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LIMITED ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED PROJECT

HERITAGE PROECTION AND PROMOTION OF SOMALILAND HERITAGE

LAAS GEEL ROCK ART SITE

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LIST OF ABBREVIATIONS

EF	Expertise France
IUCN	International Union for the Conservation of Nature
MoECC	Ministry of Environment & Climate Change
MoTT	Ministry of Trade and Tourism
SECL	Sustain Enviro-consulting Ltd.
ADF	Agence Française de Développement

1.0. STUDY BACKGROUND

SECL, Sustain Enviro Consulting Ltd, has been approached by Expertise France to undertake a 'Limited Environmental Assessment of the Protecting and Promoting Somaliland's Heritage and Preserving the Laas Geel Site' in line with its Environmental and Social (E&S) risk management policy. This report presents the result of the assessment.

Project description, study scope, objectives, and activities

The project "Protecting and Promoting Somaliland's Heritage and Preserving the Laas Geel Site," funded by the Agence Française de Développement (AFD) and implemented by Expertise France in partnership with Somaliland authorities, seeks to ensure the long-term preservation of Somaliland's cultural heritage. This project will have a duration of 30 months and will be implemented by a dedicated project team in collaboration, particularly with the Somaliland Ministry of Trade and Tourism (MOTT) and other project stakeholders including Somaliland Ministry of Information, Culture and Communication, University of Hargeisa, National Museum and the local communities and partners.

The project aims to protect the Laas Geel site and other heritage sites through managing degradation factors by rehabilitating and extending fences, managing rock fall risks, improving access (stairs, ramps), landscaping, and trail marking.

The project also aims to promote local economic development and contribute to Somaliland authorities' efforts to develop tourism around the region's natural capital and its archaeological heritage and is in line with the priorities of Franco Somaliland cooperation, largely focused on cultural cooperation.

The project consists of two main components: a) enhancement of the technical capacity of the government institutions and local institutions in the protection of Somaliland's heritage, and b) protection and enhancement of Laas Geel Site.

Proposed activities with potential environmental impacts

Following are the activities requiring consideration of need for initiation of Environmental Impact Assessment (EIA). These activities are extracted from the recommendations of the comprehensive Preliminary Assessment Report, carried out on Laas Geel rock art site (Bruxelles & Gutherz, 2023).

1. Complete fencing of the site to serve as a barrier to protect the rock art from damage, disturbance, and unauthorized access.
2. Site cleaning campaigns to remove litter, debris, and invasive plant species that proliferate and displace native plant species leading to threatening local ecosystems.
3. Installation of solar lighting aimed at deterring baboons and other wildlife that may pose a risk and damage to the site, solar-powered lighting will be installed around key areas of the heritage site.
4. Creation of access footpaths to shelters for use by visitors and site staff. These footpaths will be designed to minimize environmental disruption.
5. Establishment of a parking area to accommodate the parking needs of visitors.

6. Equipping management offices, guard rooms, and restrooms. The management office will be equipped with necessary resources, including communication tools, educational materials, and first-aid supplies, to effectively oversee site operations. Guard rooms will be furnished to ensure the safety of both staff and visitors, while restrooms will be constructed to provide essential facilities, enhancing visitor comfort and sanitation.

7. Installation of new explanatory panels and wall banners. To enhance visitor education and engagement, new explanatory panels and wall banners will be installed throughout the site. These will feature detailed information about the history, significance, and conservation efforts related to Laas Geel and other heritage sites.

8. Landscaping and rearranging of visitor circuit and paths. The visitor circuit and paths will be reconfigured to optimize the flow of foot traffic, enhance safety, and protect sensitive features of the site and enhance experience. This rearrangement will include the creation of clearly marked trails with proper signage to guide visitors.

9. Removal of animals: This would involve the careful relocation or removal of animals, such as birds, that may damage or degrade the caves and paintings. Additionally, vegetation growth will be managed to prevent moisture build up and soil erosion and any other factors which can harm both the paintings and the cave itself.

1.1. Approach and Methods

Assessment of Laas Geel site was conducted through a combination of field-based and desktop methods. These two components are described below.

1.1.1. Field Survey

Field-sampling was conducted between 26 March – 1st April 2025. Since the study area appeared to be relatively small (circa 11 ha.) and homogeneous, five sampling plots (four on each side – north, south, east, and west) – and one on top of Laas Geel massif to ensure a reasonable spread of plots. An equal number of sampling plots were then randomly selected within each zone. In addition to searching for species within each sampling plot, new species encountered while moving between sampling plots were also recorded. The study area was visited at different times of the day from morning to late afternoon. Night sampling was also conducted to document nocturnal animals.

On-site identification of the most common plant species was conducted. For species requiring further identification, specimens were taken using a plant press for later identification. For mammals, active searching and observation was the principal approach used. In addition to direct sightings of individuals in the field, signs such as spoor, scats, holes/ moles and auditory cues were used to ascertain the presence of mammal species in the area. Birds were detected using a combination of visual sightings and auditory cues. For herpetofauna, active searching was again the primary method of data collection particularly in winter when species are less active. Open areas and the surroundings of low bushes and trees were searched for the presence of diurnal lizards and snakes, while larger trees were checked for arboreal species. Additionally, stones and other objects placed on the ground were flipped over.

1.1.2. Desktop survey and literature review

Direct observation of species in the field was supplemented by a desktop review to list species which could be present in the area but were not recorded during fieldwork. The distribution and

habitat requirements of species were considered in adjudicating their likelihood of occurrence in the Laas Geel. In general, the paucity of recent literature and biodiversity monitoring data in Somaliland presented a challenge to this assessment. For example, old sources such as Drake-Brochman's 'The Mammals of Somaliland' (1910), Funaioli's 'Fauna e Caccia in Somalia' (1957) and the works of Funaioli & Simonetta (1966) remain some of the most popular contributions on mammals of the region. Recent information on the mammalian species is fragmentary, and little research has been carried out in recent decades. This assessment benefited from some more recent work in the form of an unpublished article, 'A Checklist of Terrestrial Mammals of Somaliland' (2020) (Mazuch et. al), and 'The Amphibians and Reptiles of Somaliland and Eastern Ethiopia' (2013). A vegetation survey carried out by the Somaliland Biodiversity Foundation (SBF) in 2021 was also consulted.

A wide range of sources were used to assess which reptile species could occur in the Laas Geel, including past surveys conducted in similar environments (Mazuch unpublished, from 2010 to 2021), various books and journal articles (Arillo & al., 1968, Boulenger 1896, 1921, Lanza 1981, 1983, 1990, Lanza & Carfi 1968, Lanza & Nistri 2005, Lanza & Sassi 1966, Lagen & Rasmussen 1993, Laurent 1962, Loveridge 1940, 1947, Mazuch 2013, Parker 1932, 1942, 1949, Schätti 1988, 2006) and various museum collections (e.g. British Museum of Natural History (BMNH or NHMUK), California Academy of Sciences (CAS), Museum of Comparative Zoology, Harvard (MCZ), and Museum of Vertebrate Zoology, Berkeley (MVZ). For birds, the primary sources of information were the distribution maps and habitat descriptions provided in the latest field guide to birds of the Horn of Africa (Redman, Stevenson & Fanshawe, 2009) and the atlas of the birds of Somalia (Ash & Miskell, 1998). Although relatively old, the latter is particularly useful as it provides maps showing where bird species have been recorded at half degree scale. More recent sources of information included birding trip reports, publications (e.g. Mills & Cohen, 2015) and the use of citizen science websites where photographs of birds are uploaded and mapped (<https://ebird.org> and <https://www.inaturalist.org/>).

1.2. Assumptions and Limitations

The timing of sampling in the late winter (*Jilaal*) was one significant limitation when most of the plants were stressed, bare of leaves, fruits, and inflorescences. This made identification of plants more challenging in some cases. Herpetofauna species are also less active to prevent the loss of excessive water.

2.0. LEGAL AND REGULATORY FRAMEWORK

This EIA was conducted in compliance with the laws and regulations of the Republic of Somaliland, and EF's Environmental and Social (E&S) risk management policy. It also draws upon several international and regional conventions and protocols, including the International Finance Corporation (IFC) performance standards on Environmental and Social Sustainability

The purpose of these conventions and protocols and their applicability to this project are summarised in **Tables 2 below**.

National context

The key legal instrument for environment management in Somaliland is the **Constitution**. Article 18: The Environment and the Relief of Disaster requires that the state gives a special priority to the protection and safeguarding of the environment, considered essential for the well-being of the society, and to the care of the natural resources. The care of and (the combating of) damage to the environment must therefore be determined by law.

A **National Policy** on Environment was published in 2011. The overall vision of this policy is to provide a framework management guide for the management of Somaliland's environment and natural resources to ensure that they are managed on a sustainable basis and retain their integrity to support the needs of the current and future generations. Preparation of an EIA is thus a requirement of the Somaliland National Environment Policy.

The **Environmental Management Act** (*Xeerka Maareynta Deeganka*) **No. 79/2018** was promulgated in the Republic of Somaliland with effect from 1 September 2018. This document is available in Somali and English.

The **Somaliland Heritage Act**, which is in its draft form, is intended to '*ensure the protection, management, preservation and promotion of Somaliland cultural heritage as well as to determine the responsibilities of the State, in particular the Somaliland Heritage Agency established for this purpose.*'

The objectives of the above act are: (a) To ensure that Somaliland cultural heritage is protected against all forms of threats and damage; (b) To ensure the right to access and enjoy heritage for the people of Somaliland; (c) To ensure that Somaliland cultural heritage resources are managed on an efficient and a sustainable basis; (d) To empower the government and people of Somaliland to safeguard, develop and transmit their cultural heritage; (e) To promote international cooperation and assistance.

A summary of the requirements of each of these and other relevant legislative documents and their applicability to this project is presented in Table 1 below.

Table 1: Somaliland Regulatory Framework dealing with Environmental issues.

NAME	SUMMARY	APPLICABILITY
The Somaliland Constitution (Proclaimed 32 May 2001)	The Somaliland Constitution recognises the importance of protecting the environment for the wellbeing of society. In article 18(1) of the Constitution, it is stated that: "The state shall give a special priority to the protection and safeguarding of the environment, which is essential for the wellbeing of the society, and to the care of the natural resources. The care of and (the combating of) the damage to the environment shall be determined by law". The Constitution also assigns the responsibility for managing the natural resources of the Country to the Central state. Article 12 (4) of the Constitution. In article (34) of the constitution, the duty of citizens in protecting the environment is articulated sub-article (1) of the same article also stated, "The land is a public property commonly owned by the nation, and the state is responsible for it". These Constitutional articles are among the fundamental overarching laws that provide	The project has environmental and social impacts that are governed by the Constitution.

NAME	SUMMARY	APPLICABILITY
	for the formulation of detailed legislations pertaining to natural resource conservation and environment protection in Somaliland.	
The Somaliland Heritage Act (draft)	The Somaliland Heritage Act recognizes the importance of protecting heritage sites, as noted in Article 1, which is aimed to ‘ensure the protection, management, preservation, and promotion of Somaliland cultural heritage as well as to determine the responsibilities of the State, in particular the Somaliland Heritage Agency established for this purpose.’ The act also recognizes the protection of all forms of natural heritage, whether it is floral or faunal nature.	The project may have an impact on flora and fauna.
National Environmental Policy (MoERD, 2015)	The Ministry of Environment and Rural Development (MoERD), currently the Ministry of Environment and Climate Change (MoECC), published the National Policy on Environment in 2015, and it underlines the commitment of government, in partnership with the people, to effectively manage the environment for the benefit of present and future generations. The aim of the Environment Policy is to ensure sound environmental management within a framework of sustainable development in Somaliland. Section 3.1.4 of the policy outlines the objectives and guiding principles that seek to develop a system and guidelines for Environmental Impact Assessments (EIA) and Initial Environmental Examination (IEE), approval, audits, monitoring, and evaluation so that adverse environmental impacts can be eliminated or mitigated and environmental benefits enhanced.	An EIA has been prepared for the project to effectively identify and mitigate all potential impacts.
The Environmental Conservation Act (Proclamation No.4/98)	The Environmental Conservation Act and Proclamation No. 4/98 of 3 May 1998 are two of the laws in action that enforce environmental protection in the country. The Ministry of Pastoral Development & Environment promulgated the Environmental Conservation Act to ensure the safeguard of the environment. The focus of this act is on preserving and protecting the degradation of the natural resources of the country, mainly land, forests, and wildlife. The Environmental Conservation Act identifies permanent forest reserves, preserved trees, and species of trees that can be utilized with authorization. It restricts the trade of products of the forest resource without permission. The Act bestows the responsibility of issuing environmental permits in the areas of charcoal production and development of watershed areas to the Ministry of Environment and Rural Development. It also provides the mandate for the ministry to create a special force to investigate, guard, and enforce this law to protect the environment (trees, wildlife, water, and all things pertaining to the protection of the environment).	The project fits into the predefined conditions for sake of environmental safeguards to protect the ecosystems from degradation.

