

ENJOJO FOUNDATION  
In collaboration with  
SOUTH SUDAN WILDLIFE SERVICE

KIDEPO GAME RESERVE  
WET SEASON AERIAL SURVEY

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Technical report No. 1

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## 1. SUMMARY

This report documents an assessment of the presence/absence of medium and large mammal species, distribution and impact of human activities, ecological futures, and logistic access in Kidepo Game Reserve at the end of rainy season. Interest was also given to presence/absence of elephants in the possible historical migration corridor around Kimotong (between Boma- Badingilo landscape along Kidepo River). Used methodology combined systematic reconnaissance flights spaced 5km apart (east-west direction) and reconnaissance flights targeting key landscape features, based on previous field missions and available online data analysis. The survey was conducted between 26 – 29 September 2022, at an altitude of 300ft (92m) above ground level, using a Cessna 206 aircraft. In total 182 observations of wildlife and their signs (82 and 100 observations respectively) were recorded, along with 1160 instances of human activities observations during 19.43 h of systematic and reconnaissance flights (13,8h and 5,6h respectively). Despite known near absence of medium and large mammals, important observations of 140 ostriches, 56 small antelopes, 37 hartebeests, 11 common elands and 3 lions were made. Human activities included the presence of 3 332 cattle and 1810 goats, 789 observations of agricultural fields, and other observations of human activities. Although only a small section of the Boma- Badingilo migration corridor southwards to Kdiepo Game Reserve was covered, the survey confirmed the presence of wildlife, recent elephant tracks and other wildlife signs and a very small density of human presence.

Previous survey results do not allow for meaningful comparison. The wildlife populations are low and therefore require appropriate management attention. Human activity was recorded inside the Reserve, as well as on the periphery of the surveyed area, with encroachment of domestic livestock into the protected area, as well as continued expansion of agricultural activity on the borders. Grossmann (2008) reported little human activity, including little evidence of cattle and no camps in the southern half of the reserve in May 2008 (dry season) and the vegetation was reported in undisturbed state. These findings correspond to our survey results and to the fact that lack of surface water in the reserve during dry season results in cattle movements into the mountains at the periphery (Dongotona, Imatong or Didinga).

Kidepo Game Reserve (2800km<sup>2</sup>) possesses an impressive scenic landscape containing a number of different habitats, including sand bed rivers, inselbergs, mountains, thick woody and bamboo vegetation, and open savannas. The reserve is currently the only protected area in South Sudan covering the semi-arid habitat type. The results presented here indicate the importance of the Kidepo Game Reserve area for the transboundary movements of wildlife from Kidepo National Park in Uganda.

In addition, our results brought new knowledge about Kidepo Game Reserve ecosystem to the national government, as well as increased knowledge to some staff of Ministry of Wildlife Conservation and Tourism about aerial surveys and they contributed to the identification of priority conservation areas, and to the formulation of priority management strategies within the Kidepo Game Reserve.

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## 2. BACKGROUND

Enjojo Foundation is a non-governmental organization (NGO) registered in South Sudan that signed in January 2022 a Memorandum of Understanding (MOU) with the Ministry of Wildlife and Tourism for the co-management of Kidepo Game Reserve and Lantoto National Park in South Sudan, wherein both parties agreed to cooperate for the rehabilitation and management of these two protected areas. The basis of this memorandum is a joint recognition that conservation of the environment and its biodiversity are a top priority and an essential part of the National Development Strategy for the Government of South Sudan.

Established in 1975 with an area of about 280 000ha (2800km<sup>2</sup>), Kidepo Game reserve falls under IUCN Management Category: VI = Protected area with sustainable use of natural resources (IUCN, 2022). The reserve lies between the Dongatona Mountains to the west and the Didinga hills to the east, while to the north it is bounded by the Chakari – Farasika imaginary line and to the south by the Uganda border. The Reserve's central feature is the Kidepo Valley, which meanders into the adjoining Kidepo National Park on the Ugandan side of the border. The Reserve is an integral part of the wider Kidepo Valley transboundary ecosystem, bordering Kidepo National Park in Uganda and adjacent protected areas, which is an important contiguous protected area in Eastern Africa. The historical connection to the wider Badingilo-Boma landscape is not well understood but known historical movements of elephants in the areas north of Kidepo Game reserve indicate a possible connectivity. The Reserve can play a catalytic role in securing some of the extraordinary habitat and wildlife of South Sudan.

Kidepo Reserve possesses an impressive scenic landscape containing a number of different habitats and it is currently the only protected area in Southern Sudan covering semi-arid habitat type (Grossman, 2008).

Climatic variability and site topography influence water availability and the associated distribution of vegetation communities. The vegetation can best be described as open tree savannah which varies much in structure and composition - mosaic of savanna, grassland, and woodland habitats and dense thickets. Dry riverbeds zig zag across the reserve, with Kidepo Riverbanks covered by riverine vegetation of *Borassus* palm trees. Expansive grassy plains are dotted with big rocky outcrops and flanked by steep jagged mountains and inselbergs from which one can obtain stunning views in all directions. Low ranges of rocky hills are covered in scrub. The Dongotona Mountains and Didinga Hills are covered with montane forest and shrubland. This mosaic provides a diversity of resources for wildlife. As such, the area could represent an important refuge for rare, endangered and/or endemic species to this biogeographical region.

The Kidepo game reserve contains extensive areas of significance for the conservation of large African fauna belonging to the Sudanian biogeographic zones. The ecosystem used to support populations of critically endangered Nubian Giraffe, endangered elephant, wild dog and vulnerable cheetah, as well as other rare species as roan antelope, Beisa oryx, aardwolf, and striped hyena. The Kidepo Reserve was acclaimed as an important elephant area in the 1950s through the 1980s, where elephants were observed to move between Kidepo Game Reserve in Sudan and Kidepo National Park on the Ugandan side of the border. The same was confirmed by elephant tracking data between 2008 and 2011 (WILD, 2011).

Low levels of wildlife and virtual absence of large-bodied ungulates are likely due to seasonal lack of water and intensive hunting pressure along the river. It is unlikely they have had a chance to recover during this time and currently, some of these species are believed to be locally extinct due to serious pressure from outside the reserve. Much of the remaining wildlife at this time is likely to have been supported by populations from neighbouring Kidepo National Park in Uganda (Grossmann et al., 2008).

The Kidepo game reserve also contains a relatively large human population, especially on the hills near the Ugandan border, and is important as a grazing area for all the pastoralists, cattle-owning people, living on either side of the valley. The reserve is a territory of a number of different agro-pastoralist ethnic groups, including the Lango, Logir, Didinga, Buya and Lotuko. Each of these peoples have distinct traditions, culture, and livelihood activities.

However, in terms of wildlife, the viability of the Reserve was questioned early in the 1970's in Blower's study (1977). Blower describes the following:

"The area is heavily grazed by livestock and there is very little wildlife on the Sudan (today South Sudan) side of the border [...] which is scarcely surprising since the Didinga are well armed and keen hunters which have for long been notorious as poachers in the neighboring Kidepo National Park" [in Uganda].

The current seasonal use of the reserve natural resources by communities is not well understood, but the Reserve's intact habitat, beautiful landscape and proximity to the Kidepo National Park in Uganda hold some promise for recovery and development in the future.

Figure 1: Map of the Kidepo Game Reserve ecosystem, its connectivity to transboundary protected areas, as well as possible larger connectivity to Boma-Badingilo landscape.

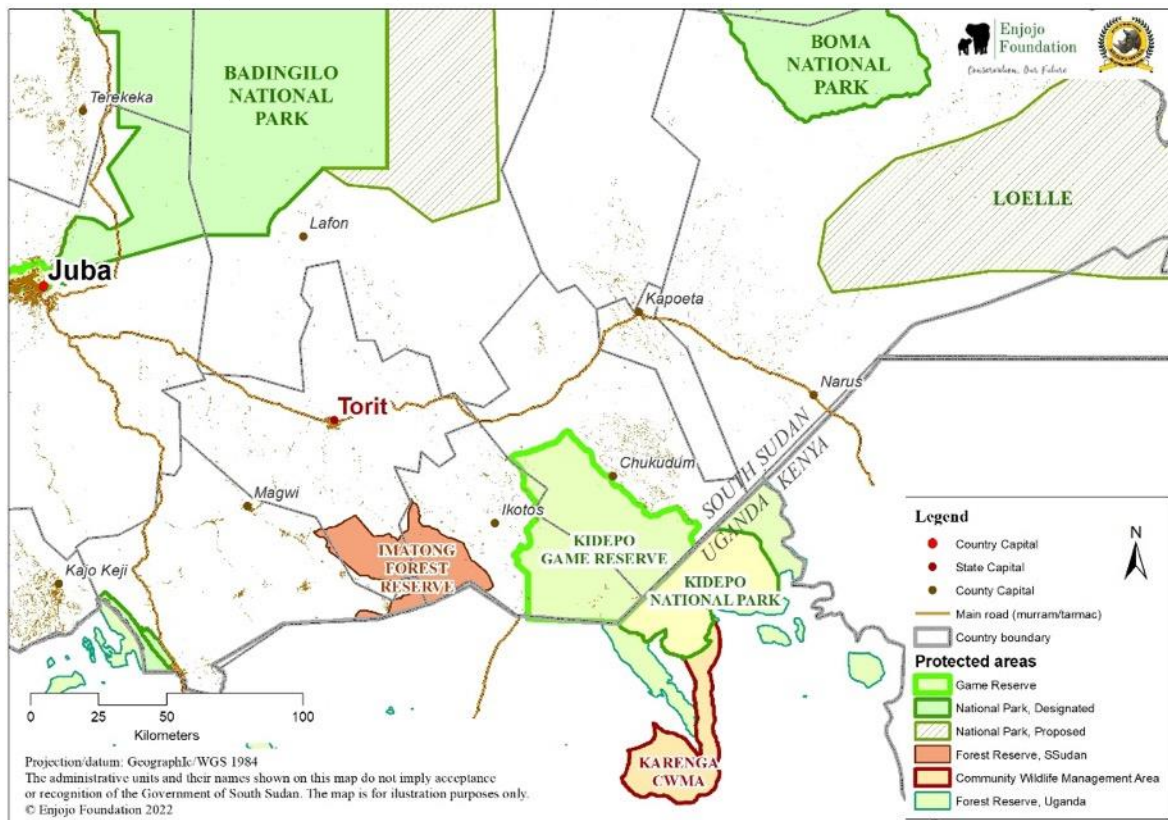


Figure 2: Detail of Kidepo Game Reserve, South Sudan.

