

OPEN SOURCE INVESTIGATION

**IDENTIFICATION OF  
ECOLOGICALLY FRAGILE  
AREAS PRIORITIZED FOR  
FOREST CONSERVATION AND  
RESTORATION IN MAMBASA  
AND MONGBWALU SECTOR,  
ITURI PROVINCE, DEMOCRATIC  
REPUBLIC OF THE CONGO**

# BLOOD FORET DE SANG IN THE FOREST



**ENVIRONMENTAL  
DEFENDERS**

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## STUDY AREA

### MAMBASA

The landscape of the Mambasa sector is facing a major transformation of its land cover since two decades. It is undergoing a gradual decline in dense and secondary forests, triggered by (legal, illegal and unregulated) resource exploitation and their unsustainable use, some detrimental forms of agriculture, rapid urban growth in absence of long-term strategic planning, all linked by instability arising from land conflicts that chronically plague the region.

The sector being considered is at the latitude/longitude [676226.57, 95245.37 : 763251.47, 174895.64 EPSG:32635 WGS 84 / UTM zone 35N], and is located southeast of the Okapi Integral Forest Reserve. In particular, the territory south of the city of Mambasa and enclosed between the dense forest and the road to the city of Biakato is analyzed. This area is known for the presence of a high number of artisanal and small-scale mines, along with intense illegal logging operations that have resulted in isolated penetrations into the forest that are causing the fragmentation of the habitat. The expansion of agriculture linked to the increase in population (in particular along the road between Mambasa and Biakato) and the growth of new urban centralities, are pressing on the ecological system in particular along the road between Mambasa and Nia-Nia that crosses the Okapi forest. Models project a loss of secondary forest area of up to 13.65% by 2035 in Mambasa sector, but could be even worse considering changes in the composition of biodiversity and the effects of climate change.

Within the resource exploitation scenario in Mambasa, community rights and individual opportunistic interests increasingly clash since the politico-military-commercial elite seizes the benefits provided by the vacuum of the state and the richness of the rainforest. The composition of the population of Mambasa differs profoundly from other territories in Ituri province. Bantu constitute the majority (70 percent), next to a large group (around 30 percent) of Mbuti or pygmies. Furthermore, there is an influx of Nande from the Beni-Butembo area (North Kivu province). Pygmies are most vulnerable as they have not been able to secure their land rights. But other population groups are also affected as communities and individual customary chiefs are being played against each other.

Given the evidence presented, this sector is targeted for environmental conservation projects involving community-driven right-based processes. Beside that, the implementation of forest restoration projects in buffer zones around vulnerable resources and their sustainable management system to control development proves significant.

The restoration of degraded ecosystems is an essential activity to achieve environmental and ecological justice. The general approach is to implement actions aimed at conserving intact ecosystems as they provide ecosystem services that are not fully recoverable upon destruction and to restore degraded ecological and ecosystem systems because degradation is taking place faster than recovery. An ecosystem is defined as restored when following a self organized ecological trajectory (change over time in ecological characteristics) in line with the desired or reference ecosystem.

Implementing conservation and restoration projects by evaluating them only from a biological perspective is not enough, as they must ensure the inclusion of local communities through a rights-based approach. Environmental and ecological justice focus on the intersections between the systemic exploitation of humans and the natural world; this includes inequities in the access and use of natural resources and in the distribution of environmental harms (by race, class, gender, among many). Furthermore, land rights for women in Africa go beyond property rights and touch on often sensitive issues around different tenure systems (statutory, customary and religious), land-based wealth, power and social relations that give or take away their right to access and control resources. These kinds of projects fit neatly within the perspective of ecological politics through whose lens we question the viability of extractive and food production models, providing alternatives to the ecological, economic, and democratic crises plaguing the Albertine rift region.

Although this perspective is being implemented in a growing number of projects spread across all areas of the planet that face critical conservation issues, some local factors are still crucial in determining the success of these interventions. For this reason, assimilating the local perspective requires a dedicated suitability analysis for the area in which to prioritize and implement conservation and restoration projects (through passive and active methods).

This study focuses on two areas located in the Ituri province, in the portion of the Albertine rift located within the territory of the Democratic Republic of Congo, and flagged as territories strongly impacted by ecological injustice.

Environmental Defenders,  
March 2021

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Open Source Investigation

**FORÊT DE SANG**  
Identification of ecologically fragile areas prioritized for forest conservation and restoration in Mambasa and Mongbwalu sector, Ituri province, Democratic Republic of the Congo