NAME	SUMMARY	APPLICABILITY
Environmental Management Act (Law No79/2018)	The Environmental Management Act is a comprehensive environmental law that was signed and promulgated by His Excellency, the President of Somaliland, in August 2018. The Environmental Management Act provides a regulatory framework law for a wide range of environmental management issues, ranging from the establishment and enforcement of environmental quality standards, licensing effluent, emission, and solid waste disposals, regulation of toxic and hazardous materials, and registration of pesticides and toxic substances to the appointment of environmental inspectors and the establishment of environmental tribunals. Part V of the Environmental Management Act is fully dedicated to environmental assessment, and it outlines the fundamental rules for EIA enforcement and administration.	The project fits into the predefined list of types of projects or sectors where an EIA has to be conducted prior to the implementation of any developmental project.
National Development Plan (2012 – 2016)	The National Development Plan focuses on key issues ranging from: • Ecotourism and the necessity to undertake certain measures primarily linked to the protection and preservation of historical and archaeological sites in Somaliland. Sites that have been protected include Laas Geel, Dhagah Kuurre, Abbasa, Qiblatayn, Dhagah Nabi Galay, and Old Amoud, among others. These measures are geared towards contributing to their long-term preservation, especially the Laas Geel heritage site, which is being promoted as a tourist attraction so it can be better integrated into the local economy. • Establishing a national cultural heritage archive to protect and promote Somali cultural heritage. • Environmental conservation and rehabilitation • Preservation of biological diversity • Empowerment and participation of local communities in the management of natural resources	The interconnectedness between heritage protection and sustainable development is highlighted. Environmental conservation and rehabilitation, and the preservation of biological diversity are key principles in the EIA.
National Forestry and Wildlife Act (69/2015)	The National Forest and Wildlife Act demonstrates the management, protection, and conservation of the forest and wildlife resources, and protection of all kinds of wildlife including the prohibition of illegal poaching, destruction of wildlife habitats.	This act underpins the importance of maintaining forests and wildlife and avoiding any form of act that leads to their destruction or extinction.
Somaliland National Climate Change Policy (SNCCP)-2021	The Somaliland National Climate Change Policy (SNCCP) was prepared by the Ministry of Environment and Climate Change (MoECC). It is a step forward towards management of a broad array of impacts resulting from climate change in Somaliland. The SNCCP focuses on two dimensions: adaptation to climate change effects on one hand and mitigation of man-made factors and emissions that contribute to climate change. It urges the development partners and other stakeholders to	Global warming is recognized as one of the biggest threats to heritage sites. However, the policy does not articulate the link between climate change and

NAME	SUMMARY	APPLICABILITY
	mainstream climate change across different sectors and programs.	tangible heritage degradation.
National Waste Management Act (83/2018)	The Waste Management Act is an act approved by the parliament. The act demonstrates the protection of both marine and aquatic environments from pollutants and controls human activities that can lead to pollution to various environment and ecosystem services.	Unmanaged waste can affect the aesthetics and image of heritage sites.

Table 2: International standards and guidelines

UNESCO Operational Guidelines for the Implementation of the World Heritage Convention	This convention recognizes the cultural and natural heritage among the ‘priceless’ and ‘irreplaceable’ whereby the loss of any of these assets constitutes an impoverishment of the heritage of all the peoples of the world.	The project fits into the guidelines of the convention although Laas Geel is yet to be recognized as a world heritage site.
The International Financial Corporation (IFC) Performance Standards on Environmental and Social Sustainability (2012)	IFC’s Sustainability Framework articulates the corporation’s strategic commitment to sustainable development and is an integral part of IFC’s approach to risk management. Out of the eight Performance Standards, the following four standards are applicable to the project: • Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts • Performance Standard 3: Resource Efficiency and Pollution Prevention • Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources • Performance Standard 8: Cultural Heritage	The assessment has been prepared in line with IFC’s guidelines.

3.0. DESCRIPTION OF THE EXISTING ENVIRONMENT AT DESKTOP LEVEL WITH LIMITED GROUND OBSERVATIONS

This section of the report looks at the baseline information of the current environmental condition of the area. The purpose is to have concrete and useful baseline data that can be assessed and monitored to evaluate the effects that are likely to result from project activities. The information provides a description of climate and rainfall, air quality, flora and mammalian fauna, terrain, and water in the area. This baseline information will also help in determining the magnitude of certain impacts on certain resources, such as water and plants.

3.1. Environmental setting of the broader region

3.1.1. Background

Somaliland is located on the Gulf of Aden's southern shore in the Horn of Africa. Ethiopia borders it to the south, Somalia to the east, and Djibouti to the northwest. Somaliland gained independence from Britain in June 1960 but joined with Italian Somalia 5 days later to form the Somali Republic. The disintegration of the Somali Republic was ultimately caused by a civil war that broke out in the 1980s because of the union's poor performance. In 1991, Somaliland unilaterally declared its independence from Somalia following a three-year civil conflict.

Somaliland consists of six regions, viz., Maroodi-jeeh, Awdal, Sahil, Togdheer, Sanaag, and Sool.

3.1.2. Laas Geel Rock Art Site

Laas Geel Rock Art site (latitude: 09° 46' 51.25" N; longitude: 44° 26' 35.86" E) contains over a dozen rock shelters covered with polychrome paintings with Neolithic paintings dated between 5000 and 11,000 years. The granitic hill on which the site lies is an approximate elevation of 1,030 m. It is also one of the most outstanding sites in the Horn of Africa in view of its exceptionality and state of preservation (Gutherz et al., 2002). Situated roughly 50 km northeast of Hargeisa and roughly 5 km north of Dhubato village on the road between Hargeisa and Berbera, it is a popular destination point for local and foreign tourists. The discovery of Laas Geel in 2002 by Dr. Xavier Gutherz and his team was a turning point for the site, suddenly changing the deserted and often avoided 'devil's haunt' into a popular tourist attraction. Moreover, due to its better access and its proximity to Hargeisa, the capital of Somaliland, the visitor traffic has been increasing over the years, raising concerns about site integrity and the associated potential for accelerated degradation of the site.

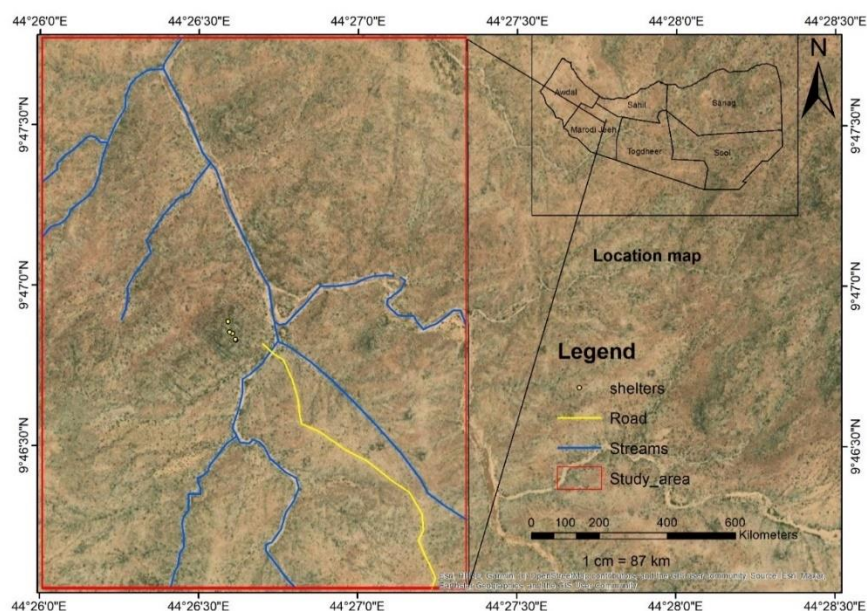


Figure 1: Laas Geel Rock Art Site Area

Geographically, Laas Geel falls in a distinct ecozone known locally as 'Ogo-Guban' which alludes to the low-lying section of the Golis Range whereby the Ogo plateau slowly slopes

and transitions to the coastal ecozone (Guban). The Golis Mountain range is an extension of the Ethiopian highlands that run parallel (east-west) with the Gulf of Aden. The central Golis Range, particularly the section between Hargeisa and Berbera is the lowest part in terms of elevation. For example, the elevation of *Dhubato* Pass to the east of Laas Geel is only 1200 metres above sea level.

Laas Geel (literally the camel waterpoint) gained its name from the myriads of camels that used to converge on its permanent shallow water during the dry season. That was a period when the wet season grazing rangelands in the *Haud* ecozone south of the Golis Range were devoid of settlements and water-harvesting infrastructures (such as *berkeds*, *ballehs* and boreholes). The significance of Laas Geel as a major livestock watering point declined, like many similar places such as Adadley, Beer, Odweyne, Hargeisa, Aw-Barkhadle, Arabsiyo, and others, due to the introduction of water-harvesting structures in the water-scarcity areas.

3.1.3. Geography

The total area of Somaliland is 137,600 Km² and the population was estimated to be 3.5 million (NDPIII, 2020). The capital, Hargeysa, has an estimated population of one million, which has been rapidly increasing, the same as other major urban towns, with immigration from rural areas. Pastoralism and agro pastoralism are the principal rural occupations.

There are three main topographic regions. The coastal strip, which widens towards the western border and narrows as one moves further to the east, is the ‘Guban’ (literally, burnt) – an allusion to the high temperature levels during the *Xagga* (summer) and the prevailing desert environment. The highlands to the south of the coastal strip, known as Golis Mountains, are cool and receive higher amounts of rainfall. The highest peak, Mount Shimbiris 2,460 m, is within this range. The third region is the Ogo and Haud plateau to the south of the Golis Mountains which continue to slope towards Somalia and eastern Ethiopia.

The Laas Geel mountain outcrop falls on an elevation of 1,300 metres above sea level, and just on the western bank of the Dhubato seasonal watercourse which drains into the Gulf of Aden. The surrounding areas, same as many parts of the country, are arid and exhibit an advanced erosional process, characterized by gravelly soil of low organic content.

3.1.4. Climate

Somaliland has a dry climate, with most regions designated as arid and with a few smaller areas as semi-arid. The temperature in the coastal and lower areas ranges from around 28-35°C but climbing to 45⁰ C during hotter months (particularly in July), while in the cooler highlands it ranges from 20-24°C. However, in recent years, the higher altitudes in the Golis Range, which used to have pleasant weather, have been experiencing an increase in temperature. For example, during the middle of April, the noon temperature of Hargeisa soared to 35⁰C.

There are four distinct seasons that comprise the spring rains of April to June, a dry summer from July to September, the autumn rains of October and November, and a dry winter from December to March.

There is no weather station in the Laas Geel site or in the nearby areas, but the average temperature of Hargeisa, which lies 1,344 metres above sea level, with its urban heat island

(UHI) can be used as a reference point, also bearing in mind that Laas Geel is slightly lower in elevation.

3.1.5. *Rainfall*

The occurrence of rainfall in Somaliland is subject to the movement of the sun back and forth across the equator twice a year. The southwest monsoon which blows from May to September, brings with it the long rains (*Gu*) and marks the beginning of the hot summer season, whereas the northeast monsoon which blows from October to April, marks the beginning of the short rains (*Deyr*) and the cool winter season. During the summer and in the absence of rainfall, a strong, hot wind with sandstorms blows, which desiccates the land and causes a considerable amount of sand erosion. The *Guban* sometimes receives light showers (*Hays*) during December.

Laas Geel area experiences annual rainfall ranging from 200 to 400 mm, with most precipitation occurring during *Gu* (spring) from April to June and *Deyr* (Autumn) from October to December. Humidity levels are generally low to moderate, typically between 30% to 60%, while average temperature ranges between 20°C at night and 30°C during the day.

3.1.6. *Noise and ambient air quality*

There are no noise and ambient air quality monitoring stations in Somaliland, and therefore, there is no reliable data on this. Sound generation in Laas Geel area is minimal. This is due to the absence of permanent human settlement except for a few site guards. However, with the popularity of Laas Geel as an important tourist attraction point, the main source of anthropogenic noises can result from vehicles visiting the site. Fortunately, the parking arrangement outside the site is a good measure to reduce noise pollution within the site.

In general, the area lies in a pastoral setting, whereby the nature of the pastoral way of life does not generate noise other than the *natural sounds* produced by natural sources in their normal soundscape such as animals, birds, wildlife, and rustling leaves. The ambient air can also be considered in its pristine form.

3.1.7. *Water and Water Quality*

The history of Laas Geel rock art and the permanent availability of water in the sand bed of the seasonal river are intertwined. Laas Geel lies at the confluence of two seasonal watercourses. At a distance not more than two hundred meters downstream from the entrance of Laas Geel site, a shallow granitic bedrock, wedged across the watercourse, serves as a subsurface dam. This physical barrier made the site a permanent waterpoint. Hence, there is no shortage of water at any time of the year.

The water for Laas Geel site is drawn from a protected shallow well fitted with a solar pump. A concrete cover slab fitted over the shallow well prevents it from surface contamination. The well was built to provide potable water for the site staff and visitors for use for hygiene and sanitation needs. However, during the assessment, the site staff reported that the system was not functioning due to a mechanical problem. Principally, the MoTT is responsible for all operation and maintenance works at Laas Geel site.