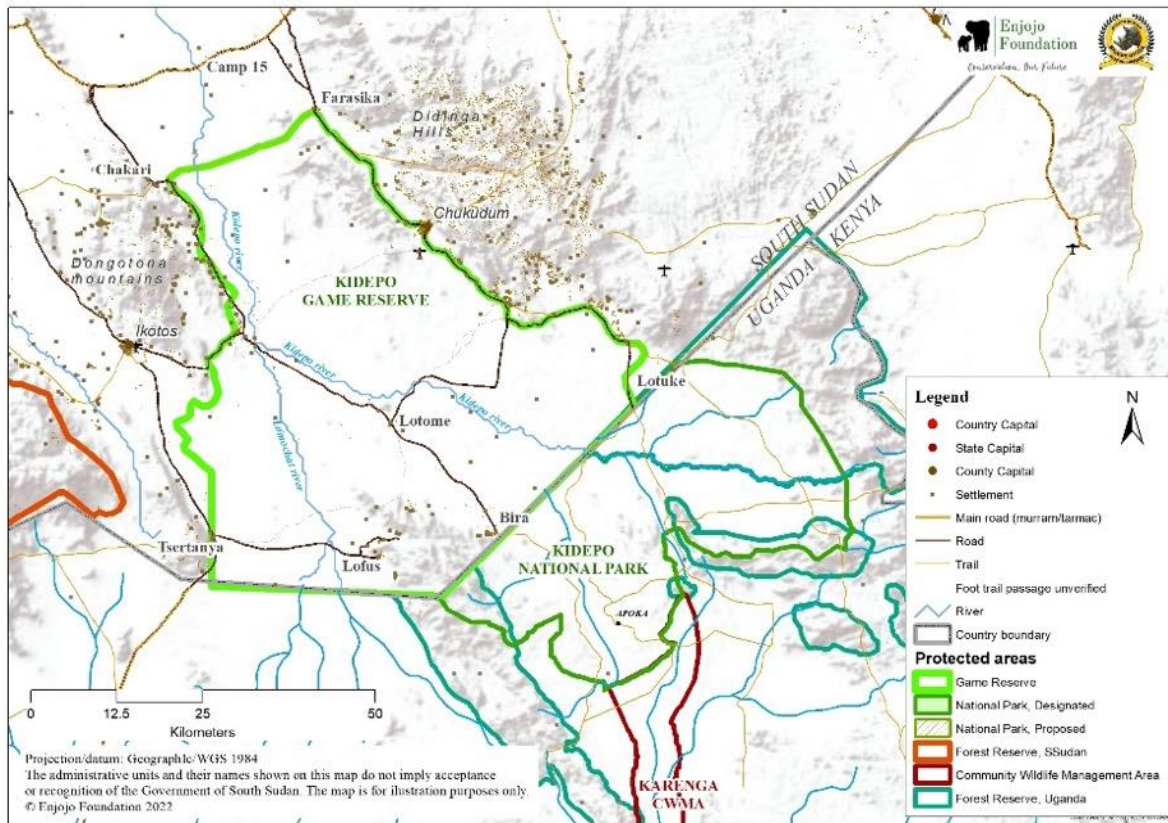
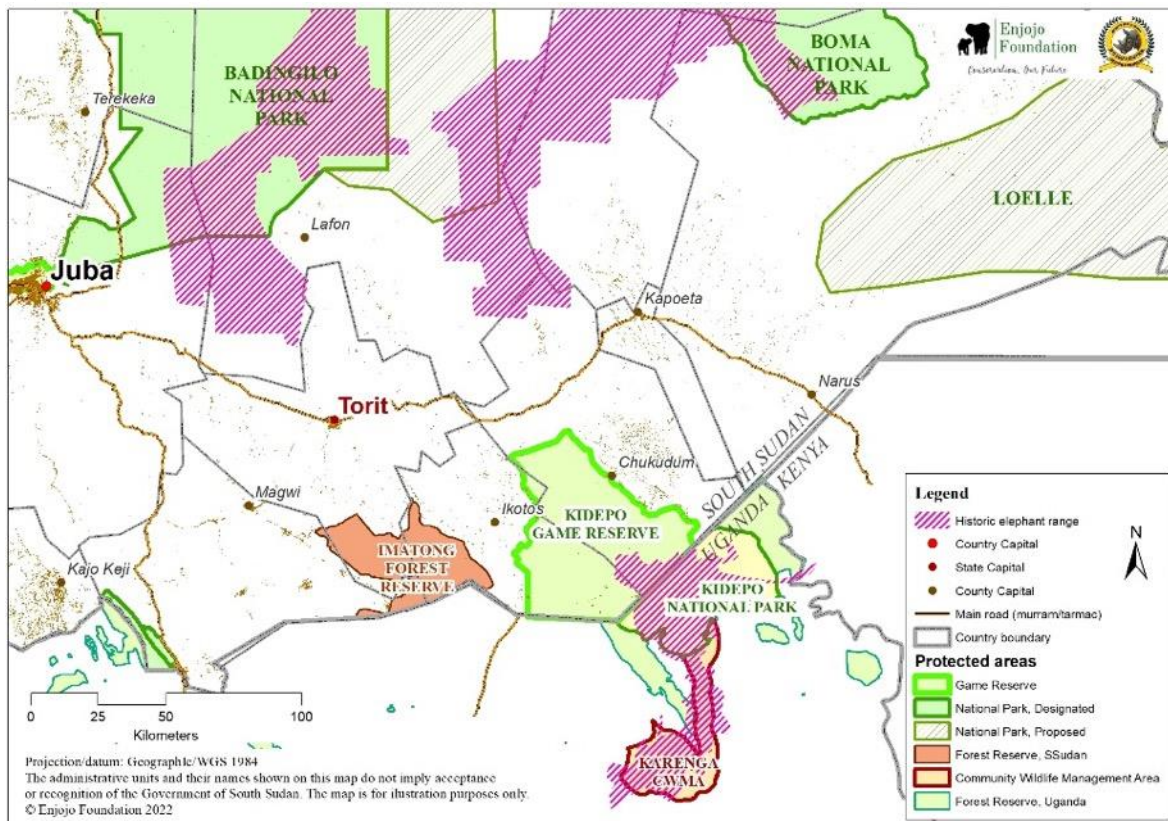


Figure 3: Known historical elephant ranges in transboundary Kidepo landscape and corridor to Boma-Badingilo landscape (Source: Wanyama et al., 2014; Grossmann et al., 2008; UWA, 2012 and WCS unpublished data).



### 3. THE SURVEY OBJECTIVES AND METHODOLOGY

Since 2008, no systematic or reconnaissance survey was done in Kidepo Game Reserve, and no data are available to explain the status of the integrity of the protected area, its wildlife and use of natural resources by local communities.

The objective of the survey was to survey KGR and adjacent Kidepo River valley to identify presence of medium and large mammals, spatial distribution of livestock populations, along with those of human activities that impact the environment, map main ecological features and logistic accessibility during wet season.

Specific objectives were identified as follows:

- *Evaluate presence/absence of medium and large mammal species in KGR during rainy season. Special attention to be given to elephant, buffaloes, and giraffes around Kidepo river and transboundary area with possibility of mammal movements from Kidepo Park in Uganda. Interest to be also given to presence of elephants in possible historical migration corridor around Kimotong (between Boma-Badingilo landscape along Kidepo River).*
- *Evaluate presence and impact of human activities within KGR in rainy season, including settlements, grazing areas, agriculture, fishing camps, dams, poaching camps, elephant carcasses, tree cutting, mining etc.*
- *Map key ecological features within KGR ecosystem.*
- *Evaluate rainy season logistic access and constraints for future management operations in KGR (status of roads, identification of main water sources, high ground areas for potential bush airstrips or camps etc.), based on findings during field missions.*
- *Increase the knowledge of key government personnel about the status of KGR and undertake capacity building in aerial surveys.*

Anticipated conservation impact

- *Contribute to the identification of priority conservation areas and formulate rehabilitation strategies within the Kidepo Game Reserve.*
- *Support identification of location for future KGR HQ.*
- *Support identification of community development strategies.*
- *Contribute to the development of KGR management and sustainability plan.*
- *Increase knowledge of key government (national and local) personnel about the status of KGR.*
- *Form the basis for the identification of the methodology and frequency of future wildlife surveys required to evaluate the performance of future management efforts in the reserve.*

#### 3.1 Survey region and methodology

The survey was carried out at the end of the wet season (September 2022). Visibility is rather low at this time of year due to high foliage on vegetation. Although last rains contributed to a cooling effect of ambient temperatures, some areas of the reserve appeared to receive less rain and occurred relatively dry with good visibility (South-east parts of the reserve).

The entire Kidepo Game Reserve (2,800 sqkm), including the southern part of the Boma-Badingilo elephant dispersal area (potential migration corridor to KGR) was identified for the aerial survey, using systematic reconnaissance flight (SRF) on transects at 5km distance. Using GIS (ArcMAP Software), the reserve was divided into 3 blocks, defined by the distribution of main rivers, the topography of their watersheds and by the KGR boundaries. The survey flight lines (transect orientation) were oriented perpendicular to the flow of main rivers and other ecological gradients.

Additional reconnaissance flights were added over key areas of the ecosystem with major ecological features, main rivers, logistic access points, human settlements, and key agricultural areas). See observation types in the Annex.



### 3.2 The team and aircraft

The survey team comprised of a pilot, a principal observer and data capturer seated in the front (FSO), and four observers at the rear of the aircraft (RSOs). High-winged Cessna aircraft 206 (providing good visibility) was used to fly parallel transects over 3 pre-determined blocks and additional reconnaissance flights. Flying was undertaken during the coolest times of the day (e.g. 6h30 - 10h30, preferably again 15h00 - 18h30).

Suitably experienced consultant was employed by Enjojo Foundation to act as FSO, KEA Aviation provided experienced pilot and the RSOs team included Enjojo Foundation team members and Government of South Sudan (GOSS), South Sudan Ministry of Wildlife Conservation and Tourism (MWCT) and South Sudan Wildlife Service (SSWS) personnel. As many team members were novices to aerial surveys, in-depth presentation of methodology and observation types was presented at the beginning of the survey. It was ensured that there are at least 2 experienced RSOs present during every flight. The whole survey also served as capacity building session for the members of Enjojo and GOSS teams.

Table 1: List of team members.

No	NAME	FUNCTION	AFFILIATION
1	Kristien Debref	CEO/RSO	Enjojo Foundation
2	Marketa Antoninova	Technical assistant/FSO	Enjojo Foundation
3	Adoa Geoffrey	Pilot KEA	KEA Aviation
4	John Simon Yokwe	Governance officer/RSO	Enjojo Foundation
5	Jackson Baa Ligigo	Observer, logistician	Enjojo Foundation
6	Umar Turyakira	Field Ops. Manager	Enjojo Foundation
7	John Okech Okello	Observer/RSO	Enjojo Foundation/GOSS
8	Ejidio Oler	C/Warden Kidepo GR/RSO	SSWS
9	Samuel Kenyi	Director Wildlife Crime Unit/RSO	SSWS
10	Mapour Kuot Mungu	Interpol coordinator/RSO	MWCT
11	Emmanuel Bazira Bale	Content creator - social media/RSO	Enjojo Foundation

The pilot navigated along the parallel transects with the aid of transect lines programmed into an Apple tablet using the OSMAnd Maps application, maintaining an altitude of 92 m (300ft) above ground.

