustainable approaches to relief, recovery and reconstruction after a natural disaster. It consists of various checklists and benchmarks for achieving environmental sustainability. This resource covers many different types of humanitarian activities.						
<b>Green Recovery and Reconstruction Toolkit (GRRT) - Materials and the Supply Chain (Module 5)</b>	<a href="#">Link</a>					
The GRRT is a toolkit that provides guidance and strategies for environmentally sustainable recovery efforts in a humanitarian context. It consists of numerous modules focused on different thematic areas of humanitarian programming.						
<b>Additional Details/Comments</b>						

**Shelter (Construction)**

Environmental Concern	Environmental Sensitivity	Potential Activity Impact	Potential Environmental Risk			
<b>Other environmental concerns</b>						
The environment has a low regenerative capacity. The effects of land and soil degradation are more significant.	Low	Null	Low			
There is a risk of air pollution from nearby activities.	Null	High	Low			
The water sources may be vulnerable to contamination. Water quality may be an issue.	Low	Low	Low			
There is low capacity to manage solid waste. Environmental sanitation and disease transmission may be an issue.	High	Low	Medium			
<b>Mitigation Tips</b>						
<b>Additional Resources</b>						
<b>Green Recovery and Reconstruction Toolkit (GRRT) - Construction (Module 6)</b>	<a href="#">Link</a>					
The GRRT is a toolkit that provides guidance and strategies for environmentally sustainable recovery efforts in a humanitarian context. It consists of numerous modules focused on different thematic areas of humanitarian programming.						
<b>Sector Environmental Guidelines: Housing Construction</b>	<a href="#">Link</a>					
USAID's Sector Environmental Guidelines aim to support environmentally sound design and management of humanitarian and development projects. These guidelines provide concise, plain-language information regarding potential environmental impacts, and prevention and mitigation strategies.						
<b>Additional Details/Comments</b>						

**Figure 6: NEAT+ Shelter results**

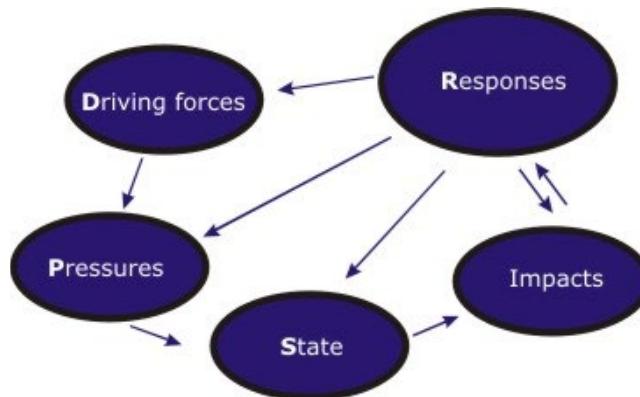
Solid waste came out as a major issue across all technical modules, including under Shelter Construction and Household waste.

**Household Items**

Environmental Concern	Environmental Sensitivity	Potential Activity Impact	Potential Environmental Risk			
<b>Other environmental concerns</b>						
The environment has fragile ecosystems. Loss of biodiversity may be an issue.	Medium	Medium	Medium			
There is low capacity to manage solid waste. Environmental sanitation and disease transmission may be an issue.	High	High	High			
<b>Mitigation Tips</b>						
<ul style="list-style-type: none"> <li>The potential environmental impacts associated with the future use of an item should be considered. Provide goods that minimize energy consumption or potential environmental impacts. Training should be a complementary activity as to educate users on appropriate practices and/or techniques.</li> <li>Strategic selection of items for distribution can reduce resource consumption and waste generation. Consider the need for the item post-crisis, and if multi-functional items are an option.</li> </ul>						
<b>Additional Resources</b>						
<a href="#">Green Recovery and Reconstruction Toolkit (GRRT) - Materials and the Supply Chain (Module 5)</a>	<a href="#">Link</a>					
The GRRT is a toolkit that provides guidance and strategies for environmentally sustainable recovery efforts in a humanitarian context. It consists of numerous modules focused on different thematic areas of humanitarian programming.						
<a href="#">Green Logistics Guide</a>	<a href="#">Link</a>					
The informational page on the Logistic Cluster's website aims to introduce logisticians to green logistics and encourage them to think sustainably in activities related to procurement and transportation.						
<b>Additional Details/Comments</b>						

## Summary of key environmental concerns

The following key environmental concerns have been identified by the NEAT+, FGDs and the secondary data review. Identifying the potential concerns, opportunities, and pressures that may negatively influence the functioning of key ecosystem services is important throughout the programming process. To understand what the key environmental concerns in Bidibidi refugee settlement are, the Pressure-State-Response (PSR) framework<sup>16</sup> can be applied to analyse the cause of environmental change and potential responses. This framework links pressures on the environment, as a result of human activities, with changes in the state (condition) of the environment (land, air, water, etc.)



The PSR is useful in this context to structure and classify information, and to assist in the identification of recommendations that are tailored to environmental concerns and local contexts. Although the PSR framework is generally applied in exclusively environmental "states", here it is slightly modified to consider environmental and humanitarian concerns.

- The State component refers to the present condition of the concern in Bidibidi Zone 3 and/or 5, according to the results obtained by the NEAT+, discussion with field staff, secondary data review or focus group discussions.
- The Pressure component identifies and tracks threats to the concern which are currently or could influence its state. Many of these pressures can be directly derived from the NEAT+ reports.

<sup>16</sup> For more about the PSR framework see the OECD-developed model, pg. 21:  
<http://www.oecd.org/environment/indicators-modelling-outlooks/24993546.pdf>

- The Response component identifies and tracks potential actions which can alleviate pressures. Where possible, current activities implemented by NRC are taken into consideration as a medium for mitigation in the below recommendations section. Many of the suggested responses come directly from or are modified by the "mitigation tips" that appear in the NEAT+ activity summaries.

Broadly, the key environmental concerns related to humanitarian activities are linked to:

1. Energy
2. Water
3. Waste management
4. Wastewater management
5. Shelter and Food security
6. Climate Change
7. Land Degradation

These concerns are often cross-cutting across humanitarian settings and are difficult to address in silos. In Bidibidi, the known key environmental concern is the dependence by both host and refugee communities on firewood and charcoal for cooking fuel, leading to extensive deforestation. Through the NEAT+ pilot, other environmental concerns that emerged included:

1. A lack of institutional waste and recycling programs
2. Lack of previously harvested forest products
3. Scarce reuse of water

These concerns are summarized in a table below and expanded upon in the following section.

*Table 1. State-Pressure-Response of key environmental concerns*

	State	Pressure	Response
<b>Waste management / environmental sanitation</b>	No waste management or recycling facilities.	<ul style="list-style-type: none"> <li>• Improper hazardous waste disposal</li> <li>• Lack of recycling / disposal options</li> <li>• Lack of education on waste / toxic waste management</li> </ul>	<ul style="list-style-type: none"> <li>• Investigate recycling as a livelihood activity</li> <li>• Community incinerators</li> <li>• Education on safe battery / toxic waste management</li> </ul>
<b>Deforestation (biomass dependency)</b>	Host and refugee residents dependent on biomass products for energy. Complete deforestation is estimated in 3 years. Residents travel	<ul style="list-style-type: none"> <li>• Increase in population puts pressure on supply of fuelwood</li> <li>• Conflict between host and refugee communities over</li> </ul>	<ul style="list-style-type: none"> <li>• Tree planting and cultivation programs</li> <li>• FMNR or tree-stump regeneration</li> <li>• Energy-saving stoves</li> </ul>

	longer distances with protection concerns.	access	● Advocacy for alternative energy sources ● Energy saving cooking practices ● Educational awareness ● Alternative sustainable livelihood activities
	Reduced rates of groundwater infiltration and decreased groundwater quality.	● Absence of energy - saving cooking methods ● Charcoal production for selling / use ● Burnt brick production (limited to date)	
<b>Wastewater management</b>	Little to no wastewater management.	● Lack of water-saving knowledge leading to unnecessary waste	● Education programs on ways to save and reuse water
<b>Natural resource dependency (construction materials)</b>	Grasses used for roof thatching.  Note: As income levels increase in host and refugee communities demand for burnt bricks is predicted to increase.	● Residents are travelling farther to get cut grass ● Residents who used to sell grass at market have no replacement income ● Conflict between host and refugee communities over grass and timber	● Introduce alternative roofing ● Community thatch harvesting management ● Use non-burned bricks - e.g. soil stabilized bricks
<b>Climate change and variability</b>	Less predictable rainfall patterns and increasing temperatures.	● Drought or floods ● Loss of crops planted too early ● Food shortages ● Loss of income	● Mainstream climate change adaptation (CCA) into activities, in particular FSL ● Education on CCA

<b>Land degradation</b>	Land degradation through land clearance and poor farming practices.	<ul style="list-style-type: none"> <li>Positive feedback loop could exacerbate negative environmental effects</li> <li>Land clearance for settlements</li> <li>Slash and burn agriculture leading to deforestation, soil compaction and loss of biodiversity</li> </ul>	<ul style="list-style-type: none"> <li>Perform comprehensive land degradation/land health study to understand rate of change and carrying capacity</li> <li>Educate residents about alternatives to slash-and-burn</li> <li>Take soil and water conservation measures</li> <li>Use sustainable farming practices e.g. agroforestry</li> </ul>
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## Waste management

There are no institutional recycling facilities in Bidibidi, or in northern Uganda that could support the recycling of plastic, glass, or other common recyclable materials. Thus, the state of waste management in Bidibidi refugee settlement and surrounding host communities is currently practiced on an ad-hoc, household-level basis which mostly involves the burning of all wastes, either after separating the plastic or not. Some women of Jomorogo Village (Host Zone 3) indicated that they reuse plastic water bottles to sell soap or oil at the market. However, participants at all focus group discussions indicated that waste burning to some degree occurs at their household.

Low capacity to manage solid waste	
Additional Information	Mitigation Tips
Unmanaged solid waste can have significant health and environmental implications. Solid waste is often host to harmful pathogens, and is also a breeding ground for insect and rodents, carriers of disease. Unmanaged solid waste can contaminate soils, surface waters and groundwater. Women are most likely to manage solid, water, and household waste, which can pose serious health risks if mismanaged. Contaminated water can also drain into streams and other surface water, which is used for washing, cleaning and bathing increasing risk of further contamination among women and children.	<ul style="list-style-type: none"> <li>Complete WASH activity module of the NEAT+</li> <li>Identify local waste management solutions</li> <li>Organize waste management within the camp/area</li> <li>Identify local/regional facilities for hazardous waste</li> <li>Share information on best waste management practices and raise awareness of negative/dangerous practices (e.g. burning plastic)</li> <li>At a minimum, provide separate dump points for organic and inorganic waste</li> <li>Identify ways to improve solid waste management (e.g. inventory of waste fractions, sorting, composting, recycling, reusing)</li> <li>Ensure that there is no low temperature plastic waste burning</li> <li>Ensure that areas used for waste burial/management are not used for other purposes (e.g. gardening)</li> <li>Ensure that there is an appropriate distance between latrines and water points</li> <li>In areas subject to flooding, opt for "elevated VIP" latrines as opposed to "ground-dug" latrines</li> </ul>

Figure 8. Bidibidi environmental sensitivity analysis with mitigation tips for the issue "Low capacity to manage solid waste"

Waste burning is generally performed by women in household-level pits located close to the house, following guidance from NRC. The impact of low temperature burning of plastics can

cause health problems such as headaches, nausea, and rashes in the short term. Over time, it can increase the risk of developing heart disease or other respiratory illnesses. The release of dioxins and furans (commonly found in PVC and plastic products) into the atmosphere has also been linked to serious health problems such as impairment of the immune and reproductive system, liver problems, certain types of cancer and effects on the developing nervous system.<sup>17</sup> Heavy rains or winds can cause leaching of these toxins into the surrounding environment and settling on crops.

Of particular and immediate concern in Bidibidi host and refugee communities is the practice of cutting open batteries and using the chemical contents mixed with water to create a smooth surface for household floors. This practice was discovered during focus group discussions and participants did indicate that they suffered health problems such as coughing when breaking open batteries. Batteries are filled with toxic chemicals dangerous to human health and should never be split open, much less repurposed for household uses. Education about the harmful effects of this practice is required immediately by organizations working on the ground. It is not clear if this practice is more widespread across Uganda/South Sudan but would warrant further investigation. When not repurposed, both host and refugee communities dispose of batteries into latrine pits. There was awareness among some groups consulted that children should not play with batteries and that it was safer to dispose of them into latrines, based on education from NRC. This environmental sanitation education could be expanded on to counter the battery splitting practice.