WEBGIS: <http://watetezi.org/data/DRC/analysis.html>



**ITURI PROVINCE  
FOREST COVER LOSS  
2001-2019**

Kibali-Ituri  
<http://watetezi.org/data/DRC/analysis.html>

Open the webmap to navigate  
and select the information

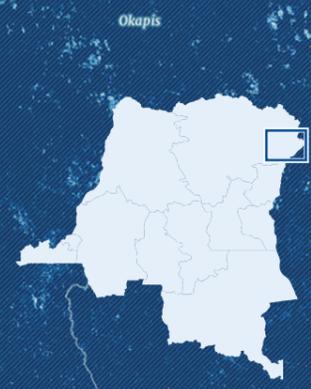


Figure 1.  
Mambasa sector

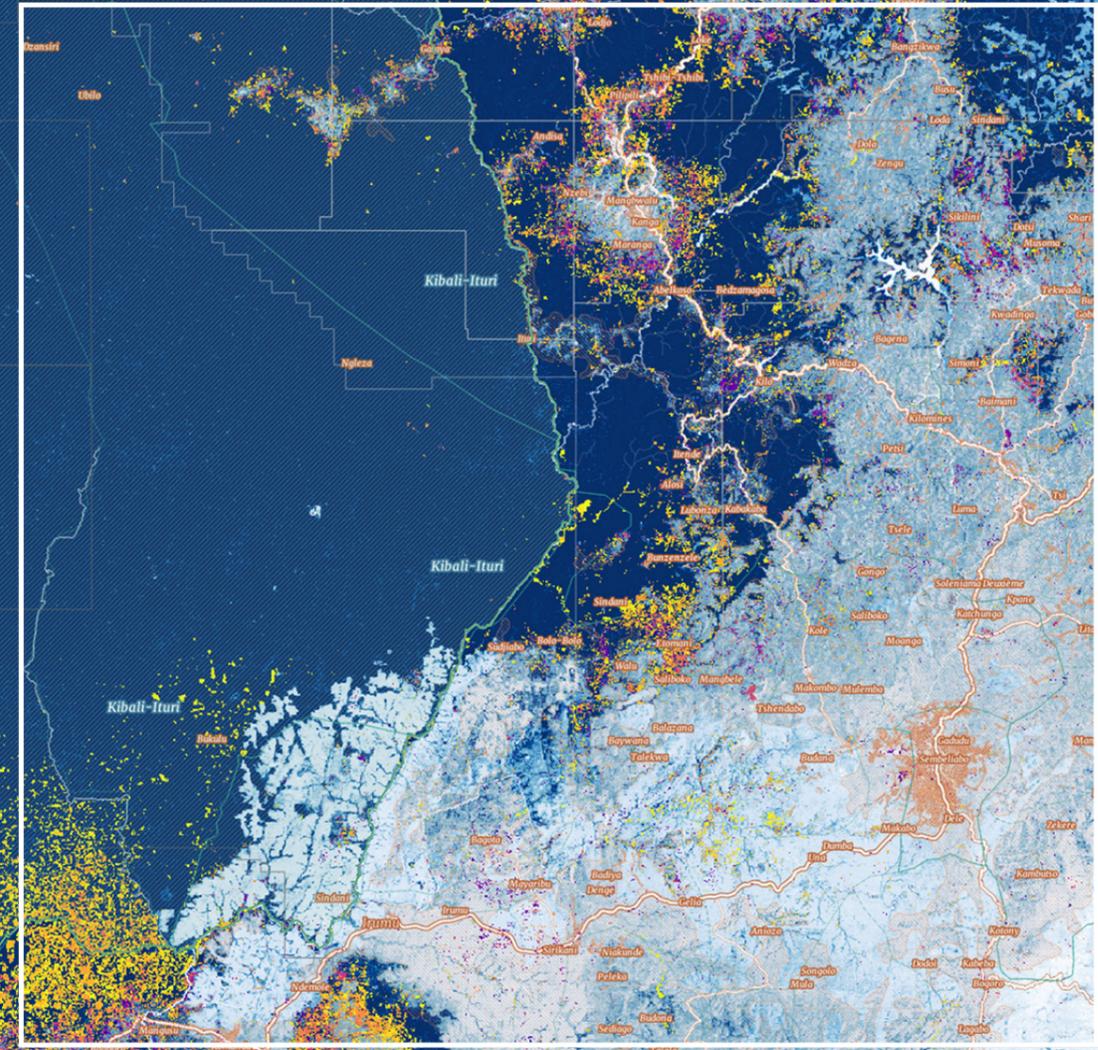
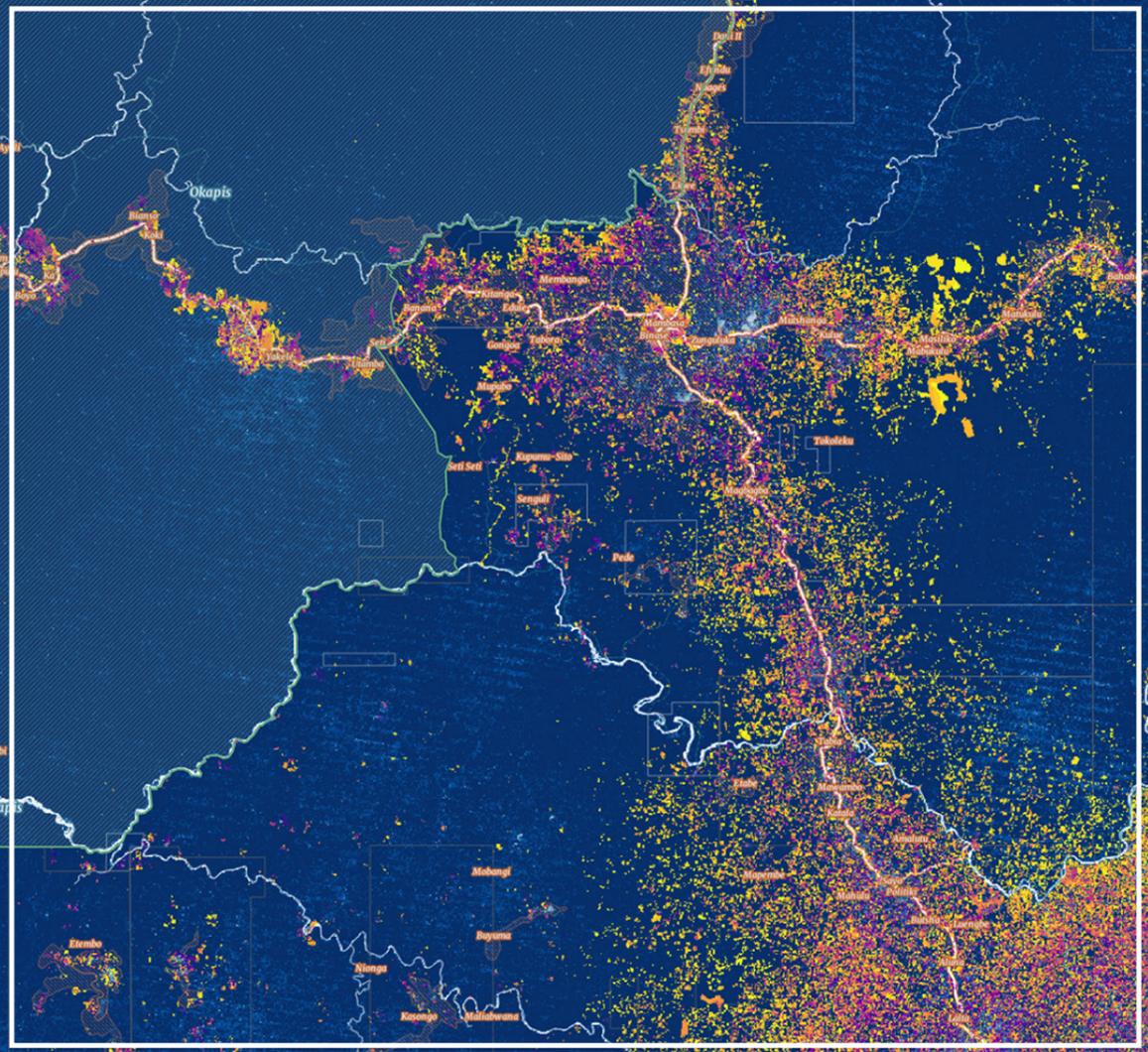
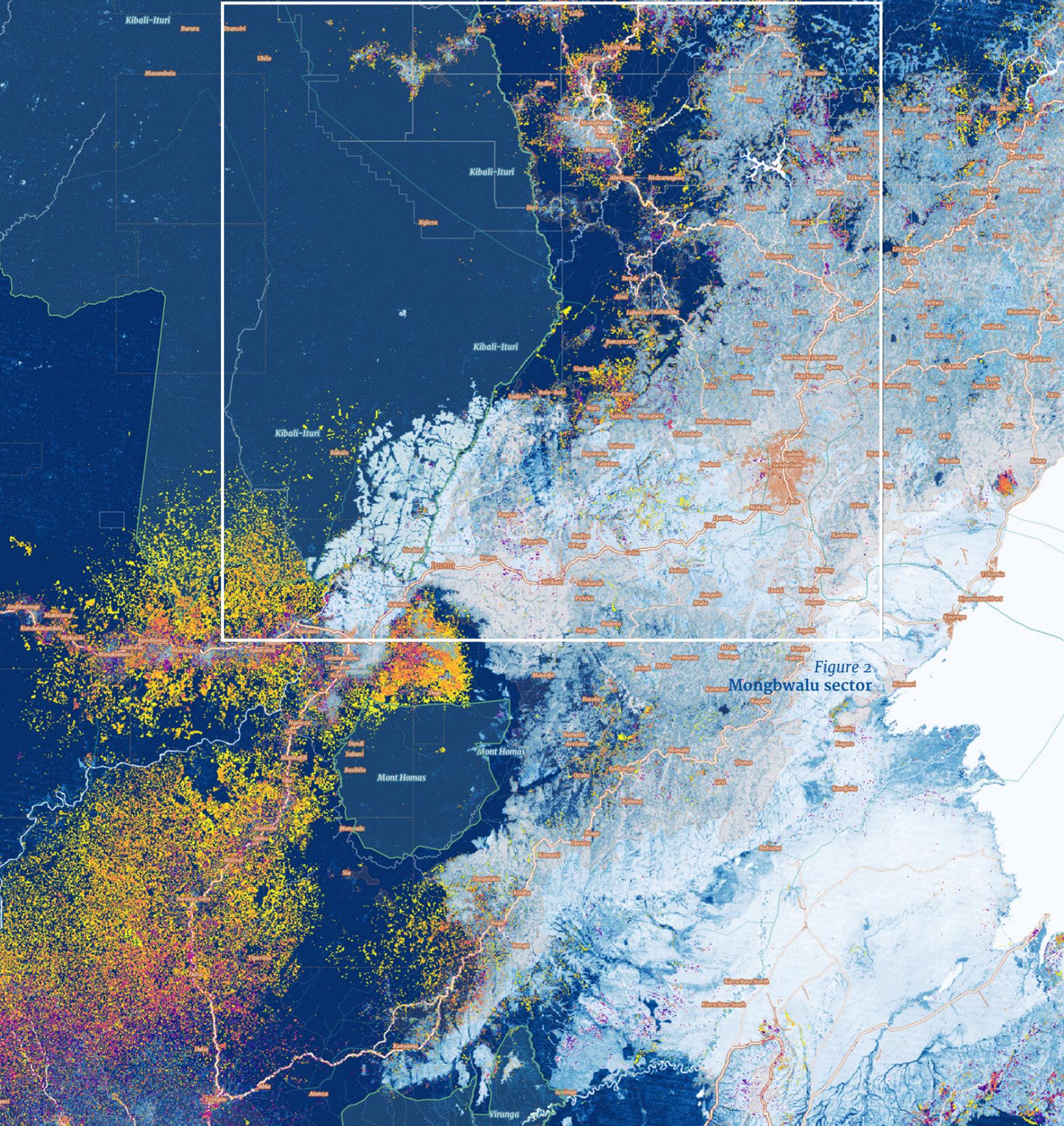


Figure 2  
Mongbwali sector



## MONGBWALU

The sector being considered is at the latitude/longitude [791384.82, 151118.60 : 873908.43, 230264.77 EPSG:32635 WGS 84 / UTM zone 35N], and is located between the city of Mongbwalu and Bunia, the capital city of Ituri province.