The RSOs called out all observations seen. Each observation was recorded by the FSO using a handheld GPS device and data sheets. A continuous track log of flight lines was recorded by the handheld GPS (see Figure 4). The data were entered into ArcMAP software to establish a spatial data based across surveyed areas.

### 3.3 Carcasses

Four categories were used standards (following the MIKE carcass categories):

- 1) *Fresh carcasses (ELECAR1) have intact bodies with a rounded appearance, vultures are usually present and there is a pool of putrefied fluid surrounding the body. This category applies to carcasses thought to be less than 3 weeks old.*
- 2) *Recent carcasses (ELECAR2) generally have skin present with the skeleton still intact and are distinguished by the presence of a rot patch. This category applies to carcasses that are older than 3 weeks.*
- 3) *Old carcasses (ELECAR3) are bones only where the rot patch has disappeared. This category applies according to standards to carcasses older than 1 year.*
- 4) *Very old elephant carcasses (ELECAR4) are bones only. This category applies according to standards to carcasses older than 3 years.*

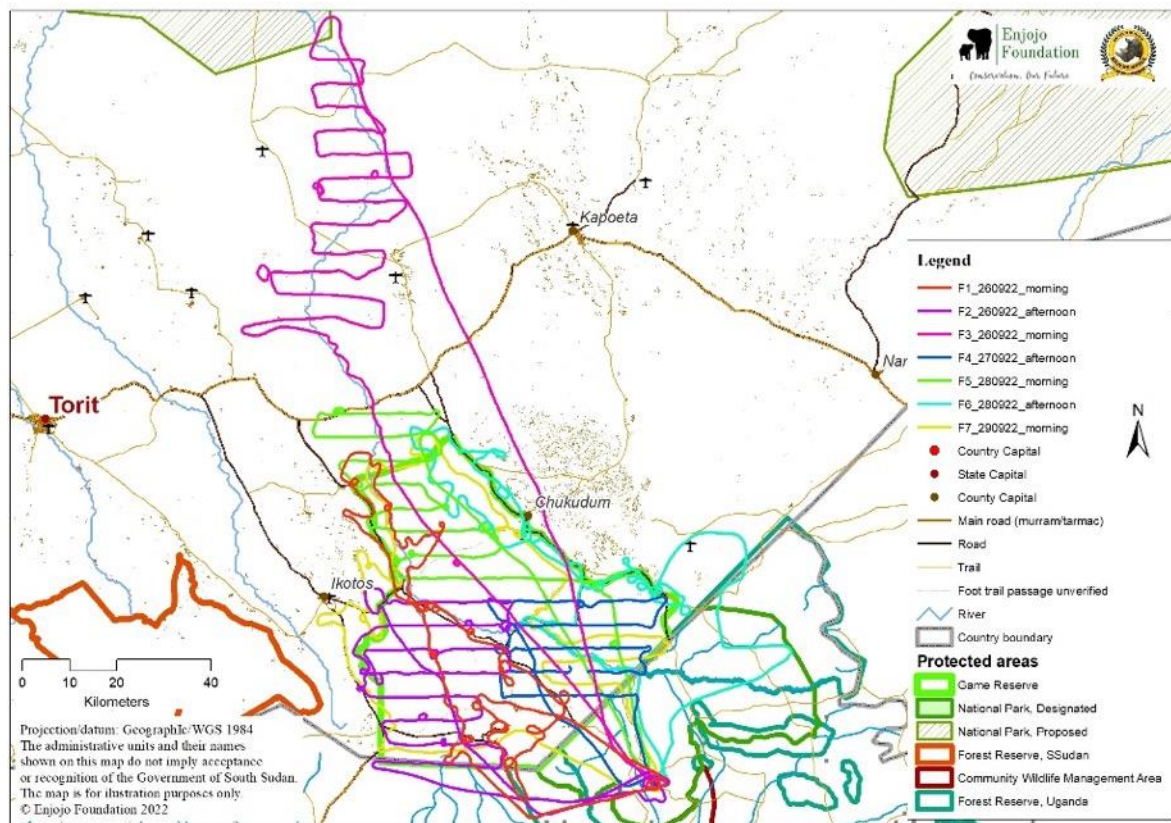
## 4. RESULTS

In total 182 observations of wildlife and their signs (82 and 100 observations respectively) were recorded, along with 1160 instances of human activities observations during 19.43 h of systematic and reconnaissance flights (3,8h and 5,6h respectively).

Table 2: Flights summary.

No	Date	Take off time	Landing time	Flight time, h	KM covered
1	26.9.2022	6:35:00 AM	9:24:00 AM	2.8	457.0
2	26.9.2022	3:16:00 PM	6:06:00 PM	2.8	493.1
3	27.9.2022	6:17:00 AM	9:47:00 AM	3.4	635.1
4	27.9.2022	3:10:00 PM	4:56:00 PM	2.5	281.6
5	28.9.2022	6:17:00 AM	8:51:00 AM	2.5	405.8
6	28.9.2022	3:04:00 PM	5:37:00 PM	2.6	438.4
7	29.9.2022	8:49:00 AM	11:31:00 AM	2.8	419.4
	TOTALS			19.43	3130.4

Figure 4: Survey area showing the actual tracks flown during the 2022 survey.



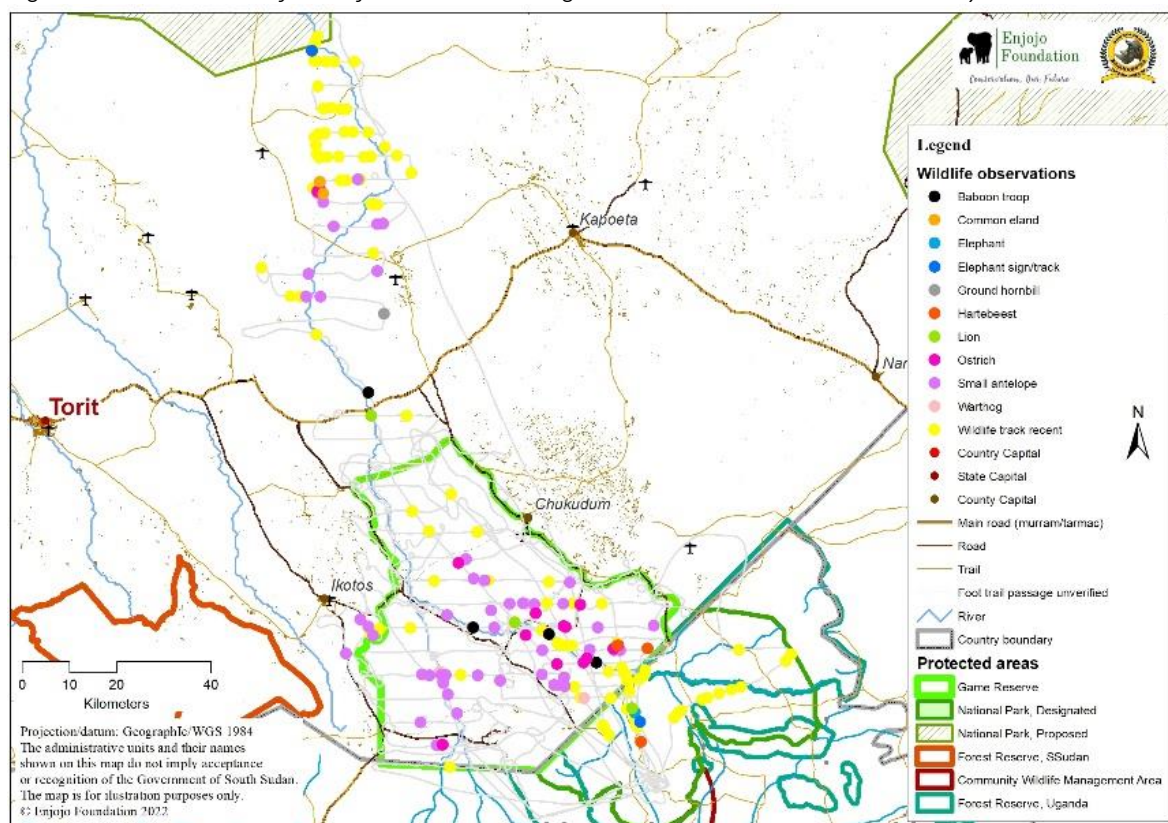
## 4.1 WILDLIFE

Wildlife observations included the presence of 140 ostriches, 37 hartebeests, 56 medium-small antelopes, 3 lions and 9 warthogs. Additionally, 11 common elands and 1 sign of elephant presence were recorded in the northern corridor. Elephants were not seen on the South Sudanese side, only on 1 occasion, a herd of 50 individuals was observed in Kidepo national park Uganda during the ferry flights close to the border with South Sudan. No elephant carcass was observed during the survey.

Table 3: Wildlife observations summary.

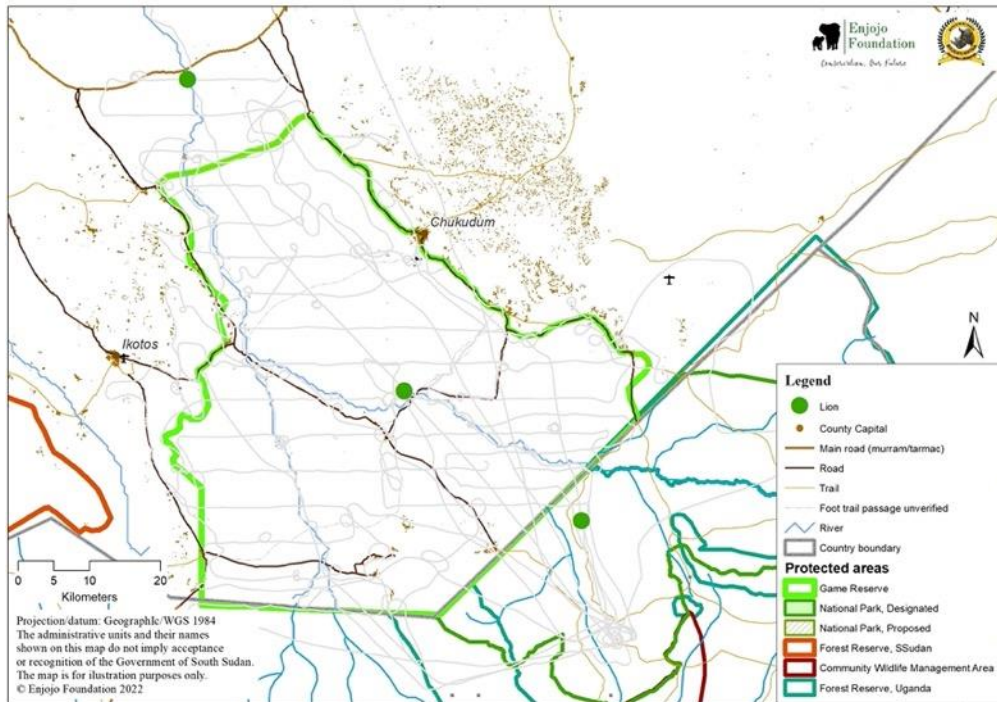
Species	No of observations	No of individuals	Note
Olive baboon	4	Troops	
Common eland	2	11	Northern corridor
Lelwel hartebeest	3	37	
Lion	2	3	
Ostrich	14	140	
Small antelopes	50	56	Mainly reedbucks
Warthog	3	9	
Elephant tracks	1		Northern corridor
Wildlife path	98		

Figure. 5: Distribution of wildlife observed during the 2022 wet season aerial survey.