Potential responses to this issue of waste management could focus on reduction of waste streams through recycling programs, and/or on improved incineration for waste management. First, a study should be conducted in order to better understand the different waste streams and quantities and identify opportunities for reduction, recycling or reuse of certain types of waste. The waste composition affects the viability of various downstream waste management processes as well as the type of contaminants that may ensue. This study can be used to inform the best-available programming decision. Ideally this should be conducted at the settlement level with UNHCR, OPM and other implementing partners.

Recycling programs can create livelihood activities for refugees and hosts. While traditional livelihood activities involving recycling plastics can involve bringing plastics to an institutional facility for cash, there are already programs in Uganda looking at innovative ways to repurpose plastic waste into usable everyday items. For example, [Ghetto Research Lab](#), which is based out of Kampala and is looking to expand into refugee settings, is creating building materials such as bricks and latrines out of recycled plastics. [Reform Africa](#), also based in Kampala, creates durable and waterproof bags out of recycled plastic bags. In Zone 2, village 6, a prototype of a house built out of plastic bottles is currently underway. Investing in and deploying in one or more alternative waste management strategies could drastically reduce the open burning of waste. Plastics and batteries should be prioritized given their potential for impact on human health with

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<sup>17</sup> Lali Z (2018) Release of Dioxins from Solid Waste Burning and its Impacts on Urban Human Population- A Review. J Pollut Eff Cont 6: 215. doi: 10.4172/2375-4397.1000215.

currently used practices, as well as the lack of existing local recycling schemes. It is usually preferable to set up local recycling schemes that do not rely on national/global markets, or need large quantities of materials to be viable. There are however examples of recycling schemes in settlements where the materials are sorted and processed as a livelihood activity before selling on to the capital.<sup>18</sup>

For waste that cannot be recycled, incinerators provide a safer alternative to low temperature garbage burning. Medical clinics in Bidibidi (according to OSM,<sup>19</sup> there are 70 points within the Bidibidi boundary area labelled as "clinic" or "doctor") may already have incinerators on-site, or access to medical incinerators for their hazardous goods. Partnering with these medical facilities to provide safe methods of waste disposal for nearby residents could greatly reduce health risks associated with household burning. Community-level incinerators and/or a safely managed dumpsite can help lower the amount of waste burning occurring at the household level. Of pressing importance would be safe management of hazardous waste, as current practices may pose excessive health and environmental risks, particularly the process of reusing dry cell battery chemicals to create household floor surfaces. [Asante Waste Management](#) provides a battery recycling program in Uganda which could be viable in Bidibidi (the process includes requesting a battery recycling container, installing it in a visible location and paying for collection and recycling costs).

*Table 2.*

Waste Management	
<b>Relevant NRC Activities</b>	NRC does not have any activities in Zones 3 or 4 that are focused on waste management.
<b>Mitigation tips</b>	<ul style="list-style-type: none"> <li>• Conduct study on waste streams and quantities, including identification of local waste management solutions.</li> <li>• Investigate reuse and recycling opportunities already deployed in country as livelihood opportunity or to reduce health risks (i.e. battery or plastic recycling).</li> <li>• Consider the establishment of a community incinerator and/or safely managed dump site with management capabilities to avoid burning waste on household plots in proximity to homes, posing a health risk.</li> <li>• Immediately communicate the dangers of repurposing batteries for household use to both host and refugee communities.</li> <li>• Establish a safe system for dry cell battery and toxic waste disposal. Potential hazardous waste should be separated at the source and managed separately. Hazardous waste can have significant public health or environmental implications.</li> </ul>

<sup>18</sup> See for example the work of ICRC and Kenya Red Cross in Dadaab:

<https://www.icrc.org/en/document/kenya-dadaab-refugee-camp-recycle-plastic-income-livelihoods>

<sup>19</sup> Extract of OSM data completed August 2019 using the [HOTOSM Export Tool](#).

- Share information on best waste management practices and raise awareness of negative/dangerous practices (e.g. burning plastic).
- Promote the reuse of organic waste, for example for compost or mulch, rather than being burned/buried.

## Energy

It is well documented by several reports and assessments<sup>20</sup> that the dependency of host and refugee communities on biomass for fuel has degraded forest resources and created conflict and competition between communities. An FAO rapid biomass assessment<sup>21</sup> in 2017 estimated that the aboveground biomass in Bidibidi would be completely deforested within three years without intervention. The participatory focus group discussions confirmed this: when asked to delineate previous and current firewood harvesting locations, the women of Jomorogo village indicated that firewood collection used to occur within a 1-mile boundary of the village. Now, they travel up to 7 miles to collect firewood, a journey that takes a full day and must be completed two to three times a week (see Figure 9 for a map of traditional and current harvesting areas). In addition, host communities cited that while they used to only collect dry wood, now both host and refugee communities cut down live trees. This new and heavy dependence on this age group of trees prevents the natural regeneration of the forest.

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<sup>20</sup> World Bank & FAO (2018). "Rapid Assessment of Natural Resources Degradation in Areas Impacted by the South Sudan Refugee Influx in Northern Uganda." Accessible from:

<https://data2.unhcr.org/en/documents/details/67827>

<sup>21</sup> FAO. (2017) "Rapid woodfuel assessment: 2017 baseline for the Bidibidi Settlement, Uganda".

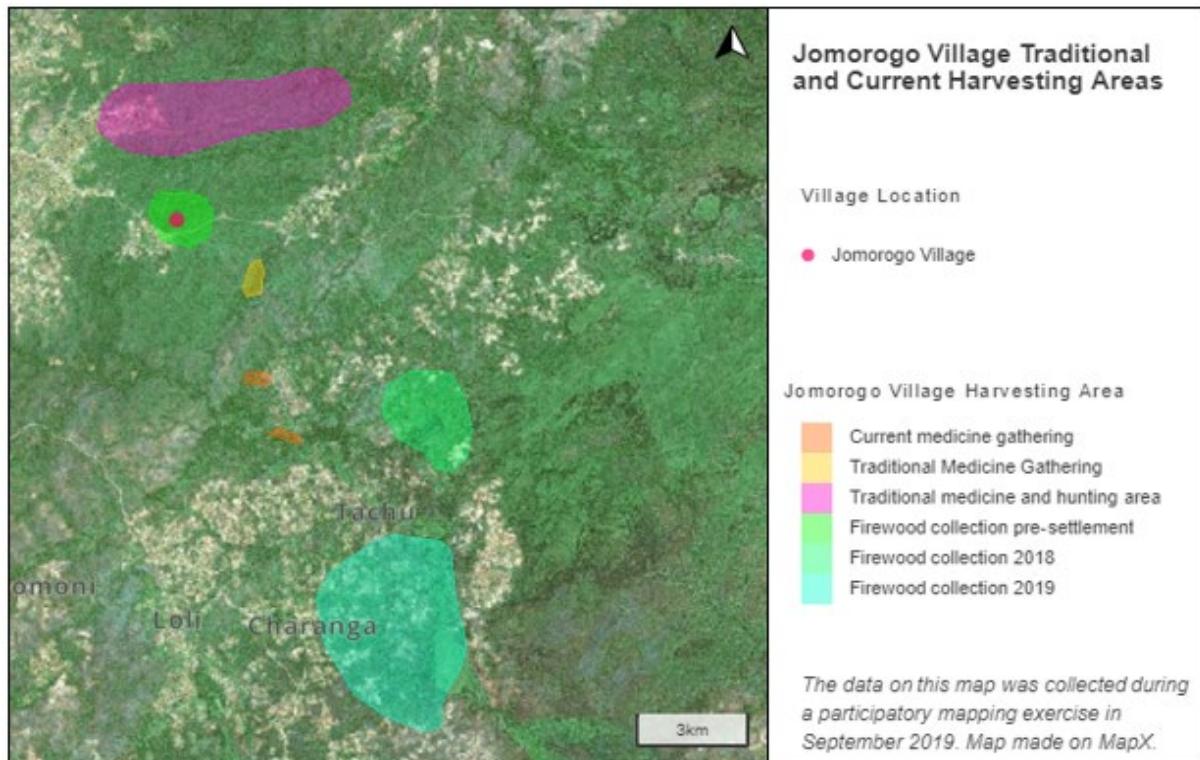


Figure 9. Map displaying traditional and current harvesting areas for residents of Jomorogo Village, host community Zone 3. This data was collected during participatory mapping exercise and is meant for indicative purposes only

The NEAT+ environmental sensitivity module offers several mitigation tips regarding the issue of deforestation (see Figure 10 below), some of which are being implemented in Bidibidi and some which are new.

Unsustainable rates of deforestation	
Additional Information	Mitigation Tips
Climates such as arid or continental have low capacities for regrowth and regeneration. Removed vegetation for energy, agricultural or livestock needs can take a long time to grow back. Deforestation is a threat multiplier for other environmental risks, exacerbating the local consequences of climate change, desertification, erosion, flooding - just to name a few. Women and children are often disproportionately burdened by deforestation due to gendered roles in the collection of wood for cooking and/or heating.	<ul style="list-style-type: none"> <li>Identify key drivers of deforestation and plan to transition away from reliance on local timber as a construction material and/or on fuelwood for cooking energy</li> <li>Introduce alternatives to timber/wood with economic incentives</li> <li>Conduct a biomass assessment</li> <li>Consult local environmental organizations for expertise on impacts and mitigation techniques</li> <li>Promote the use of sustainable land management techniques, both traditional and innovative</li> <li>Support sustainable food growing systems to improve land (and its biodiversity)</li> <li>Consider land degradation targets and consult the Land Degradation Neutrality Target Setting Project (<a href="https://www.iucn.org/theme/ecosystem-management/our-work/global-drylands-initiative/gdi-projects/land-degradation-neutrality-target-setting-project">https://www.iucn.org/theme/ecosystem-management/our-work/global-drylands-initiative/gdi-projects/land-degradation-neutrality-target-setting-project</a>)</li> <li>Diversify livelihoods</li> <li>Establish/promote ecological restoration programs (such as through the promotion of livelihood activities involving nursery/replantation activities)</li> <li>Establish community-based forest management practices</li> <li>Work with local communities to raise awareness of how to sustainably manage shared land.</li> <li>Assess and identify opportunities for restoration alternatives</li> <li>Rehabilitate land that has been degraded</li> </ul>

Figure 10. Environmental sensitivity analysis result with mitigation tips regarding the issue “Unsustainable rates of deforestation”

The loss of forest cover and increase in population density has corresponded to a loss of biodiversity: forest resources such as traditional medicines and animals hunted for meat

(including dik-diks, waterbucks and guinea fowl) can also no longer be found in former hunting areas. This has also caused a shift in dependency to medical clinics run by humanitarian organizations and sedentary livestock for protein. However, all host groups preferred using modern medicines provided by new clinics in the area, indicating that some aid provided to refugees has benefitted the host community. This benefit was particularly evident in Zone 5, where there have to date been more positive than negative impacts from the influx of refugees (also, for example, increased access to safe drinking water) as expanded on below.

Collecting firewood has become a source of conflict between host and refugee communities. In Zone 5, both host and refugee communities indicated that conflicts had occurred and were increasing. Women, who are the primary collectors of firewood, travel in large groups for security. Refugees in Zone 5 noted that due to previous conflicts, they no longer collect firewood, instead buying or trading agricultural products for fuelwood with the host community. Superstitions and cultural beliefs have also pervaded this conflict. Host communities of Okubani village (Zone 5) wondered whether the lack of rains in recent years was due to sacred trees being cut down, or access to sacred trees (where traditional rites would occur) being restricted due to the nearby refugee settlement. Similarly, the host community of Jomorogo Village also noted a perceived causal effect: that since the refugees had arrived, the rains had become more erratic.

The host-refugee relations of Zone 5 seem overall more harmonious than those of Zone 3 (see Figure 11 for locations of host villages). As Zone 3 has been established for longer than Zone 5, residents of Jomorogo Village have been competing for resources with refugees from Zones 3 and 4 for longer than residents of Okubani village, which borders Zone 5. A key grievance of the host community of Jomorogo was that while they are treated as hosts of Zone 3, the village actually lies directly between Zones 3 and 4. Thus, they are competing for natural resources with refugees from two zones yet only receiving aid for one. Expected reception of aid from organizations appeared to be the tipping point for host-refugee relations in the FGDs. The residents of Okubani village are looking forward to receiving aid and resources that are being allocated to the refugees of Zone 5, while already enjoying access to some, such as a new medical clinic and water point.