The small town of Mongbwalu is known for being an industrial-scale gold mining area, where international companies have been present since 1900 (gold was first discovered in the area by Australian prospectors in 1905 and has been mined ever since). Competition over control of these goldfields began during the 1998 Congolese war and is continuing to the present; despite the international community has not officially recognized a link between the exploitation of resources and the armed conflict in Democratic Republic of Congo, a long series of human rights violations have been recorded in the mining sites. In addition, the relationship between national and international companies controlling gold reserves with armed groups through exchanges of logistical and financial support in return for political benefits and security for the workers has been proven (e.g. the AngloGold Ashanti gold producer with the Nationalist and Integrationist Front - FNI armed group). Gold mining operation employs thousand workers and is one of the main providers of employment; people of different ethnicities have come to live in Mongbwalu to work in the gold mines or in related activities.

A century of exploration and exploitation of subsoil resources have seriously compromised the ecological balance of the sector. Therefore, considering the trend of land degradation drivers that have already been critical for years, this sector is targeted for environmental restoration projects, particularly in depleted mining sites and those that have been subject to exploration.

## METHODOLOGY

In the study, a GIS based Weighted Overlay Process is applied to identify areas affected by degradation (where to target conservation efforts and activating forest restoration projects); Weighted Overlay is a method of modeling suitability.

Recognition of the suitable areas to the proposal requires many different elements to be evaluated together in the decision making process, and Geographical Information Systems provide convenience for the interpretation of large-scale and complex data.

We call parameters the thematic classes employed to perform a weighted analysis among the elements considered (e.g. biodiversity and natural resources or drivers of conflict). Following that, specific criteria and sub-criteria are hierarchically identified for each of the parameters (e.g. biodiversity intactness index and species range-size are criteria subject to the biodiversity and natural resources parameter) and scored to a common suitability scale range (Fig. 3).

The parameters and criteria are identified as a result of the literature researches and studies made specifically for the study area. Weights for determined parameters and scores for criteria are obtained by a participation process involving Civil Society Organizations, community leaders, and with the help of experts. At this stage, complementary methods such as the Analytical Hierarchy Process (AHP) have not been adopted, given the lack of participation in the selection of criteria and parameters of stakeholders who should critically contribute to decision making processes.

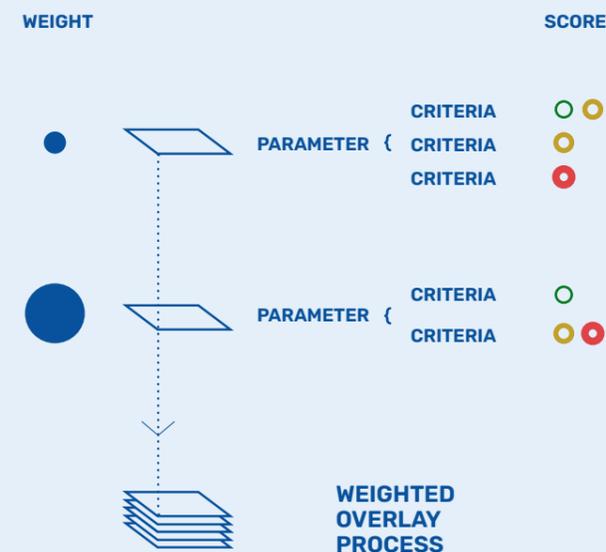


Figure 3  
Parameters and Criteria

## WEIGHTED OVERLAY ANALYSIS

### Selection of parameters and weights

Six parameters are identified: biodiversity and natural resources; carbon cycle; people; drivers of conflict - mining sector; drivers of conflict - others; alerts. To assign a relative degree of importance (weight) to every parameter based on a fundamental suitability scale, Environmental Defenders collaboratively defined these values through dialogue with the Civil Society Organizations operating in the Ituri province, the systematization of knowledge accumulated on the ground, and the review of the literature (Tab. 1).

### Parameter Maps

#### Parameter: BIODIVERSITY AND NATURAL RESOURCES

##### Criteria: Species Range-Size Rarity

The Species Range-Size Rarity is calculated as the rarity of species occupancy among areas. In this case, all threatened amphibians, birds and mammals included among IUCN Red List's categories CR (Critically Endangered), EN (Endangered), and VU (Vulnerable) are considered.

##### Criteria: Species Richness

The Species Richness represents the number of species potentially occurring in a spatial grid. In this case, all threatened amphibians, birds and mammals included among IUCN Red List's categories CR (Critically Endangered), EN (Endangered), and VU (Vulnerable) are considered.

##### Criteria: Biodiversity Intactness Index

The Biodiversity Intactness Index (BII) estimates how the average abundance of native terrestrial species in a region compares with their abundances before pronounced human impacts. A value around 50% indicates that the species originally present are on average only half as abundant compared with pristine conditions (pre-industrial climate period).

For the purpose of the analysis, is determined a range of BII values within which the impact is defined as critical considering the trend of land use/land cover change and dynamics in the territory over the last ten years.

##### Criteria: Waterway

Deforestation and associated water pollution threaten the waterways of Ituri Province. Water quality deterioration from heavy metal pollution is a major issue of concern nearby mining sites, particularly given the considerable environmental legacy of intensive industrial-scale mining and with different magnitudes given the artisanal and small-scale mining. Also, the extensive land cover and land use changes encountered in some case studies, have led to excessive rates of soil erosion within many catchments increasing the risk for sediment pollution.

For this reason, just for the scope of this analysis, all areas pertaining to waterways are considered as critical and designated as priorities for protection and conservation (a buffer zone has been defined).

#### Criteria: Protected Area

Protected areas are established in the state forest domain or in other sites of national, provincial or local interest and include: 1) Natural Integral Reserves; 2) National Parks; 3) Natural monuments; 4) Habitat or species management areas; 5) Biosphere Reserves; 6) Protected land or sea landscapes; 7) Zoological and Botanical Gardens; 8) Hunting Areas and Reserves; 9) any other category that special laws and regulations designate as such for the conservation of species of fauna and flora, soil, water, mountains or other natural habitats. These areas are managed mainly by Law No. 14/003 of 11 February 2014 on nature conservation.

The most representative protected area in the Ituri province is the Okapi Natural Integral Reserve, established in 1992, and listed also as a World Heritage Site (2006). Over the past years, the park has been suffering from increased poaching, deforestation, and illegal mining operations located particularly on the edge of the reserve designated border, but also rebel activity and immigration. For this reason, a 1 km buffer zone surrounding the designated protected area is also considered critical for conservation purposes and for the scope of this analysis.

#### Criteria: Gross Forest Cover Loss

Gross Forest Cover Loss is defined as the area of forest cover removed because of any disturbance, including both natural and human-induced causes. Gross forest cover loss is not the same as deforestation, but a loss legal or non-regulated: swidden and permanent agriculture, artisanal logging, industrial logging, carbonization and/or fuelwood, mining, and bushfires. And indirect causes influenced by population density increasing, biophysical factors (forest fragmentation and degradation), and institutional aspects (policy failure, lack or difficulties to implement projects due to governance system, pandemics, wars and conflicts). Because at this time we cannot perform a forest cover loss analysis to spatially identify the cause of deforestation, while also considering the availability of data and aware that the forest cover gain value is not taken into account, we include all areas that suffered from forest cover loss during the period 2001-2019 among those with restoration priorities.