4.0. GEOLOGY

4.1. General geology on country-wide scale

Somaliland has varied geological formations with the thickness of lithology differing from one area to another. The major geological formations in the area can be mainly divided into the following units:

1. Precambrian formation: this formation is the Basement Complex, which is composed of metamorphic and igneous rocks of Proterozoic eon. The most common basement rock in the country are gneisses, schists, marbles and quartzites intruded by granites, gabbros and diorites. The previous studies identified four main complexes: the Qabri-baxar, Abdulqadir, Moora and Inda Ad complexes.
2. Jurassic formations: this formation is composed of thick continental, arenaceous sandstone in the lower Jurassic, which is overlain by alternating limestone and shale beds of the middle to upper Jurassic. The lower continental sandstone bed is called Adigrat Formation, while the upper marine formation is the Bihendula Formation.
3. Cretaceous formations: Cretaceous sediments were deposited in continental and lagoonal environments, consisting of fine to coarse-grained, differently coloured, soft, and cross-bedded quartz sandstone rock. This formation also includes Tisje limestone and intercalations of shale.
4. Tertiary (Eocene) formations: This period is characterized by limestone and evaporitic rocks
 - 4.1. Auradu Formation(limestone): this formation consists of grey to white, hard, massive and un-bedded limestone. It was deposited in the lower Eocene due to sea ingression and is one of the most outcropping rocks in Somaliland.
 - 4.2. Taleex Formation (Gypsum and Anhydrite): Massive and dense anhydrite beds with intercalations of Gypsum and limestone. In the middle Eocene, this formation formed following a sea regression occurred in the region.
 - 4.3. Karkar Formation (limestone): Fossiliferous, bedded, white, marly limestone from the upper Eocene. Thin Gypsum layer may intercalate in some areas.
5. Tertiary (Oligocene to Miocene): Thick extensive series of sedimentary rocks
 - 5.1. Daban series: Oligocene-Miocene sediments occur in the Daban Basin (southeast of Berbera) bordering the Somaliland plateau. These sediments were deposited in a fast subsiding, faulted, rotated block during rifting and opening of the Gulf of Aden (Bosellini, 1992; Abbate et al., 1993a). It is constituted of different layers of sedimentary rocks (sandstones, shales, limestone, marl, anhydrite and, gypsum)
6. Pleistocene to Recent Alluvium
 - 6.1. Basaltic rocks: the volcanic activity that is associated with the Gulf of Aden rift has formed volcanic rocks, mainly basalts. The volcanic outcrops (basalts, rhyolites, tuffs, and obsidian) have been exposed along the coastal belt.
 - 6.2. Alluvial sediments: old alluvial deposits of Geed-deeble basin are composed of red sandy clay with lenses of sand and fine gravel. The recent sediments have filled the numerous streams of the mountainous range, coastal plains, coastal belt, and many depressions throughout the country.

4.2. The Geology of the Study Area

Based on the observations from the field assessment and study of the previous geological maps and reports, the study area is outcropped by late Proterozoic basement crystalline rocks. The petrology is predominantly composed of granite, with intrusions of pegmatite extending several kilometres around the site. The painted rock shelters are located on a granite hill. It is characterized by its durable, hard, and coarse-grained texture primarily composed of quartz, feldspar and mica. Approximately 14 kilometres north of the site, Pleistocene basalt rock outcrops are present. To the south, Nubian sandstone is exposed, which is overlain by Eocene limestone along the sides of the Hargeisa-Berbera highway, near Dhubato village. In general, the country features five main geomorphological and topographical landscapes: the coastal belt, coastal plain, mountainous range, plateaus, and valleys. The study area is in the mountainous zone, which has higher elevations and rainfall, along with lower temperatures. The site is eroded granite rocky hills with a soil type of mainly gravel, sand, and clay.

4.2.1. Hydrology

Several seasonal watercourses with recent alluvial sediments flow through the area. The site lies on the confluence of the Dhubato watercourse and another smaller ephemeral dry riverbed originating from several km south of Laas. At this junction, a permanent spring called Laas Geel emerges. The name of the site has been derived from this waterpoint. The groundwater in the area is limited and shallow because it is covered by crystalline basement formations with low porosity and permeability. There is a very shallow hand-dug well located beside the entrance gate of the site. Boreholes, surface water catchments and man-made water sources are not observed in the area; therefore, the community relies on the shallow wells in Dhubato and nearby villages. Generally, the water flows northward toward the coastal belt, which is the main basin of the region.

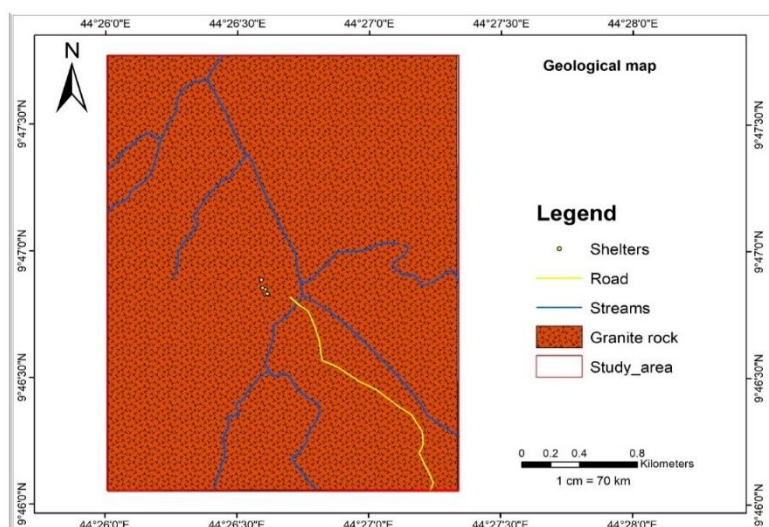


Figure 2 : The geological map of the study area.

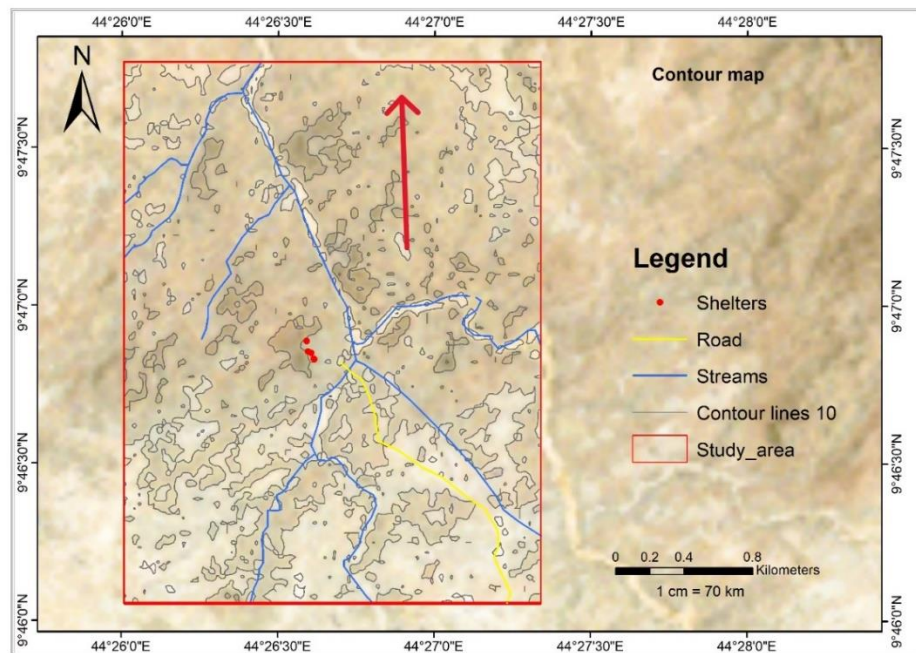


Figure 3: Direction of water flow (the red arrow indicates the downstream)

4.2.2. The Physical and Chemical Analysis of Rock Weathering

The weathering process of the granite is both chemical and mechanical. The rising temperatures contribute to the weathering process. Changes in temperature cause rock to expand during the day and contract during the night, thus weakening rock structure. The most common reaction involves acids that attack the surface of rocks. Some of the paintings show white blotches and bands resulting from such a process. The northeastern face of the shelters is exposed to rain, dust, and direct sunlight. Prolonged exposure to these elements and the rising daytime temperature can lead to faster weathering and erosion. Rainwater can affect both rock material and pigments.

In some of the painted rock shelters, during the rainy season water leaking from the top of the overhanging rock runs over the granite rock, which contains feldspar (one of its mineral compositions), leading to a chemical reaction (hydrolysis). Such reaction causes the formation of clay minerals, including illite, smectite, and kaolinite. This resulting clay, which is softer in structure, can be transported over time by water onto the surface of some of the rock paintings, leaving a film of dust over them. There is also a flaking of rock surfaces caused by temperature changes and pressure releases whereby thin layers of the granite can be seen peeling off from the surfaces of some of the shelters. This phenomenon is a type of exfoliation weathering that may cause detachment and loss of the heritage art on the surface.



Figure 4: *Top left:* Dark stains probably of fungal origin. *Top right:* Surface flaking and exfoliation of rock paintings. *Bottom left:* Evidence of a wasp in action. *Bottom right:* Dust accumulation in the painted rock shelters.



Figure 5: *Top left:* *Capparis cartilaginea* thriving in an overhanging rock crevice. *Top right:* Dust accumulation and trails of burrowing insects. *Bottom left:* Wasp nests. *Bottom right:* Insect booby holes.

A recent negative development at Laas Geel rock art site is the use of paint in trail marking. This not only causes visual pollution but could also be a cause for confusion for archaeologists when some of these painted stones may end up near the painted rock shelters. Contrasting white painted columns have also been used in supporting a falling rock (Fig. 8). This may indicate the absence of rock art conservation and management skills, techniques, and guidelines.



Figure 6: Trail with stone border markings.



Figure 7: painted marking on granite.



Figure 8: Masonry pillars of a contrasting colour built to support a falling rock shelter.

5.0. FLORAL AND FAUNAL ASSESSMENT OF LAAS GEEL ROCK ART SITE

5.1. Faunal Assessment

In total there are about 167 species and subspecies of Amphibians and Reptiles in Somaliland (Balletto 1968; Channing & Rödel 2019; Lanza 1981, 1983, 1990; Largen & Rasmussen 1993; Spawls & al. 2023; Mazuch unpublished), of which thirteen species belong to amphibians (frogs only), three to chelonians (tortoises and terrapins or turtles), ninety-seven to lizards and fifty-four to snakes (of which 12 are dangerous to humans). Thirty-one (19%) species and subspecies are endemic or near-endemic to Somaliland (Mazuch unpublished).

The territory of Somaliland can be divided into several biogeographical units or ecoregions based on different climate, geography (inland vs. coastal areas, altitude), geology (different type of soils), and distributional patterns of flora and fauna. Except several herpetofaunal species, which are ubiquitous, most other taxons bear pattern of distribution and are mostly typical for one of these regions: 1/ Guban, low altitude hot coastal sandy plain along the Gulf of Aden, 2/ Ogo, the central mountainous area between 500-1200 m, including also higher mountainous ranges as Golis or Wagar, including partially Cal Madow Mountains 3/ Haud, flat red sandy plateau along the border with Ethiopia in the south, 4/ Nogal Valley and surrounding plains in the east with mostly gypseous soils, including partially Cal Madow Mountains. Each of these regions is rich for endemic and more or less other typical species with the prevailing distribution in that region.

The study area, Laas Geel (hereafter referred to as LG), is found just in Ogo region, the central mountainous area for which are typical faunal species that prefer mean annual rainfall between 300-500 mm, mean annual temperatures which vary between 20-24°C (Muchiri, 2007), medium altitudes (around 100 m above sea level) and fairly low cover of vegetation. Most of the species that are typical for the other regions mentioned above are absent here, or if present, then they are widespread species with low ecological requirements. The Ogo area has the highest biodiversity in the country compared to other regions (Balletto 1968; Parker 1942, 1949; Spawls & al. 2023).

5.1.1. Approach and Methods

Assessment of the biodiversity of the LG was conducted through a combination of field-based and desktop methods. These two components are described below.

Herpetofaunal surveys were conducted for a total of 8 days between 2010 and 2025, during different seasons of the year (February in 2017 and 2025, July in 2011, August in 2017, November in 2010). The study area was visited in different parts of the day, in the morning, at noon, during late afternoon and during the first two or three hours after sunset. Taking into account previous experience in the similar sites in Somaliland, data were collected only using active searching during walking transects, which was conducted in a fenced-off area directly adjacent to the cave paintings of Laas Geel (approximately within a perimeter of 200 m on all sides of the central part of the study area, N 9°46'50.50", E 44°26'36.67"). Opportunistic surveys in neighbouring areas, especially in the vicinity of the road leading southwards to the village of Dhubbato (approx. 5 km from the primary study area) were also conducted throughout the sampling period. This wider area (corresponding to a perimeter of about 5 km)

was chosen because it is a larger area and therefore may contain more species that could not be observed in the primary study area for unspecified reasons but may nevertheless be confirmed by other researchers in the future.

