
TULU MOYE GEOTHERMAL PROJECT RAPID BIODIVERSITY STUDY REPORT

Prepared for



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LIST OF ACRONYMS

AZE	Alliance for zero extinction
CBD	Convention on Biological Diversity
CITES	Convention on international trade in endangered species
GIS	Global Information System
GN	General Notes
GPS	Global positioning System
Herpetofauna	Reptiles and Amphibians
IBA	Important Bird area
IFC	International Finance corporation
IUCN	International union for conservation of nature
KBA	Key Biodiversity Area
RG	Reykjavik Geothermal
MWe	Megawatt energy

Therefore, Hitosa Woreda environment, forest and climate change office and Hitosa Woreda administration and relevant offices have to take immediate measure to control expansion of farming activities at the expense of destroying the natural forest and displacing wild animals.

Regarding bird species, White-backed Vulture, Hooded Vulture and Ruppell's Vulture which are categorized as critically endangered, Lappet-faced Vulture which is categorized as endangered and Pallid Harrier which is categorized as near threatened bird species - were not all seen during the study period but confirmed as residents of the project area through secondary sources. These vultures are either opportunistic scavengers or flying across the area and are not utilizing the area permanently for food, shelter and as breeding ground. These bird species are also not a concern to Ethiopia. The African vultures as a whole are in good status in Ethiopia despite their threat concern in many parts of Africa.

Even though Gnaro Lava Field may be a candidate as an Important Bird Area (IBA) with a total of 18 records of biome affiliated birds it is not significant number and there is no restricted range species or congregations of any sort of migratory birds that provides the site more focus to qualify as an IBA.

The current survey in Herpetofauna has enabled to recognize the occurrence of at least a few species of amphibians and reptiles at Tulu Moye area. Potential occurrence of more species of herps is very likely, as snakes and other reptiles in particular could be less active during the relatively cold rainy season. Endemics, threatened species or illegally traded frogs and reptiles were not recorded in the study area. However, the planned development of the area for geothermal use will have to consider availability of safe micro-habitats for breeding of amphibians (that are less mobile and highly sensitive for dehydration) and less agile species of reptiles.

1 INTRODUCTION

1.1 Study Background

Ethiopia has identified several sites in the rift valley area that have great potential for the production of geothermal energy. Over the last decade geothermal energy development projects have started exploration and production in East Arsi zone. Reykjavik Geothermal, an Iceland based company, is developing geothermal energy in Oromia region, Arsi zone, Hitosa Woreda (district), Tulu Moye area based on an agreement made with the Government of Ethiopia. Up to 3-500 MWe power installation is planned within the Tulu Moye geothermal area (the Project). The Project will be developed in two phases: the first phase will include exploration drilling, production drilling, well/drill pads, access road(s), water supply, quarries, pipeline(s), and up to a 100 MWe power installation. The second phase will involve expansion of power installation from 100 MWe up to 300 MWe, with potential of 500 MWe.

Energy exploration in many parts of the world has resulted in environmental changes, with significant local and regional impacts. Biodiversity is one of the environmental sector that could be affected by energy extraction projects. The impacts could be due to habitat loss and degradation, habitat fragmentation, loss of species, impairment of ecological processes, and introduction of alien invasive species.

Geothermal development activities mostly affect vegetation by gaseous emissions, physical removal of vegetation to pave way for roads, drilling pads, and buildings and hot or cold geothermal brine flowing on the surface (Jennifer 2010).

1.2 Project Location

The Tulu Moye geothermal prospect is located about 100 km south east of Addis Ababa, with Lake Koka to the north and Lake Ziway to the south. The initial location of exploration wells is about 40 km south of Adama City, about 24 km north of Assela and about 11 km from the town of Iteya.

1.3 Scope of works

Baseline biodiversity study has been conducted on the larger Project area. The Rapid (follow-up) biodiversity study focused only on the Gnaro lava field and surrounding areas and will attempt to update the survey findings of the original baseline study. It also gives emphasis to investigate and cover species possibly not found in the original baseline study on biological environment.

The Gnaro lava field lies mostly within the Tulu Moye kebele (also referred to as Tero Moye kebele). North of Gnaro lies Tero Desta kebele and Anole kebele to the east.

1.4 Objective of the rapid biodiversity study

To carry out follow-up rapid Biodiversity Study on plants, mammals, birds, and Herpetofauna (reptiles and amphibians) around recently defined drilling area in and around the Gnaro lava field during the wet-season.