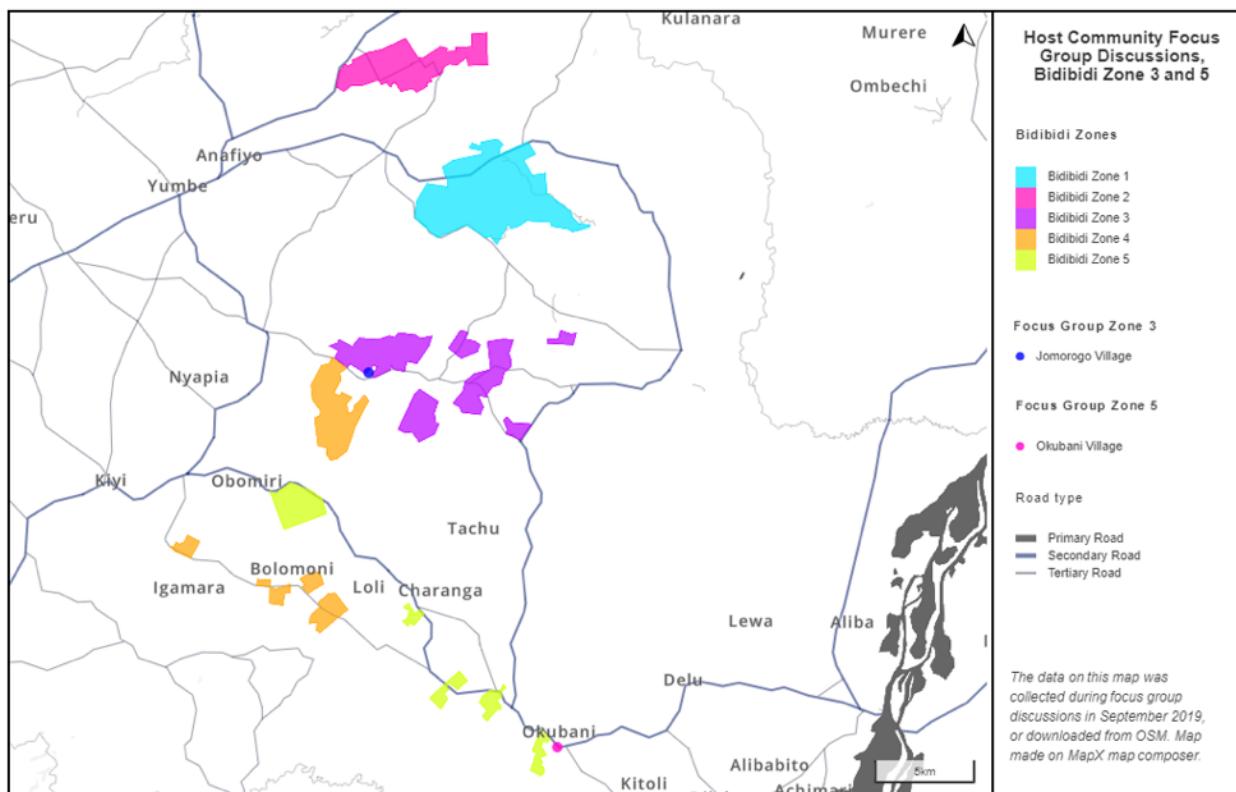


Figure 11. Map showing location of host villages for Zones 3 and 5, and Bidibidi Refugee Settlement Zones

While natural resources are often a source for conflict, they can also be a useful vehicle for cooperation. As natural resources cross boundaries and divided groups often share a common dependence, sustainable and peaceful use is desired by all stakeholders. Furthermore, sustainable use usually requires a long timeframe, stability, and buy-in from stakeholders at multiple levels. Biomass in particular presents a good use case for natural resource cooperation as the technical dimensions can be quantified relatively easily, as has been done already in several reports and guidance documents based in Bidibidi and on a national level.

On a national level, the Biomass Energy Strategy Uganda (BEST)<sup>22</sup> was developed by the Ministry of Energy and Mineral Development (MEMD) in 2013 to report on the national context. The situation analysis quantified the national state of overdependence on tree biomass: in 2013, the estimated consumption of tree biomass was 44 million tonnes, however the available tree resources could only sustainably supply 26 million tonnes. The report also estimated that 90% of the demand for biomass products, including both charcoal and firewood, is created by the household sector. Potential solutions explored included using varying sources of biomass such as bushes, shrubs, and vegetal waste in the biomass energy mix, utilizing more efficient charcoal burning methods and introducing incentives for compliance.

<sup>22</sup> Ministry of Energy and Mineral Development & UNDP. (2013) "Biomass Energy Strategy (BEST) Uganda". Accessible from: <https://data2.unhcr.org/en/documents/download/64163>

The UNHCR Uganda Safe Access to Fuel and Energy (SAFE) Strategy of 2016-2020 outlines issues with protection and accessibility in collecting firewood and the inefficiency of current cooking practices in refugee communities. It also promotes a strategy which includes improved access to fuel-efficient technologies and renewable energy, community-based management of woodlots and plantations, and integration of energy requirements into emergency preparedness and response plans. It is aligned with various government and institutional frameworks and would require USD 20 million to execute in entirety. Some of these strategy elements are being addressed by various organizations in Bidibidi including NRC, however it appears that overall, the education element of adopting fuel-efficient technologies is lacking, hindering the uptake of the SAFE strategy.

Responses to the issue of biomass depletion in Bidibidi are underway by several organizations, in the form of community woodlots (World Vision), tree planting programs (NRC), and the introduction of fuel-efficient stoves (NRC) to replace the traditional tree-stone fire. Receiving community support and monitoring the continued success of these programs remains a challenge: in one focus group discussion, it was revealed that several participants had a fuel-efficient stove but were not using them for various reasons. The focus groups indicated that if more environmentally sustainable ways of cooking were presented to them, they would consider shifting practices to more fuel-efficient techniques. In addition, many participants were not aware of energy-saving cooking methods such as soaking beans before cooking. Both host and refugee communities would benefit from campaigns to raise awareness of sustainable cooking practices.



*Figure 12: Lorena stoves built with NRC*

Focus group discussions showed that while almost many refugee participants had been provided with solar panels by UNHCR or other organizations, most of them were no longer in use or in need of maintenance. Instead, refugees were using their phones for light, and paying to charge them at local solar powered charging stations run by individuals, or using flashlights run on store-bought dry cell batteries. They were not aware of who to contact or how to discuss fixing the solar panels. This is an example of where improving feedback mechanisms, such as



*Figure 13: Solar panels for charging phones*

promoting the use of the UNHCR settlement-wide hotline, may also improve the uptake of energy-efficient technology and behaviours.

Lack of incentive to practice sustainable behaviors	
Additional Information	Mitigation Tips
A state of locational uncertainty can foster environmentally detrimental behavior due to short time horizons and a lack of attachment to the local area. This can be further exacerbated by an absence of strong social governance systems. Livelihood opportunities and a strong protective environment can strengthen sense of place. Highlighting the benefits of appropriate environmental behaviors for their livelihoods might increase incentive to cooperate.	<ul style="list-style-type: none"> <li>• Set up community grievance/feedback mechanisms</li> <li>• Organize sensitization campaigns to raise awareness on the benefits of adopting sustainable behavior and ensure that host community and people of concern are involved in the planning process</li> </ul>

*Figure 14. Environmental sensitivity analysis of Bidibidi showing mitigation tips for the issue "lack of incentive to practice sustainable behaviours"*

An integrated approach to tackling the issue of biomass dependency could include creating a "forest friendly" marker for all new programmes implemented in Bidibidi. This should extend to programmes that are seemingly independent of natural resources as they can still cause deforestation. For example, agricultural programs may cause encroachment into natural ecosystems despite less obviously depleting biomass as, for example, would brick production as a livelihood activity. A simple screening questionnaire could be deployed to organizations working in Bidibidi, to be completed during the planning process, ensuring that activities would cause no unnecessary deforestation, working in parallel with the forestry department.

NRC is already engaged in tree planting activities, seedling nurseries, and promoting FMNR<sup>23</sup> and tree stump regeneration - highly effective where rootstocks are already in place where the regeneration is rapid especially if guided by specific pruning techniques, which also provides firewood. These should be expanded on under the new EUTF programme, advocating to OPM for more land for woodlots and nurseries. There is a strong appetite for a nursery in Zone 5 by the refugee community, and even a former nursery attendant in the refugee community that could work with NRC. This should be combined with increased education on the importance of tree planting but also on the existence of the nurseries. There is currently a low knowledge among FGD respondents of the existence of the NRC free seedling provision in village 8 of Zone 3.

As firewood or charcoal remain the desired energy source for households both within Bidibidi and across Uganda, production and consumption will likely continue whether regulated or not. Firewood is used widely in Bidibidi at the time of writing because households cannot afford charcoal. Charcoal is being produced and sold locally and also exported from Yumbe province

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<sup>23</sup> Farmer-managed natural regeneration is a low-cost, sustainable land restoration technique used to combat poverty by increasing food and timber production and resilience to climate extremes. It involves the systematic regeneration and management of trees and shrubs from tree stumps, roots and seeds.

to other regions of Uganda, including Kampala, to be sold at a high mark-up.<sup>24</sup> Demand for charcoal in urban areas is high: it is estimated that 65% of urban households use charcoal.<sup>25</sup> It is unlikely that this demand for charcoal from rural regions will reduce significantly in the short term. While education about the unsustainability of charcoal can be improved, immediate measures to improve the efficiency of current charcoal burning practices could vastly reduce the impact on forest resources. 99.9% of charcoal now is produced using inefficient earth kilns<sup>26</sup> which create 10 kg of charcoal for every 100 kg of wood. Efficient charcoal kilns can produce up to 30 kg of charcoal for the equivalent amount of wood. Charcoal production should still be actively avoided as new livelihoods activities and alternatives provided.

Additional impacts of deforestation due to biomass dependency predicted if deforestation rates continue include reduced rates of groundwater infiltration and decreased groundwater quality. Bidibidi settlement primarily depends on groundwater sources for drinking water. Removal of vegetation decreases rates of aquifer recharge and also the natural filtration provided. Increased scarcity and competition for resources is also predicted given that wood is the primary resource for energy and shelter, and decreasing availability will cause social conflict amongst refugees, and between refugee and host communities. This in turn will result in a productivity/economic burden from scarcity and a protection risk from the increased need to collect/buy wood.

*Table 3*

Element	Energy / Deforestation
<b>Relevant NRC Activities</b>	<p><b>Natural Resources Management and Environmental Protection initiatives</b></p> <p>Environmental protection through supply of 300 portable biomass stoves to 300 households both from the refugees and host communities.</p> <p><b>Agricultural Livelihoods support</b></p> <p>Supporting households through agricultural seeds provision and capacity building on good agronomic practices. NRC Project staff and 40 TOTs facilitated the training to the targeted 642 household farmers. The aim of this activity is to boost household food production to supplement on the food aid ratio being distributed by World Food Program.</p> <p><b>Permaculture Program</b></p> <p>NRC has trained, through a cascading TOT model, 500 refugees in permaculture agricultural methods. While permaculture is not a direct mitigation for reducing deforestation, permaculture principles and practices such as on-contour ditches to slow, spread and sink water into</p>

<sup>24</sup> As indicated by local field staff, bags of charcoal are bought at 10-15k shillings in Yumbe and sold for 80k shillings in Kampala.

<sup>25</sup> Ministry of Energy and Mineral Development. "Uganda National Charcoal Survey 2016: Policy Brief."

<sup>26</sup> Ibid.

the soil, agroforestry, producing no waste and leaving natural features in the fields are designed to build healthy soil, retain vegetation cover and reduce or reverse land degradation.

- Mitigation tips**
- Create "forest friendly" screening benchmark for organizations in the planning phase, to ensure no unnecessary deforestation is being caused by activities.
  - Expand existing woodlots and seedling nurseries through continued advocacy to OPM for more land, and promote seedling nurseries and the free access to seedlings.
  - Organize sensitization campaigns to raise awareness on the benefits of adopting sustainable behavior - for example on building/using Lorena stoves and alternative energy sources - and ensure that host and refugee community members are involved in the process, including the delivery of messages through community advocates of such practices.
  - Introduce alternatives to timber/wood with economic incentives (i.e. briquette production).
  - Explore and educate residents on using alternative sources of biomass such as vegetal waste, bushes and shrubs.
  - Work with local communities to raise awareness of how to sustainably manage shared land. Support sustainable food growing systems to improve land (and its biodiversity).
  - Consult local environmental organizations for expertise on impacts and mitigation techniques.
  - Establish/promote ecological restoration programs (such as through the promotion of livelihood activities involving nursery/replantation/ FMNR or tree-stump regeneration activities).

## Wastewater

According to focus group discussions, residents of both host and refugee communities in Bidibidi largely do not reuse household grey water from kitchens or from washing or bathing. Some have the perception that it is harmful for crops or kitchen gardens. The majority of households choose to either throw it into the bush or into the rubbish bin. Some of the refugees in Zone 3 who participated in the permaculture training facilitated by NRC indicated that they reuse water in circle gardens or similar infrastructure. However, no community members consulted practiced water re-use of any kind.