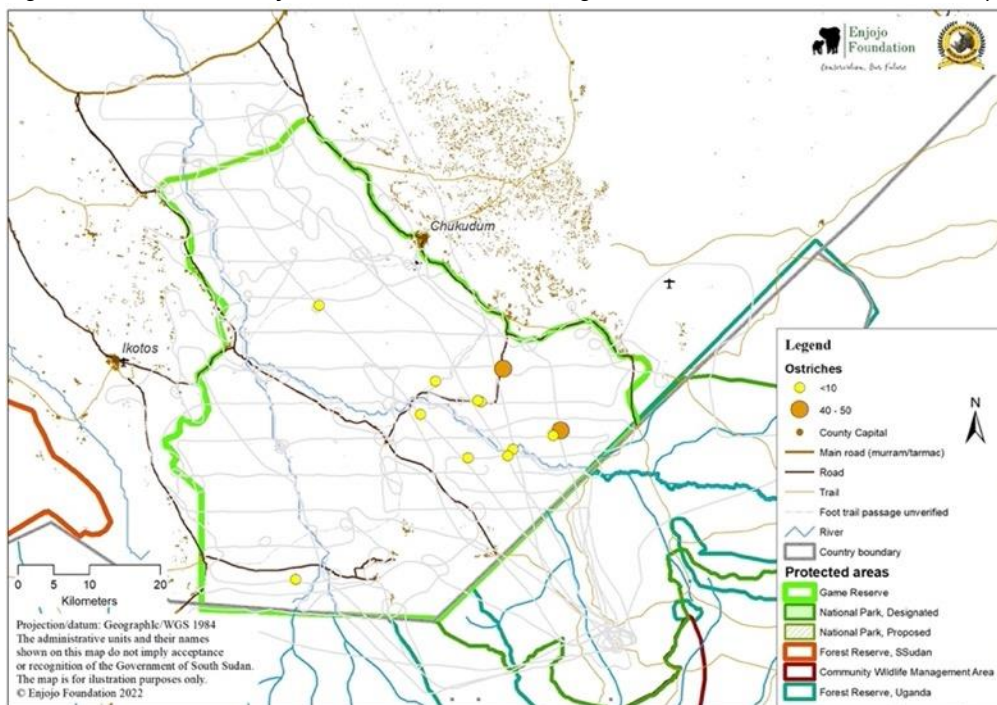
Majority of wildlife was observed in south-east part of the reserve, adjacent to the Kidepo national park in Uganda. The most common observation were small antelopes, largely reedbucks, ostriches, and baboons. Although some 200 elephants are estimated to reside on Ugandan side in Kidepo national Park (Grossmann, 2008), no direct or indirect observations of elephants were recorded in Kidepo game Reserve in South Sudan. Few elephants were observed close to the international boundary in Kidepo national Park, Uganda. In the northern corridor recent elephant tracks, common eland, ostrich and small antelopes were observed, as well as many recent or fresh wildlife paths.

Figure. 6: Distribution of lions observed during the 2022 wet season aerial survey.



Four lions were observed during the survey, one individual in the north of the reserve close to main Kapoeta-Torit road, two individuals in the central area of the reserve and one individual in Kidepo national park in Uganda, close to the national boundary.

Figure. 7: Distribution of ostriches observed during the 2022 wet season aerial survey.



Ostriches were one of the most common wildlife observations. In total 114 individuals in 14 observations were recorded. Two large groups, one group of about 40 - mainly young male individuals and another of about 50 - mainly young female individuals were observed.

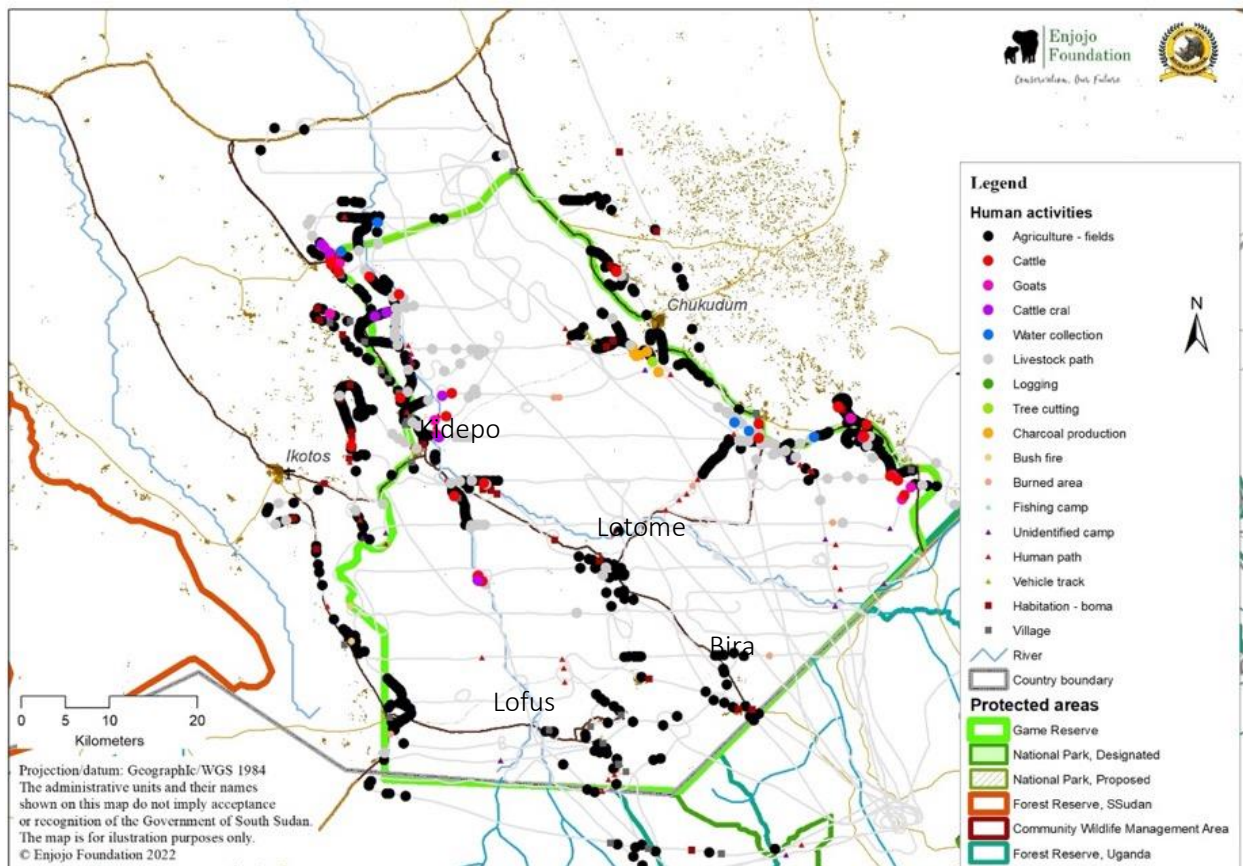
## 4.2 HUMAN ACTIVITIES

Human activities included the presence of 3 332 cattle and 1810 goats, 789 observations of agricultural fields, and other observations of human activities (Figure 6). The four biggest herds of cattle observed counted 300 - 500 individuals (average 133 individuals) and the biggest herd of goats observed counted 400 individuals (Average 111 individuals). But half of cattle and goat herds (53,8% and 50% respectively) were herds of a size inferior to 100 individuals. A list of observed human activities is summarised in the tables below.

Table 4: Key human activities observations summary.

Observation	No of observ.	No of individ.	Note
Agriculture - fields	789		Actively cultivated fields and new clearings only
Cattle	25	3332	
Goats	16	1810	
Livestock cral	10		Cattle fences
Livestock path	108		Recent or old (mainly likely from dry season)
Water catchment	7		For livestock
Charcoal production	6		Around Chukudum
Logging/tree cutting	2		Logging in gallery forests of Mt. Lotuke
Fishing camp	1		Old
Unidentified camp	10		Majority old, possible old cattle crals, 2 recently used
Habitation/boma	32		Small settlements, bomas,
Villages	30		

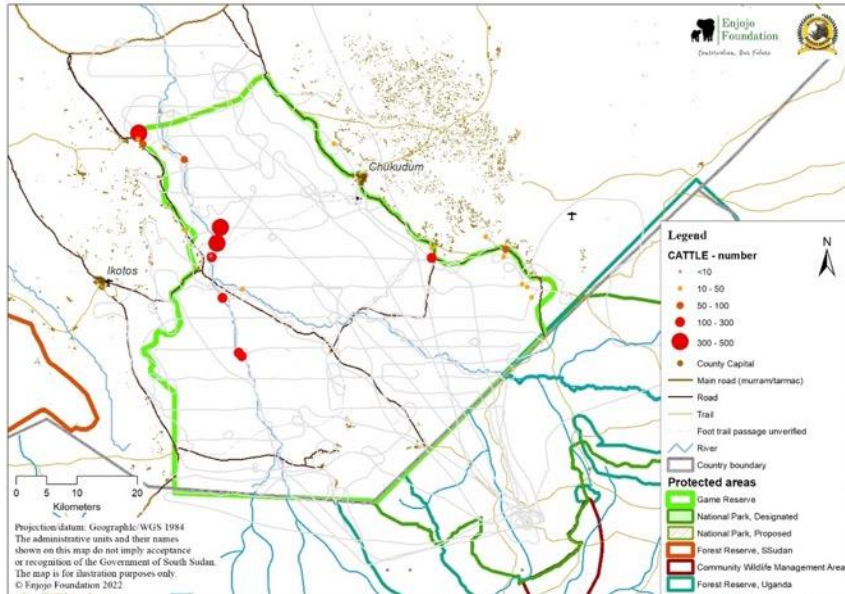
Figure 6: Distribution of all human activities - cattle and goats, agriculture and other human activities observed during the 2022 aerial survey.