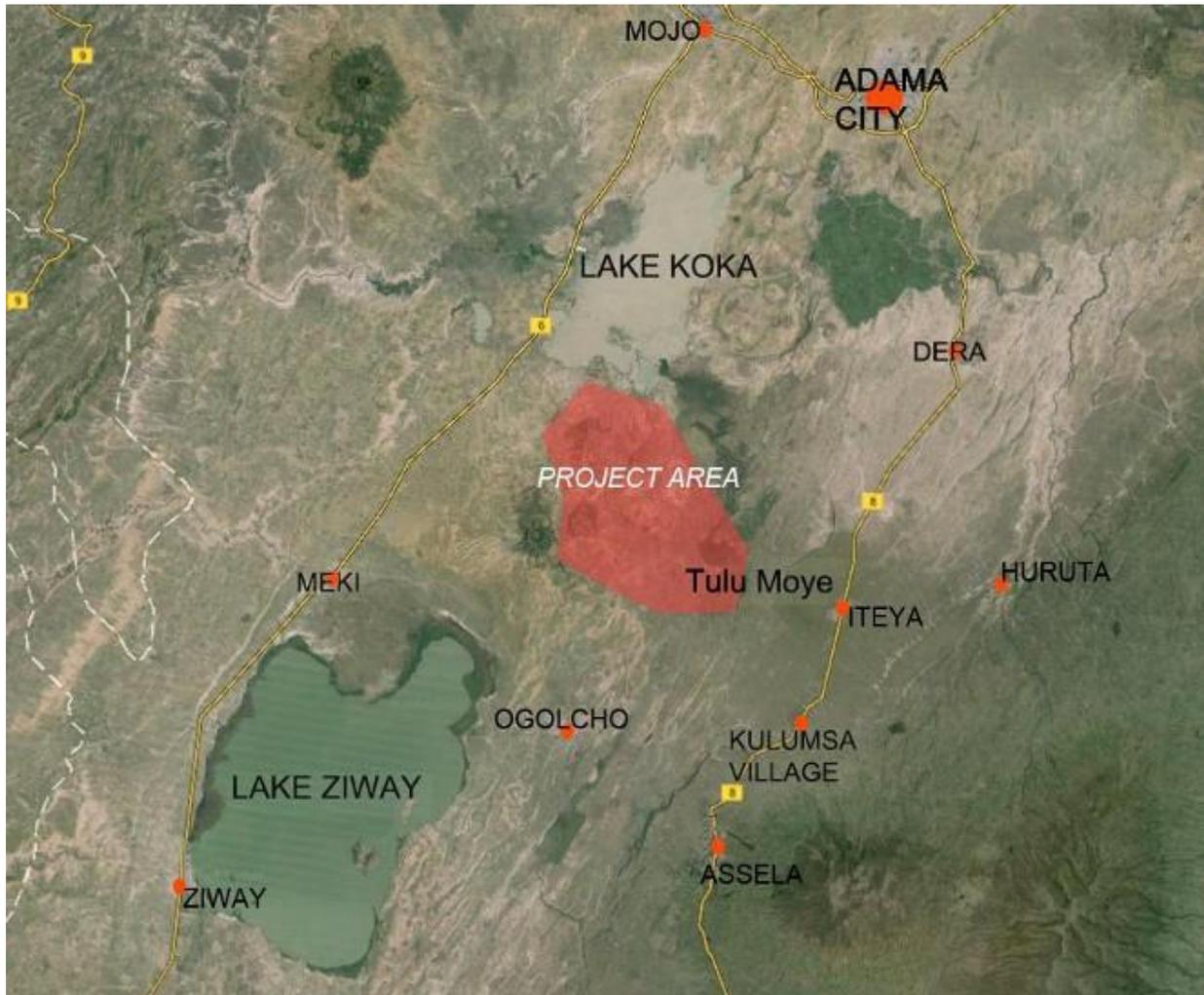


Figure 1-1: Project location.