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Low capacity to manage wastewater	
Additional Information	Mitigation Tips
A lack of drainage infrastructure leads to unmanaged wastewater. Wastewater is a carrier of contamination which can be harmful to human health and also to livelihood activities such as farming and livestock. Pools of wastewater are breeding grounds for mosquitoes. Contaminated water can also drain into streams and other surface water, which is used for washing, cleaning and bathing increasing risk of further contamination among women and children.	<ul style="list-style-type: none"> <li>• Complete WASH activity module of the NEAT+</li> <li>• Develop sensitization messages on links between environmental sanitation and disease transmission</li> <li>• Undertake sensitization sessions with the community</li> <li>• Ensure waterpoints have infiltration built in</li> <li>• Introduce greywater capture</li> <li>• Promote ground cover vegetation to enhance infiltration and reduce surface runoff</li> <li>• Conduct WASH assessments</li> <li>• Consult health authorities</li> <li>• Identify improvements to waste water management (e.g. suitable technology for treating and managing waste water, possible re-use of waste water)</li> </ul>

*Figure 15: Environmental sensitivity analysis of Bidibidi showing mitigation tips for the issue "low capacity to manage wastewater"*

Re-using household grey water could represent an important source of water for gardens and crops, especially during the dry season. Education could be provided in the form of workshops or community discussions in which alternatives for household water use are introduced and practiced. However, a test of the water quality of wastewater should be performed to understand the potential health and environmental impacts of reuse. If the soap being used (which is produced locally) is too caustic it may not be appropriate to use for watering plants - however it could still be utilized for pest control or diluted.

*Table 4*

	Wastewater
Relevant NRC Activities	WASH
	Capacity building of beneficiaries' preventive maintenance of water supply installations, community management structures were supported, and 37 water user committees were trained in Zone 3 and 4 to enhance sustainability of water sources.
<b>Mitigation tips</b>	<ul style="list-style-type: none"> <li>• Grey water can be reused for small- or medium-scale agriculture, reducing demand for water. Water quality testing and comparison to discharge standards can provide guidance on suitability. Open and stagnant water bodies should be avoided in the diversion and storage of grey water.</li> <li>• The quality of the wastewater should be tested to understand the potential health and environmental impacts, and to inform the design of any drainage and wastewater treatment system. Wastewater quality should be compared to the relevant discharge standards and should be tested at the point of convergence.</li> </ul>

- Black and grey water should be separated at the source and managed separately.
- Establish greywater capture and enhanced filtration.
- Visual inspection of the area around the community should be undertaken in order to confirm the effectiveness of drainage interventions. Inspections should occur in periods with and without precipitation to ensure an absence of stagnant pools of water.

## Water

Bidibidi as a whole largely does not suffer from severe water contamination or extended water shortages. This was not always the case: up until 2018, 27% of water coming into Bidibidi was arriving via water truck.<sup>27</sup> The recent development of high powered borehole pumps has improved access and quality of water supplies.<sup>28</sup> According to OSM data, there are 64 "water points", 27 boreholes, 210 hand pumps, 99 wells or springs, and 239 water taps within the Bidibidi boundaries. Bidibidi is well situated geologically for deep ground wells.



*Figure 16: Water point in Zone 5*

Residents interviewed at focus group discussions indicated that while sometimes the water from the infrastructure is discoloured, they do not get sick from it. Some residents who did collect water from the nearby stream in Zone 5 reported getting sick from this water, with "headaches and stomach pains". The reason they collect water from the stream instead of the borehole is either because they live closer to the stream, or the boreholes are out of commission. Residents from most groups indicated that if a water pump or borehole breaks, they are quickly fixed. There was a

request from the refugee men of Zone 5 to be trained to fix the pumps so that when they break down in the future (which happens often), they are able to fix them themselves. Any future WASH interventions should include this training to improve reliance on aid organizations.

<sup>27</sup> Andreasi Bassi, S., Tange, I., Holm, B., Boldrin, A., & Rygaard, M. (2018). A Multi-Criteria Assessment of Water Supply in Ugandan Refugee Settlements. *Water*, 10 (10), 1493.

<sup>28</sup> Julia Crawford (May 2019). "Swiss project gets water flowing to massive refugee camp"  
<https://www.swissinfo.ch/eng/bidi-bidi-uganda-groundwater/44901952>

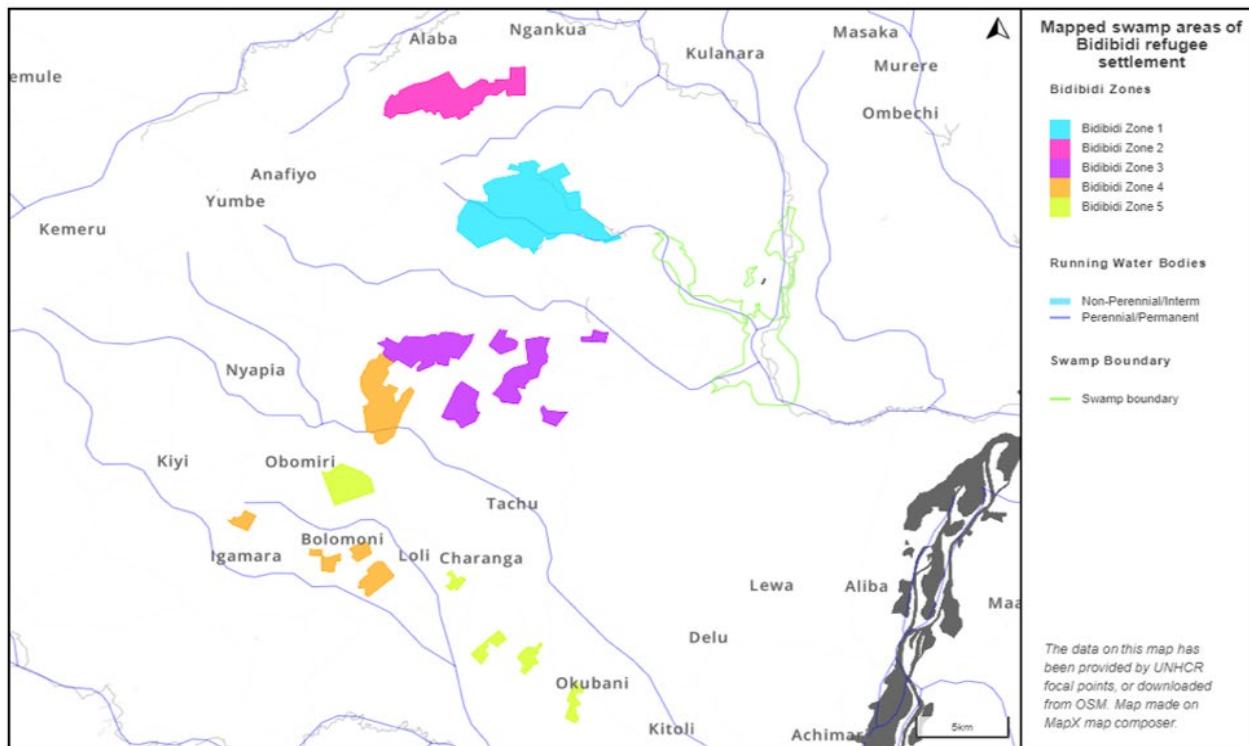


Figure 17. Mapped swamp area of Bidibidi refugee settlement. Swamps are a type of forested wetland. Similarly mapping the swamp boundary within Zone 5 can help in future planning and programming

Flooding and contamination of pumped water sources do not seem to be an issue, however Zone 5 is more waterlogged than other areas. There is a swamp within the boundaries of Zone 5, which should be mapped and monitored to understand flood behaviour. There is a wetland that has been mapped close to Zones 3 and 1 (see Figure 14), but as of yet there is no similar data available on the wetland in Zone 5. While flooding impacts livelihood activities, it can also have longer-term environmental impacts. For example, latrine flooding can lead to contamination of water sources or agricultural crops. This is particularly the case if toxic materials such as batteries are being disposed of in latrines.

Wetlands are important to preserve because they provide critical ecological and WASH services. They act as a natural sponge, catching and slowing down the flow of surface water and then releasing the water slowly, which reduces the amount of flooding downstream. As water is slowed down this allows for groundwater to recharge as well as improving water quality. Wetlands can also remove pollutants from surface water. Wetlands also provide excellent habitat for wildlife.

Table 5

	Water
Relevant NRC Activities	WASH

**Safe water supply through construction of hybrid motorized water supply system;**

A total of 22,500 persons of concern in zone 3 now receive safe water; 20 litres per person per day from the just completed 100cubic meter hybrid system in village 1. The system with 30 tap stands has reduced queuing time, walking distance and increased water per capita;

**Operation and maintenance of piped water systems;**

Fuel is supplied to 14 water systems; routine servicing of generators and pipe network repairs are done to ensure functionality of the established systems.40 hand pumps were rehabilitated to augment safe water from motorized schemes in both refugee camps and host communities in Zones 3 and 4;

**Capacity building of beneficiaries and preventive maintenance of water supply installations;**

Community management structures were supported, 37 water user committees were trained in Zones 3 and 4 to enhance the sustainability of water sources;

**Water treatment and installation of chlorination systems in 12 water supply systems for disinfecting and protecting water supplied to persons of concern;** hygiene promotion activities through house to house visits and community meeting; supporting household latrine construction; construction of institutional latrines; decommissioning filled up temporary latrines, desludging institutional latrines; distribution of hygiene kits to primary schools.

- |                        |   |
|------------------------|---|
| <b>Mitigation tips</b> | <ul style="list-style-type: none"> <li>● Maintain the wetlands areas to prevent flooding, preserve water quality, and allow for ground water recharge.</li> <li>● Zone 5 is more waterlogged than other areas and there is more potential for contamination from latrines. Investigate this potential for contamination.</li> <li>● Stagnant water pools/ponds can act as a host for disease vectors.</li> <li>● Educate residents about the dangers of collecting water from the stream.</li> <li>● Improve feedback mechanism for broken water infrastructure.</li> <li>● Train residents in borehole pump repair.</li> </ul> |
|------------------------|---|

## **Shelter**

Household structures are currently framed using wooden poles (an estimated 0.9 m<sup>3</sup> of wood is used per building<sup>29</sup>) and built in with mud or mud bricks. There is less permanent housing in

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<sup>29</sup> FAO Rapid Woodfuel Assessment.

Zone 5 than Zone 3, because Zone 5 is newer, but importantly also because in Zone 5 refugees have to buy all their natural resources from the host community, often in uneven exchanges for food rations. Overall at the time of writing, the environmental impact of construction of shelters is low in comparison to the reliance on biomass for energy. However, it is predicted that residents will choose to build with burnt bricks in the future if income levels rise. This is currently rare due to the higher cost of burnt bricks, however some refugee men in Zone 3 reported being involved in brick production activities - mostly on a small scale due to the lack of availability of wood to fire the kilns. Livelihoods and Shelter interventions should actively discourage the production of burnt bricks. Equally, NRC's shelter and construction activities should not use burnt bricks. An alternative could be training people to produce soil stabilized bricks which are then used in construction activities. Crudely constructed (i.e. not industrial) burnt bricks are extremely energy inefficient and typically powered by firewood or charcoal. It is estimated that 20 trees are required to produce 5 small houses worth of burnt bricks. This is the equivalent of 4 trees per household.

Traditional roofs are built with grasses for thatching and need to be replaced approximately every two years due to termites and inclement weather. Host communities indicated during focus group discussions that collecting grass to sell at the market was a previous source of income for women. Now, it is difficult to find grasses nearby in quantities necessary for home-building or taking to market, largely due to an increase in demand with the refugee influx, and disturbance of natural ecosystems.

Responses to this issue could take two avenues: providing alternative roofing structures and/or improving grass sustainability. Corrugated iron (CGI) provides a long-lasting alternative to grasses. However, the CGI manufacturing process requires large quantities of steel, zinc and other metals, requires being transported and manufacturing takes place in large scale factories using energy intensive processes. Factories can cause severe air and water pollution, if poorly managed, and manufacturing processes may release toxic heavy metals. CGI can be dangerous in strong winds and should be well fixed to the house structure. It can cause discomfort and health issues because of generating excessive heat - some focus group participants using CGI noted this as an issue. Despite the lack of environmental benefits, CGI sheeting can become a valuable material and is often resold in times of food shortages. If CGI is distributed, it should be good quality. Lower quality sheets which are affordable to low-income groups corrode and rust rapidly. This deterioration increases thermal comfort and safety issues, and can be demoralizing for the owners.<sup>30</sup>

Sustainability of grasses is a preferable roofing strategy and could be introduced through the creation of community grasslands, which are maintained, harvested (rotationally) and sold by community groups, managed by both refugee and host communities.