The open space (especially in the vicinity of the main rock formation) and the surroundings of low bushes and trees were searched for presence of day active lizards and snakes; higher trees (mostly *Vachellia tortilis* and associated vegetation) were checked for presence of tree-dwelling geckos, chameleons and snakes; stones or other objects placed on the ground (e.g. piece of textile, wooden boards, plastic canisters) were flipped and checked, if any snakes, ground-dwelling geckos or other reptiles and frogs are present there; the wadi immediately adjacent to the eastern edge of the study area was checked for the presence of amphibians (frogs), aquatic turtle species and snakes, especially at night, when these species are mostly active. Rocks, the dominant feature of the study area, were checked for the presence of various species of lizards (especially agamas and geckos) and snakes. Captured specimens were closely examined, photographed, and finally released at the exact location of their capture. The species was identified using a combination of morphological characters given by the relevant literature (Arillo et al. 1968; Channing & Rödel 2019; Parker 1942, 1949; Largen & Rasmussen 1993; Lanza 1978; Largen & Spawls 2006, 2010; Loveridge 1947; Spawls & al. 2023). The following abbreviations are used in this book: NHMUK – Natural History Museum, London, CAS – California Academy of Sciences, San Francisco, MCZ – Museum of Comparative Zoology, Harvard University, MVZ - Museum of Vertebrate Zoology, Berkeley. Representative photographs of all species observed in the study area are included in this report. Unless otherwise stated, all individuals in the photographs are from the LG study area.

5.1.2. Herpetofauna

According to recent personal survey (February 2025) as well as several other surveys conducted in the past (2010-2017) by the sector expert (Tomas Mazuch), and reviewing available published books and papers (Arillo & al. 1968; Boulenger 1896, 1921; Lanza 1981, 1983, 1990; Lanza & Carfi 1968; Lanza & Nistri 2005; Lanza & Sassi 1966; Largen & Rasmussen 1993; Loveridge 1940, 1947; Mazuch 2013; Parker 1932, 1942, 1949; Schätti 1988, 2006; Spawls & al. 2023) and various museum collections (NHMUK, CAS, MCZ, MVZ), approximately 34 species of amphibians and reptiles were or are expected to be reported from LG and its neighbouring areas, approximately within a 5 km radius (Appendix A). A total of 12 reptile species and 2 frogs were recorded during our field sampling from the study area of LG (Appendix B) and 6 additional species from a neighbouring area, mostly along the road between Laas Geel and Dhubbato village (Appendix C).

According to the microhabitat preferences of the species that have been captured or observed in the LG, they can be divided into four basic groups:

Representatives of the first group (1) prefer living on rocks or in rocky areas or are best adapted to this microhabitat. Examples of these rupicolous species are *Agama somalica* (recently described species, in older literature known from Somaliland as *A. spinosa*), *Hemidactylus barodanus*, and *Trachylepis quinquetaeniata quinquetaeniata*.

Another group (2) are species that prefer open landscapes without the need for rocks or rock outcrops. Typical representatives are *Agama rueppelli*, *Latastia longicaudata revoili*, *Pseuderemias mucronata*, or *Hemidactylus citernii*.

The third group (3) are species that largely use the man-made structures (e.g. buildings, walls, and building debris) in their microhabitat selection, typical representatives are several geckos of the genus *Hemidactylus*, in our case *H. robustus* or partially *H. barodanus*.

The fourth (4) and final group are species that are tied to the aquatic environment, in this case the adjacent wadis, examples are frogs *Sclerophrys dodsoni* or *Tomopterna kachowskii*, or turtles *Pelomedusa somalica*. Most of the species found in the LG or adjacent environments (see Appendix B and C) occur in multiple microhabitats and are not, with few exceptions, restricted to a single microhabitat. The exceptions are aquatic species belonging to Group 4 (*Pelomedusa somalica*, *Sclerophrys dodsoni* and *Tomopterna kachowskii*) and an introduced gecko species (*Hemidactylus robustus*) belonging to Group 3; the latter was not found elsewhere than in brick buildings belonging to the LG. Of the species occurring in or near LG, there are several that are closely tied to the rock microhabitats, e.g. *Agama somalica*, *Hemidactylus barodanus*, and *Trachylepis q. quinquetaeniata*. These species are usually very abundant in such suitable locations. Like the previous group, there are several species that are associated with the stony microhabitats in the biotope. These species (e.g. *Hemidactylus citernii*, *H. ophiolepidoides*, *Tarentola annularis*) almost exclusively find daytime shelters under rocks or stones or in their crevices. Species that prefer more open habitats with sandy or sandy-stony soil, richer vegetation and rather absence of rocky formations are e.g. *Agama rueppelli*, *A. robecchii*, *Chalcides ragazzii*, *Latastia longicaudata revoili*, *Pristurus crucifer*, *Pseuderemias mucronata*, *Stigmochelys pardalis*, *Xenagama taylori*.

A total of 12 species was recorded from LG during our field surveys (Appendix B). The most common species that can usually be observed without much effort, during each site visit and in often larger numbers are the following species: *Agama somalica*, *Hemidactylus barodanus*, *H. citernii*, *Latastia longicaudata revoili*, *Stigmochelys pardalis*, and *Trachylepis q. quinquetaeniata*. In the vicinity of the LG, but outside the fenced area (see Appendix C), these species are e.g. *Chalcides ragazzii*, *Pristurus crucifer*, and *Tarentola annularis*. Aquatic species, mainly associated with adjacent wadi, can be considered as common. All but one of the species can be considered widely distributed in Somaliland and most are also common to very common in terms of abundance, only *Hemidactylus barodanus* is more narrowly distributed as it is associated with rocky habitats (mostly large quartz and granitic boulders) in the mid-western regions of Somaliland (Spawls et al. 2023). As can be seen from Appendix B, no snake species were observed during our research. However, for several widely distributed species (see Appendix A), their occurrence in the LG or its immediate vicinity is highly probable. It is worth mentioning that two of these species are venomous and deadly to humans if bitten: *Bitis arietans somalica*, *Naja pallida*.

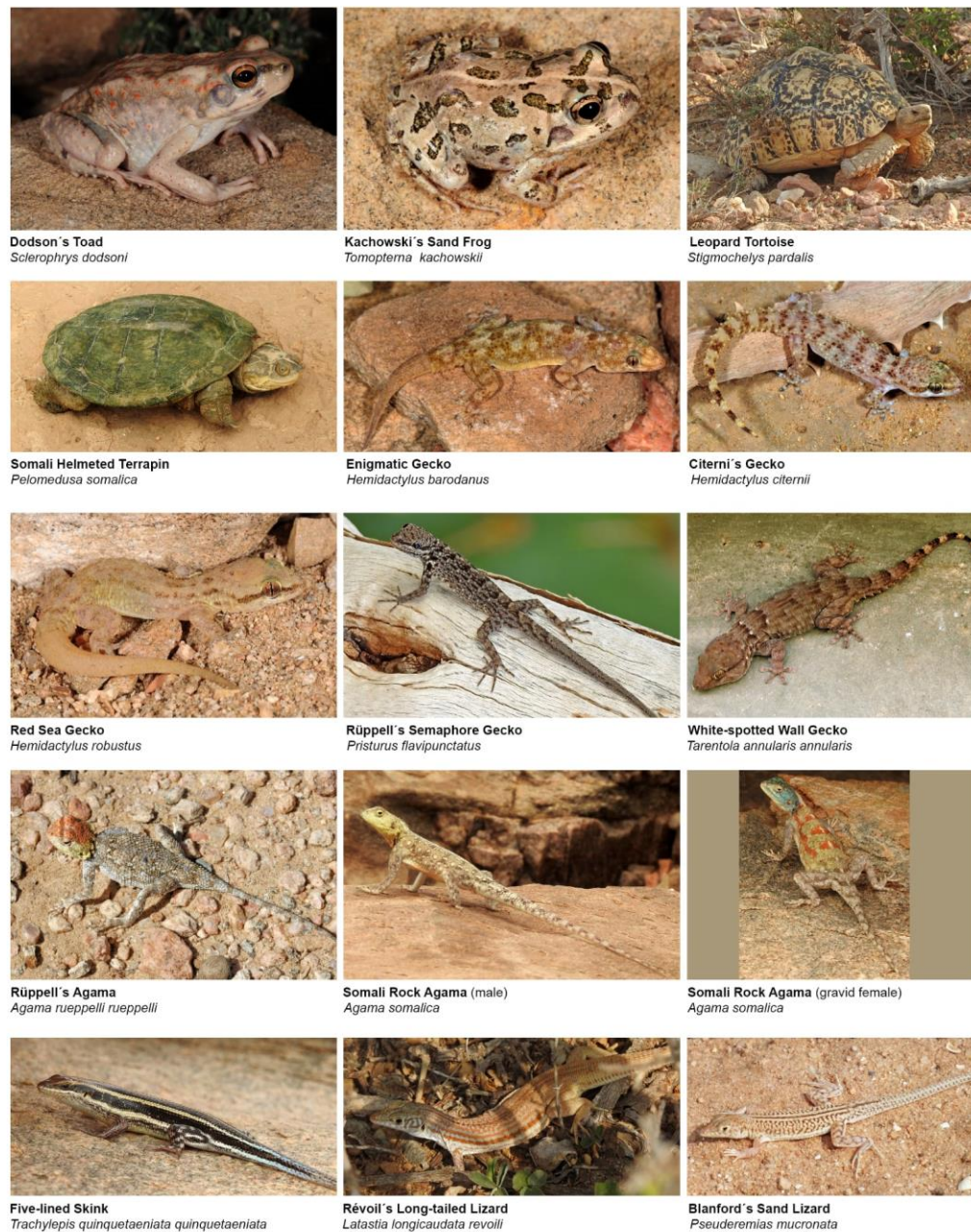


Figure 9: Frogs and reptiles from the fenced study area.

5.1.3. Species of conservation significance

None of the recorded species in Laas Geel found during recent biodiversity surveys is threatened according to IUCN Red List criteria. The only species that occurs in study area and is locally threatened (albeit still Least Concern globally according to IUCN Red List) is Leopard Tortoise (*Stigmochelys pardalis*). Although this species is still very abundant in Somaliland, particularly in the western half of the country, its numbers may be threatened in the future, especially by increasing traffic and other infrastructure and then by illegal

collecting for the pet trade. The species that are endemic to Somaliland and its immediate surrounding (see Appendix A) and that occur in the study area (see Appendix B) are: *Agama somalica*, *Hemidactylus barodanus*, *H. citernii*, and *Latastia longicaudata revoili*. However, these species are common to very common here and in surrounding areas. None of the species listed in Appendix B or C are closely restricted to the study area and occur in the wider area (see also Spawls et al. 2023). According to the author's (Mazuch unpublished) long-term experience (since 2010) from field-studies in Somaliland, the population trends of all species listed in Appendix C can be considered as stable (according to IUCN Red List criteria).

5.1.4. Exotic and/or invasive fauna

One exotic or alien (non-native) species is recorded from LG: *Hemidactylus robustus*. Specimens of this species were observed only inside the building at the eastern edge of the study area. Several individuals were observed during the day hiding behind presentation panels hanging on the walls inside the building. Another near-endemic species, *Hemidactylus barodanus*, which was also recorded on buildings here was, unlike this species, only seen on the exterior walls of buildings or inside external toilets. *Hemidactylus robustus* is strongly invasive and competes with other species of the genus *Hemidactylus* for space and food.

5.1.5. Avifauna

The number of bird species recorded from Laas Geel and surrounding areas up to a radius of 5 km is 31. None of the species listed in Appendix E are threatened based on the IUCN.

Red list.



Figure 10: *Oenanthe phillipsi* (Somali wheatear). **Figure 11:** *Cursorius cursor* (cream coloured courser).

5.2. Mammals

In total there are about 100 species of small and large mammals in the territory of Somaliland (Agnelli, Azzaroli, Simonetta, 1990; Bryja & al. 2019; Burgin & al., 2020; Drake-Brockman 1910; Hunt 1951; Funaioli 1957, 1971; Funaioli & Simonetta 1966; Jenner 2020; Kingdon 2015; Kingdon & al., eds. 2013; Lanza, Funaioli & Riccucci 2015; Monadjem, Taylor, Denys & Cotterill, 2015; Scaramella, Russo, D'Errico 1974; Wilson & Mittermeier, eds., 2009-2019), of which 25 species are rodents, 25 species are bats, 16 species of even-toed ungulates,

22 species of insectivores and carnivores, 3 or 4 species of primates, two species of elephant shrews, three species of hyraxes and odd-toed ungulates, one species of hares, and three species of armadillo and hedgehog. An additional 5 species are of uncertain occurrence, and 7 species are regarded as extinct or better extirpated from the country (e.g., Lion, Somali Wild Dog, African Savanna Elephant, Northern Giraffe, Black Rhinoceros).