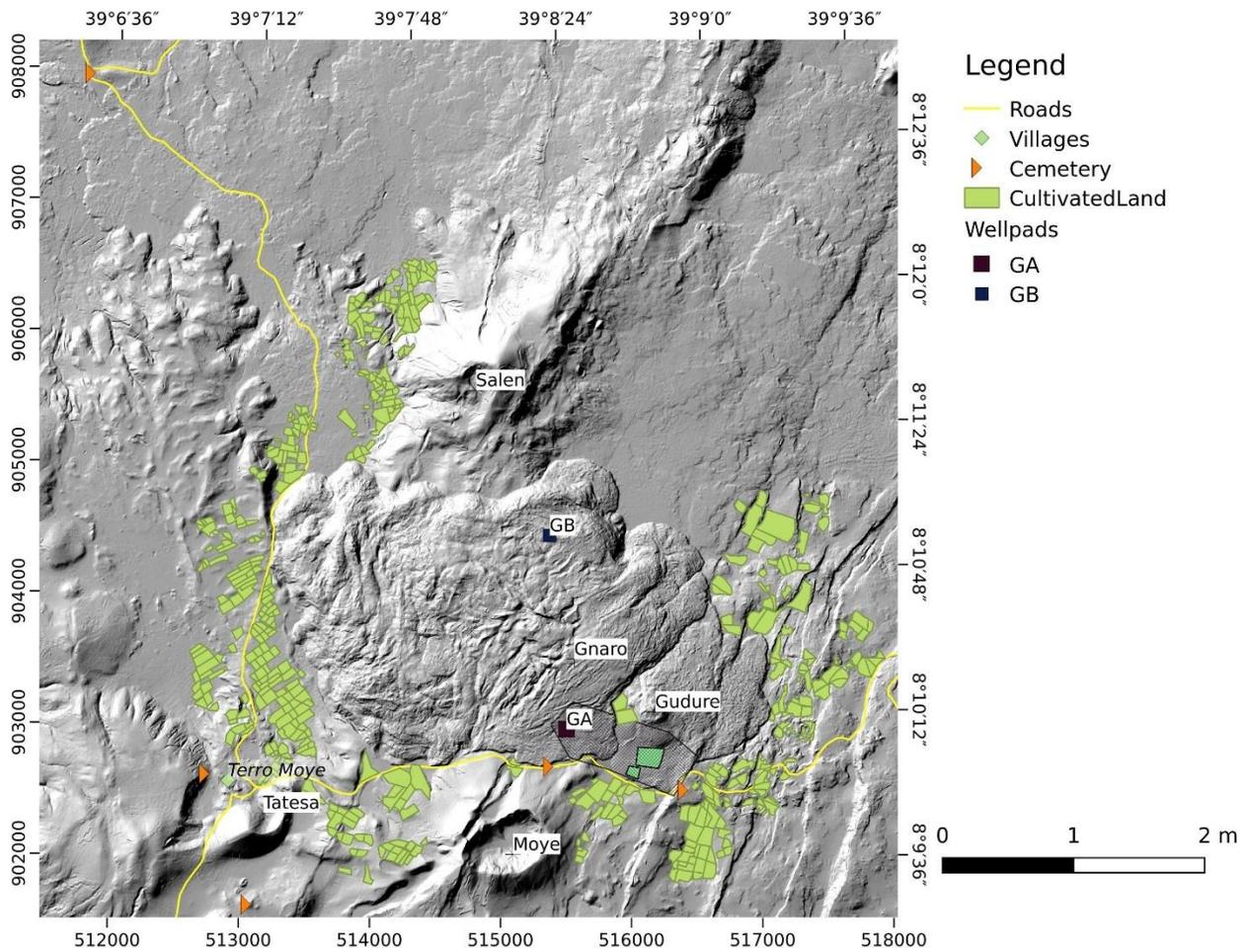


Figure 1-2: The Gnaro lava field, tentative location of well pads GA and GB. Power station and lay-down area (dark-green squares) in south part of older lava part called Gudure

2 APPROACH AND STUDY METHODS

Both flora and fauna ecological characteristics were collected through quantitative (field sampling) and quantitative study (desk review and other secondary information) methods. The general approach includes:

- Field investigation, survey and observations
- Discussion with local key informants
- Use of GPS, binoculars and GIS digital and analytical technology
- Desk review of published and unpublished documents
- Consultation with relevant government institutions heads and experts
- Discussion using semi- structured interviews

In order to conduct the rapid biodiversity studies in agreement with accepted standards and regulations in the field, TS Environment have undertaken the following:

- Undertake sampling for the specialist studies during the applicable period considered as wet season, if at all possible the wet season sampling should follow rains fairly closely in order to highlight ephemerals for the area;
- Conduct the field studies in accordance with relevant national regulations and restrictions (legal or religious), but also ensuring compliance with international standards, policies, laws and regulations;
- Evaluate implications of results in terms of relevant legislation, guidelines and standards applicable to the protection and/or management of that environment in Ethiopia and according to IFC PS6:
 - Provide a description of the existing environment and habitat parameters in the study area considered (baseline conditions) and define their diversity and quality;
 - Provide a description of key species and species groups occurrence within the habitats defined in the study area considered and define the potential of the area in terms of diversity and quality based on usual sources of classification (IUCN red list, CITES, PROTA) by identifying threatened, rare and/or endemic species or subspecies;
 - Moreover, depending on supporting literature existence, provide background trends for the species and indicate how this may be affected by the project development;
 - Indicate the value and/or conservation importance of each component of the environment;
 - Identify biodiversity contribution to the sustained delivery and maintenance of ecosystem services and map this distribution in the landscape of relevance;
 - During biodiversity baseline studies, identify local values and uses attached to life forms sampled and integrate this information to highlight ecosystem services hotspots from a human use point of view in order to contribute to the natural resources use studies;

- Provide comprehensive description to the existing environment in the study area to enable a standardized assessment of the sensitivity of the study area and define modified, natural and critical habitat zones.

2.1 Specific Methods for Plants

The rapid plant diversity assessment of Tulu Moye Geothermal project site follows first the identification of natural and modified habitats. The International Finance Corporation (IFC) approach was followed for the identification of natural, modified and critical habitats. Natural habitats are those with large natural vegetation cover and with little anthropogenic disturbances. Vegetation is the typical land cover of natural habitats. Modified habitats are those highly modified and converted to non-vegetated land uses. Agricultural land, grazing land, plantation forest, mined area, and so forth - are examples of modified habitats.