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<sup>30</sup> [Environmental Guide To Selection Of Common Building Materials \(2016\)](#)

*Table 6*

	<b>Shelter</b>
<b>Relevant NRC Activities</b>	Construction of emergency and semi-permanent shelter and latrines, prioritizing refugees with specific needs including people with disabilities and the elderly. Building and rehabilitating schools and fitting classrooms with furniture.
<b>Mitigation tips</b>	<ul style="list-style-type: none"> <li>• Create sustainably managed grasslands in addition to woodlots, managed by community groups.</li> <li>• While these are being created, diversify material dependency by providing some alternative roofing. This can be CGI if good quality.</li> <li>• Monitor the production rate of burnt bricks in the settlement and surrounding area and provide alternative livelihood opportunities to those engaged in brick production (e.g. some of the Zone 3 refugee men).</li> <li>• Use non-burned bricks for construction: e.g. soil stabilized bricks.</li> <li>• Train people to produce soil stabilized bricks for use in NRC's construction activities and for individual homes.</li> </ul>

### Climate change and climate variability

All groups consulted - both host and refugee communities - in addition to the results of the NEAT+ noted increasing climatic change and variability with negative consequences on livelihoods, particularly agricultural production. All groups noted increased temperatures, the later arrival of the rains and more erratic rainfall patterns. Rainfall is becoming harder to predict, and this is impacting on crop productivity as there is often either too much rain, or not enough. This is having a strong impact on agricultural production and crops planted at the "normal" times are being lost, forcing a later planting season.

There is a clear lack of awareness around why this is happening. The host community men and women of Zone 5 believe that it could be related to refugees cutting down sacred trees where they used to make sacrifices to bring the rains. FGD participants in Zone 5 have however had some education in how to adapt to the changing climate, despite not understanding why it is happening. For example, they now plant later in the year, and have changed from traditional crops to fast growing crops like maize and groundnut. However, in Zone 3, host communities were still planting traditional crops and had much lower adaptation education.

*Table 7*

	<b>Climate change adaptation</b>
<b>Relevant NRC Activities</b>	Community awareness campaigns conducted on environmental protection,

and engagement of local community in public awareness campaigns.

- |                        |   |
|------------------------|---|
| <b>Mitigation tips</b> | <ul style="list-style-type: none"> <li>● Integrate further adaptation measures into new programme planning to increase community resilience.</li> <li>● Conduct climate vulnerability assessment and seek assistance from a climate change adaptation expert.</li> <li>● Consult national climate change adaptation plans.</li> <li>● Permaculture courses have been very successful in educating participants in a range of topics. These could be expanded to include messaging around climate change adaptation, and other sustainable livelihoods practices.</li> <li>● Support and provide training on sustainable farming and/or climate smart/climate resilient agricultural practices.</li> <li>● Provide faster growing seed varieties/more hardy seeds as part of livelihoods programming.</li> <li>● Undertake adaptation measures (e.g. the Climate Resilience Evaluation for Adaptation Through Empowerment (CREATE) <a href="https://cmsdata.iucn.org/downloads/create_factsheet_final.pdf">https://cmsdata.iucn.org/downloads/create_factsheet_final.pdf</a>)</li> <li>● Promote the use and mainstreaming of nature-based solutions such as ecosystem-based approaches for climate adaptation (e.g. the use of alternatives and crop diversification to tackle climate change and natural resources scarcity).</li> </ul> |
|------------------------|---|

## Land Use/Land Change

With the opening of any new settlement, some level of land use and land degradation can be expected. Understanding the rates and “hotspot” areas of change is vital in minimizing the potential for unnecessary degradation or land conversion and planning activities. Land degradation is often caused by an accumulation of factors, such as poor farming practices, land clearance, inappropriate irrigation and pollution. Left unchecked these factors can create a positive feedback loop which exacerbates soil erosion, causes waterlogging and salinization in irrigated areas and leads to a decline in soil fertility. Beyond the effects to the land itself, degradation and conversion lead to system-level losses in biodiversity and disruptions to key ecosystem services, including food production, microclimate regulation, water retention and carbon storage.

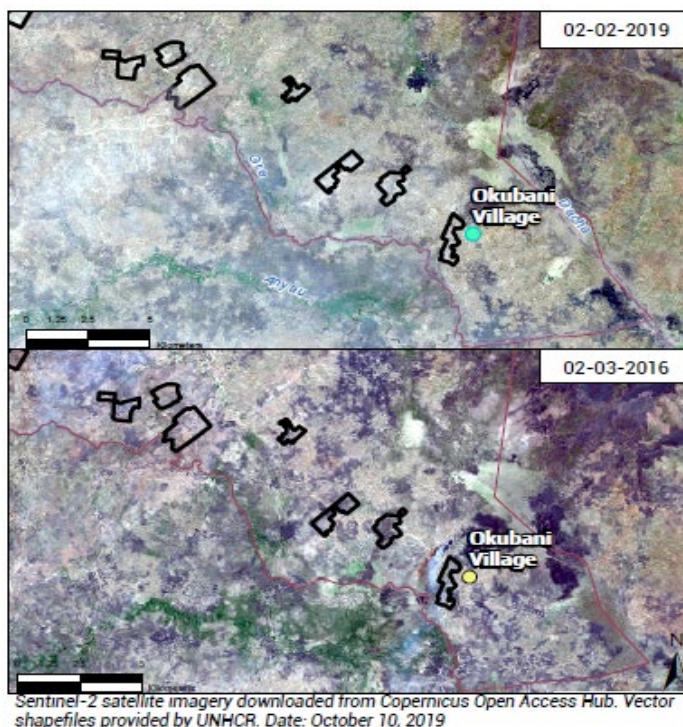
While land clearance and conversion can be expected in the case of Bidibidi, minimizing the conversion of forests to developed or bare soil and providing alternatives to harmful farming practices can help reduce the likelihood of ecosystem service disruption. Focus group discussions and secondary data reviews established that land use change has occurred to varying degrees. To visually assess broad changes in land cover, optical satellite imagery was analyzed to map and classify land use and vegetation cover before and after the establishment.

The area of interest was the entire settlement within the UNHCR gazetted Bidibidi boundary area, with a special focus on the areas around Jomorogo and Okubani villages (host communities for Zones 3 and 5, respectively). A more comprehensive land degradation survey, including ground-

truthing and the use of radar data should be performed across Bidibidi to understand the impact of land degradation and to demarcate areas of high potential for restoration and protection.

The two satellite images used for the comparison are from 3 February 2016 and 2 February 2019. These images were selected due to the following reasons:

- Dry season in northern Uganda generally occurs during this time period, with January and February having the lowest rainfall levels of the year. Thus, it is expected that seasonal grasslands will be dry, leaving only annual vegetation such as woodlands clearly demarcated.
- The time periods are selected for before the Bidibidi settlement was established (2016) and the most recent dry season (2019) in order to understand change in land use and vegetation cover.



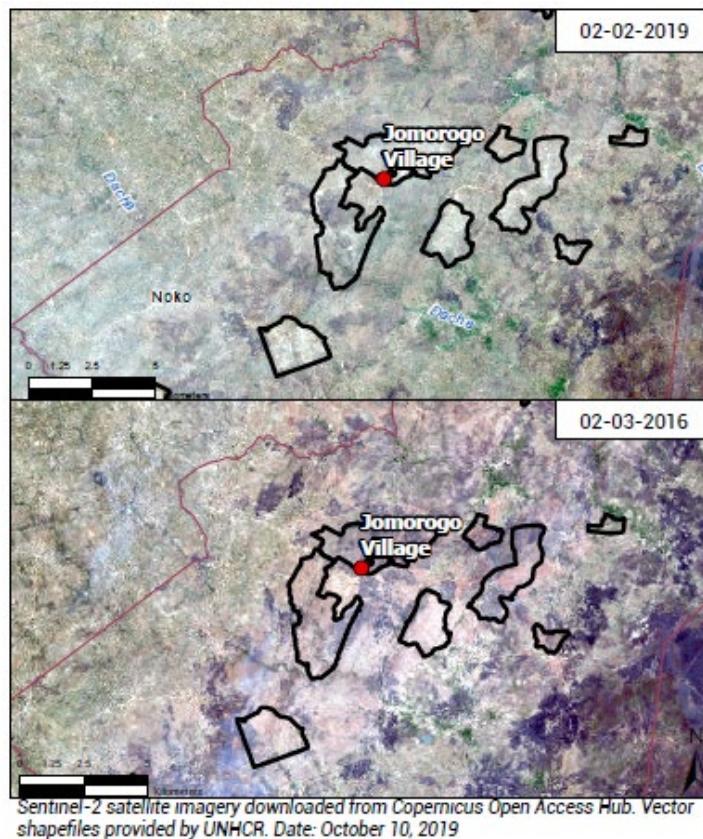


Figure 18. Satellite imagery pre-Bidibidi settlement (February 3, 2016) and from 2019 (February 2, 2019) are compared in host communities in these images

The methodology, including description of land use categories for the supervised classification, can be found in Annex C. The categories delineated included<sup>31</sup>: Woodland (open and closed), Cultivated Area, Bushlands, Developed/Bare Soil, and Burnt Areas. As residents of the Bidibidi area widely practice slash-and-burn agriculture during the dry season, burnt areas had to be considered in the analysis. Slash-and-burn agriculture is widely practiced in Africa, Asia, and South America to clear land for planting. The technique is closely related to the oldest forms of land clearing and crop production and has sustained crop yields over millennia. Slash-and-burn agriculture can lead to land degradation through soil degradation and compaction and deforestation of natural forests.<sup>32</sup> According to the host community of Jomorogo Village, bush burning was practiced in order to hunt bush rats for food. This focus group also advocated for stopping burning, and felt strongly that refugees should not be allowed to burn their land.

Longer-term changes may be masked by complex seasonal and anthropogenic factors in remote sensing analyses. In this case, it is difficult to ascertain historical land type before burning occurred. As slash-and-burn agriculture is often abandoned after a few years, the conversion between shrubland/grassland to planted/cultivated may be too minor for satellite

<sup>31</sup> Description of these categories can be found in Annex C.

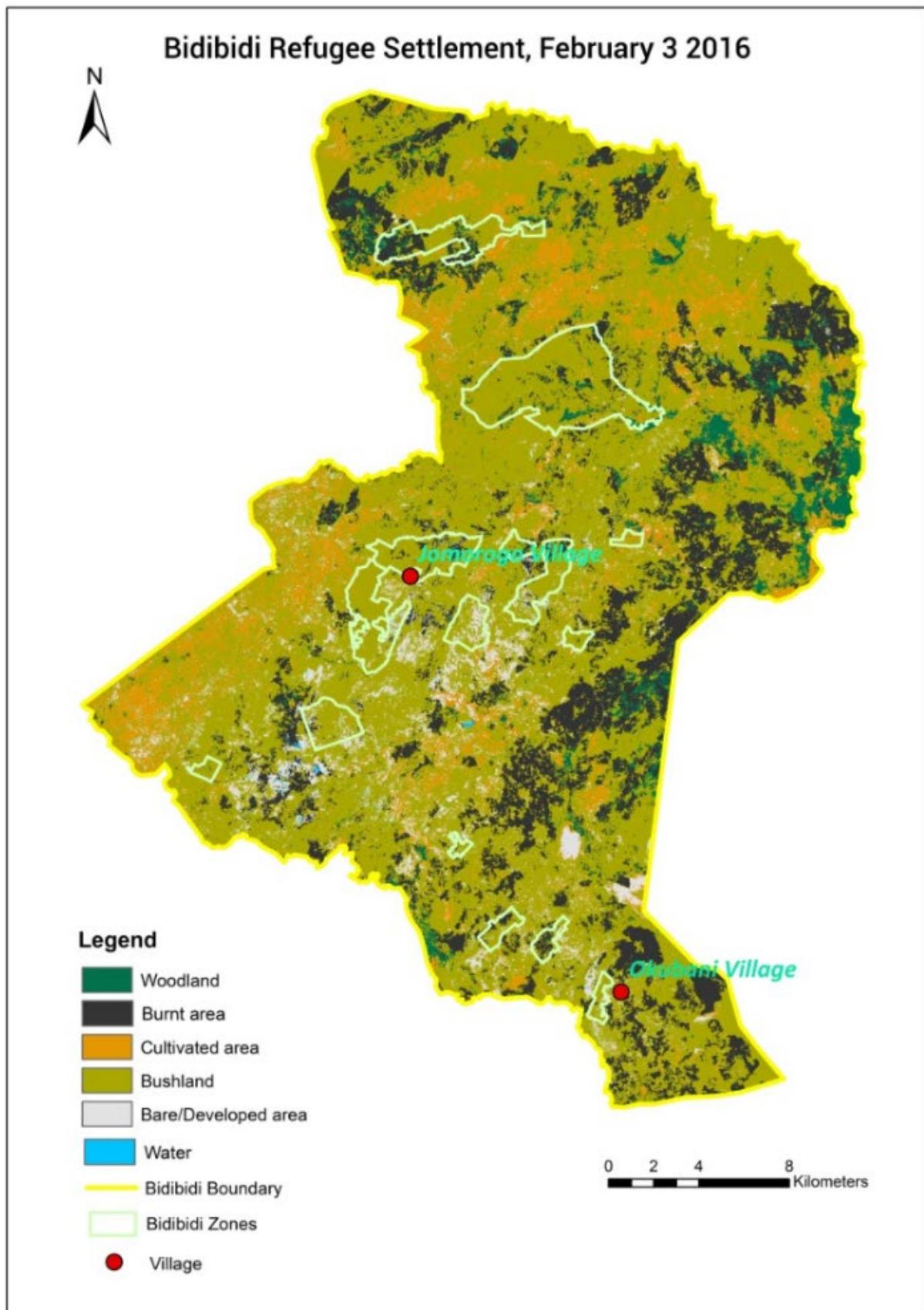
<sup>32</sup> Gay-des-Combes, J. M., Sanz Carrillo, C., Robroek, B., Jassey, V., Mills, R., Arif, M. S. Buttler, A. (2017). Tropical soils degraded by slash-and-burn cultivation can be recultivated when amended with ashes and compost. *Ecology and evolution*, 7(14), 5378–5388. doi:10.1002/ece3.3104

classification to display. While presumably, land burned is either cultivated/planted or shrubland/grassland class, the influx of refugees and new residents makes it highly likely that other land types, such as forests, were also converted into cultivated areas via the practice of burning.