## LIVESTOCK

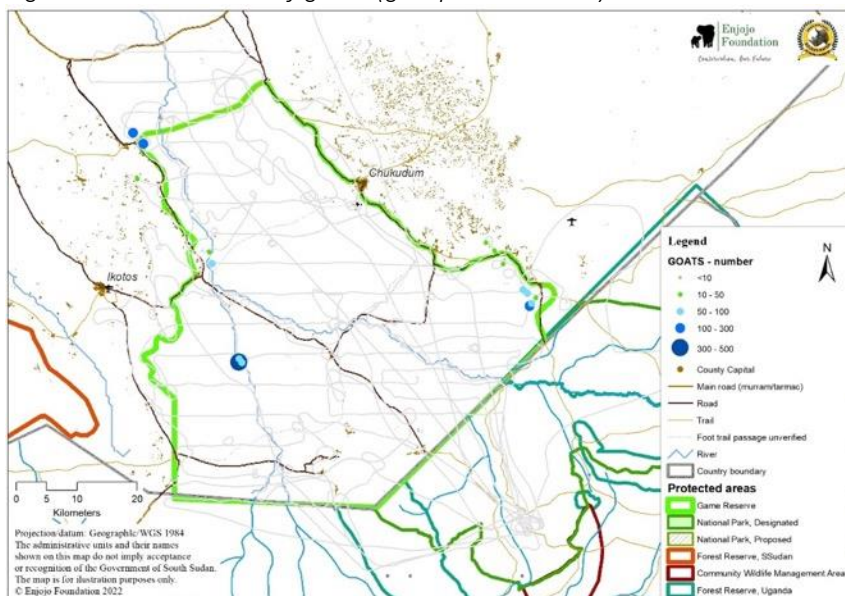
Field, livestock and habitation were distributed along the eastern and western boundary of the reserve, and around three main inhabited areas within the reserve - Lotome, Bira and Lofus. Kidepo is a locality where the 2 rivers – Kidepo and Lomochat connect with a high density of human activities.

Figure 7: Observations of cattle (group size 2 – 500).



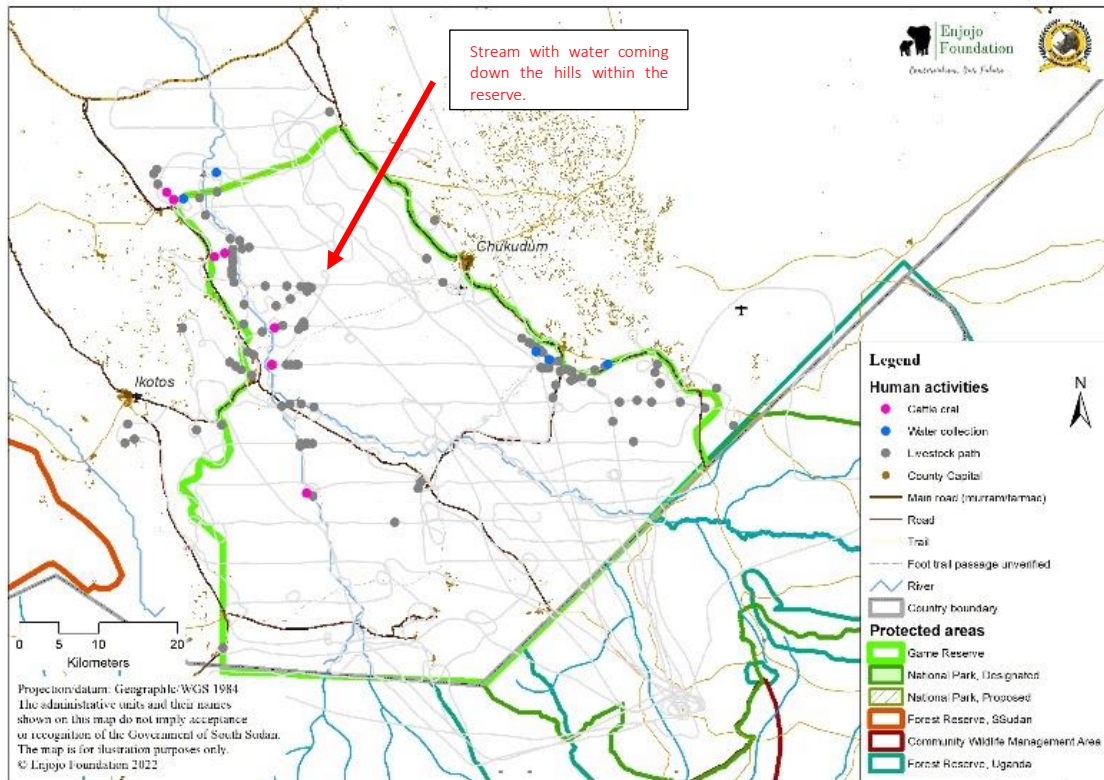
Large herds of cattle up to 500 individuals were observed mainly in north-western boundary of the reserve, in proximity of the Kidepo river, that still provided water. Cattle was also observed along Lomochat river, some 10km southward inside the reserve from the Kidepo bridge.

Figure 7: Observations of goats (group size 2 – 400).



Goats in large herds up to 400 individuals were observed during the survey, again in proximity of Kidepo and Lomochat rivers. The largest herd was observed along Lomochat river, some 10km southward inside the reserve from Kidepo bridge, where cattle and herders crals were also observed.

Figure 8: Observations of other livestock keeping related sightings – cattle crals, water catchments and cattle paths (tracks).



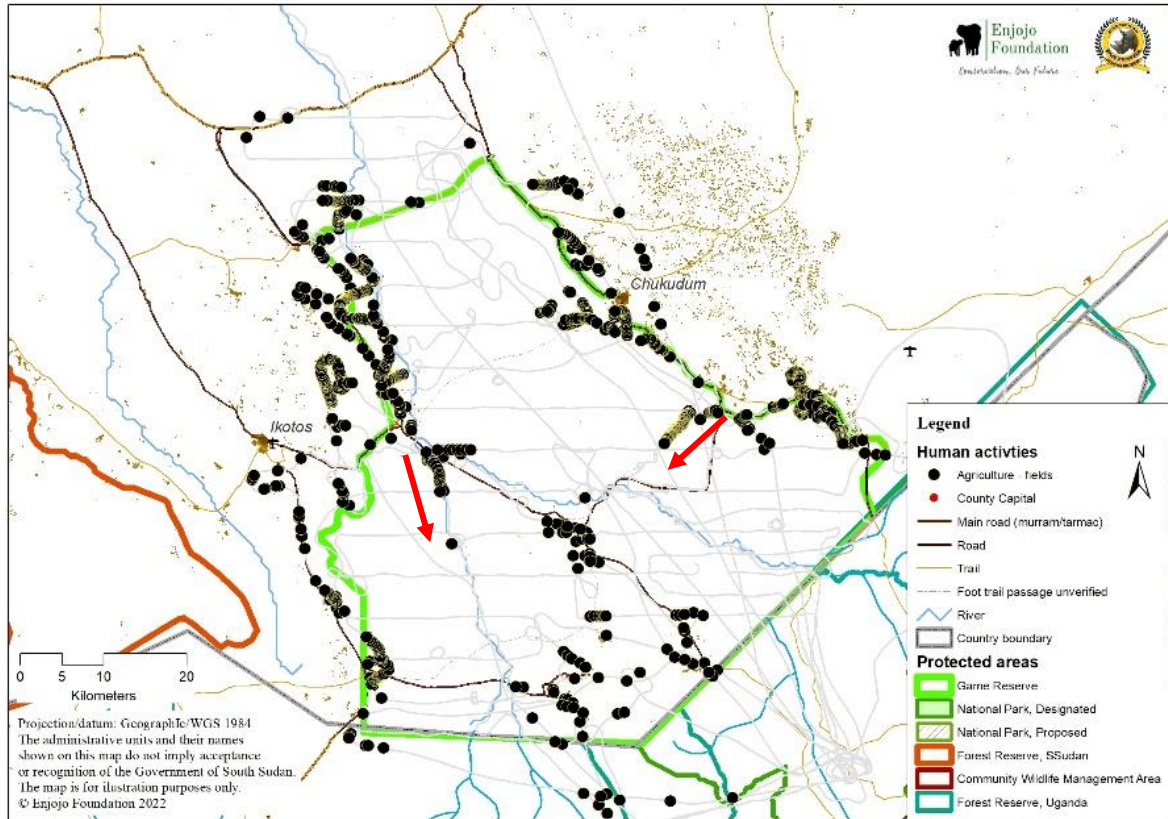
In relation to livestock keeping, the observations of livestock crals (fences for livestock), water catchments and livestock paths were recorded. In total 10 livestock crals, 7 water catchments and 108 cattle paths/tracks were recorded. Cattle crals were observed mainly around northern part of Kidepo and Lomochat rivers, where water was still available. Water catchments were recorded around the north-western corner of the reserve as well as on eastern boundary near Kikilai area, where a concentration of livestock and fields was recorded.



## AGRICULTURE

We recorded 789 agricultural fields within surveyed area. These were observed on the edges of the reserve boundary and in areas of Lotome, Bira and Lofus villages. Agricultural fields are intruding up to 10 km into the protected area near Kidepo village along Lomochat river and near Kikilai along the lowland area.

Figure 9: Observations of agriculture (fields).





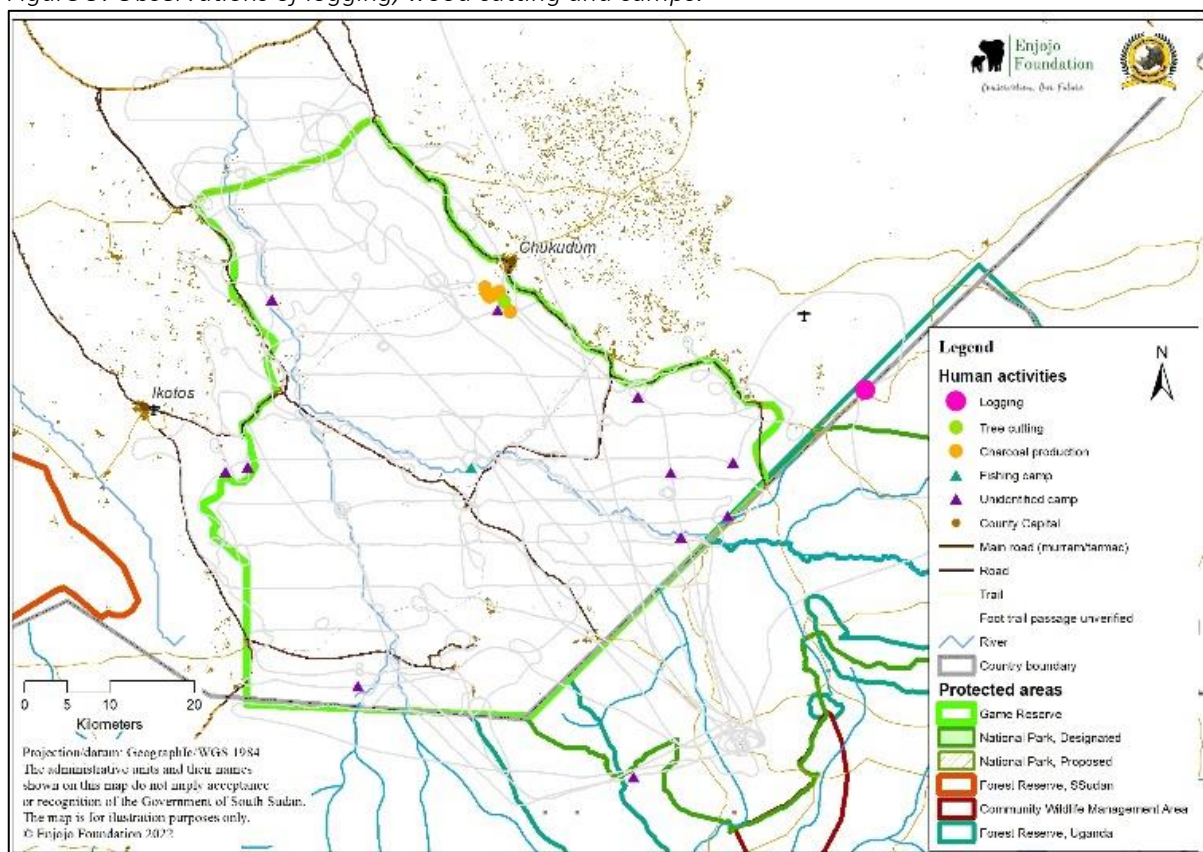
## WOOD EXPLOITATION and GENERAL HUMAN PRESENCE

We recorded eight (8) observations of charcoal production, wood cutting and logging. Majority of these observations were in Chukudum areas, which seemed to be centre of charcoal production. One case of intensive logging was recorded on Mt. Lotuke, outside of the reserve, where wide vehicle path was heading into the gallery forest in mountain valleys and smoke was observed. Mt. Lotuke is on the boundary with Uganda, and close to the Urungo village and SSPDF military base.