Within each natural and modified habitat, sample plots of 20 m X 20 m were laid along altitudinal gradient. Within each sample plot all woody species (trees, shrubs) were recorded. Herbaceous and graminoid species were recorded in a 2 m X 2 m subplot laid within the larger plot. Some of the plant species were identified on site. Plant specimens were collected for those which were difficult to identify for later identification using the Floras of Ethiopia and Eritrea.

Hierarchical cluster analysis using Euclidean distances and Ward's method of hierarchical grouping was performed to identify plant community groups using PC-ORD software (McCune and Mefford, 1999). Input data are species presence/absence.

The vertical structure of both natural and modified habits was described based on such variables as (i) number of vertical layers (ii) maximum vegetation height and (iii) maximum vegetation cover.

The provision of ecosystem services both by the natural and modified ecosystems has been assessed using expert elucidation and key informant discussion methods. Discussion was made with experts of the Hitosa district Department of Environment and Forest and farmers at Tulu Moye /Tero Moye kebele.

Biodiversity sensitivity assessment was done for the different habitat types identified. Landscape feature, plant species richness, vegetation structure and presence of endemic plant species were the criteria for the assessment. The assessment varies from 1 (very low sensitivity) to 5 (very high sensitivity). Presence of signs of anthropogenic disturbance (tree cutting, charcoal making, forest grazing) and land degradation were observed and recorded.

2.2 Specific Methods for Mammals

For Mammals' rapid assessment, both direct and indirect faunal survey methodologies were employed. By direct observation, rapid survey of the wildlife resource of the area has been assessed by selecting representative vantage points in five observations zones. Walking along transects lines was also applied. In case of, indirect observation, main emphasis has been given for identifying mammals sign, like analysing the animals foot print, burrows, skeleton, fecal

materials, hairs, horn etc. and visiting the dens, caves, sleeping sites. Since most mammals are secretive or nocturnal, they are seldom seen by the casual observer. But their presence is often revealed by tracks, burrows, nests, evidence of feeding and its residues, foot prints, tail markings, fecal material or scats.

Community elders (key informant) were utilized as secondary sources after a thorough discussion to supplement literature review.

Survey walks along transect lines and observation on suitable vantage points mainly applied for large and medium mammals. The surveys were conducted both at early morning and late afternoon until dusks (when the animals were active).

In addition to the field survey, discussions were conducted with the local communities that lived for more than ten years around the project site. The discussions were conducted using semi-structured questionnaire and utilization of field guides, photos (illustrations) and demonstration of the colour, behaviour, sound, and the possible habitat of the animal. During the discussion time, long discussion time was given to exhaustively list out all animals that live around their locality.

For Small Mammals, like for Bats, dusk-time walks near forest streams, potential roosting sites (e.g. caves) and fruiting/flowering trees provide an indication of presence of bats and abundance. In addition to the direct observation, caves, hollow trees and fallen logs were visited. For Rodents and Insectivores; searching under fallen logs for runs where tiny feet have left a distinct path, as well as for signs of discarded food remains or fecal pellets were sampled. Other indirect signs of small mammals' presence include observation of their teeth, skull and other skeletal remains.

2.3 Specific Methods for Birds

Birds were recorded along six line transects measuring 1–4 km (mean= c.2.12 km), systematically selected to sample all major habitats along altitudinal gradients.

Two line transects were taken at the Drillpad_Area1 center point measuring 1 and 1.5 km radius respectively and one line transect at the Drillpad_Area2 center point measuring a distance of 1.48 km. Another one line transect was taken in the middle of the bushland habitat and two line transects in areas which are occupied by cultivated land and settlements surrounding the project impact area. Transects were 200–250 m apart and were visited on different days. All bird species seen or heard were recorded as present, irrespective of their distance from transects.

As the primary objective of the study was to record the species present in the area, quantitative data, such as the number of individuals or the frequency of occurrence along each transect, were not collected.

Birds were identified using binoculars and a field guide (Redman *et al.* 2011). Each transect was visited twice; thus, c.12.75 km was covered. The surveys were conducted early in the morning 09:30–12.30 hrs. In addition, birds observed opportunistically in the forest and surrounding

agricultural areas were also noted. As a broad guide to a species' local abundance, relative frequency of occurrence was calculated using a simple formula: $(T_i/T_n) \times 100$; where, T_i = number of transects along which a species was recorded, and T_n = the total number of transects surveyed. Species were then classified as common (observed along at least five, or 75%, of six transects), frequent or fairly common (observed on 50–74% of transects), uncommon (25–49%) or rare (<25%). In addition to determining the relative abundance of each bird species of the project impact sites the 2016 IUCN Red List status of birds was used to determine the current threat status of birds of the study area.