#### Parameter: CARBON CYCLE

##### Criteria: Carbon dioxide emissions from tree cover loss

The carbon dioxide emission from tree cover loss reflects the emission to the atmosphere as a result of aboveground biomass loss. Emissions are gross estimates, meaning that information about the fate of land after clearing, and its associated carbon value, is not incorporated. All of the aboveground carbon is considered to be "committed" emissions to the atmosphere upon clearing. This value is associated with the annual forest cover loss data from 2001 through 2018 (from Hansen et al. 2013).

Disturbances to forest cover, resulting from natural and human-induced causes, have been found in the areas involved, that are prioritized for implementation of conservation projects through active and passive restoration methods.

**Criteria: Carbon accumulation potential for natural forest regrowth in reforestable areas**

The carbon accumulation potential, expressed in Mg carbon/ha/yr, represents the rate at which forests could capture carbon from the atmosphere and store it in aboveground live biomass over the first 30 years of natural forest regrowth. Those values are applicable to natural forest regrowth only, and do not apply to other active restoration methods (management techniques such as planting seeds or seedlings, agroforestry, etc.). For this reason they are taken into account for their priority of conservation as potentially significant in carbon removals by natural forest regrowth.

**Criteria: REDD+ project**

Aware of the great potential for REDD+ projects (Reducing Emissions from Deforestation and forest Degradation) in the country, DRC has forged ahead with both the planning and implementation stages of REDD+ preparedness. REDD+ has resulted in the ongoing implementation of investment projects to tackle direct and indirect drivers of deforestation and forest degradation in the DRC. These investments include sectoral projects with a national footprint, and integrated projects at province level. US\$15 million of investments were planned in Ituri province (Kabengele, 2017) and specifically in an area south of Mambasa town, up to the border with Nord Kivu province.

For the purposes of this research, areas that are not part of already active or planned REDD+ projects are considered as priorities to encourage implementation of conservation projects in degraded or threatened areas not otherwise targeted.

**Parameter: PEOPLE**

**Criteria: Indigenous**

The protection of tropical forests is essential in order to achieve the objectives set out in the Paris Agreements (2015). This protection cannot be achieved effectively and efficiently without ensuring the participation of those most affected: the people who live in and depend on these forests. The protection of forests requires a strong local anchorage, which implies the active participation of the forest communities in the definition and implementation of development policies.

60% of the population depends directly on natural resources and food agriculture for their survival, including millions of people living in or around forests; between 400,000 and 600,000 according to established estimates (2007) are indigenous Pygmies. As such, they are particularly vulnerable to the challenges of climate change and deforestation.

The Efé are semi nomadic people who hunt and gather forest resources in the Ituri province forest for their own consumption and for exchange with sedentary subsistence farmers. Efé represent the largest group in the region, and the lands they ancestrally occupy are considered a priority for conservation action to preserve their role as land stewards.

**Criteria: Displacement and Urban dynamics**

Since December 2017, violence in the Ituri province has left nearly 1,000 people dead and half a million

displaced. Breaking out in the territory of Djugu, small-scale attacks first pitted the two main communities in Ituri, the Hema and Lendu, against each other. Subsequently, Lendu militias targeted the Hema, and then the national army, before attacking nearby territories. External actors, including from North Kivu province and bordering countries, are also involved.

In December 2019, the UN Office for the Coordination of Humanitarian Affairs (OCHA) estimated that 360,000 individuals had been displaced due to the latest crisis in Ituri. It acknowledged that the movement of displaced persons was continuing, and that only a portion of them (227,000) were housed in the 72 sites maintained by the UN High Commissioner for Refugees (UNHCR). Displaced people live in overcrowded makeshift camps, in dreadful conditions, and many have to travel in search of food. Continued militia attacks prevent most aid workers from reaching them and helping them protect themselves against COVID-19 pandemics and ebola outbreaks.

In addition, it should be noted that the lack of legal provisions to protect collective customary land rights encourages land seizure and eviction of groups of people without compensation and displaced in the camps.

These conflicts are creating new urban centralities that are the result of these forced migratory movements. The speed of transformation of these urban bodies is accentuated, producing a transformation of the landscape and generating clutches with the management of land resources. For this reason it is critical to plan the sustainable development of the recent urban expansion by designing an urban buffer zone that is included in this analysis as a critical area where to perform sustainability assessments.

**Parameter: DRIVERS OF CONFLICT – MINING SECTOR**

**Criteria: Exploitation and Exploration permit**

Underground minerals belong exclusively to the state. However, any private party may be authorised by the state to engage in mining activities (from exploration to exploitation and distribution), provided that specific objectives of eligibility, priority and capacity criteria set forth in the Mining Code (adopted by the Congolese Parliament on 27 January 2018) are met.

The country's subsoil is rich in minerals which are traded internationally (mining sector accounted for more than 80% of export revenues in 2015); mining is not new to the DRC but it is expanding, and exploration and exploitation permits now cover more than 39% of the country. Mining is often carried out illegally, with companies and the authorities equally failing to respect provisions of the 2018 Mining Code, including the right of mining-affected communities to compensation, and the Forest Code.

The types of mining permits available in the DRC are research/exploration permits, exploitation permits (including small-scale mines) and tailing exploitation permits. An exploration permit may be granted to any eligible private company for a period of five years, renewable once for the same duration, with respect to all mineral substances; before starting any research activity the company will have to submit a rehabilitation and mitigation plan. Should the holder of an exploration permit demonstrate through a feasibility study the existence of an economically workable ore deposit and sufficient financial capacity for the development, construction and exploitation of a mine, the Minister of Mines may grant an exploitation permit for a duration of 25 years,

renewable for successive periods of 15 years. Given the limited effectiveness and feasibility of environmental management plans for areas subject to exploration and exploitation permits, those within the limits established by the Ministry of Mines are included as areas of first interest for this study.

**Criteria: Artisanal and small-scale mine**

Artisanal small-scale mining and associated infrastructure, such as construction of access roads, energy infrastructure and work camps, and inflows of mineworkers, play a great role in forest degradation. Roads fragment the forest and enable encroachment. Pressures on land use, including demand for arable land to feed mineworkers, intensifies competition for land and for areas of high conservation value forests. Ore processing contaminates water and damages other natural resources.

The development of artisanal and small-scale mining poses problems in terms of the authorities' capacity to monitor. For example, one of the biggest sources of conflict associated with mining exploitation is the uneven and opaque distribution of revenues from exploitation, and the collection of customs fees. The situation is not as critical as a few years ago (in particular from 1999 to 2003) when the management of customs and gold, wood and coffee operations had in practice fallen under the control of armed groups; although an increase in tensions would allow armed groups to take advantage of the weakness of the state to be central to trafficking operations (as revealed by field surveys carried out by IPIS in the surrounding of Mambasa observing the interference or presence of FARDC militias in the mine sites). Three representatives of local authorities described illegal taxation and ownership of gold mines by members of the 1301st Regiment of FARDC at Mongbwalu. The same sources estimated that between 15,000 and 20,000 artisanal gold diggers worked at Mongbwalu's sites during 2020.

Considering the characteristics of these extractive sites, which yield an isolated forest penetration effect on biodiversity along with their ability to generate conflict, extraction areas with processing points and auxiliary areas and their buffer zones of up to 1 km are targeted by this analysis.

**Parameter: DRIVERS OF CONFLICT – OTHERS**

**Criteria: Artisanal logging sector and logging concession**

The artisanal logging sector is characterized by a lack of clear regulations in a scenario of corruption by political and military elite; artisanal logging is described as lucrative but is largely informal and illegal. At the same time, the overall national framework for land allocation and forest concession zoning in the DRC is still driving deforestation and failing to protect customary land and livelihood rights. Mambasa territory is experiencing an influx of artisanal loggers from neighbouring North Kivu province and bordering countries such as Uganda and Kenya. Compared with neighboring countries, artisanal operators in eastern DRC harvest timber in dense forests; the main implication is that smallholder farmers often clear these areas once artisanal loggers have removed the largest trees.