LULC	2016		2019	
	Area/km <sup>2</sup>	Area (%)	Area/km <sup>2</sup>	Area (%)
<b>Woodland</b>	6114.51	7.43	2245.68	2.73
<b>Burnt area</b>	12790.9	15.53	9238.1	11.22
<b>Cultivated area</b>	7613.29	9.25	14542.37	17.66
<b>Bush land</b>	51415.32	62.44	50081.82	60.82
<b>Bare/Developed</b>	4347.68	5.28	6231.95	7.57
<b>Water</b>	58.22	0.07	0	0
<b>Total</b>	82339.92	100.00	82339.92	100.00

*Table 8. Land use transfer matrix for Bidibidi supervised classification*

A land use transfer matrix was calculated to determine the difference in area of classes between the two years. The most notable differences between 2016 and 2019 are the increase in developed area and decrease of burnt and woodland areas. No water was found in the 2019 image. To better understand deforestation rates, a further radar analysis (for example, using Sentinel-1 data) can provide insight into canopy rates of change.



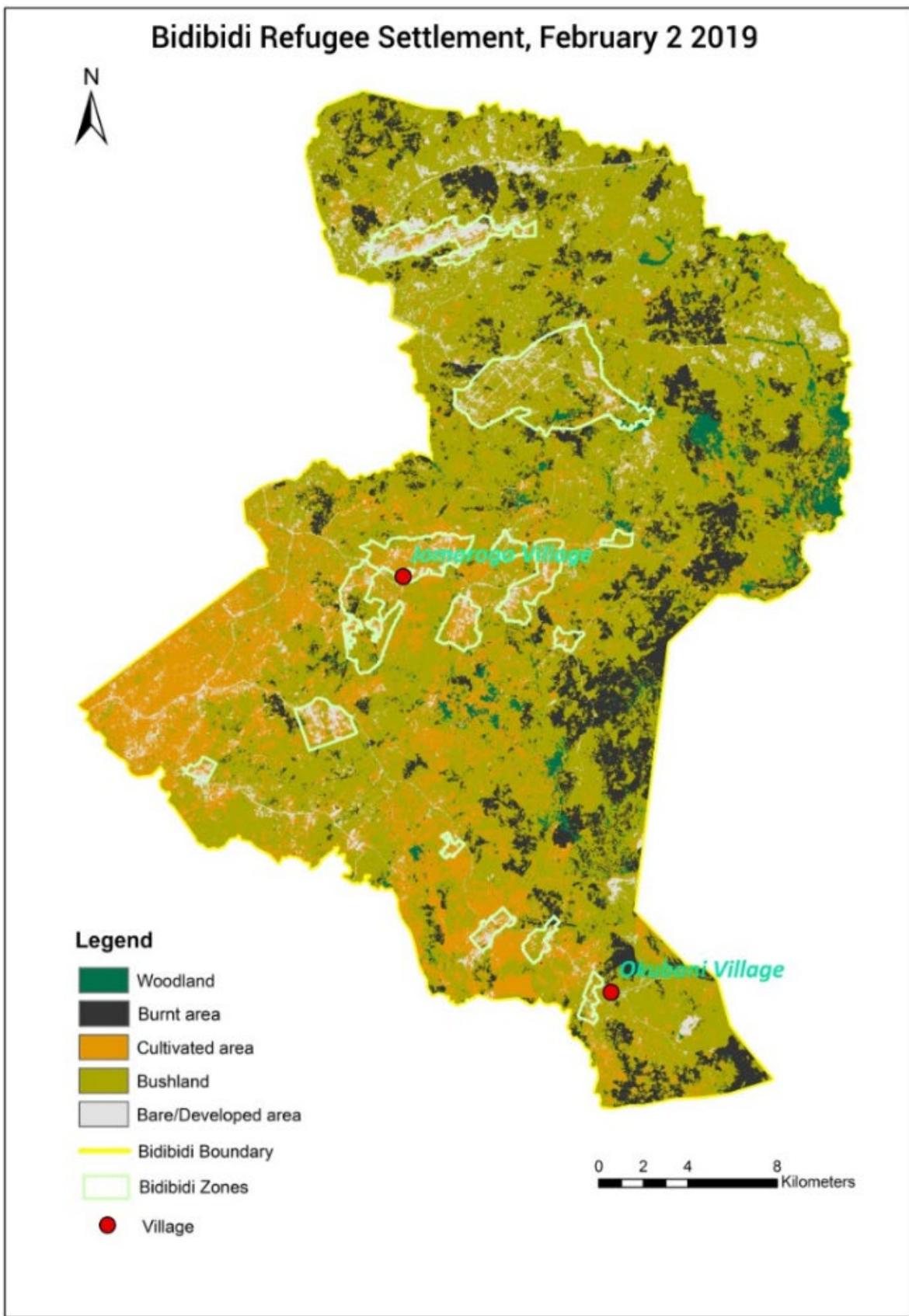


Figure 19. Supervised classifications performed on Sentinel-2 satellite imagery downloaded from Copernicus Open Access Hub for February 3, 2016 and February 2, 2019 by Xiaoyang Li, UNEP. These maps are indicative

Although it is difficult to assign causality to any particular change in land use, burning practices have decreased since the establishment of the settlement. This is likely because previously burnt areas are now permanently inhabited by refugees. While the refugee settlement has increased the amount of bare/developed land since 2016, the reduction of widespread burning could mitigate some environmental risks. Education about alternatives to slash-and-burn agriculture can be mainstreamed through livelihood and farmer training programs.

A normalized differential vegetation index (NDVI) was also performed on the satellite images to assess vegetation cover. The NDVI is a standardized method of measuring healthy vegetation since it helps to compensate for changes in lighting conditions, surface slope, exposure, and other external factors by normalizing green leaf scattering in the Near Infra-red wavelength and chlorophyll absorption in the red wavelength. The result is a single band dataset that represents vegetation health, with a scaled legend of values between -1 and 1. Negative and low values represent clouds, water, and snow, and the values near zero represent rock and bare soil. High values represent dense, healthy vegetation. In this case, high values (shown in green) likely represent woodland areas and values close to zero (shown as red) represent bare soil, developed land and burnt areas. There is a significant reduction in burnt areas from 2016 to 2019, although also a reduction in healthy (dark green) vegetation areas.

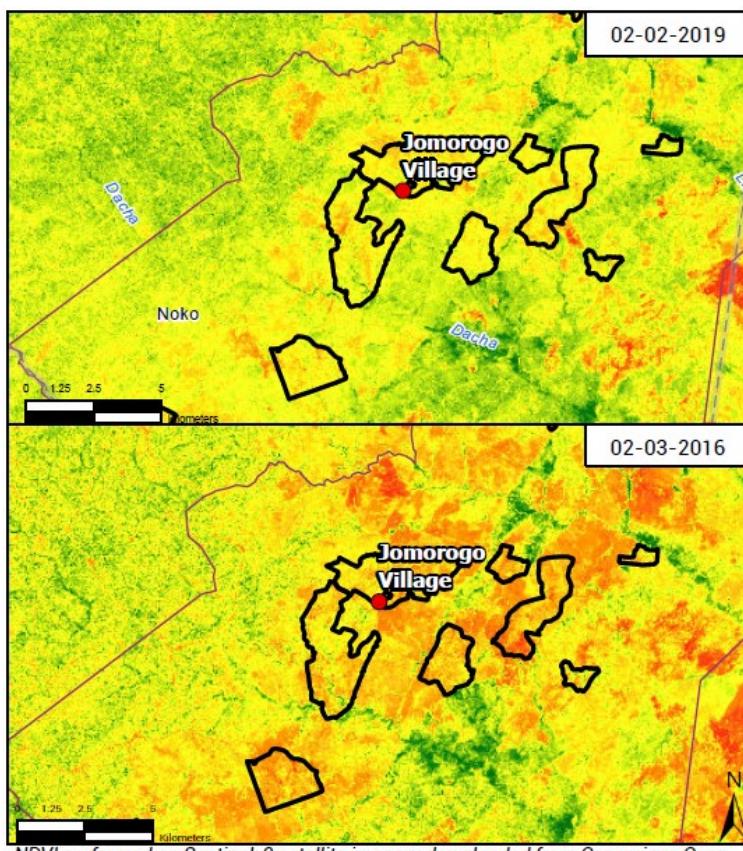


Figure 20. NDVI at Jomorogo Village, 2016 - 2019

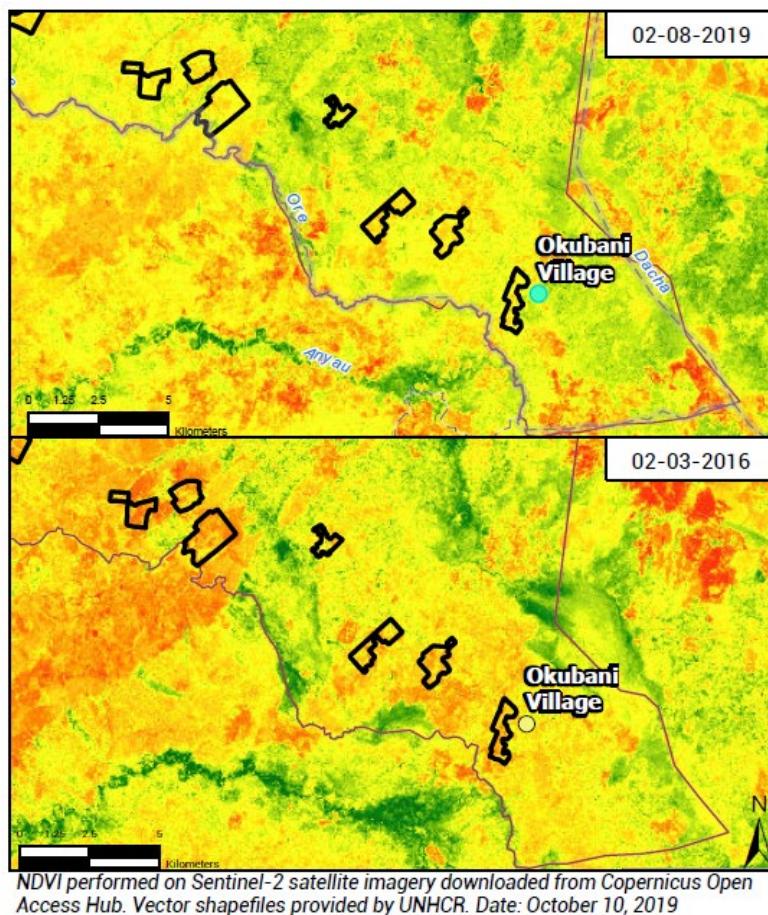


Figure 21. NDVI at Okubani Village, 2016 - 2019

These NDVI images are taken from two satellite images, however running a multi-temporal analysis using Google Earth Engine and multiple images from each year would provide a more accurate assessment of changes in vegetation health over the 3-year period.

Table 9

	Land Degradation/Conversion
Relevant NRC Activities	TBC
Mitigation tips	<ul style="list-style-type: none"> <li>Perform a land degradation analysis of Bidibidi - including the use of optical and radar satellite imagery and field-level surveys to understand the definition of land degradation and current rates of change. See the <a href="#">Land Degradation Surveillance Framework</a> as a starting point.</li> <li>Take soil and water conservation measures.</li> <li>Look for synergies in different uses of land. For example, livestock activities can enhance and restore grazing and agricultural land</li> </ul>

- through rotational land use activities.
- Rehabilitate land that has been degraded. Consider land degradation targets and consult the Land Degradation Neutrality Target Setting Project (<https://www.iucn.org/theme/ecosystem-management/our-work/global-drylands-initiative/gdi-projects/land-degradation-neutrality-target-setting-project>).
- Mainstream education about alternatives to slash-and-burn agriculture or other poor farming practices through livelihood activities.
- Perform ecosystem services assessment within Bidibidi to understand where key opportunities for restoration and protection are.
- Use sustainable farming practices e.g. agroforestry.