2.4 Specific Methods for Herpetofauna (Reptiles and Amphibians)

The survey on the herpetofauna was conducted at different micro-habitats during the day and in the evening. Open grasslands, on and under rocks, on piles of boulders, in flood pools, earthen holes, on tree branches, under mosses, under leaf litter and rotting logs. Vocal sound produced by frog calls was used to triangulate specimens for close observation and to take photos. GPS records were taken to outline the area covered during the field survey, and to show specific points where specimens were encountered. Specimens were neither treated in inhumane manner, nor killed during the survey. Photos were taken using Nikon digital camera.

In general, internationally and/or nationally recognized areas of high biodiversity value will likely qualify as critical habitat; examples include the following:

Areas that meet the criteria of the IUCN’s Protected Area Management Categories Ia, Ib and II, although areas that meet criteria for Management Categories III-VI may also qualify depending on the biodiversity values inherent to those sites.

This project area as well as within 10 km radius of it, there are no protected areas i.e. any National Parks, Wildlife /Game Reserves, and wildlife sanctuaries. However, Lake Koka and Lake Ziway found close to the Project area (more than 10 km distance from Drilling area) are listed as Important Bird Areas (IBAs).

The endemic plant, *Impatiens rothii* is not listed in the IUCN red list. The socio-economic study of the study area did not reveal any specific ecosystem that the local community wanted to be protected for their cultural and economic importance. Therefore, the study team could not recognize critical habitat at Tulu Moye area.

Following IFC Performance Standard 6 and general note 57 (GN 57), the project area has been evaluated whether there is critical habitat or not. As the result indicated that (Table 3.1), there is no critical habitat around the project area. Following the result, the project area is divided in to as natural and modified habitats.

Table 3.1: Qualifying Critical Habitat based on GN 57

No.	Criteria	Present/Absent	Project Impact and recommended action
1	Presence or absence of IBA site	Absent (at more than 10 km distance Lake Zeway and Koka IBA sites)	Precautionary principle to apply
2	Presence or absence of Protected Areas (National park, Game reserves, wildlife sanctuaries)	Absent	None
3	Presence or absence of Ramsar wetlands site	Absent	None (No Ramsar site in Ethiopia)
4	Presence or absence of Alliance for zero extinction (AZE) site	Absent	None
5	Presence or absence of Horn of Africa Biodiversity Hot spot	Absent	Precautionary principle to apply. (The site is in the Great Rift Valley)
6	Potential species of conservation concern	Absent	None

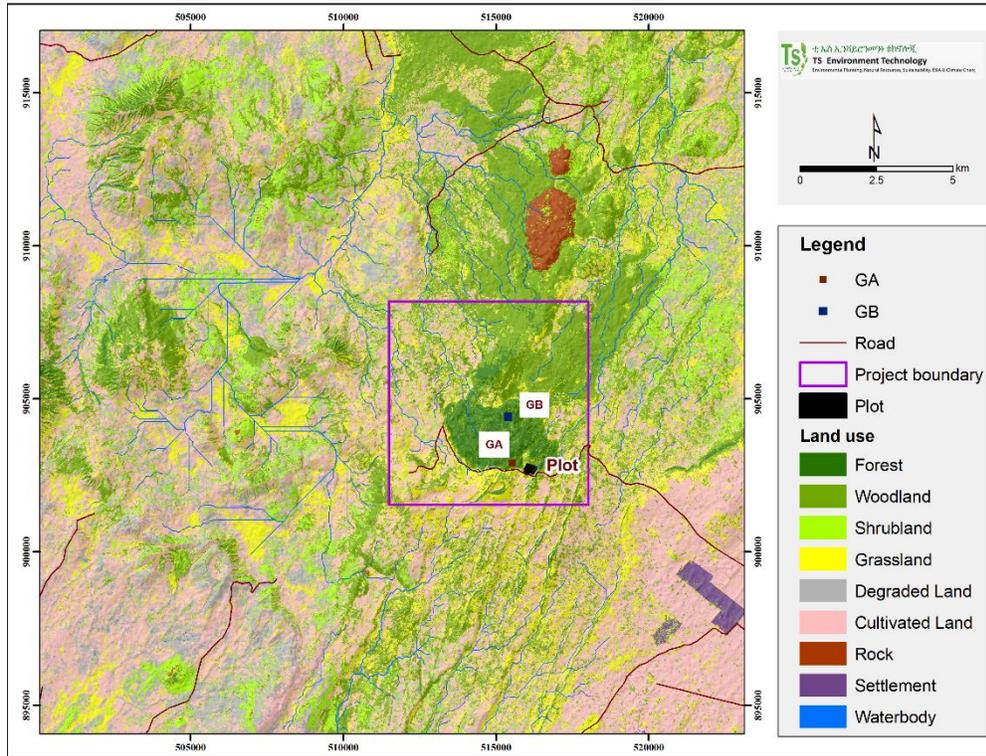


Figure 3-1:
Habitat type identification in the study area of Tulu Moye, Gnaro lava field area.