The Forest Code issued by ministerial decree in 2002, provides that forests are state property and designates three categories of forest: classified forests, which form part of the public state domain and whose function broadly relates to environmental protection,

with highly restricted usage rights; protected forests, where local people have the right to use forest products to meet their needs in accordance with local custom; and permanent production forests, designated for exploitation through the granting of concession contracts. Artisanal permits are intended for Congolese citizens for small-scale domestic logging but are increasingly misused by local and foreign companies for logging on an industrial scale, circumventing the 2002 moratorium on new commercial concessions and enabling operators to avoid monitoring and taxes. In addition, due to a structural gap in data collection, it is hard to understand the extent of active logging concessions; therefore, for the purposes of the analysis, only industrial logging concessions are considered as the most susceptible regarding forest restoration and priority for conservation.

**Criteria: Swidden and Commercial Agriculture**

Rules governing access to land for agricultural purposes vary according to region and community. Despite formal legislation, access to agricultural land is generally regulated by custom. Traditional authorities such as village chiefs usually allocate land by family descent within the village. Non-descendants may rent land for food production and for fuelwood; when such cultivation ceases, the fields have to be returned to the landowner or chief. Around urban centres, producers from outside a village may rent land to farm commercially in response to demand from urban dwellers. Land may also be purchased.

Several published studies have identified swidden agriculture as one of the greatest drivers of land degradation, but in fact it is difficult to distinguish between permanent deforestation and temporary clearance for customary land use practices that allow the forest to regenerate. Agricultural production is almost entirely informal, with 90 percent of the sector driven by informal, small-scale activities.

With no detailed analysis of the different forms of agriculture, and considering the potential of some of these areas as suitable for reducing degradation through active forms of restoration such as agroecology, all areas identified as agricultural are considered as priorities for the purposes of this analysis.

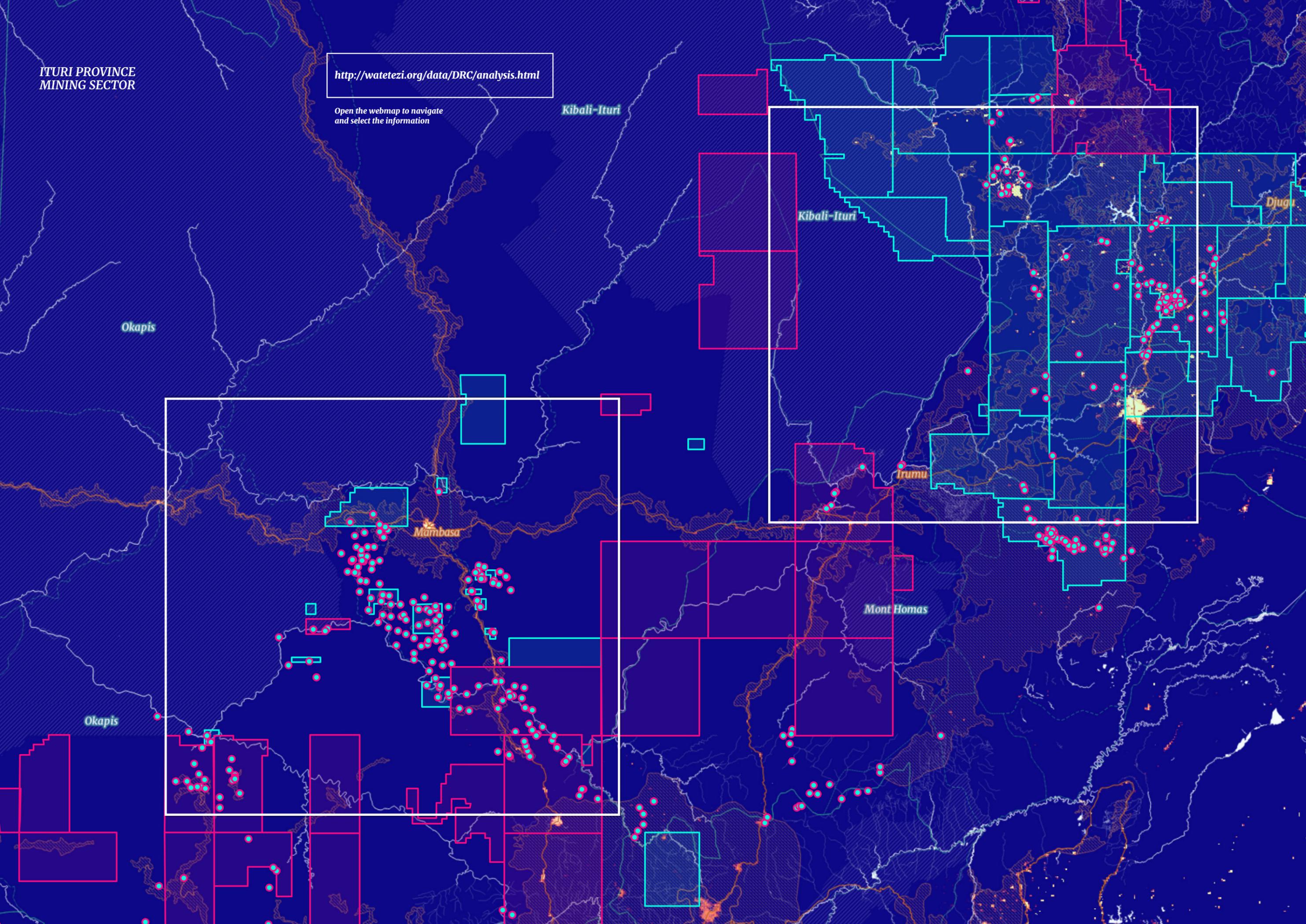
**Criteria: Oil concession**

The oil exploration area at Lake Albert is divided into five blocks, two of which are in the Ituri province (Blocks I and II). Block III straddles the southernmost of the Ituri province and the northern part of the province of North Kivu. Explorations began in 1987 and until now have taken place discontinuously and with different impact in different blocks. There is no recent and certain information regarding the locations where exploration has already taken place, the presence of oil reserves and potentially the amount of oil that can be extracted. Evaluating the dynamics taking place in the areas subject to oil concessions on the other side of Lake Albert, in Uganda (Hoima district), where oil exploration and extraction has produced a high impact on the environment and negative repercussions on the respect of human rights, and considering that the DRC's oil sector is not legally obliged to share its revenue and contribute to local development, all the areas that fall within the perimeter of active concessions fall between those we are analyzing.