Fishing activities were only once observed during the survey, through presence of an old fishing camp, likely due to lack of flowing water in main rivers. Direct poaching observation were not recorded during the survey, which may be due to low densities of wildlife.

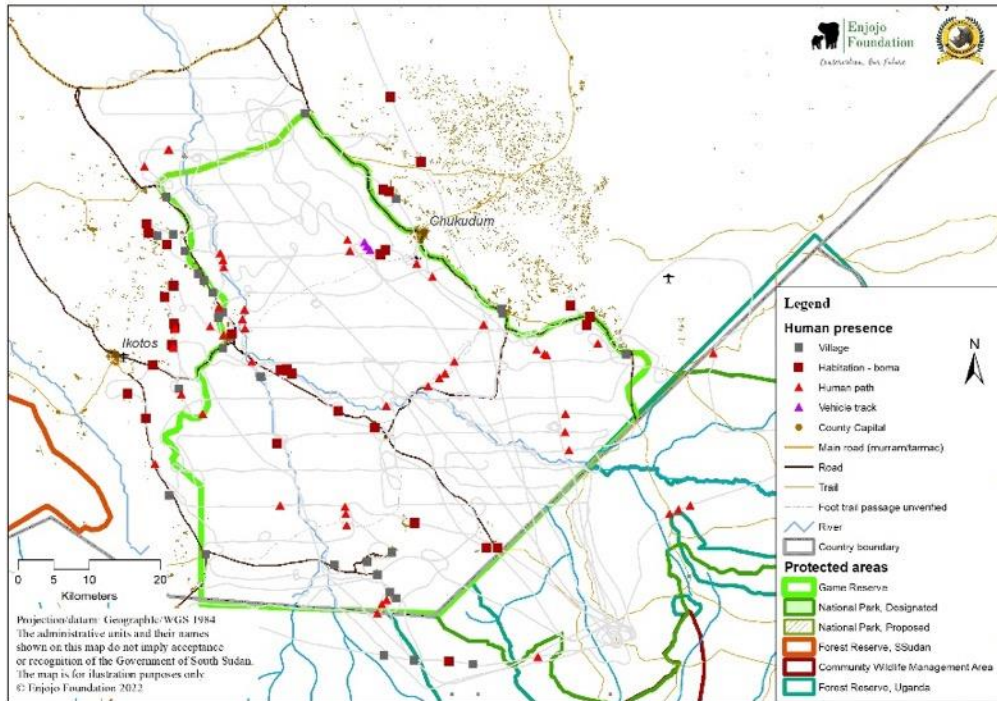
In total 10 unidentified camps were observed, of which only two were recent. The camps located close to the Ugandan border indicate likely movements of poachers to wildlife richer areas near or in Kidepo National Park in Uganda.

Figure 9: Observations of logging, wood cutting and camps.



Other observations of human presence were observed such as villages, bomas (habitation with few huts, usually in the hills or closer to the permanent fields), human paths and vehicle tracks (off road/newly created road). These human signs correlated with observations of agriculture, livestock keeping and trespassing between inhabited areas and possible poaching in Kidepo NP, Uganda.

Figure 10: Other observations of human presence – inhabited areas, human paths and vehicle tracks.



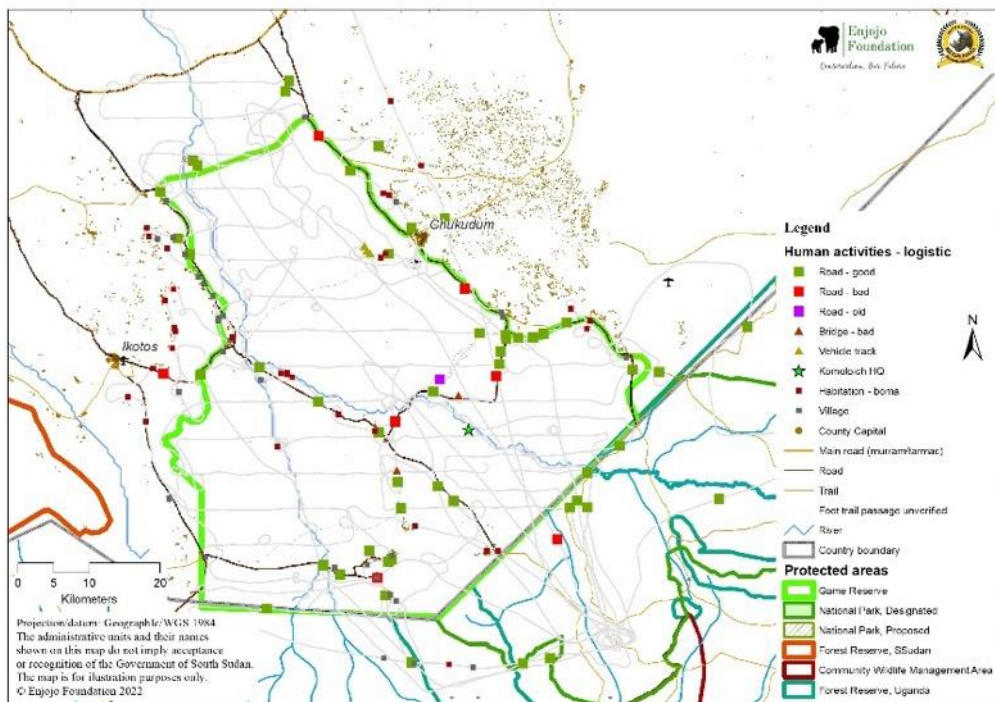
Presence of villages and bomas and human paths correspond to landscape use, including fields distribution, livestock keeping and possible poaching. Extensive agriculture fields in Chukudum area within the reserve are connected by well used vehicle track, indicating large scale agricultural production (mainly millet).



## LOGISTIC ACCESS

During the survey we recorded information about logistic access to the reserve. Planned reconnaissance flights followed key roads, bridges, and Wildlife Service infrastructure.

Figure 11: Observations of roads, bridges and Wildlife Service infrastructure.



As the rains already decreased in September, majority of roads were in good condition, and although sandy or murram covered, they seemed to be passable by 4x4 vehicle. Only few spots or extended parts of the roads were recorded in bad conditions, namely Ikotos – Kidepo road (the whole road), road section before Kikilai (several hundreds of meters muddy) and long sections of road close to Farasika, north of Chukudum, between hills (very muddy). The road from Bira to Lotome was in a very good condition, likely due to her higher altitude position relatively far from hills and the river. The main Kidepo bridge is in excellent condition, and two small culverts were in bad conditions.

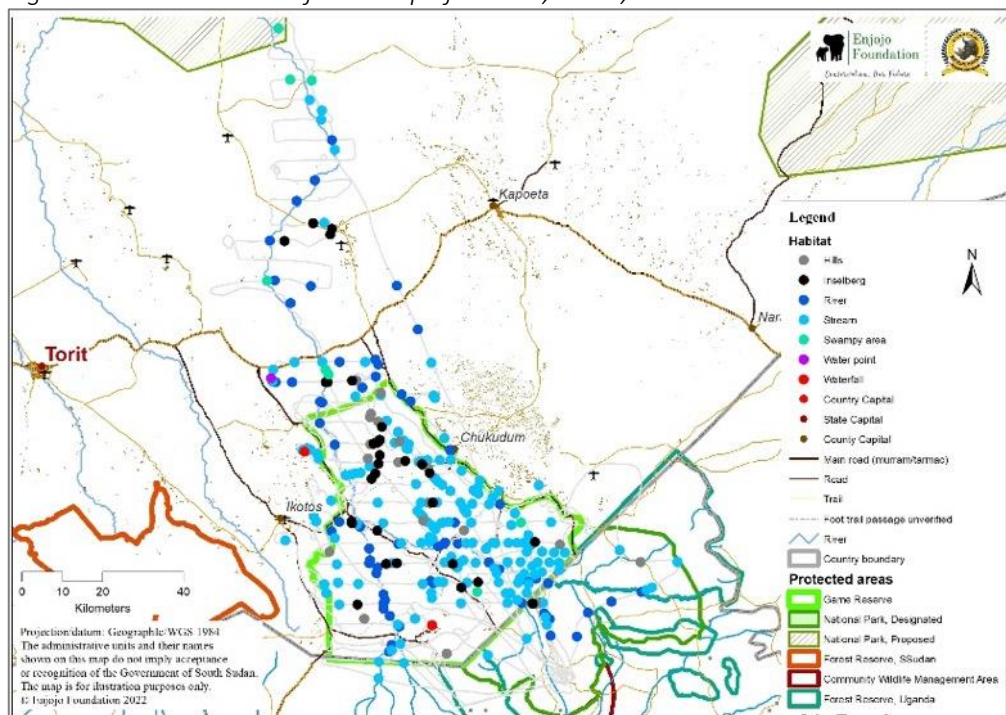


## HABITAT

The main objective were observations of water availability in the ecosystem at the ned of rainy season. The Kidepo river was not flowing, and water remained in “pockets”, often in locations where there were new streams coming from hills or areas with higher altitude joining the river. The northern half of the Kidepo river within the reserve is heavily used by cattle herders and for agriculture. The sandy bed of Kidepo River causes water to sink fast, leaving the riverbed wet, and water seemed to be just under the sandy surface.

The second largest river, the Lomochat River crossing the Western block of the reserve, had surface water, and was used by cattle herders and for agriculture. Very few other rivers/streams had surface water present at the time of the survey and many small streams likely flow only temporarily after heavy rains. Small hills and inselbergs were also recorded during the survey, as they could be a source of water of streams and ideal areas for future tourism development.