During the field survey, seven mammal species were directly sighted in the study area (Hamadryas Baboon, *Papio hamadryas*; Louise's Spiny Mouse, *Acomys louisae*; Roan Hyrax, *Procavia capensis*; Somali Klipspringer, *Oreotragus somalicus*; Somali Sengi, *Galeegeska revoilii*; Speke's Gundi, *Pectinator spekei*; Spotted Hyena, *Crocuta crocuta*), while a further five species were observed in the immediate vicinity beyond the fence of the study area (African Golden Wolf, *Canis lupaster*; Common Warthog, *Phacochoerus africanus*; Northern Gerenuk, *Litocranius walleri sclateri*; Phillip's Dik-dik, *Madoqua phillipsi*; Unstriped ground squirrel, *Xerus rutilus*).

Speke's Gundi (*Pectinator spekei*), a small rupicolous rodent, is the most frequently encountered mammal species. Basically, every day the study area is visited by a large group (about 30-50 individuals) of Hamadryas Baboon (*Papio hamadryas*).

The global level of threats according to IUCN Red List is in all mentioned species 'Least Concern' (LC), except of Northern Gerenuk (*Litocranius walleri sclateri*) which is 'Near Threatened' (NT) and Somali Sengi (*Galeegeska revoilii*) 'Data Deficient' (DD).

5.3. Flora

The floral assessment revealed that the site, despite its smallness in area (roughly 11 ha.) and semi-arid climate, hosts a good number of species in relation to its condition. The current assessment lists 113 species consisting of 41 families. Here, it is important to note that the vascular species in the Somali flora consist of 157 families, meaning that 26% of the total families are found in Laas Geel. The assessment also revealed that the number has been increasing since the fencing was put in place. In 2016, only 46 species were reported in the site by the lead author of the current assessment. This is over a 200% increase in the number of species within a period of eight years. Such impressive vegetation restoration can be attributed to the fact that the soil serves as a seed bank and a repository to produce subsequent plants that may have been eradicated through overgrazing on account of their higher palatability. The extended period of rest, made possible by the existing fence, facilitated the regeneration of these species. As the site continues to remain protected, we anticipate more species recruitment.

Out of the 113 species, only 9 (7%) is a result of human introduction as trees and shrubs intended as amenity species. The ratio of shrubs and grasses to trees is 77% and 23%, respectively.

Description		% (Somali Flora)	Indigenous/introduced
Number of species	113	3%	93% / 7%
Number of families	43	27%	

Table 3: Species documented from Laas Geel

In analysing the vegetation recovery and trends, over 90% of the regenerated species since the site was protected are shrubs and grasses. One example is the tall grass species *Andropogon kelleri*, locally known as *Duur* which has declined in most parts of the country due to overgrazing and its multi-purpose use in the Somali culture. (See Fig. 13).

Most of the species in the site are deciduous (meaning that they shed their leaves and shut down their photosynthesis process) during the dry season. In terms of distribution, the base of the Laas Geel massif, where there is enough soil to support vegetation, hosts most of the species found in the area, while the higher grounds are dominated by bare granitic rock.

5.2.1. Exotic and invasive flora

There are three exotic/invasive species found at Laas Geel site. These are *Opuntia ficus-indica* and *Opuntia stricta* (both Cacti), and *Prosopis juliflora*, all of them believed to have been introduced by monkeys. The cacti are extremely prolific in the site in comparison to *P. Juliflora* since the area is fenced and browsers that cause the latter to proliferate are restricted from the site.

There are also several species that have been intentionally introduced to the site for amenity reasons. These are planted in an area near the entrance gate of the site. Some of these species, such as *Ficus Vasta*, *Ficus sycomorus*, *Vachellia nilotica*, and *Phoenix dactylifera* are indigenous. *Tecoma stans*, an ornamental flower shrub, is also among the species introduced into the site.

5.2.2. Species of conservation significance

In terms of species rarity, there is one species that is most likely to have been extirpated in most of its habitat in the Golis Range but was found standing in a not-easy-to-access rock crevice, in Laas Geel. This species, namely *Maytenus undata*, is widespread in tropical and Southern Africa and globally listed as ‘least concern (LC)’ in the IUCN Red List, but it can be categorized locally as ‘vulnerable (Vu)’. The presence of species such as this one highlights the indirect benefits of protecting the site and how floral and faunal species thrive that would have otherwise become threatened in the wild.



Figure 12: *Maytenus undata* (a rare indigenous shrub. Only one plant recorded from Laas Geel).



Figure 14: *Andropogon Kelleri*, a grass species.



Figure 13: *Cissus sp.*, a trailing plant in one of the rock shelters.



Figure 16: *Vachellia bussei*, a common in Laas Geel area.



Figure 15: *Ficus populifolia* is a common tree in Laas Geel site

6.0. ADVERSE AND POSITIVE PROJECT IMPACTS

6.1. Negative Impact Characterization and Analysis

Human interventions impact the environment in several ways, and these impacts can either be positive or negative. Typical effects include degraded air and water quality, increased pollution and greenhouse gas emissions, loss of biodiversity, etc. Therefore, EIA is an important tool for decision-making to minimize the negative impacts of development projects. The negative impacts that result from development activities in heritage sites such as Laas Geel, depending on the type of activity, can vary from visual pollution that can cause from distraction to litter and ambient air pollution, depending on the nature of the activities and existing conditions, the impacts are assessed for their importance.

In the proposed project '**Protecting and promoting Somaliland's heritage and preserving the Laas Geel site**' the impact (positive and negative) of the project on the environment of Laas Geel heritage and the likely consequences that may result are discussed here below. The following table indicates receptors/components that the project is going to negatively impact and mitigation measures that can be put in place to manage and counteract these impacts.

Table 4: Negative Impact Characterization and Analysis

Issue	Potential Impact	Impact type, and rating	Extend	Duration	Remark
Air quality	Health impacts associated with increased levels of pollutants particularly dust generation and nuisance resulting from physical interventions	Direct, Minor	Limited	Temporary	
Water resource	Groundwater pollution	Direct, Minor	Limited	Temporary	Depending on the nature and scale of project activities, there are no foreseeable negative impacts on the shallow water of Laas Geel seasonal water course. In any case the contractor should maintain good housekeeping practices such as proper disposal of garbage and

					pollutants that may result from operations.
Biodiversity	Damage to flora	Direct, Insignificant	Limited	Temporary	Fencing can serve as a tool for biodiversity enhancement. The activities do not involve land ground clearing which may be a risk for flora and fauna. The vehicle parking needs can be aligned with the vegetation without resorting to land clearing activities.
	Damage to fauna	Indirect, Moderate	Limited	Temporary	
	Land contamination	Direct, insignificant	Limited	Temporary	Removal of animals from their habitats can expose them to new predators and may cause stress, hunger and other negative effects. Such action can also lead to disturbance of the normal breeding calendar. Depending on the nature and scale of project activities, there are no foreseeable negative impacts on the shallow water of Laas Geel seasonal water course. In any case the contractor should maintain good housekeeping practices such as proper disposal of garbage and pollutants that may result from operations.
Noise and Vibration	Increase of ambient noise levels with the potential of disturbance during the operations	Direct, insignificant	Limited	Temporary	Excessive noise and vibration levels can disrupt wildlife habitats, alter animal behaviour, and affect ecological processes. However, the low levels of ambient noise can be temporarily tolerated.

6.2. Table for the Rock Art Stability Index (RASI)

The Rock Art Stability Index (RASI) is a rapid, vital assessment tool used to estimate the condition and preservation of rock art sites. It helps to identify the different environmental and biological impacts affecting the stability of the rock arts. The RASI scoring system, ranging from 1 to 5 indicates degrees of deterioration and levels of risks. 1 indicates *severe deterioration and critical risk* and needs immediate action. A score 2 signifies *a high-risk impact*, where urgent intervention is needed. A score of 3 reflects *a moderate risk* with visible issues. Finally, score 4 represents *low risk with minor concerns*, while score 5 indicates *stable condition and minimal deterioration*.

Table 5: Rock Art Stability Index (RASI)

Factor	Description	Impact on rock art	RASI score (1-5)	Management
Exposure to elements	Some of the shelters are exposed to sunlight, wind and rain, and resulted in the quickened damage of rock paintings.	Increase weathering and erosion. Potential pigment loss.	4	- Provide suitable protective material - Monitor environmental conditions.
Chemical weathering	Water leaks cause hydrolysis of feldspar, forming clay minerals.	- Softens rock and affects paint - Increased deterioration.	3	- Improve drainage if possible. - Covering top of the fissures.
Animal interactions	Organisms inhabit shelters, contributing to biological weathering.	- Damage from nests and burrowing - Increased dust.	4	- Control animal access - Clean nests without harming species.
fissures and joints	- Fractures allow plant root penetration and water infiltration.	- Accelerates rock breakdown - Promotes plant v. - Increase future break-off of the painted surfaces.	3	- Plug the cracks where feasible with suitable material - Monitor plant growth.
Flaking	Temperature changes cause thin layers of rock to peel away.	-Loss of heritage art - Potential detachment of pictographs.	5	-Stabilize flaking areas
Plant growth	Roots from plants search for water in clay formed from feldspar hydrolysis.	Can damage rock structure	2	- Manage vegetation - Assess root impact regularly.
Dark/brown stain	This stain is organic material	Damages and covers pictographs.	2	- Clear it from the surface.

6.3. *Positive Anticipated Project Impacts*

The project's overall goal is to enhance the protection of the site, promote local economic development, and contribute to the efforts to develop tourism that will in turn stimulate local economies. The activities proposed contribute to the fulfilment of the above goal.

The enhancement of the site protection will also contribute to a small bio-reserve – an ecosystem with plants and animals that may have scientific and natural interest. The documentation of these diverse species found within the fenced area and the nearby areas will add to the value of the site for eco-tourism. This may increase the number of people visiting the place not only to watch the rock art but at the same time appreciate the biodiversity of the site.

During the construction phase, the project will also create income-generating opportunities through job creation. The proposed physical activities are not sophisticated and do not involve complex systems. Therefore, the local community will be the immediate beneficiaries.

During the construction phase, the program will create new income-generating opportunities through job creation (direct and indirect). Approximately 50 new jobs will be created. This project will involve a need for unskilled or low-skilled labour and qualified technicians. The recruitment of labour, mainly unskilled, will be done at the local level, for civil engineering works and clearing of land, which will contribute to the drop in youth unemployment.

6.4. *Environmental Consideration in Rock Art Degradation*

6.4.1. *Possible source of the air-borne dust*

Modern research on the degradation of rock art establishes a strong connection between climate emergency – global warming in particular - and the fading away of many priceless rock arts around the world. Climate change is also recognized as one of the major drivers of land degradation which is a genuine problem in Somaliland. Deforestation and overgrazing lead to desertification while at the same time leading to changes in the local temperature and humidity.

Experience shows that areas with good vegetation cover play a crucial role in mitigating dust concentration by stabilizing the soil, reducing wind erosion, and trapping airborne particles (Chad 2025). However, over the past few decades in Somaliland, accelerated environmental degradation processes, deforestation, and overgrazing have resulted, among other things, in the thinning of land cover and therefore exposing the soil to the erosional processes of wind and water.

A question that can be raised is, ‘where does this dust originate from?’ The study team believes that this dust is transported from far-off distances in the *Ogo* plateau to the south of Laas Geel and as far as the severely degraded treeless plains of Qool-cadey and Gumburaha. In the past, those plains were covered with grasses and shrubs which are more effective than trees, in stopping erosion and soil transportation. As a result, these denuded land-surfaces, now with sparse vegetation, which have now turned into ‘dust bowl’ are subjected to the fierce south-westerly winds during the dry summer season (*Hagga*). The ensuing fine dust particles suspended in the air are transported to distant areas where they settle. This process

has also been highlighted in a recent report whereby, in poorly protected soils in semi-arid countries like Somaliland, the wind can mobilize fine sediments transported from long distance (Bruxelles & Gutherz, 2023). On the floor of one of the shelters of Laas Geel, the study team documented a layer of fine dust measuring three centimetres deep.



Figure 17: Dust sedimentation on the floor of one of the rock shelters of Laas Geel

Dust can be a significant factor in the deterioration of sheltered rock art, particularly through trampling of the floor sediment and archaeological excavations (Morwood 1994).

It is also worth noting that the terrain of Laas Geel which is rocky and gravelly, allows the minimum generation of local air-borne dust. On the other hand, while the improvement of vegetation cover of Laas Geel site is a positive development, not only as an unintended floral and faunal conservation measure but also contributing to minimizing locally generated dust.

6.4.2. Importance of Climate Monitoring

As climate change could lead to faster deterioration of rock art, it is very important to understand climate trends in Laas Geel area. Currently there is no weather monitoring station anywhere near Laas Geel. Therefore, to get consistent and reliable data on climate trends, it would be judicious to set up a weather station, which may be useful for valuable decision-making processes. The preliminary study carried out in 2023 by Bruxelles and Gutherz also underscored the importance of equipping the shelters with temperature and humidity probes.