ITURI PROVINCE  
MINING SECTOR

<http://watetezi.org/data/DRC/analysis.html>

Open the webmap to navigate  
and select the information



Kibali-Ituri

Kibali-Ituri

Djugu

Okapis

Mambasa

Inumu

Mont Homas

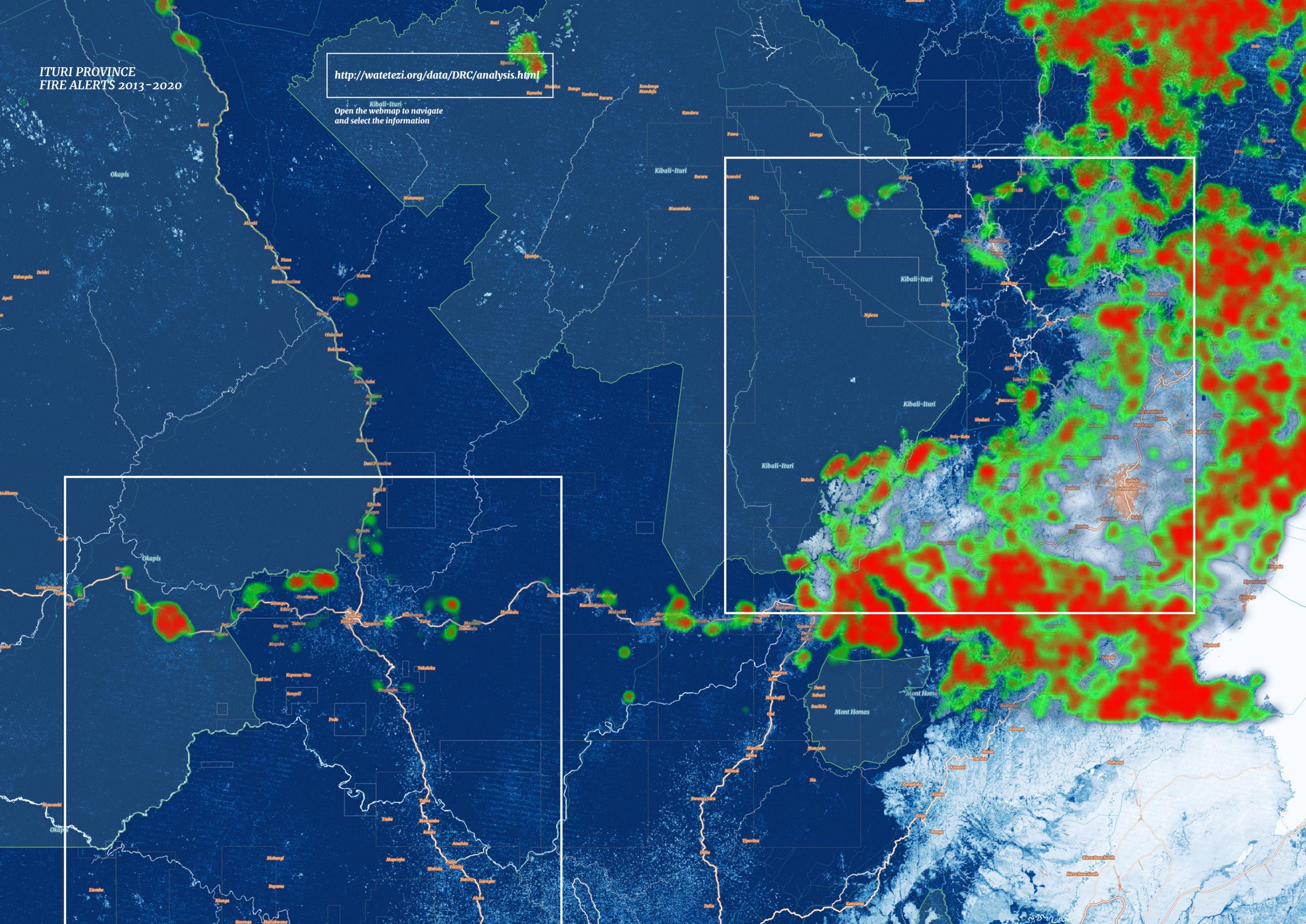
Okapis



ITURI PROVINCE  
FIRE ALERTS 2013-2020

<http://watetezi.org/data/DRC/analysis.html>

Kibali-Ituri  
Open the webmap to navigate  
and select the information



Parameter	Average Weight	Criteria	Subcriteria	Average Score
Biodiversity and natural resources	0.3	Species Range-Size Rarity	> 0.0005	2
			Species Richness	5-10
		10-25		2
		0.5-0.6		1
		Biodiversity Intactness Index	0.6-0.75	2
			0.75-1	3
		Waterway	Waterway buffer zone 0-250 m	3
			Waterway buffer zone 250-500 m	2
			Waterway buffer zone 500 - 1000 m	1
		Protected Area	Protected Area buffer zone 0-250 m	3
Protected Area buffer zone 250-500 m	2			
Protected Area buffer zone 500 - 1000 m	1			
Gross Forest Cover Loss	Cover loss area	3		
Carbon Cycle	0.05	Carbon dioxide emissions from tree cover loss	10-25 Mg CO <sub>2</sub> / pixel	1
			25-50 Mg CO <sub>2</sub> / pixel	2
			50-100 Mg CO <sub>2</sub> / pixel	3
		Carbon accumulation potential for natural forest regrowth in reforestable areas	1-2 Mg carbon / ha / yr	1
			2-5 Mg carbon / ha / yr	2
REDD+	Area Not included in REDD+ programs	3		
People	0.2	Indigenous	Presence of Indigenous people	3
		Displacement and Urban dynamics	Inhabited area buffer zone 0-500 m	2
			Inhabited area buffer zone 500-2000 m	3
Conflict - Mining sector	0.25	Artisanal logging sector and logging concession	Mining site buffer zone 0-250 m	3
			Mining site buffer zone 250-500 m	2
			Mining site buffer zone 500-1000 m	1
		Exploitation and Exploration permit	Area within exploitation and exploration permit	3
Conflict - Other	0.15	Artisanal logging sector and logging concession	Area within industrial logging concession	2
			Swidden and Commercial Agriculture	Agricultural area buffer zone 0-500 m
		Oil concession	Area within oil concession	2
Alerts	0.05	Deforestation Alerts	Deforestation Alert Area "Confirmed"	3
		Fire Alerts	Fire Alert Area	2

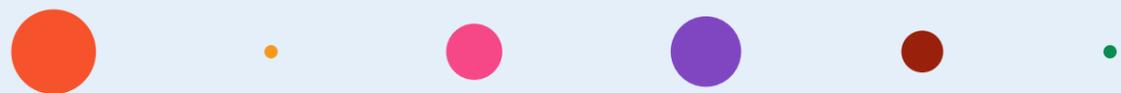


Table 1  
Weights and Scores for Used Parameters

**Parameter: ALERTS**

**Criteria: Deforestation Alerts**

The GLAD alert system devised by the University of Maryland's Global Analysis and Discovery (GLAD) lab uses satellite imagery to collect weekly data on deforestation across the tropics. Each GLAD alert indicates a 30 by 30 meter area that has experienced a disturbance in the forest canopy, which indicates that trees in that area may have been lost or removed. The primary purpose of the GLAD alert system is to alert people to potential deforestation, but GLAD alerts also pick up additional disturbances such as rotation cycles in plantations, forest degradation from fires and storms, and natural changes like landslides and windthrows.

All areas where alerts were found in 2020 classified by GLAD lab as "confirmed" are included in these analyses.

**Criteria: Fire Alerts**

Fire alerts and thermal anomalies detected by the Visible Infrared Imaging Radiometer Suite (VIIRS), provides improved information of fire perimeters. These events (analyzed for the time frame 2013-2020) have multiple causes and they may not all have a correlation with deforestation. For instance are worth mentioning, the cultural norms in the agricultural tradition known as slash and burn (every year at the end of the dry season, farmers set fire to the bush and use the ashes as fertilizer), and on a greater scale the massive use of fire in swidden agriculture; but agricultural burning tends to lick at the edges of the dense, moist rainforests without making much of an impact. In addition, given the absence of electricity and other energy sources, open fires are widely used for cooking. As a result, increased fire density correlated with growing human density is damaging biomass with major impacts on soil fertility.

For this reason, and given the difficulty of classifying alarms according to their cause, all areas with a high fire alert density are flagged as priority for protection and conversation.

**Standardization**

Initially, all the criteria have diverse and dissimilar units. Standardization converts the measurement to uniform units for further processing in Weighted Overlay Analysis (WOA). The parameters lose their dimensions and the subcriteria are brought to a common suitability scale ranging from 1 to 3 in order to eliminate their inherent vagueness (Tab. 1).

**RESULTS AND INTERPRETATION**

The outcome of the analysis can be visualized in maps that determine the degree of sensitivity for threatened and degraded areas where to prioritize and implement conservation or active/passive restoration projects.