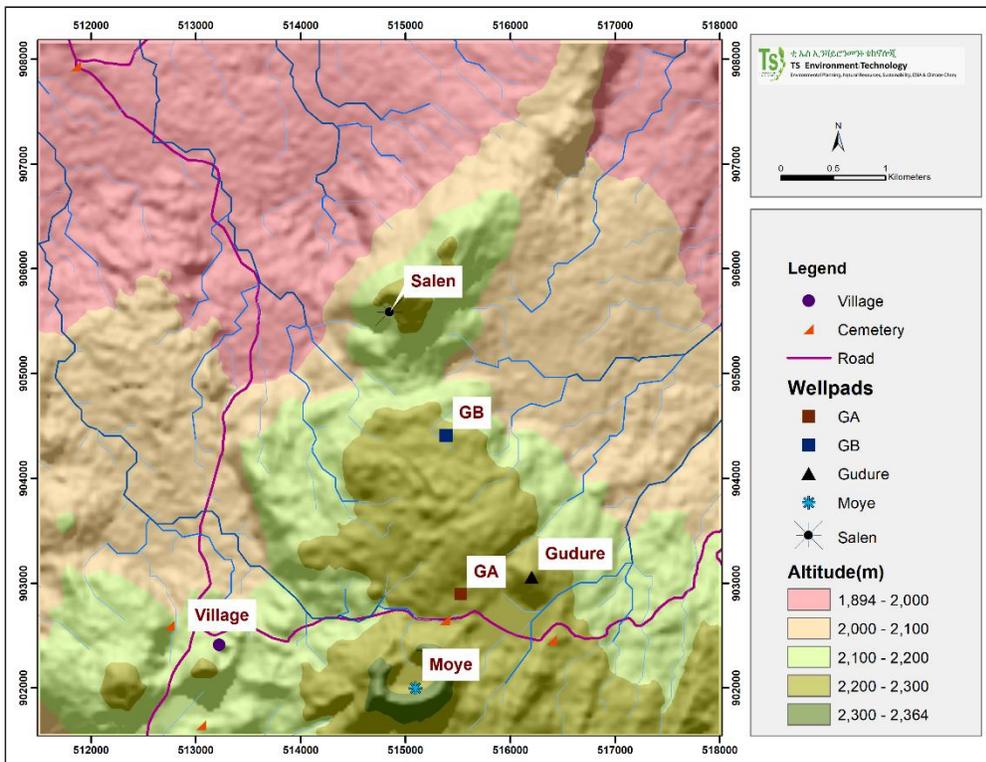


Figure 3-2:
Altitude map of Tulu Moye, Gnaro lava field and omega.

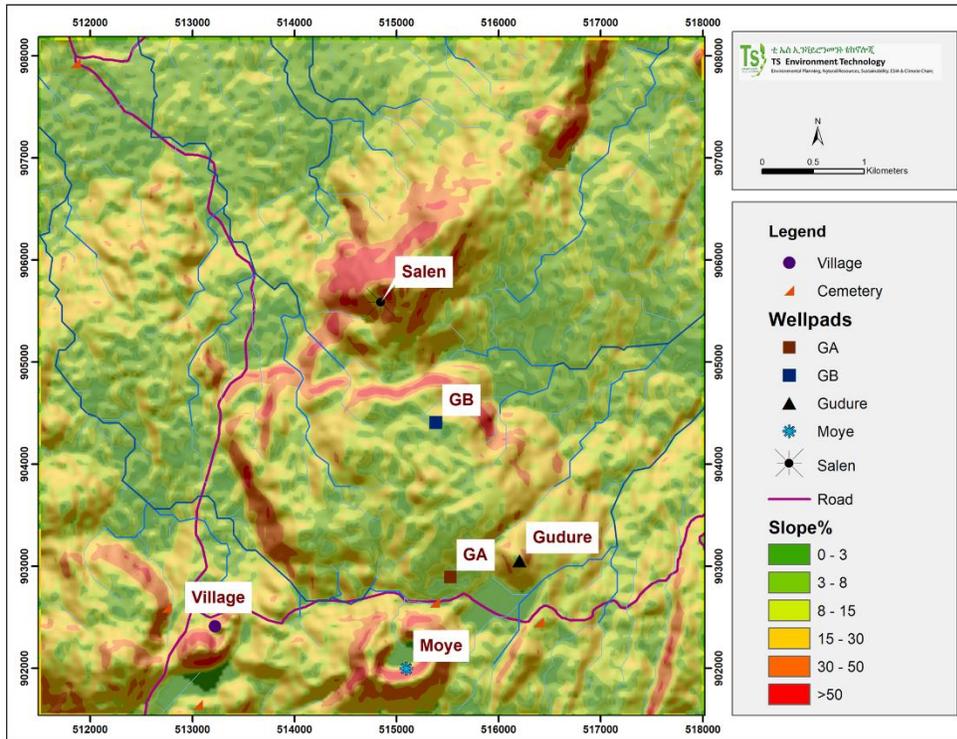


Figure 3-3:
Slope map of Tulu Moye, Gnaro lava field and omega.