6.4.3. Sustainability of the fencing

Fencing plays an important role in preserving the archaeological site by creating a physical barrier to restrict unauthorized access into the area. The main pressure on Laas Geel site emanates from livestock herders who have a semi-permanent presence in the vicinity of the site. When grazing and browsing materials are scarce, some community members are tempted

to let their livestock graze inside the protected area. Moreover, Laas Geel as an important livestock waterpoint, attracts livestock coming from far-flung areas as well as wildlife such as baboons, warthogs, etc. During the assessment, the EIA team noted several locations where the fencing was torn apart. Livestock droppings (excrement) were also seen strewn within the enclosed area.

Therefore, the durability and effectiveness of any fencing will depend on addressing the social aspect, which will either make or break the sustainability of the site. Interaction with the community should lead to ownership creation. The involvement of the district authorities and community elders is very crucial. Site by-laws, drafted by the MoTT in consultation with the local authority and the community, must be established.

On the other hand, the fence, in terms of design and materials, must be reinforced. Making the fencing more durable will not only stop site trespasses but also reduce future maintenance costs. Maintaining the distance between any two fence posts should not be more than 2.5 m. Moreover, the size of the fence posts should be strong enough to support the weight of a camel that may lean on the fence. In addition, the construction of a 60 cm rubble masonry wall all along the perimeter of the site could permanently stop access of livestock into the site and burrowing animals such as warthogs and tortoises that often break the fencing.

6.5. *Alternative Analysis*

There is a strong justification to go ahead with the implementation of the proposed activities. On one hand, the anticipated negative environmental impacts are insignificant. The components of the project are so specific and have been carefully analysed in terms of their actions and intended locations so that no alternatives are proposed. However, the proposed mitigation measures should be endorsed and implemented by the proponent.

7.0. IMPACT ASSESSMENT AND MITIGATION

7.1. *Air Quality*

The project area is pristine and there is minimal incidence of pollution in the area. The only form of air pollution is air-borne dust particles which peak during the summer. Pollution emanating from vehicular emissions and tyre dust is also negligible because the vehicles are parked outside the site.

The proposed project activities will not involve extensive digging and land disturbance. However, the accumulated dust on the floor of the painted rock shelter can be blown through human trampling.

Mitigation

-
- ***Dust has accumulated on the floors of the painted rock shelters. Gravel should be covered with gravel to stop dust from being kicked up and damaging the rock art.***
 - ***The vegetation plays a crucial role in trapping dust particles on their leaves; therefore, the intensification of vegetation cover in lowlands of Laas Geel massif should be encouraged. On the other hand, the effect of increasing vegetation (Cacti and Prosopis juliflora in particular) in proximity with the painted rock shelters should be studied and analysed.***
-

7.2. Water source and water quality

Water is a key resource in the project area. The shallow water of Laas Geel water point has been frequented by pastoralists for several millennia to water their livestock and collect for domestic use. The proposed project activities are limited in terms of temporal and spatial considerations. Garbage generated during the project period will need to be managed so as not to be a cause of surface contamination. The site staff draws water from a cemented shallow well protected from surface contamination, which was not functioning during the assessment. Livestock excreta (urine and faeces) were seen by the assessment team in the watercourse. This highlights the importance of making the protected shallow well functional.

Mitigation

-
- ***To handle surface water contamination, an efficient sanitation system should be put in place in the project site.***
 - ***The protected shallow well, fitted with a solar pump, which serve the water needs of the site staff and the visitors, is currently mal-functioning and should be repaired.***
-

7.3. Soil

No major earth disturbances are expected from the proposed project activities. The area is mainly gravelly and may have low soluble nutrient contents (nitrogen, sulphur and potassium). However, it supports diverse shrubs, grasses. and trees. During the construction phase, cement may be used in the fixing of the fence posts. The direct effect of cement on soil is the alkalization (elevated pH levels) and alteration of the chemical composition of the soil.

Mitigation

- ***Preparing cement mortar (mixing it with sand and water) directly on the soil can cause waterproofing of the soil, i.e., the loss of its capacity to infiltrate and retain water. Therefore, by using a barrier such as polyethylene sheet or iron sheet, the contact of mortar with cement can be avoided.***
-

7.4. Flora and Fauna

The restoration of the ecological environment of the site will contribute to the reduction of the deterioration processes of the rock art. In addition to this, the site will serve as a bio-reserve – an ecosystem with plants and animals that may have scientific and natural interest.

Mitigation

- ***The proliferation of alien invasive species such as cacti and prosopis juliflora in the vicinity of the rock art shelter must be controlled.***
 - ***Precautions must be taken in introducing new species into the site.***
 - ***Introduction of indigenous plant species that are declining in number or threatened in the wild must be encouraged.***
 - ***In removing and/or relocating faunal species such as birds that may damage or degrade the rock painting, care must be taken in the timing of the removal, which should be timed with when the fledglings are mature enough to fend for themselves.***
-

7.5. Visual Aesthetics

It is anticipated the proposed activities will have negligible impacts on the aesthetics of the pristine environment. No new buildings are proposed in the project. However, there may be residual waste resulting from the project operations.

Mitigation

- ***Building materials and building designs must be in line with the landscape.***
 - ***Construction workers should be made aware by the contractor of the adoption of zero-waste principle.***
 - ***Resultant residual waste must be properly disposed***
-

7.6. 'Relocation' of wildlife

Animals that are removed from their habitats may experience stress, starvation, and other adverse impacts in addition to being exposed to new predators. A disruption of the regular breeding calendar may also result from such an action.

Safe handling of wildlife for relocation requires certain skills and equipment (including personal protective equipment) which are not available in the country. Besides, the species of wildlife present in Laas Geel site are varied. They include birds, reptiles, mammals and insects. Health and physical risks such as zoonotic diseases and injuries/bites are also involved in any 'enforcement' operation. Also, the term 'relocation' alludes to somewhat known alternative sites, which is not the case in the current circumstance. Therefore, it can be realistic to suggest that only those species that are thought to be damaging the rock art be targeted. Here two bird species namely Ethiopian Swallow (*Hirundo aethiopica*) Large Rock Martin (*Ptyonoprogne fuligula*) that make mud nests in Laas Geel rock shelters. Artificial cup nests can be made and installed in rock shelters not containing any rock art and on the eaves of the few existing buildings in Laas Geel. Existing nests can be destroyed after fledgling which normally occurs 26-32 days after hatching.

As for wasp and hornet nest removal, eco-friendly (non-chemical) solutions for their control can be explored. These include soap and water solution, mothballs to be hung near the nests, essential oils, vinegar solutions. There is also a pair of Klipspringers (rock antelope) which do not pose any threat to the rock art, and therefore can be left alone unless they multiply, whereby an expert relocation to a suitable location or release into the wild will be required. Cheetah Conservation Fund (CCF), which is based in Somaliland, may be help in their relocation.

Mitigation

-
- ***The removal of wildlife should be prioritized and restricted to those species whose presence negatively impacts rock art.***
 - ***Artificial cup nests can be made and placed in rock shelters that do not contain rock art, as well as on the eaves of the few existing buildings in Laas Geel.***
 - ***Resultant residual waste must be properly disposed of.***
 - ***Use of eco-friendly solutions for the control of wasp and hornet nests.***
-

8.0. Environmental Management Plan (EMP)

By establishing and sustaining effective mitigation plans against negative environmental impacts that may arise during the project period, the objective of this plan is to reduce the adverse impacts on the environment. The activities listed here are those which the proponent plans to implement.

Activity/Aspects	Environmental Impacts	Environmental management measures	Monitoring indicators	Methods	Action carried by
Complete fencing of the site	Soil: Contact of cement mortar with soil can cause waterproofing and loss of soil capacity to infiltrate and retain water. This will also turn the soil into hard pan and barren spots.	Contact of mortar with soil can be avoided by using a barrier such as a polyethylene sheet or an iron sheet.	Presence and regeneration of flora on the disturbed grounds.	Site observation	EF
Construction/rehabilitation works	- Air/ land/ Noise - Erosion or compaction from machinery i.e. trucks loaded with construction material. - Waste generation - -	- Use environmentally friendly building practices. - Proper procurement planning by the contractor to minimize residual material and waste. - Use eco-friendly building materials. - Dispose of waste properly - Contractor vehicles properly maintained (to minimize air pollution. - Avoid hooting when not necessary. - Good housekeeping by the contractor throughout the construction phase.	Waste disposal points established and utilized.	Observation. Record maintaining material.	EF/ Contractor

Site cleaning campaigns to remove litter, debris, and invasive plant species that proliferate and displace native plant species leading to threatening local ecosystems.	- Areas near the painted rock shelters that are cleared from litter and invasive plants may be subject to dust generation which may impact the rock art.	- Use of gravel to stabilize the soil and to minimize dust from being kicked up on the surface of rock arts. - Proper disposal of the invasive cacti by burning in waste disposal pits to prevent it from re-growing.	Proliferation of invasive species are controlled. Waste disposal pits utilized.	Observation. Record maintaining material.	EF/ Contractor
Installation of solar lighting	Solar lighting is a renewable energy. Hence, no negative impacts are anticipated.	- Staff training on the proper care, operation and maintenance of the solar units including panel cleaning	- Cleaning sessions (twice per year) - Power output efficiency.	Observation.	EF / MoTT to ensure the same
Creation of access footpaths to shelters for use by visitors and site staff. These footpaths will be designed to minimize environmental disruption.	-				
Establishment of a parking area to accommodate the parking needs of visitors.	- Vegetation removal	The design and construct the parking are in a way it is in harmony with the surrounding area with the least cutting of trees.	Visitor and staff vehicles use the parking area.	Record maintaining material.	MoTT
Landscaping and rearranging of visitor circuit and paths.	- Landscaping and paths cause soil compaction and vegetation loss. - Paths can cause soil erosion and gully formation.	The footpaths can be designed in a way that reduces vegetation loss and soil erosion. The route should go over barren areas and at the same time meander to reduce the surface runoff power and hence reduce soil erosion and gully formation.	Walking is limited to a narrow area thus reducing trampling on vegetation.	Footpath condition reports and biodiversity surveys (when and if conducted).	EF/ MoTT/ Biodiversity experts.

Equipping management offices, guard rooms, and restrooms.	- Cheap and low durability equipment can end up in waste too soon.	Resultant waste can be reduced by procuring durable equipment and materials.	Physical verification of the equipment and furniture	Observation and record maintaining material.	EF/ MoTT
Installation of new explanatory panels and wall banners	_____ ditto _____	_____ ditto _____	_____ ditto _____	_____ ditto _____	_____ ditto _____

9.0. CONCLUSIONS AND RECOMMENDATIONS

8.1. *Conclusions*

- The environmental condition of Laas Geel rock art site has improved since the original fencing was put in place in 2019. In a matter of eight years, the number of plant species recorded within the fenced area has jumped from 46 to 113. Except for a few introduced species (3%), the remaining number is a result of natural regeneration. Generally, soil acts as a seed bank and some seeds can persist underground for decades and germinate with the presence of all the necessary conditions (temperature, humidity, oxygen, and light).
- The impact characterization and analysis of the proposed project activities show that their negative impacts are insignificant. On the contrary, it is anticipated that the environmental condition of the site will further be enhanced. Installation of a more durable fencing will limit access of browsers and grazers, hence a further improvement in the vegetation cover. Rearrangement of the stairs/ramps will be more user-friendly and possibly improve access for the elderly visitors. Marked trails with proper signage to guide visitors will minimize trampling which can break young plants and reduce vegetation cover. The use of sustainable exterior solar-powered-lighting around the key areas of Laas Geel site is another environmentally friendly initiative.

8.2. *Recommendations*

The protection of Laas Geel Rock Art site is essential for preserving humanity's shared heritage values, historical knowledge and ecological integrity. The site has irreplaceable records of ancient expression, belief systems, and lifeways, often dating back thousands of years, thus protection of such sites is important for both current and future generations and for the sustainability of global heritage as well. The protection and safeguarding of this site is not just about conserving art, it is about honouring the stories, identities, and environmental values that have shaped human civilization across time.

However, the protection of Laas Geel rock Art site needs to involve a careful balance between conservation, education, access, and cultural sensitivity. While noting the significant positive impacts resulting from the project include the local economy growth through eco-tourism, improvement of biodiversity and ecosystem services, as well as preserving the culture and heritage values possessed by Laas Geel as such, there is strong recommendation to go ahead to project implementation.

Effective protection of Laas Geel Rock Art site requires the integration of legal, physical safeguards, community involvement, scientific research, and public education initiatives. Respect for indigenous custodianship and cultural values must remain central to any conservation strategy. Apart from the mitigation measures proposed, below are some of the key recommendations to be considered throughout the project implementation.