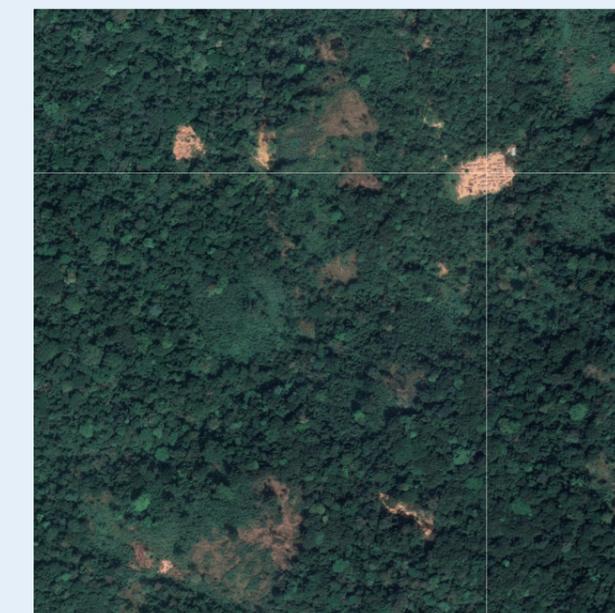
**MAMBASA**

The areas that emerged in the analysis (Fig.3) as critically threatened or degraded are those around the banks of the Ituri and Epulu rivers (in the area bordering the south of the Okapi Reserve boundary near the location of Etembo at the confluence with the Ibina River; near the locality of Teturi, on the Makeke-Mambasa axis at the intersection between the RN44 road and the river Ituri; on the Apodo-Mambasa axis at the intersection between the RP430 road and the river Epulu) and those within the Okapi reserve along the Route Nationale 4 (particularly near the localities of Bandisende, Yakele, Eboyo, Epulu).

The following case studies are reported for recognition and characterization:

Figure 4  
Isolated penetrations into the forest  
Coordinates 719301.9, 135390.0  
(EPSG:32635 WGS 84 / UTM zone 35N)

Land degradation causes: mining, logging



This site is found near the Ituri River, within dense forest. The presence of an artisanal mining site known as Apamakele is noted, and there is evidence of recent deforestation (2020) near the site. A network of logging roads was built to reach the sites at these coordinates and the many neighboring sites, up to the river banks of the Ituri River; the same river is probably used to carry people and materials to the trading centers.

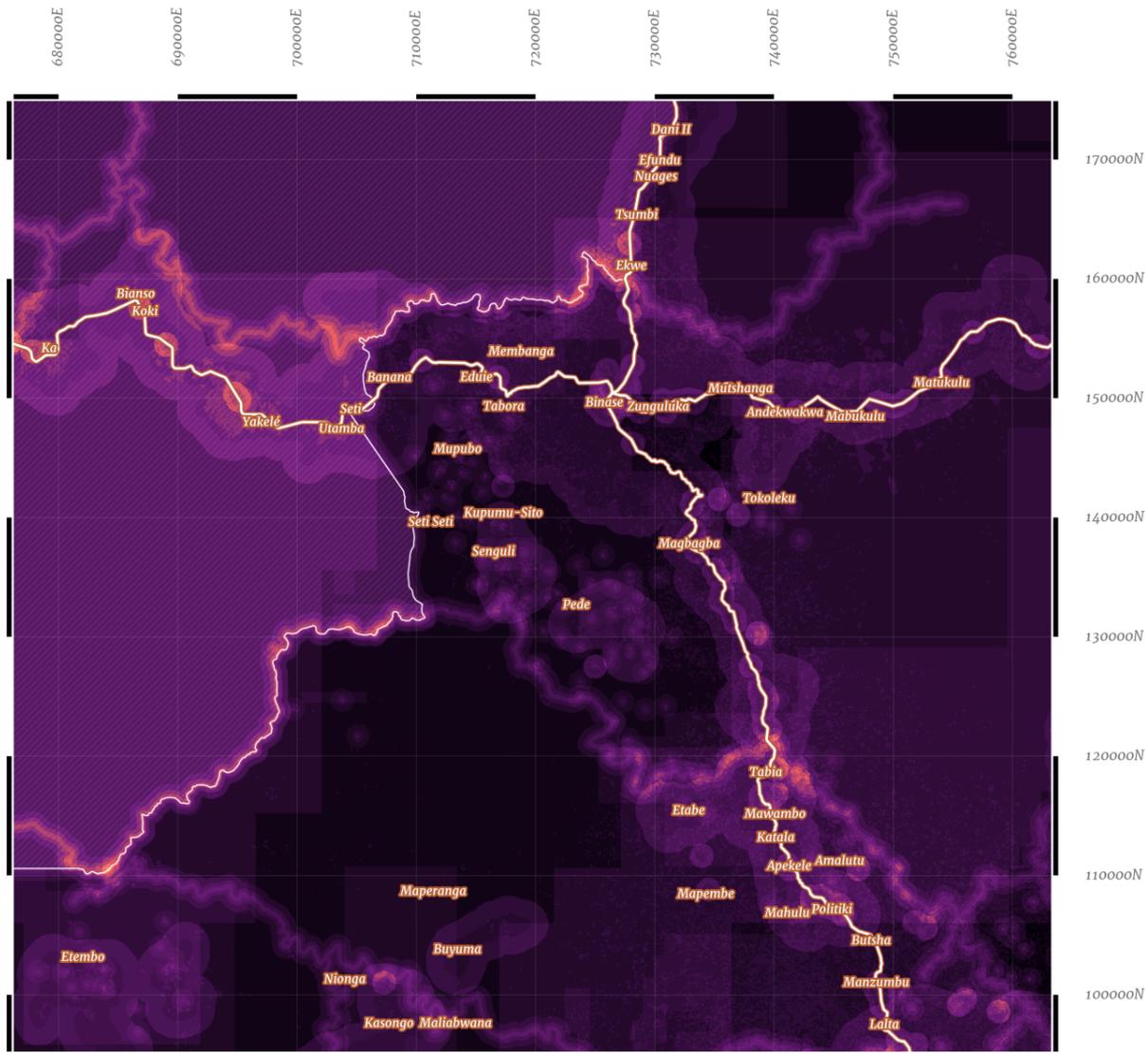
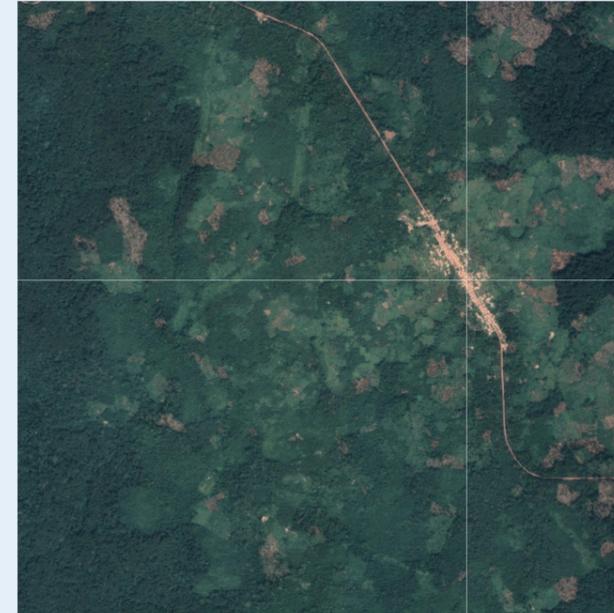


Figure 3  
Suitability map for Mambasa sector / conservation and restoration  
(EPSG:32635 WGS 84 / UTM zone 35N)

Figure 5  
Village along main road  
Coordinate 740485.0, 124807.9  
(EPSG:32635 WGS 84 / UTM zone 35N)

Land degradation causes: mining, logging



The urban area of Mayuwano, on the Makeke-Mambasa road axis, saw its growth to depend on the exploitation of the adjacent mine known as Cinquantenaire (SOMIBAF) and overtime became a trading center for minerals mined in the region. Many of those who live in the area depend on the mineral trade enough to force farmers to turn into miners, attracted by the chance of a better income.

Figure 6  
Village in the Okapi reserve  
Coordinate 695244.0, 149560.0  
(EPSG:32635 WGS 84 / UTM zone 35N)

Land degradation causes: logging, swidden agriculture



The village of Bandisende is located along Route Nationale 4 within the Okapi reserve. The forest within this area is dominated by Gilbertiodendron dewevrei and Musanga cecropioides and is undergoing a progressive exploitation of timber by subsistence farmers, although the presence of swidden agriculture is increasing; timber sales from illegal logging are also reported to be increasing.