3.3.1 Natural Habitat

The natural habitat at Tulu Moye includes the natural forest and scrubland vegetation. Natural forest is found at altitudes from 2100 to 2300 m and with slope of up to 30% in the southern part of the study area. It covers 19% of the study area. The natural forest has only one stratum of tree which is dominated by *Olea europaea* subsp *cuspidata* and *Juniperus procera*. The shrub layer is dominated by *Rhus retinorrhoea*, *Olinia rochetiana*, *Maytenus arbutifolia*, *Euclea schimperi*, *Clutia abyssinica* and *Erica arborea*. The herb *Commelina forskaolii* dominates the ground layer.



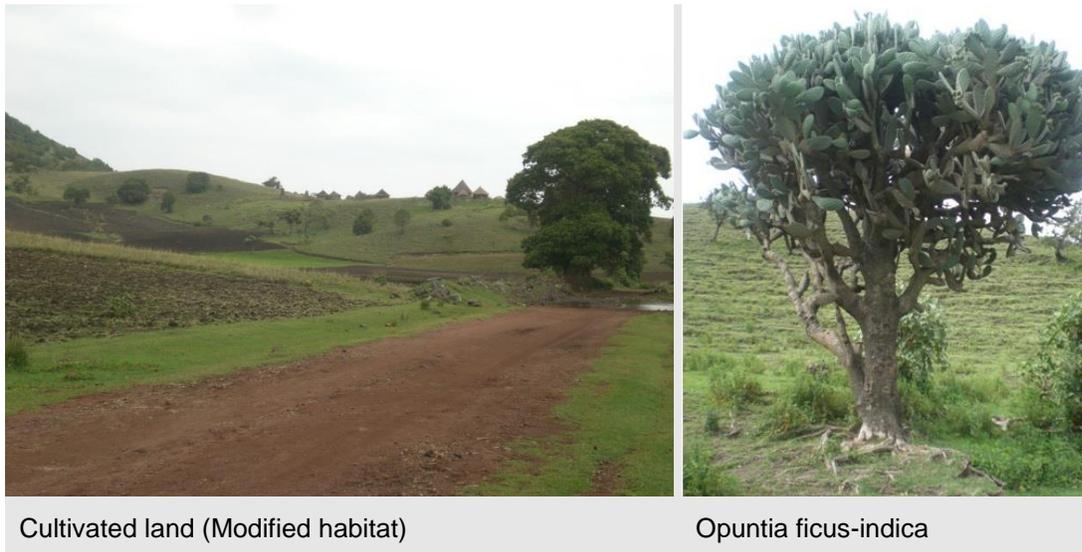
Forest vegetation grown in the sloppy mountain

Scrubland (natural habitat)

Figure 3-4: Natural Habitat at Tulu Moye

get into the forest vegetation and graze the ground vegetation thereby affecting seedling and saplings, which are the raw materials for the future survival of the forests.

Cultivated land: - Crop is the dominant land cover during growing season (June to December), otherwise the land remains bare for the rest of the months. The fact that natural vegetation is found adjacent to cultivated land (Figure 3.6) and the presence of isolated trees on farm land (Figure 3.6) indicate that the farm land developed through conversion of the scrubland. *Olea europaea* subsp *cuspidata*, *Acacia abyssinica*, *Acacia seyal* are some of the trees seen on farm land. Farmers plant *Agave sisalana* (Agavaceae) as live fence around their compound. *Opuntia ficus-indica* (Cactaceae) is planted by some farmers on their crop field (see Figure 3.6).



Cultivated land (Modified habitat)

Opuntia ficus-indica

Figure 3-6: Modified Habitat at Tulu Moye

3.3.3 Plant communities

Based on hierarchical cluster analysis, three plant communities were recognized. Plant community 1 is named *Croton macrostachyus-Calpurnia aurea* after the two species which were found in more than 80% of the sample plots constituting the community type. This community type represents modified habitats (farmland and grazing land) of Tulu Moye area. 54 plant species are represented in this plant community. Since trees and shrubs are found widely scattered, there is no vertical stratification into tree and shrub layer. Less than 10% of the ground is covered by woody species. The ground layer is dominated by the grass *Cyanodon dactylon* which is the main nutritious grass for livestock.