## Recommendations

Recommendations are divided into three sections: Programmatic, Organizational Strategy, and External advocacy and capacity building.

### 1. Programmatic: Project Implementation (Zones 3 & 5)

It is critical that a plan to mitigate the above environmental and human impacts is designed and put into place now, while there is still time to prevent further irreversible damage. There is the opportunity for Bidibidi to become an example of good practice for future refugee settlements. Too often, humanitarian practitioners overlook necessary environmental objectives due to the uncertainty of length of stay and maintain a short-term outlook due to programme and funding cycles. Numerous case studies of refugee contexts have documented the socio-economic consequences of this short-term mentality. If action is not taken now, remedial action will come at a much greater cost, with less satisfactory results. There are clear future consequences if current trends in deforestation continue. NRC and partners have already made good progress in sustainable livelihoods and energy support to both host and refugee communities that can be built on.

Programmatic recommendations specific to the major environmental issues outlined above can be found across the previous section of the report. In addition, the following are recommended:

1. **Look at environmental issues across sectors and not in isolation** to understand their full impacts - for example how energy, FSL and shelter all impact on deforestation.
2. **Increased focus on community engagement and accountability to affected people:**  
Many of the issues noted around social conflict and environment can be avoided by better community engagement and accountability to communities. This was an area that was noticeably lacking in the settlement, with very few accountability mechanisms in place like

feedback systems or regular methods of communication with host and refugee communities. Additionally, the focus group discussions held during the field test highlighted both known and unknown (to the NRC Yumbe field staff) environmental and social issues. The unknown issues were significant - the repurposing of batteries into household floor surfaces, for example, represents a high risk to human health. Gone unnoticed, this could lead to significant increase of disease and respiratory issues, raising required resources at nearby health centres. Thus, open and accessible methods of dialogue between communities and organizations should be encouraged. Community engagement is important throughout the project lifecycle - from planning to implementation to closure. Engagement can take many forms, including focus group discussions, household surveys or online/SMS forms. As many hosts and refugees have cell phones, promoting the UNHCR hotline number may serve as an ideal starting point for community engagement. The staffing and coordination mechanism of the UNHCR hotline would need to be further investigated.

3. **Increase environmental education:** Environmental education was stressed as necessary by staff, technical focal points and refugee and host community members. There was a particular appetite for education and information from the host community in Zone 5 who have to date not received much, and were grateful even for the messages transmitted in the focus group discussions (e.g. around the use of eco-friendly fertilizers). Based on the NEAT+ results, FGDs and secondary data analysis, the most prevalent issue seemed to be a lack of awareness of environmental risks and sustainable practices. Education for both host and refugee communities can fall under the livelihood programs (adapting agricultural practices to climate variability), WASH (re-using wastewater, caution against collecting water from stream), and energy (efficient cooking practices and how to adapt to using the Lorena stove), all of which are sectors in which NRC works. The upcoming EUTF programme represents a key opportunity to mainstream environmental education and awareness into livelihood and food security activities.
4. **Consider working in waste management or advocating to government / other partners to do so:** one significant gap in NRC activities to address the major environmental issues of concern identified by the assessment is the issue of waste management. Waste management practices can be mainstreamed through other sector activities (for example, education about efficient cooking practices could also include appropriate methods for disposing of utensil wastewater or compost), or NRC could work with partner organizations or initiatives that do work in waste management to ensure that the lifecycle of project activities is environmentally accountable.
5. **Capitalize on host community knowledge while also educating both communities:** natural resources can become a source of cooperation, rather than conflict, if they are managed in an equitable and transparent manner. This process involves building trusting relationships between stakeholders to ensure that all parties involved understand the consequences of mismanagement and importance of openness and accountability. The host communities of Bidibidi have a wealth of intimate local knowledge about the surrounding ecosystems and how to sustainably harvest and manage natural resources. The sharp increase in population density has rendered some of the previous practices

unrealistic (for example, the previous practice of selective firewood harvesting may now be impossible due to the level of deforestation that has already occurred). However, traditional practices should be given a venue for sharing with organizations and with refugee communities. Shared environmental practices and increased understanding of cultural practices of the other community can improve social cohesion between hosts and refugees. If all stakeholders hold the same information about traditional/best practices, it is easier to hold each other accountable to conducting activities in a sustainable way.

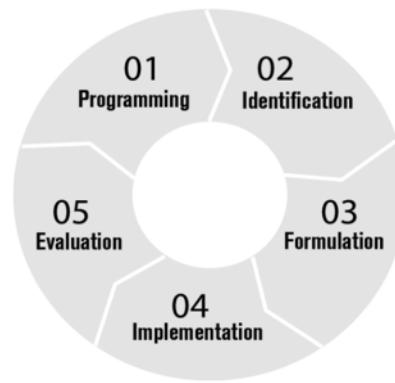
6. **Jomorogo Village Grievances:** If possible, the grievance raised by Jomorogo village residents regarding their status as host community for Zone 3, rather than Zone 3 and Zone 4, should be raised with OPM for mediation. In focus group discussions, Jomorogo village residents indicated that those who share land with refugees in informal land-sharing agreements, all share with refugees from Zone 4. Additionally, the residents perceived that the majority of conflict over collecting firewood occurs with residents from Zone 4. This was confirmed by the refugees of Zone 3, who used the participatory mapping exercise to show that they collect firewood in an area north of Zone 3, which does not coincide with the Jomorogo residents' areas of collection. As host-refugee relations seemed more tense in Zone 3 than Zone 5, encouraging peaceful interactions may begin with recognizing the status of Jomoro village as a dual-host community.
7. **Repeat the NEAT+ methodology in Zone 4:** The field test was completed in Zones 3 and 5 in order to draw a strong comparison between a newer and older settlement. Zone 4 was intended to be tested during the pilot as well, however due to time constraints this was not possible. The methodology completed in Zones 3 and 5 should be repeated in Zone 4 by NRC Yumbe field staff. This will not only solidify the NEAT+ methodology and concepts with the field staff but also allow for a stronger comparison of environmental situations between zones. As discovered in this test, while programme activities are implemented broadly across the entire settlement or entire zones, the biophysical characteristics can differ significantly between zones, creating unique environmental situations which may need to be considered in planning. For example, water availability and soil types may affect the propensity for soil erosion in a certain cluster, meaning that certain agricultural activities and irrigation need to be limited to avoid negative environmental consequences.
8. **Formalize land sharing agreements:** Many host participants in the focus group discussions indicated that they share their land with refugees through informal land sharing agreements. These arrangements generally involve some form of share-cropping or informal rent payments. Conversely, some refugees in focus group discussions shared land with host community, however cited previous incidents of conflicts over shared land - such as being chased off the land when the crops were ready to harvest. Formalizing these land sharing agreements could provide protection for both host and refugee community members.

## 2. Organizational strategy: Mainstreaming NEAT in NRC

NRC does not have an environmental management system in Uganda or globally, but there are opportunities for the tool to fit into the organization's programme management system and strategy revision process. Integrating the NEAT+ into organizational processes will ensure that the tool does not remain a standalone function but becomes systematically used across the organization to inform sustainable programme planning or adjustment when used as a monitoring tool. Uganda and the East Africa Region can illustrate how this could be done more broadly in NRC. A pilot in Myanmar in late September 2019 can also inform this discussion.

In East Africa, a hallmark of the strategy states that it is the collective expectation that NRC's programmes in the East Africa and Yemen region articulate: "*An environmental analysis and how environmental good practice run through our operations and contributes to the programme outcomes.*" This is expanded on further: "*NRC in the region does not expect to implement stand-alone environmental programmes. Nor do we expect every project to have carried out an independent environmental impact assessment, though environmental understanding is increasingly, and rightly, being asked by donors. Good programming demands that all country programmes are able to articulate an understanding of the environment they work in and how the programmes we implement will positively or negatively impact that environment. This could be briefly outlined in the country strategy or could be represented by a larger study or collection of work that allows us to articulate our understanding and response.*" The NEAT+ could serve as a pragmatic tool for the environmental analysis stated in the strategy. As NRC Uganda begins a strategy revision process this could be an opportunity to formalize the use of the tool for environmental analysis.

NRC's PCM Framework will be revised in 2020 and is currently in a consultation process. There is an opportunity to link the environmental analysis element of the East Africa Strategy to include the NEAT+ as a tool to be used in the "Identification" phase for sustainable programme development, and the "Implementation" phase for monitoring and evaluation. As the Bidibidi pilots showed, there is an opportunity for NRC to use the NEAT for both these programme management phases.<sup>33</sup>



The NEAT was originally developed by NRC with the same modules that it currently contains, based on the greater level of environmental impact of NRC's programmes. Therefore a "light" adaptation of the NEAT+ could be conducted for NRC if deemed necessary, for example by updating the language or mitigation tips to reference NRCs PCM, specific vocabulary used, or reference organizational documents, strategies and policies. This would not be a time-

<sup>33</sup> E.g. Identification for the new EUTF programme in Zone 5 and the Implementation of existing programmes in Zones 3 and 4, where the results of the NEAT can be used to adjust existing activities to mitigate the risks identified.

consuming procedure; however it would need to be decided whether to do this at the national, regional or global level. Limited technical expertise would be needed given that the backend logic of the tool would not need to be changed for this, just the text edited.

#### Recommendations:

1. Adapt the NEAT+ for NRC (a "light" adaptation - vocabulary, mitigation tips, links for further guidance, resources).
2. Include the NEAT+ as a tool for "environmental analysis" of programmes in NRC East Africa, working towards achieving the environmental hallmark of the EastAfrica Strategy.
3. Conduct a baseline (environmental sensitivity module) across the country for all NRC programmes to analyze the country level trends and use as an advocacy tool for funding to address the main risk identified or for additional technical support. Use this as a pilot for a global baseline initiative. Note that a future update of the NEAT+ is expected to include a dashboard function, which could be used for comparison and monitoring of programmes in different locations.
4. Include environment as a cross cutting issue in the country level strategy, but with pragmatic suggestions for environmental mainstreaming, including a screening/analysis process that contributes towards programme proposals, design and development.
5. To articulate how environment fits as a cross cutting issue, highlight where in the PCM Framework the NEAT+ fits - the recommendation is a part of "Identification" that leads to sustainable project formulation.
6. Exchange between Uganda and Myanmar post-pilots.
7. Share this report with the region, and globally - e.g. At the LFS meeting in October or the upcoming regional strategy meeting.

### 3. External advocacy and capacity building: With GoU and other partners

There was substantial interest from NEMA at the Kampala workshop to investigate how the NEAT+ could fit into Uganda's regulatory framework and be aligned strategically with the national environmental screening process that precedes an EIA. There are national requirements that exist for EIAs in refugee programming in Uganda, though NEMA is not enforcing EIA requirements because of capacity issues and lack of strong linkages with regional authorities. EIAs should be predicated by an environmental screening highlighting areas of focus for the EIA although there is currently no standard screening tool in Uganda for humanitarian programmes. AVSI mentioned that while no particular tool is used, they do screen for environmental risks in their activities, particularly procurement. There was also interest in testing the NEAT+ predictive capacities in areas of new projects, to compare levels of risk for different proposed activities, as well as to minimize the time taken for environmental screening given the time efficiencies of the NEAT+.

The NEMA representative (George Muganga) suggested that conducting a scoping of other environmental screening tools deployed by organizations in Uganda could be useful for government to understand what processes are being used or could be adapted for the national context. This idea was supported by the JEU representative who emphasized that the NEAT+ can be tailored to national/local regulations (including references to national legislation, government bodies, and relevant local organizations) and that support for this process could come either through the JEU or other actors who have the capacity to develop and update the tool.

UNHCR mentioned guidance they are currently developing in collaboration with the Government of Uganda on environmental mainstreaming in refugee settings. It is intended to be cross-sectoral and a representative from NEMA suggested that the NEAT+ could be included in the guidance as one of the tools to assist in environmental screening/EIA processes, following a scoping of existing screening tools in the country. The draft guidance will be shared with the interagency Environment and Energy Working Group in October or November 2019.