8.2.1. *Recommendations for Expertise France*

- a) To stop the accumulated dust on the floor of the painted rock shelters from being kicked up and damaging the rock art, a layer of gravel can be spread on the floor. The gravel may also prevent small insects from burrowing into the dust and safely staying there and breeding.
- b) Remove the invasive species (cacti species and *Prosopis juliflora*) in the vicinity of the painted rock shelters and encourage the natural recruitment of local shrubs.
- c) The fence installation work may warrant the use of cement mortar. Direct contact of cement with soil can cause waterproofing and loss of soil capacity to infiltrate and retain water. Therefore, by using a barrier such as a polyethylene sheet or an iron sheet, the contact of mortar with cement can be avoided.
- d) In removing and /or relocating faunal species such as birds that may damage or degrade the rock painting, care must be taken to time it with when the fledglings are mature enough to fend for themselves. (See section 7.6 for details).
- e) Water is a key resource in the project area. The shallow water of Laas Geel water point has been frequented by pastoralists for several millennia to water their livestock and collect for domestic use. Garbage generated during the project period will need to be managed so as not to be a cause of surface contamination.
- f) Through the planned activities, the wire fencing is expected to be installed for the third time in not more than a decade's time. The damage to the fence generally emanates from the pastoral households in the vicinity of the site who want to graze their animals in the protected area. Therefore, unless this social issue is addressed in collaboration with the district officers, the community, and the relevant government ministries, the problem will continue to recur.
- g) Use of locally available construction material that matches with the features of the site.
- h) The durability and effectiveness of any fencing will depend on addressing the social aspect, which can either make or break the sustainability of a given project. Interaction with the community should lead to ownership creation. The involvement of the district authorities and community elders is very crucial. Site by-laws, drafted by the MoTT in consultation with the local authority and the community, must be established.

8.2.2. *General recommendations for Laas Geel site sustainability*

- a) Precautionary approach to species introduction (floral and faunal) to avoid noxious or invasive species recruitment in the site.
- b) The site can serve as a refuge for indigenous plant species that are threatened in the wild. Therefore, the MoTT can collaborate with the MoECC in the introduction of plant species that may have been threatened in the wild. All introductions must be restricted to indigenous species.
- c) As climate change could lead to faster deterioration of rock art, it is very important to understand climate trends in Laas Geel area. Currently there is no weather monitoring station anywhere near Laas Geel. Therefore, to get consistent and reliable data on climate trends, it would be judicious to set up a weather station, which may be useful for valuable decision-making processes. On this matter, the MoTT can collaborate with the Ministry of Agricultural Development who

manages weather stations in many parts of the country. Equipping the shelters with temperature and humidity probes can also suffice the purpose.

- d) There is a need to improve interpretive signage, visitor centres, and guided tours to educate the public about the cultural and scientific importance of the site.
- e) A participatory conservation approach must be applied by involving the local community in every step of the project, creating ownership, and leveraging their potential for better protection and conservation of the site and the ambient environment.
- f) The enforcement bodies must put in place strict penalties for vandalism and damage to the environmental and physical features in the site.
- g) The fence, in terms of design and materials, must be reinforced. Making the fencing more durable will not only stop site trespasses but also reduce future maintenance costs. The distance between any two fence posts should not be more than 2.5 m. Moreover, the size of the fence posts should be strong enough to support the weight of a camel that may lean on the fence. In addition, the construction of a 60 cm rubble masonry wall all along the perimeter of the site could permanently stop access of livestock into the site and burrowing animals such as warthogs and tortoises that often break the fencing.

9.0. APPENDICES

Appendix A: Complete list of amphibians and reptiles recorded in LG and observed by the author during the field survey or potentially present in neighbouring areas (approximately within a 5 km radius). For all species, global categorization according to IUCN Red List is given and it is stated how common they are in Somaliland (column ‘Status’). The IUCN Red List status for *Psammophis trivirgatus* is the one currently listed for *P. punctulatus*. Šmíd et al. (2023) recently elevated *P. trivirgatus* to a separate species, originally classified as a subspecies of *P. punctulatus*. The IUCN Red List status for *Boaedon broadleyi* is missing, because this species has only recently been described (Hallermann & Hawlitschek 2025) as a new species. The column ‘Endemicity’ indicates if species or subspecies is endemic to Somaliland and its immediate surroundings.

Order	Family	Common Name	Latin Name	Status	Endemicity	IUCN Status
Anura	Bufonidae	Dodson’s Toad	<i>Sclerophrys dodsoni</i>	Common	No	Least Concern
	Pyxicephalidae	Kachowski’s Sand Frog	<i>Tomopterna kachowskii</i>	Common	No	Least Concern
	Ptychadenidae	Anchieta’s Rocket Frog	<i>Ptychadena anchietae</i>	Fairly common	No	Least Concern
Testudines	Testudinidae	Leopard Tortoise	<i>Stigmochelys pardalis</i>	Locally common	No	Least Concern
	Pelomedusidae	Somali Helmeted Terrapin	<i>Pelomedusa somalica</i>	Common	yes	Least Concern
Squamata / Sauria	Gekkonidae	Enigmatic Gecko	<i>Hemidactylus barodanus</i>	Locally common	Yes	Least Concern
		Citerni’s Gecko	<i>Hemidactylus citernii</i>	Common	Yes	Least Concern
		Somaliland Ground Gecko	<i>Hemidactylus ophioleoides</i>	Uncommon	Yes	Least Concern
		North Somali House Gecko	<i>Hemidactylus pauciporosus</i>	Common	Yes	Least Concern
		Red Sea Gecko	<i>Hemidactylus robustus</i>	Common, Alien	No	Least Concern
	Sphaerodactylidae	Cross-marked Semaphore Gecko	<i>Pristurus crucifer</i>	Common	No	Least Concern
		Rüppell’s Semaphore Gecko	<i>Pristurus flavipunctatus</i>	Common	No	Least Concern
	Phyllodactylidae	White-spotted Wall Gecko	<i>Tarentola annularis annularis</i>	Common	No	Least Concern
	Agamidae	Robecchi’s Agama	<i>Agama robecchii</i>	Uncommon	Yes	Least Concern
		Rüppell’s Agama	<i>Agama rueppelli rueppelli</i>	Common	No	Least Concern
		Somali Rock Agama	<i>Agama somalica</i>	Very common	Yes	Least Concern
		Taylor’s Strange Agama	<i>Xenagama taylori</i>	Locally common	Yes	Least Concern
	Scincidae	Ragazzi’s Bronze Skink	<i>Chalcides ragazzii</i>	Common	Yes	Least Concern
		Somali Writhing Skink	<i>Mochlus somalicus</i>	Fairly common	Yes	Least Concern
		Five-lined Skink	<i>Trachylepis quinquetaeniata quinquetaeniata</i>	Common	No	Least Concern
	Lacertidae	Révoil’s Long-tailed Lizard	<i>Latastia longicaudata revouli</i>	Common	Yes	Least Concern
		Blanford’s Sand Lizard	<i>Pseuderemias mucronata</i>	Very common	No	Least Concern
	Varanidae	White-throated Savanna Monitor	<i>Varanus albigularis microstictus</i>	Fairly common	No	Least Concern
Squamata / Serpentes	Leptotyphlopidae	Cairo Worm Snake	<i>Myriopholis cairi</i>	Uncommon	No	Least Concern
		Nurse’s Worm Snake	<i>Myriopholis nursii</i>	Uncommon	No	Least Concern
		Boettger’s Cliff Racer	<i>Platyceps rhodorachis subniger</i>	Common	No	Least Concern
		African Large-eyed Cat Snake	<i>Telescopus obtusus</i>	Common	No	Least Concern
	Lamprophiidae	Broadley’s House Snake	<i>Boaedon cf. broadleyi</i>	Common	No	Not assessed
		Flat-snouted Wolf Snake	<i>Lycophidion depressirostre</i>	Uncommon	No	Least Concern
	Psammophiidae	Tanganyika Sand Snake	<i>Psammophis tanganicus</i>	Common	No	Least Concern
		Northern Speckled Sand Snake	<i>Psammophis trivirgatus</i>	Very common	No	Least Concern
		Red-spotted Beaked Snake	<i>Rhamphiophis rubropunctatus</i>	Very common	No	Least Concern
	Elapidae	Red Spitting Cobra	<i>Naja pallida</i>	Very common	No	Least Concern
	Viperidae	Somali Puff Adder	<i>Bitis arietans somalica</i>	Common	No	Least Concern

Appendix B: Complete list of amphibians and reptiles recorded in study area of Laas Geel by the authors during the field surveys (2010-2025). The column 'Status' states how common are in the study area of LG.

Order	Family	Common Name	Latin Name	Habitat
Anura	Bufonidae	Dodson's Toad	<i>Sclerophrys dodsoni</i>	Aquatic
	Pyxicephalidae	Kachowski's Sand Frog	<i>Tomopterna kachowskii</i>	Aquatic
Testudines	Testudinidae	Leopard Tortoise	<i>Stigmochelys pardalis</i>	Open savanna
	Pelomedusidae	Somali Helmeted Terrapin	<i>Pelomedusa somalica</i>	Aquatic
Squamata	Gekkonidae	Enigmatic Gecko	<i>Hemidactylus barodanus</i>	Rocks, buildings
		Citerni's Gecko	<i>Hemidactylus citernii</i>	Open savanna
		Somaliland Ground Gecko	<i>Hemidactylus ophiolepidoides</i>	Open savanna
		North Somali House Gecko	<i>Hemidactylus pauciporosus</i>	Buildings
		Red Sea Gecko	<i>Hemidactylus robustus</i>	Buildings
	Sphaerodactylidae	Cross-marked Semaphore Gecko	<i>Pristurus crucifer</i>	Open savanna
		Rüppell's Semaphore Gecko	<i>Pristurus flavipunctatus</i>	Trees, Rocks
	Phyllodactylidae	White-spotted Wall Gecko	<i>Tarentola annularis annularis</i>	Open savanna, Rocks
		Robecchi's Agama	<i>Agama robecchii</i>	Open savanna
	Agamidae	Rüppell's Agama	<i>Agama rueppelli rueppelli</i>	Open savanna
		Somali Rock Agama	<i>Agama somalica</i>	Rocks
		Taylor's Strange Agama	<i>Xenagama taylori</i>	Open savanna
	Scincidae	Ragazzi's Bronze Skink	<i>Chalcides ragazzii</i>	Open savanna
		Five-lined Skink	<i>Trachylepis quinquetaeniata quinquetaeniata</i>	Rocks
	Lacertidae	Révoil's Long-tailed Lizard	<i>Latastia longicaudata revoili</i>	Open savanna
		Blanford's Sand Lizard	<i>Pseuderemias mucronata</i>	Open savanna

Appendix C: Complete list of amphibians and reptiles recorded in Laas Geel and observed by the authors during the field surveys in neighbouring areas (approximately within a 5 km radius). The column entitled 'Habitat' shows the preference of each species for different microhabitat/s in study area.

Order	Family	Common Name	Latin Name	Status
Anura	Bufonidae	Dodson's Toad	<i>Sclerophrys dodsoni</i>	Common
	Pyxicephalidae	Kachowski's Sand Frog	<i>Tomopterna kachowskii</i>	Common
Testudines	Testudinidae	Leopard Tortoise	<i>Stigmochelys pardalis</i>	Fairly common
	Pelomedusidae	Somali Helmeted Terrapin	<i>Pelomedusa somalica</i>	Common
Squamata / Sauria	Gekkonidae	Enigmatic Gecko	<i>Hemidactylus barodanus</i>	Very common
		Citerni's Gecko	<i>Hemidactylus citernii</i>	Common
		Red Sea Gecko	<i>Hemidactylus robustus</i>	Common
		Rüppell's Semaphore Gecko	<i>Pristurus flavipunctatus</i>	Common
	Phyllodactylidae	White-spotted Wall Gecko	<i>Tarentola annularis annularis</i>	Uncommon
	Agamidae	Rüppell's Agama	<i>Agama rueppelli rueppelli</i>	Uncommon
		Somali Rock Agama	<i>Agama somalica</i>	Very common
		Five-lined Skink	<i>Trachylepis quinquetaeniata quinquetaeniata</i>	Common
	Lacertidae	Révoil's Long-tailed Lizard	<i>Latastia longicaudata revoili</i>	Fairly common
		Blanford's Sand Lizard	<i>Pseuderemias mucronata</i>	Uncommon

Appendix D: Birds seen in Laas Geel Area

Birds seen in Laas Geel Area

IUCN red data list status is also given: LC = least concern, NT = near threatened, VU = vulnerable, NE = not evaluated.