Figure 12: Observations of landscape features, rivers, streams and water sources..



## 5. DISCUSSION

The only aerial survey conducted in Kidepo Game Reserve in the past was done in 2008 by Wildlife Conservation Society (Grossmann et al., 2008) and the results of that survey represent an important dataset, and although a meaningful comparison with our survey results would be difficult (different methodology and different period of the year), there are few findings that are further discussed and become valuable facts for the reserve management and its future development. The Kidepo valley is an important source of water for wildlife, livestock, and people in the area and so the protection of this drainage is a cross-border issue. The future of Kidepo Reserve's viability is directly associated with its role as a transboundary protected area contiguous with Kidepo Park in Uganda.

### WILDLIFE

The Reserve is currently the only protected area in South Sudan covering semi-arid habitat type, that if protected could support important biodiversity. Low levels of wildlife and absence of large-bodied ungulates (no buffalo or large antelope species observations recorded) are likely due to seasonal lack of water and intensive hunting pressure. The populations of wildlife were reportedly hunted out in the 1970s (Blower 1977) and it is unlikely they have had a chance to recover since that time. Much of the remaining wildlife at today is likely still supported by populations from neighbouring Kidepo National Park in Uganda. The wildlife populations are low and therefore require appropriate management attention.

Important observations of lions were made during the aerial survey, of which one north of the reserve, two individuals inside the reserve and one individual in Kidepo NP, Uganda, close to the boundary. Lion population in Kidepo NP, Uganda was estimated at 132 in 2009 (UWA, 2010), mainly present in Narus Valley, but recently few lions were observed in Kidepo and currently new survey is in progress to establish population status.

Ostriches were the most observed wildlife in the Reserve, and the population seems to be healthy with good potential for increase and dispersal if well protected.

Historical data on elephant movement showed transboundary movements between Uganda and Kidepo Game Reserve in South Sudan, although elephants did not seem to move deep into South Sudan (WILD, 2011). The reason for only sporadic movements of elephants to South Sudan are likely lack of water in dry season and poaching pressure.

Recent elephant tracks observed in northern corridor towards Badingilo National Park confirm past observations of elephant use of the area (WCS unpublished data). Further monitoring would confirm extent of the use of the area and seasonality, which seems to correspond to beginning and mid rainy season, when the area is wet and not used by cattle herders.

### HUMAN ACTIVITIES

Various activities relating to the natural resources of the Kidepo ecosystem were noted during the survey. This includes agricultural expansion, domestic animal grazing, fishing, charcoal production, and logging. Human presence was detected in certain "hotspots" mainly around human habitation and livestock keeping areas, indicating further encroachment of human activities into the ecosystem and activities representing direct threats to the ecological integrity of the Kidepo Game Reserve.

Human activity was recorded inside, as well as on the periphery of the surveyed area, with encroachment of domestic livestock into the protected area, as well as continued expansion of agricultural activity on the borders. Grossmann (2008) reported little human activity, including little evidence of cattle and no camps in the southern half of the reserve in May 2008 (dry season) and the vegetation was reported in undisturbed state. These findings correspond to our survey results and to the fact that lack of surface water in the reserve during dry season results in cattle movements into the mountains at the periphery (Dongotona, Imatong or

Didinga). The cattle distribution tended to be relatively localised in Kidepo Game Reserve and mainly observed at periphery. At the onset of the first rains in April, new grass cover and small water points attract grazers, including cattle. This provides incentives for cattle herders to move deeper into the protected area later in the year. This observation is supported by the relatively large number of cattle paths towards the inside of the reserve for grazing and returning to the periphery at night where water is available.

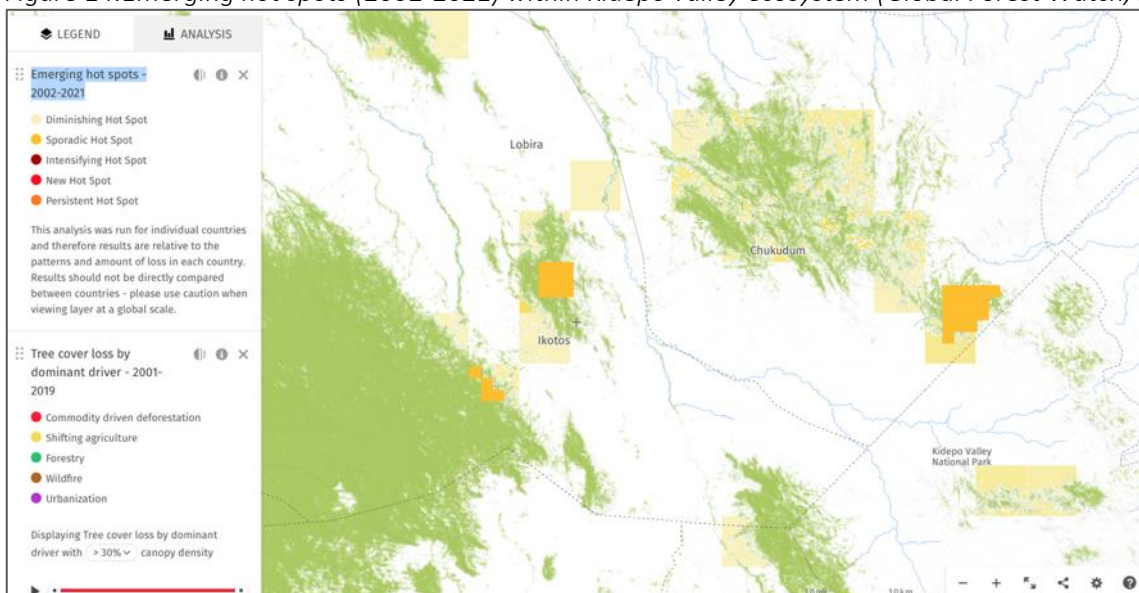
Over the last three decades, global warming and population growth in the subregion have altered the natural landscapes on the periphery of the reserve, along with their resources. The tree cover loss images illustrate the extend of the increase in pressures on the protected area, which also indicate the associated economic and social issues that they represent. The extend of the threats to the Kidepo Game Reserve is still relatively low in comparison to its periphery areas, where the threat arise from the constraints brought by the expansion of agriculture (shifting agricultural practices) since 2001 that are demonstrated in the two images of the land use below. Didinga and Dongotona hills are the most affected by tree cover loss.

Figure 13: Tree cover loss by dominant driver - 2001-2021 (Source: Global Forest Loss).



Mt. Lotuke, neighbouring Kidepo Game Reserve at its south-east corner, at the boundary with Uganda and the Dongotona Mountains at its western boundary, were identified to be affected by tree cover loss and as sporadic emerging hotspot (Global Forest Watch, 2022) - a location that is an on-again then off-again hot spot, where less than 18 of the 19 years have been statistically significant hot spots (Harris, 2017).

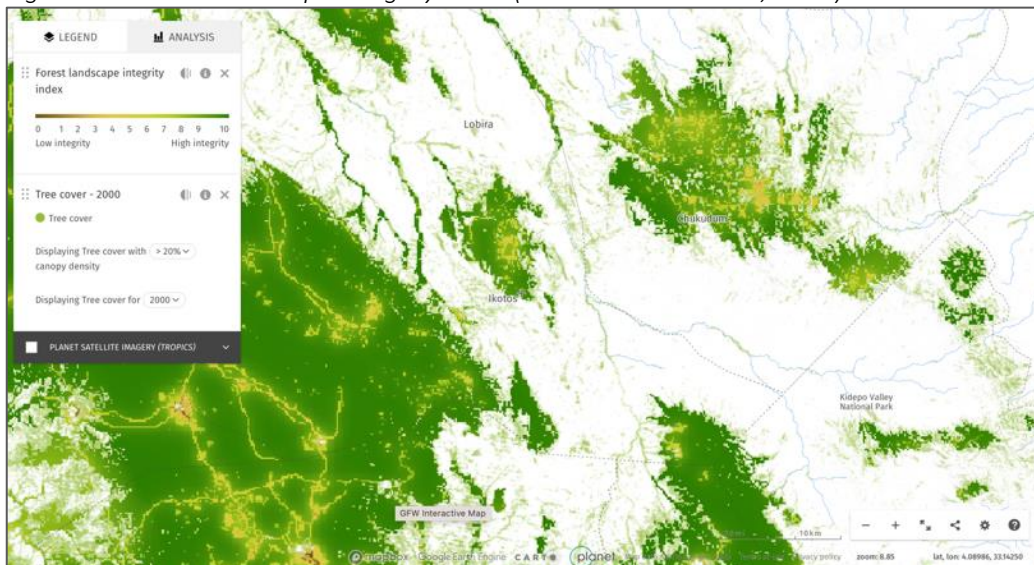
Figure 14: Emerging hot spots (2002-2021) within Kidepo valley ecosystem (Global Forest Watch, 2022).



The emerging hot spots data set identifies the most significant clusters of primary forest loss between 2002-2021 at a country level basis, on a tropical scale. The term 'hot spot' is defined as an area that exhibits statistically significant clustering in the spatial patterns of loss. In this analysis, observed patterns of primary forest loss are likely to be attributable to underlying, as opposed to random, spatial processes Harris, N. L. et al., (2017).

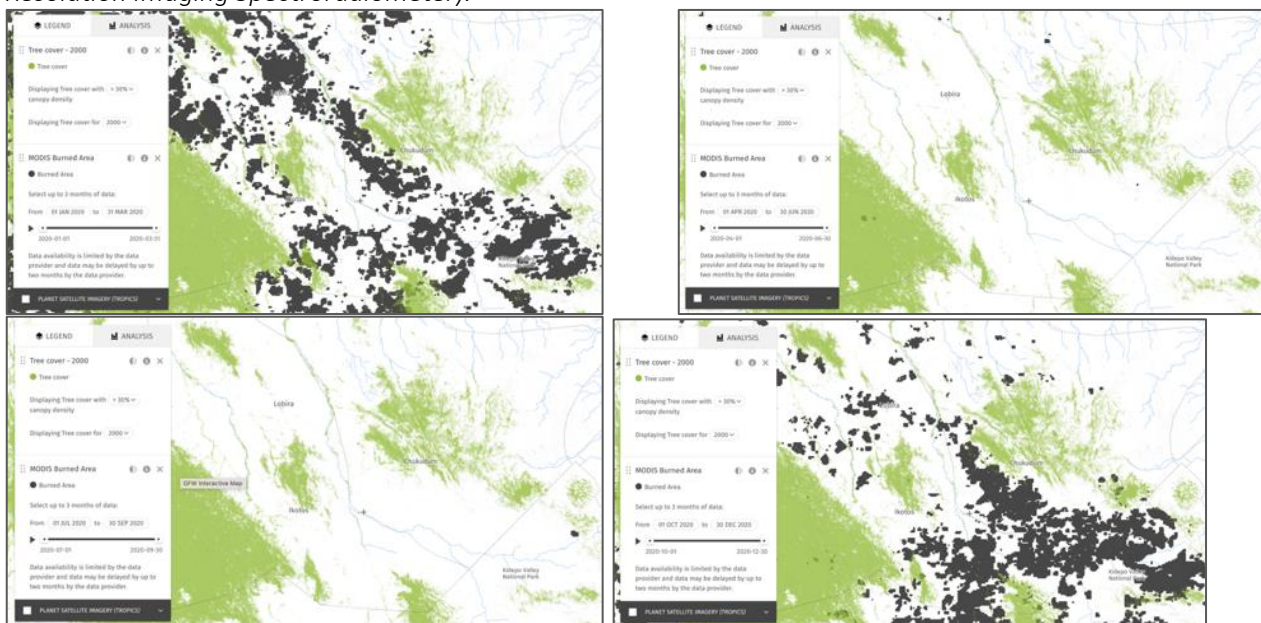
These findings are further supported by the analysis of forest landscape integrity, where areas with identified lower integrity are Didinga and Dongotona hills, Mt. Lotuke and additionally also areas around Lofus village inside the Kidepo Game Reserve.