#### Recommendations:

1. Follow the recommendation of OPM and ensure that the tool is used.
2. Share NEAT pilot results with group who attended the workshop as well as the Environment & Energy (E&E) working group chaired by UNHCR and OPM.
3. Use the Work with the E&E working group as a forum for continuing the discussions started at the workshop, to take NEAT pilots forward and having a broader discussion on how it could like with national requirements.
4. Keep the organizations who can drive policy up to date (OPM, UNHCR, Ministry of Environment and Energy).
5. Capitalize on the momentum created by the workshop and the interest shown by Government (NEMA) to look into a country-level NEAT+ adaptation.
6. Promote the idea of a country-level "pilot" or adaptation working with NEMA, OPM and UNHCR which could include:
  - a. scope what environmental screening tools exist, if any, and are being used in Uganda by partners, EIA Framework links;
  - b. adapt NEAT to Uganda's regulatory context (e.g. adapt text to indicate when EIA/ESIAs are needed; update vocabulary, references - or scope out what this would take);
  - c. Include the NEAT+ in NEMA's guidance as a screening tool pre-EIA.  
*NOTE: If NRC does not have staff who could do this, the JEU could explore options for support.*
7. Include the NEAT+ in UNHCR environmental mainstreaming guidance as an example of a screening tool that can be used pre-ESIA/EIA. Review the draft shard by UNHCR in October/November and follow up with NEMA and UNHCR, who are open to the inclusion. Ideally an adapted version for Uganda would be included.

## Annexes

### A: The NEAT+ Presentation

- The NEAT+ introductory presentation, given to all staff at the NRC Yumbe office:  
[https://docs.google.com/presentation/d/1pD6ORHlkxcD3-UyntDbkt93hxgLasLQ\\_v-UaMTUh-Nc/edit#slide=id.g6061adcd5c\\_0\\_141](https://docs.google.com/presentation/d/1pD6ORHlkxcD3-UyntDbkt93hxgLasLQ_v-UaMTUh-Nc/edit#slide=id.g6061adcd5c_0_141)

### B: Kampala workshop summary

On 6 September 2019, a workshop was held by the Norwegian Refugee Council (NRC) and the UNEP/OCHA Joint Environment Unit (JEU) at the Silver Springs Hotel in Kampala to present the NEAT+ and preliminary findings from the Bidibidi field test, and to engage participants in broader discussions about different aspects of screening and assessing environmental risk in humanitarian settings. Twenty-five representatives from the government, civil society organizations and UN agencies attended the half-day workshop (see participant list in Annex 2). The workshop was opened by a representative from the Office of the Prime Minister, who emphasized the need for continued cross-sectoral collaboration in humanitarian and environmental affairs in Uganda and a request to share the results of the Bidibidi pilot.

#### **Part 1: The NEAT+**

After receiving an overview of the NEAT+ tool and preliminary results from the Bidibidi field test (see presentations in Annex 1), participants engaged in a discussion about potential applications of the NEAT+ in their own operations and in national environmental management systems and regulatory requirements. In particular, the key questions that were posed to participants were:

1. What tools, if any, do you use to screen for environmental risk of humanitarian activities?
2. Can you envisage using the NEAT+ as a precursor to an Environmental Impact Assessment in Uganda?

Participants discussed the national requirements that exist for EIAs in refugee programming in Uganda, which should be predicated by an environmental screening highlighting areas of focus for the EIA. There is currently no standard screening tool in Uganda for humanitarian programmes. Interest was shown by participants, including government representatives, in ways in which the NEAT+ can be aligned strategically with the national environmental screening process that precedes an EIA. The NEMA representative suggested that conducting a scoping of other environmental screening tools deployed by organizations in Uganda could be useful for government to understand what processes are being used or could be adapted for the national context. Facilitators emphasized that the NEAT+ can be tailored to national/local regulations (including references to national legislation, government bodies, and relevant local organizations) and that support for this process could come either through the JEU or other actors who have the capacity to develop and update the tool.

UNHCR mentioned guidance they are currently developing in collaboration with the Government of Uganda on environmental mainstreaming in refugee settings. It is intended to be cross-sectoral and a representative from NEMA suggested that the NEAT+ could be included in the guidance as one of the tools to assist in environmental screening/EIA processes, following a scoping of existing screening tools in the country. The draft guidance will be shared with the interagency Environment and Energy Working Group in the next few weeks.

Overall it seems that organizations do not have specific tools that they are applying broadly to screen for environmental challenges. Some NGOs mentioned that while no particular tool is used, they do screen for environmental risks in their activities, particularly procurement. There was also interest in testing the NEAT+ predictive capacities in areas of new projects, to compare levels of risk for different proposed activities, as well as to minimize the time taken for environmental screening given the time efficiencies of the NEAT+.

Participants discussed the reporting function of the NEAT+ and the traffic light system used in the automatically generated reports. An important point was emphasized, that many of the lower (green coloured) risks are still significant and that it might help to change their colour so that the green does not give the impression of not being important. A new version of the NEAT+ will be available soon on <https://www.eecentre.org/resources/neat/> with this updated reporting feature (red, orange, yellow).

Participants discussed the opportunity for the Environment & Energy working group to serve as a space for partners to discuss future NEAT+ tests as well as the potential for the tool to be included in national guidance.

## **Part 2: Environmental data in humanitarian contexts**

The second part of the workshop focused on environmental data use in humanitarian contexts, including a discussion on data sharing and geospatial data. The discussion followed a presentation of MapX and some results from participatory mapping exercises held in Bidibidi with host and refugee communities (see presentation in Annex 1). The questions posed to participants included:

1. Do you use environmental data in your work and how?
2. What challenges do you face in accessing or using (environmental) data?
3. How do you share data?

Regarding humanitarian data in Uganda, and particularly the Bidibidi settlement, there is a somewhat unique situation in that there are large amounts of data being collected on the ground by multiple levels of stakeholders - from community members for [Humanitarian OpenStreetMap](#) to staff working at the field level for organizations such as FAO, WFP, and ICRAF. Some of this data is streamed into monthly dashboards produced by [UNHCR](#), who co-chair the Information Management Working Group (IMWG) for Uganda with the Uganda Bureau of Statistics (UBoS). While collected and analyzed data is being streamlined into reports as maps and figures, the

underlying data is often not being shared across organizations (with the exception of the OpenStreetMap). While many participants at the workshop were members of the Environment & Energy Working Group, only 2-3 indicated that they participate in the IMWG.

Data sharing between organizations working in humanitarian contexts reduces redundancies and ensures the effective coordination of efforts. Unfortunately, organizations working at the ground level sometimes struggle to access timely information about who is working where. Additionally, participants noted that changing softwares which are not interoperable with institutional systems is also an obstacle to sharing and accessing data. This is a cross-sectoral issue and can partially be addressed by creating incentives for data sharing, and easy data sharing mechanisms for data contributors. This mechanism should be open source and cloud-based if possible, to reduce the likelihood of a "data graveyard" occurring. The use of proprietary services can marginalize civil society organizations from participation in information sharing and access. The question of choosing the right data custodian is a key concern, as often those who hold the most data and information consequently have the most power over a situation. Without a strong framework in place guiding information management and sharing, organizations lack incentive to share timely data with government, UNHCR, or other actors working as data custodians.

Participants were interested in the integration of spatial data into the NEAT+, especially the ability to spatialize where environmental risks are occurring. Remote sensing data and satellite imagery were mentioned as valuable sources of data. A representative from NEMA mentioned that the National State of Environment report, which is released every two years, contains a land use and land classification map which is not shared through the UBoS geoportal. FAO also completes land use and land classification maps in its work in refugee settlements in Uganda, which are also not available for download and independent analysis. The representative from UBoS brought up several concerns about MapX and the NEAT+ regarding data sensitivity and confidentiality, open source software vs. proprietary software, metadata and data quality, and was reassured that these issues of concern were taken into account during the development and roll out of the tools. The representative also indicated that in order to create a data sharing mechanism on a national level, organizations must add their voice to the dialogue to put pressure on each other to meet data sharing regulations and standards (which currently do not exist).

## Next steps

- An updated version of the NEAT+ will be available from 21 September on <https://www.eecentre.org/neat/> with an improved reporting feature.
- Participants are encouraged to discuss the results of the NEAT+ tests at the Environment and Energy Working Group, as well as possibilities for adaptation to National Requirements
- If support from the UN Environment Programme / OCHA Joint Unit is needed, please contact [george14@un.org](mailto:george14@un.org) or [ochaunep@un.org](mailto:ochaunep@un.org).

## Presentations

- The NEAT+ presentation:  
<https://docs.google.com/document/d/1zgCH2fVy3PP5XxVBvxKMfNzgVHg1rm6SVExeTrEnMMC/edit#>
- MapX story Map presentation: <https://app.mapbox.org?project=MX-HOD-2BD-1WQ-UJN-K1Q&views=MX-U9VQK-BP68F-6TQTL&storyAutoStart=true>

## Participant list

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## C: Methodology of Satellite Imagery Analysis

The analysis used freely available satellite imagery from the Sentinel-2 mission of the European Union Copernicus programme. Due to the limited capacity to complete this analysis, only optical imagery was used. However, a deeper analysis using a combination of satellite and radar (i.e. Sentinel-1 mission) data should be considered in the future (FAO completed a rapid biomass assessment in 2017 with methodology available online<sup>34</sup>) to obtain more accurate and timely results.

### Methods

The two satellite images used for the comparison are from 3 February, 2016 and 2 February 2019. These images were selected due to the following reasons:

- The year of images are selected for before the Bidibidi settlement was established (2016) and the most recent dry season (2019) in order to understand change in land classification.
- The month of the images are from the dry season. It is expected that seasonal grasslands will be dry, leaving only annual vegetation such as open and closed woodlands, to clearly delineate different vegetation types.

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<sup>34</sup> FAO (2014) 'Assessing wood fuel in displacement settings: a technical handbook'. Available from: <http://www.fao.org/3/a-i5762e.pdf>

Analyses were completed using the ESA open-source earth observation program, [Sentinel Application Program](#), on a Copernicus Research and User Support (RUS) virtual machine. The virtual desktop environment allows the download, exploration and subsequent analysis of the satellite imagery without slowing down other processes on the local computer. Maps were then created with SNAP products on ArcGIS Pro. Images were atmospherically corrected using Sen2Cor processor in SNAP.

### Limitations

Satellite imagery offers limitless possibilities to analyze and classify data. However, this analysis and resulting statistics are indicative only and should not be used as a basis for planning and programming activities. Some limitations of the data include:

- Longer-term changes may be masked by complex seasonal and anthropogenic factors
- Areas are burned regularly in this part of the country during the dry season. It is difficult to ascertain whether burnt areas are cultivated land or bushland/grassland. However, an assumption is made that these burnt areas are likely not closed or open woodlands.
- Considerably more burning took place in February 2016 than February 2019. It is difficult to determine the reason for the reduction of burning.

### Land Use Change

An unsupervised K-means classification was performed on the satellite images to create a land use map. K-means clustering is an unsupervised algorithm that tries to cluster data based on their similarity. Initially the algorithm assigns each pixel to a cluster randomly and then finds the centroid of each cluster. Then pixels are reassigned to the cluster where the centroid is the closest. 7 Land Use classes were delineated: Closed Woodland, Open Woodland, Grasslands/Bushlands, Lightly Burnt Area, Cultivated Land, Bare Ground and Burnt Areas. The unsupervised classification was performed to ascertain whether the 7 classes would be significantly spectrally different from each other. It was discovered that the Lightly Burnt Areas, Grasslands/Bushlands and Cultivated Land were very close to each other.

With the aid of Google Earth imagery, a “random trees” supervised classification was performed using 5 classes to determine change in land use. The land use categories were:

- Woodland: areas where trees and shrubs are predominant. Categorized as closed (>40% canopy) and open (canopy cover of 10-40%).
- Bushland/Shrubland: vegetation dominated by bush, scrub and thicket growing together. Various trees may occur on this land, but grasses and low-growing vegetation dominate the landscape.
- Bare/Developed: includes bare/open land with no or very limited vegetation cover, as well as settlements without vegetation.
- Cultivated Area: Scattered trees are frequently found in the vicinity of the homesteads. The cropping systems include mono- and mixed cropping.
- Burnt area: area which has been burnt, presumably intentionally, by residents of the area for slash-and-burn agriculture. While it is difficult to determine the land use before

the burning, it is assumed that burnt areas occur in previously cultivated land or grassland/shrubland land classification.

- Water: water was only found in the 2016 image.

A land use transfer matrix was calculated using the results of the two images.

#### Non-differential vegetation index (NDVI)

This most known and used vegetation index is a simple, but effective vegetation index for quantifying green vegetation. It normalizes green leaf scattering in the Near Infra-red wavelength and chlorophyll absorption in the red wavelength.

NDVI is calculated in accordance with the formula:

$$\text{NDVI} = \frac{\text{NIR} - \text{RED}}{\text{NIR} + \text{RED}}$$

*NIR - reflection in the near-infrared spectrum*

*RED - reflection in the red range of the spectrum*

The result is a single band dataset that represents vegetation health, with a scaled legend of values between -1 and 1. Negative and low values represent clouds, water, and snow, and the values near zero represent rock and bare soil. High values represent dense, healthy vegetation. The NDVI was calculated in SNAP, using the Sentinel-2 band 8 as the infra-red and 4 as visible red.