	Family	ScientificName	Common name	IUCN status
1	ACCIPITRIDAE	<i>Circaetus pectoralis</i>	Black-chested snake eagle	NE
2	ACCIPITRIDAE	<i>Melierax poliopterus</i>	Eastern chanting Goshawk	LC
3	ACROCEPHALIDAE	<i>Hippolais languida</i>	Upcher's Warbler	LC
4	ALAUDIDAE	<i>Ammomanes deserti</i>	Desert Lark	LC
5	ALAUDIDAE	<i>Mirafrja gilletti</i>	gilletti's Lark	LC
6	CHARADRIIDAE	<i>Charadrius tricollaris</i>	African Three-banded Blover	LC
7	CISTICOLIDAE	<i>Prinia rufifrons</i>	Red-fronted Prinia	LC
8	COLUMBIDAE	<i>Columba guinea</i>	Speckled Pigeon	LC
9	COLUMBIDAE	<i>Streptopelia capicola</i>	Ring-necked Dove	LC
10	CORVIDAE	<i>Corvus capensis</i>	Cape Crow	LC
11	EMBERIZIDAE	<i>Fringillaria polioptera</i>	Somali Bunting	NE
2	ESTRILDIDAE	<i>Euodice cantans</i>	African Silverbill	LC
13	FRINGILLIDAE	<i>Crithagra dorsostrata</i>	White-bellied Canary	LC
14	HIRUNDINIDAE	<i>Ptyonoprogne fuligula</i>	Large Rock Martin	LC
15	HIRUNDINIDAE	<i>Hirundo aethiopica</i>	Ethiopian Swallow	LC
16	MALACONOTIDAE	<i>Laniarius funebris</i>	Slate-coloured Boubou	LC
17	MALACONOTIDAE	<i>Nilaus afer</i>	Brubru	LC
18	MUSCICAPIDAE	<i>Bradornis microrhynchus</i>	African grey Flycatcher	LC
19	MUSCICAPIDAE	<i>Cercotrichas leucophrys</i>	White-browed Scrub Robin	LC
20	MUSCICAPIDAE	<i>Oenanthe deserti</i>	Desert Wheatear	LC
21	MUSCICAPIDAE	<i>Oenanthe lugubris</i>	Abyssinian Wheatear	LC
22	MUSCICAPIDAE	<i>Oenanthe melanura</i>	Blackstart	LC
23	MUSCICAPIDAE	<i>Oenanthe phillipsi</i>	Somali Wheatear	LC
24	MUSOPHAGIDAE	<i>Criniferoides leucogaster</i>	White-bellied Go-away-bird	LC
25	NECTARINIIDAE	<i>Cinnyris venustus</i>	Variable Sunbird	LC
26	PASSERIDAE	<i>Gymnoris pyrgita</i>	Yellow-spotted Bush-sparrow	LC
27	PASSERIDAE	<i>Passer griseus</i>	Northern Gre-headed Sparrow	LC
28	PHOENICULIDAE	<i>Rhinopomastus minor</i>	Abyssinian Scimitarbill	LC
29	PICIDAE	<i>Dendropicos fuscescens</i>	Cardinal Woodpecker	LC
30	PYCNONOTIDAE	<i>Pycnonotus barbatus somaliensis</i>	Common Bulbul	LC
31	SYLVIIDAE	<i>Sylvia leucomelaena</i>	Arabian Warbler	LC
32	GLAREOLIDAE	<i>Cursorius cursor</i>	Cream-coloured Crouser	LC

Appendix E: List of floral species found in Laas Geel Rock Art Site

List of floral species found in Laas Geel Rock Art Site

IUCN red data list status is also given: LC = least concern, NT = near threatened, VU = vulnerable, NE = not evaluated.

#	Genus and Species	Family	Vernacular name	IUCN RedList	Notes
1	<i>Blepharis boranensis</i>	Acanthaceae	Geed-qodxeed	NE	
2	<i>Hypoestes forskalii</i>	Acanthaceae	Geeda-waraabe	NE	
3	<i>Justicia sp.</i>	Acanthaceae	Buuxiso	NE	
4	<i>Ruellia sp.</i>	Acanthaceae	Geed-cad	NE	
5	<i>Schinus molle</i>	Anacardiaceae	Mirimiri	LC	Introduced
6	<i>Phoenix dactylifera</i>	Arecaceae	Timir	LC	Introduced
7	<i>Aizoon canariense</i>	Aizoaceae	Gusungus	NE	
8	<i>Aerva javanica</i>	Amaranthaceae	Soonah	NE	
9	<i>Chionothrix somalensis</i>	Amaranthaceae	Xagan; Xagan-geel	NE	
10	<i>Halothamnus somalensis</i>	Amaranthaceae	Margiya-daalis	NE	
11	<i>Ouret lanata</i>	Amaranthaceae	Wancad	NE	
12	<i>Pupalia robecchii</i>	Amaranthaceae	Maraboob	NE	
13	<i>Blyttia fruticulosa</i>	Apocynaceae	Geesa-riyaad	NE	
14	<i>Desmidorchis penicillata</i>	Apocynaceae	Ubaateys	NE	
15	<i>Monolluma socotrana</i>	Apocynaceae	Gowracato	NE	
16	<i>Echidnopsis dammanniana</i>	Apocynaceae	Xaadoole	NE	
17	<i>Glossonema revoilii</i>	Apocynaceae	Sobkax	NE	
18	<i>Pergularia daemia</i>	Apocynaceae	Casuuro	NE	
19	<i>Aloe megalacantha</i>	Asphodelaceae	Dacar-dhegweyn	NE	
20	<i>Iphionopsis rotundifolia</i>	Asteraceae	Gagabood	NE	
21	<i>Kleinia odora</i>	Asteraceae	Godor	NE	
22	<i>Launaea sp.</i>	Asteraceae	Burdad	NE	
23	<i>Vernonia cinerascens</i>	Asteraceae	Hiil	NE	
24	<i>Diceratella incana</i>	Brassicaceae	Foodcadde	NE	
25	<i>Tecoma stans</i>	Bignoniaceae	Tikooma	LC	Introduced
26	<i>Commiphora gileadensis</i>	Burseraceae	Dhasayno	NE	
27	<i>Commiphora myrrha</i>	Burseraceae	Dhiddin	NE	
28	<i>Opuntia dillenii</i>	Cactaceae	Tiin-qodaxyare	NE	
29	<i>Opuntia ficus-indica</i>	Cactaceae	Tiin-qodxaale	NE	Invasive
30	<i>Opuntia stricta</i>	Cactaceae	Tiin-qodaxbadane	NE	Invasive
31	<i>Cadaba farinosa</i>	Capparaceae	Dhiitacab	NE	
32	<i>Capparis cartilaginea</i>	Capparaceae	Qox	NE	
33	<i>Maerua crassifolia</i>	Capparaceae	Jiic	NE	
34	<i>Maerua sp.</i>	Capparaceae	Qalanbooli	NE	
35	<i>Maerua sessiliflora</i>	Capparaceae	Qalaanqal/ Jiic	NE	
36	<i>Maytenus undata</i>	Celastraceae	Sarad	LC	(local endangered)
37	<i>Cleome brachycarpa</i>	Cleomaceae	Dufanood	NE	
38	<i>Combretum sp.</i>	Combretaceae	Cobol	NE	
39	<i>Commelina sp.</i>	Commelinaceae	Baar	NE	
40	<i>Hildebrandtia somalensis</i>	Convolvulaceae	Daanyo	NE	

41	<i>Ipomoea cicatricosa</i>	Convolvulaceae	Waxara-waalis	NE	
42	<i>Ipomoea donaldsonii</i>	Convolvulaceae	Bulumbul	NE	
43	<i>Seddera latifolia</i>	Convolvulaceae	Nagaadh	NE	
44	<i>Kalanchoe sp.</i>	Crassulaceae	Kabaqor	NE	
45	<i>Cucumis sp.</i>	Cucurbitaceae	Qambool	NE	
46	<i>Tragia pungens</i>	Euphorbiaceae	Gubtanhanyo	NE	
47	<i>Crotalaria dumosa</i>	Fabaceae	Nagaadh	NE	
48	<i>Delonix elata</i>	Fabaceae	Lebi	NE	
49	<i>Indigofera hochstetteri</i>	Fabaceae	Jillab	NE	
50	<i>Indigofera spiniflora</i>	Fabaceae	Majin	NE	
51	<i>Indigofera spinosa</i>	Fabaceae	Xajiin	NE	
52	<i>Indigofera suaveolens</i>	Fabaceae	Qaansoole	NE	
53	<i>Prosopis juliflora</i>	Fabaceae	Garanwaa	NE	Invasive
54	<i>Senegalia senegal</i>	Fabaceae	Cadaad	NE	
55	<i>Tephrosia lortii</i>	Fabaceae	Xajiin	NE	
56	<i>Vachellia bussei</i>	Fabaceae	Galool	NE	
57	<i>Vachellia horrida</i>	Fabaceae	Sarmaan	NE	
58	<i>Tamarindus indica</i>	Fabaceae	Xamar	LC	Introduced
59	<i>Vachellia tortilis</i>	Fabaceae	Qudhac	NE	
60	<i>Vachellia nilotica</i>	Fabaceae	Tugaar	LC	Introduced
61	<i>Leucaena leucocephala</i>	Fabaceae	Xoola-naaxiye	LC	Introduced
62	<i>Endostemon sp.</i>	Lamiaceae	Reexaan	NE	
63	<i>Leucas sp</i>	Lamiaceae	Geed-xajiin	NE	
64	<i>Ocimum americanum</i>	Lamiaceae	Reexaan	NE	
65	<i>Ocimum forskoolii</i>	Lamiaceae	Maraboob	NE	
66	<i>Premna resinosa</i>	Lamiaceae	Dhuumood	LC	
67	<i>Lowsonia inermis</i>	Lythraceae	Cillaan	LC	
68	<i>Abutilon fruticosum</i>	Malvaceae	Wancad	NE	
69	<i>Abutilon graveolens</i>	Malvaceae	Balanbaal	NE	
70	<i>Grewia erythraea</i>	Malvaceae	Midhcaanyo	NE	
71	<i>Grewia tenax</i>	Malvaceae	Dhafaruur	LC	
72	<i>Grewia villosa</i>	Malvaceae	Gomoshaa	NE	
73	<i>Hibiscus micranthus</i>	Malvaceae	Midha-geeljire	NE	
74	<i>Hibiscus somalensis</i>	Malvaceae	Midha-geeljire	NE	
75	<i>Pavonia zeylanica</i>	Malvaceae	Xajiin	NE	
76	<i>Sida ovata</i>	Malvaceae	Yagar-geel	NE	
77	<i>Azadirachta indica</i>	Meliaceae	Geed-hindi	LC	Introduced
78	<i>Turraea parvifolia</i>	Meliaceae	Dhumay	NE	
79	<i>Ficus populifolia</i>	Moraceae	Nidiq	NE	
80	<i>Ficus vasta</i>	Moraceae	Berde	NE	Introduced
81	<i>Ficus sycamorus</i>	Moraceae	Daray	LC	Introduced
82	<i>Eucalyptus camaldulensis</i>	Myrtaceae	Baxrasaaf	LC	Introduced
83	<i>Boerhavia diffusa</i>	Nyctaginaceae	Cayo	NE	
84	<i>Commicarpus helenae</i>	Nyctaginaceae	Geed-irmaan	NE	
85	<i>Andrachne somalensis</i>	Phyllanthaceae	?	NE	
86	<i>Andropogon kelleri</i>	Poaceae	Duur	NE	

87	<i>Aristida adscensionis</i>	Poaceae	Ibatiiti	NE
88	<i>Brachiaria leersioides</i>	Poaceae	Cgaar	NE
89	<i>Cymbopogon commutatus</i>	Poaceae	Hadaf	NE
90	<i>Cymbopoganschoenanthus</i>	Poaceae	Caws-dameer	NE
91	<i>Dactyloctenium aegyptium</i>	Poaceae	Saddexo	NE
92	<i>Melinis sp.</i>	Poaceae	Ramaas-buur	NE
93	<i>Sehima nervosum</i>	Poaceae	Caws-guduud	NE
94	<i>Tetrapogon tenellus</i>	Poaceae	Ayax-ma-kare	NE
95	<i>Tricholaena teneriffae</i>	Poaceae	Cagaar	NE
96	<i>Urochloa</i>	Poaceae	Baldhoole	NE
97	<i>Urochloa xantholeuca</i> var. <i>leucacantha</i>	Poaceae	Baldhoole-cagaar	NE
98	<i>Ochradenus baccatus</i>	Resedaceae	Mirrow	LC
99	<i>Ziziphus mauritiana</i>	Rhamnaceae	Gob	LC
100	<i>Conostomium longitubum</i>	Rubiaceae	Barakow-aleenle	NE
101	<i>Pyrostria phyllanthoidea</i>	Rubiaceae	Qoodhe-orgi	VU
102	<i>Salvadora persica</i>	Salvadoraceae	Caday	LC
103	<i>Osyris lanceolata</i>	Santalaceae	Casaaso	LC
104	<i>Solanum schimperianum</i>	Solanaceae	Kariir	LC
105	<i>Solanum somalense</i>	Solanaceae	Mooh	LC
106	<i>Withania sphaerocarpa</i>	Solanaceae	Geed-laan	NE
107	<i>Lippia carviadora</i>	Verbenaceae	Geed-xamar	NE
108	<i>Cissus rotundifolia</i>	Vitaceae	Carmo	LC
109	<i>Balanites aegyptiaca</i>	Zygophyllaceae	Quud	LC
110	<i>Balanites glabra</i>	Zygophyllaceae	Kidi	LC
111	<i>Tribulus terrestris</i>	Zygophyllaceae	Gocondho	LC
112	<i>Anacampseros vespertina</i>	<i>Anacampserotaceae</i>	Dhaaraan	NE
113	<i>Sterculia africana</i>	<i>Sterculiaceae</i>	Qarari	LC

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