Figure 15 : Forest landscape integrity index (Global Forest Watch, 2022).



Another factor affecting the ecosystem dynamics are bush fires. Although natural bushfires may occur, majority of fires are human induced for various reasons such as fires to clear agriculture fields prior to planting, fires to obtain new grazing for livestock or to attract wildlife for poaching. Visibility in the bush and potential movements of people through the reserve in relation to tribal conflict should also be considered. Several recently burned areas were observed during the survey, meaning that bush fires may start as soon as in September (likely depending on annual rainfall), although some parts of the reserve are still relatively wet. Following the data obtained from satellite sensors, it is likely that the whole area of Kidepo Game Reserve is burned annually between October and March.

Figure 16: Example of burned areas within Kidepo Ecosystem in 2020 observed. Sensor: MODIS (Moderate Resolution Imaging Spectroradiometer).

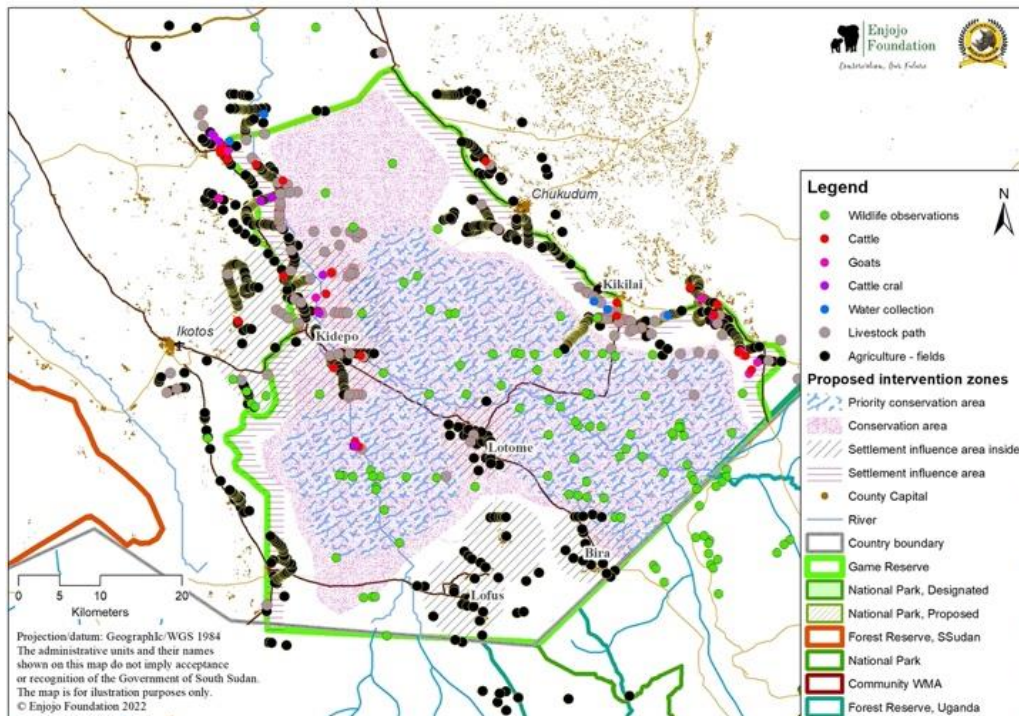


The survey findings, corroborated with satellite data above, will play crucial role in designing future management strategies of Kidepo ecosystem, including restoration of key areas or species, as well as tourism development. Although a viable tourism sector could take years, even decades, to develop, the proximity to Kidepo National Park in Uganda and the possibility of transboundary tourism increases the overall value of the reserve.

The survey showed that the main roads coming across the international border into the Kidepo game reserve are in relatively good shape even at the end of the rainy season. The main road entering through Bira could serve as a possible logistic access road from Uganda, leading to the core area of the reserve, the Lotome village. Logistic access from Uganda (Gulu, Kitgum) would be also suitable through Tserenya border crossing, but because of the road from Ikotos to the park being in a very bad state, almost impassable in rainy season, puts this access to disadvantage. Overall lack of roads in the reserve will have to be addressed by management to allow access to key conservation areas. The former South Sudan Wildlife Service HQ in Komoloch at the bank of Kidepo River was originally built for peacebuilding purposes and is now in ruins. Considering its remote position and difficult access, the management of the Reserve shall consider a new site selection for reserve headquarters.

The legal framework of Kidepo Game Reserve allows for sustainable utilisation of natural resources including grazing and hunting rights, as described in Wildlife Conservation and National Parks Act, 2003. Land use planning and zoning will be a crucial step towards a sustainable future of the reserve for wildlife and people. Based on the data collected during the aerial survey corroborated with field data, key zones with human use and priority conservation area have been identified. The management of the reserve shall as soon as possible establish operations node (HQ) to establish presence, secure core conservation area and initiate active dialogue with communities.

Figure 17: Zones identified through aerial survey data and field missions.



The southern section of Boma-Badingilo migration corridor was added to the coverage of the 2022 aerial survey because historically there could have been a potential connection with Kidepo Game Reserve. The aerial survey recorded presence of wildlife, including elephant tracks and very little encroachment of human activities. However, the potential of connectivity with Kidepo Game Reserve and future potential of classification as protected area (e.g. community reserve) requires further investigation.



## 6. CONCLUSIONS

Grazing represents a major threat to wildlife populations, as herders are often implicated in poaching and poisoning. Although currently the Reserve seems to maintain large areas of relatively undisturbed habitat, large numbers of unregulated cattle will result in overgrazing, habitat, and water source destruction (including wood cutting for cattle feeding and disturbance of wildlife species), and potential transmission of diseases to wildlife. Disease transmission may already be happening and requires thorough monitoring and implementation of management practices (vaccination, tick control, zoning) on the ground. The encroachment of agriculture and housing in the Reserve represents a direct threat to the ecological integrity of the Kidepo Game Reserve and needs to be addressed. Consideration must be given to the fact, that very low wildlife numbers and species diversity exist in the reserve, with many species that were historically present now being locally extinct. Moreover, the reserve is already an isolated natural ecosystem embedded within an agro-pastoral landscape that itself is undergoing economic, social, and cultural transformation. The populations of the communities living in its proximity and inside the reserve are still economically dependent on their traditional knowledge and their social and cultural links with their environment. Land and natural resources remain fundamental to their existence. Resolving these issues over the next 20 years should therefore be at the centre of the land use planning process.

The methodology used (reconnaissance flights combined with 5km spaced systematic transects) was selected based on initial knowledge of very low wildlife numbers and set objectives of the survey. Obtained results are therefore good for determining the spatial distribution of species and human activities. Our survey constitutes an important dataset contributing to the assessment of the status of wildlife, livestock, human activity, and habitat of Kidepo Game Reserve. Together with the data from 2007 and data collected during field missions, these data will form the baseline for the development of management strategy/plan for the reserve.

The Kidepo Reserve's significance is greatest in its connectivity with the Kidepo National Park on the Ugandan side which is reported to have some important populations of large bodied ungulates and elephants. Both surveys (2008 and 2022) conducted in Kidepo Reserve in South Sudan showed results similar to the status described in the late 1970's with very low numbers of large bodied ungulates. Nevertheless, its potential as transboundary protected area remains an important conservation consideration and chance for recovery of some species in the South Sudan section.

### **General recommendations resulting from this survey:**

The survey presented constitutes an important information dataset, and the following steps are proposed to further improve the knowledge about the reserve:

- *Wildlife populations, livestock, and human activity in the survey area are known to be highly seasonally mobile. There is a need for the survey to be conducted in the dry season to record these movements. The methodology, frequency, and season for future surveys should be determined to allow for statistical evaluation and comparison of results.*
- *Start general monitoring through regular aerial surveillance and terrestrial monitoring, including collection of mortality data (when applicable).*
- *Aerial surveys are not considered to be the appropriate method for monitoring of large carnivores. It is advisable to establish terrestrial predator monitoring activities to obtain accurate information on predators, especially lions, cheetah, spotted hyena and leopard.*
- *Use the research and monitoring results to recommend management measures to ensure the long-term persistence of key wildlife species in the Kidepo Game Reserve.*
- *Conduct applied research on community land-use and pastoralism in the Kidepo ecosystem including assessment of grazing patterns and health of livestock.*
- *Engage community and government stakeholders in discussion on encroachment of settlements and expansion of agricultural fields into the reserve.*
- *Establish and maintain active inter-state relationship/dialogue with the authorities in Uganda (UWA).*

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## 8. ANNEX - Selection of photographs from the survey

### 1. *The survey team at Kidepo airstrip, Uganda*



### 2. *Didinga Hills.*



3. *Didinga hills inside the reserve.*



4. *Kidepo River with Borassus palm tree and Dongotona Mountains at the horizon.*



5. Kidepo River with *Borassus* palm trees.



6. Stream with dense vegetation coming down from Didinga hills to the reserve.



7. Many streams cut through the Kidepo savanna, flowing only after intense rains.



8. *Inselbergs, common in the northern part of the reserve.*



9. *Hills inside the reserve.*



10. Agriculture with settlements at the foot of Dongotona Mountains.



11. Agricultural activities extend up to 10 km into the reserve along Lomochat River.





12. Agriculture at the foot of Dongotona Mountains, reaching to Kidepo River. At the background with Didinga Hills.



13. Cattle and crals inside the reserve near Kidepo River, with Dongotona Mountains at the background.



14. Water catchment for livestock at the north-eastern corner of the reserve.



15. Cattle paths heading into the reserve.



16. Settlements at the hills of Dongotona Mountains, with agriculture in the valleys along the stream.



17. Mt. Lotuke.



18. Signs of logging in gallery forests of Mt. Lotuke.



19. Group of about 50 ostriches.



20. Landscape – open savannah.



21. Savanna with small hills inside the central area of the reserve.



22. Bush savannah with Didinga Hills at the horizon.



23. Drying grassland in the south of the reserve, close to Ugandan border.



24. Lotome village.





25. Burned area.



26. Northern corridor – Kidepo River with flowing water.