MONGBWALU

The areas that emerged in the analysis as critically threatened or degraded are those surrounded by and within the industrial mining sites of Mongbwalu City and Sayo, up to the banks of the Ituri River and still along this waterway in the south up to the administrative border with the Mambasa territories. The high amount of area degraded due to industrial-scale gold mining is astonishing, and considering that a large part of the nearly depleted mineral deposits have not been subjected to any restoration project. The economy of Mongbwalu is centered on gold

mining and trade. In the last century, mining in the Mongbwalu area is estimated to have produced 46,000 kg of gold; two types of gold are present in the area that also characterize the occurrence of different kinds of land degradation: l'or sec is found in flecks and small nuggets in unconsolidated mineral deposits in riverbeds or topsoil and it is obtained through open pit mining and alluvial mining, and Amalgame gold that is extracted from rocks that are obtained through underground mining and open pit mining.

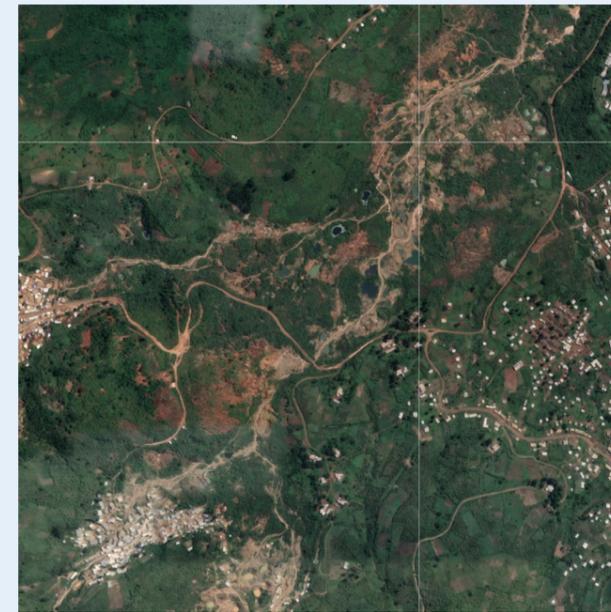
## CONCLUSION

The analysis reveals that in the Mambasa and Mongbwalu sectors there are lands degraded mostly by the presence of a network of mining and related operations, which together with (illegal) logging represent a threat to the conservation of areas of high ecological interest. Policy failure, lack or difficulties to implement projects due to governance systems, the challenge of directly involving the local population, pandemics, and conflicts are among the barriers in developing conservation and restoration projects.

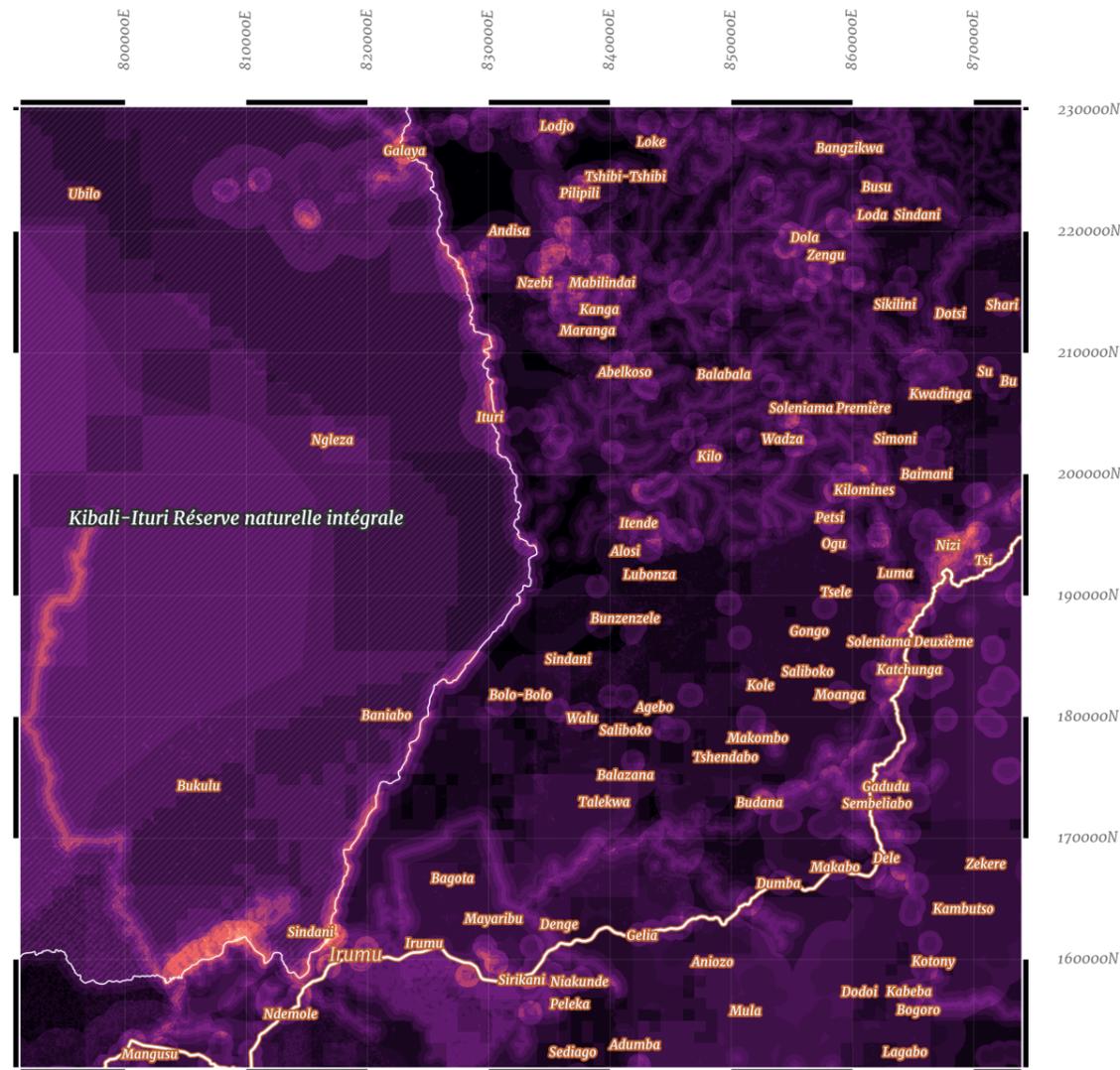
The following case study is reported for recognition and characterization:

**Figure 8**  
**Industrial mining in urban area**  
 Coordinate 837652.9, 214661.5  
 (EPSG:32635 WGS 84 / UTM zone 35N)

**Land degradation causes: artisanal and small-scale mining, industrial-scale mining**



This depleted mine site is located north of Mongbwalu town, on the road that connects the town to the locality of Sayo Kati. Directly at the northern edge of this site a new high impact industrial mining area is being developed under the formal name of *Mongbwalu Gold Project*. The original morphology of the territory is totally compromised and due to the complex network of mining sites each ecological value is considered critical.



**Figure 7**  
**Suitability map for Mongbwalu sector / conservation and restoration**  
 (EPSG:32635 WGS 84 / UTM zone 35N)

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Mining Exploitation Permit	Cadastre Minier – CAMI
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**Environmental Defenders (ED)** is an eco-feminist Environmental and Human Rights Defenders (EHRDs) organization that provide capacity-building support to Human Rights and environmental defenders in Albertine Region.

**ED** was established in 2017 amidst severe threats to the environment and restrictions on the work of land and environmental defenders in Uganda, specifically in the Albertine Region, West Nile and Northern Uganda, concerned for the protection of the environment and wellbeing of indigenous and rural communities who are vulnerable to poorly conceived and executed resource development projects.

**ED** actions are driven by the idea of protecting the environment through the conservation of forest ecology and the use of nature-based solutions as a strategy of defense against climate change. Promoting equitable governance, effective management and positive conservation outcomes. We believe that accepted environmental and human rights principles embody the right of everyone to a secure, healthy and ecologically sound environment, and that environmental degradation leads to human rights violations such as the right to life, health and culture.



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