Plant community 2 is named *Osyris quadripartita-Commelina forskoolii* after the two species that are found in all the sample plots constituting the plant community. *Jasminum grandiflorum* (climber), *Olea europaea* subsp *cuspidata*, *Rhus retinorrhoea* and *Senecio lyratus* are other species that are present in all sample plots. This plant community contains plant species from the modified and natural habitats. 56 plant species are included in this plant community. Aerial cover of the vegetation varies between 10% and 60%

Juniperus procera-*Clerodendron myricoides* is the third plant community. The community type is represented in the natural vegetation of the study area. This community type differs from the other two plant communities by the abundance of *Juniperus procera*, *Clerodendron myricoides*, *Erica arborea*, *Asparagus racemosus* *Clematis hirsuta*, *Euclea schimperi* and *Pittosporum viridiflorum*. In general, 88 plant species are represented in this plant community. The vegetation structure contains three vertical strata: the tree layer reaching up to 15 m in height; the shrub layer is generally reach a height of 4 to 6 meters. The ground herbaceous layer is generally lower than 0.5 m. The aerial vegetation cover is generally more than 70%.

3.3.4 Ecosystem services

Discussion with key informant indicated the community's understanding of multiple ecosystem services provided by the natural ecosystem of Tulu Moye. Provisioning ecosystem services are those that are mostly enjoyed by the local people daily. These services are dependent on annual crop production as well as goods collected from the natural ecosystem. Table 3.3 presents the provisional ecosystem services mentioned by local people.

Table 3.3: Provisional ecosystem services provided by the ecosystem of Tulu Moye area

Plants used for livestock feed	For treatment of human and livestock disease	Fuel source	For House construction	Food source
Calpurnia aurea,	Calpurnia aurea,	Acacia etbaica	Croton macrostachyus	Carissa spinarum
Cyanodon dactylon	Aloe sp.	Acacia seyal	Ehretia cymosa	Ficus ovate
Hyoestes forskaollii	Clerodendron myricoides	Croton macrostachyus	Ficus ovata	Rhus vulgaris
Maytenus arbutifolia	Kalanchoe quartiniana	Rhus retinorrhoea	Olea europaea subsp cuspidata	Opuntia ficus-indica
Senna didymobotrya	Heteromorpha arborescens	Rhus vulgaris	Juniperus procera	
	Myrsine africana		Rhus retinorrhoea	
			Schefflera volkensii	
			Euphorbia tirucalii	

Acacia abyssinica (Fabaceae) is used for providing shed both for people and livestock. *Acacia abyssinica*, *Acacia etbaica* (Fabaceae), *Acacia persiciflora* (Fabaceae), *Acacia seyal*

Table 3.4: Ecosystem service review for Tulu Moye area

Ecosystem services	Degree of impact (Type I)	Degree of dependence community (Type II)	Relevance to affected community (Type I)	Degree of management control (Type I/II)
PROVISIONING				
Crops	Medium	NO	High	Low
Livestock	Low	NO	High	Low
Capture fisheries	-	NO	-	-
Aquaculture	-	NO	-	-
Wild foods	Low	NO	Very low	-
Timber & wood products	Medium	NO	Medium	Low
Biomass fuel	Medium	NO	High	Low
Freshwater	Medium	High	High	Low
Genetic resources	No data	NO	No data	-
Medicines, biochemical	No data	NO	No data	-
REGULATING				
Air quality control	Medium	NO	Low	High
Global climate regulation	-	NO	-	-
Regional/local climate regulation	-	NO	-	-
Water regulation	High	HIGH	High	Low
Erosion regulation	High	LOW	High	Medium
Water purification and waste treatment	No data	LOW	No data	Low
Pest and disease regulation	No data	NO	No data	Medium
Pollination	High	NO	High	Low
Flood regulation	High	HIGH	High	Low
CULTURAL				
Sacred or spiritual purposes	-	NO	-	Low
Areas used for religious purposes	-	NO	-	Low
SUPPORTING				
Nutrient capture and recycling	No data	High	No data	Low
Primary production	Low	NO	High	Low
Pathways for genetic exchange	No data	NO	No data	Low

3.3.5 Human Disturbance

Tree cutting for construction, fuel and charcoal making are the major types of disturbance recorded in the study area (see Figure 3.8 & 3.9).

Although, such activities are illegal, farmers are continually exploiting the scrubland for fuel wood sources. Charcoal production is threatening the woody plant diversity of the study area.

Some of the common woods selected for charcoal making are *Acacia etbaica*, *Acacia seyal*, *Croton macrostachyus*, and *Rhus vulgaris*. Livestock were found grazing inside the scrubland. Seedlings and saplings could be damaged by grazing and trampling, thereby affecting the regeneration capacity of the vegetation.



Fuel wood collected from the forest and Illegal charcoal making at Tulu Moye

Figure 3-8: Modified Habitat at Tulu Moye



Illegal cutting at the natural forest

Figure 3-9: Modified Habitat at Tulu Moye

3.3.6 Biodiversity sensitivity

In general, the biodiversity sensitivity assessment of the different habitats at Tulu Moye project area shows that the natural habitat has medium sensitivity because of higher species diversity and the endemic *Impatiens rothii*. The regenerating forest land has also medium sensitivity because of its location on mountain slope, its early seral development stage and the presence

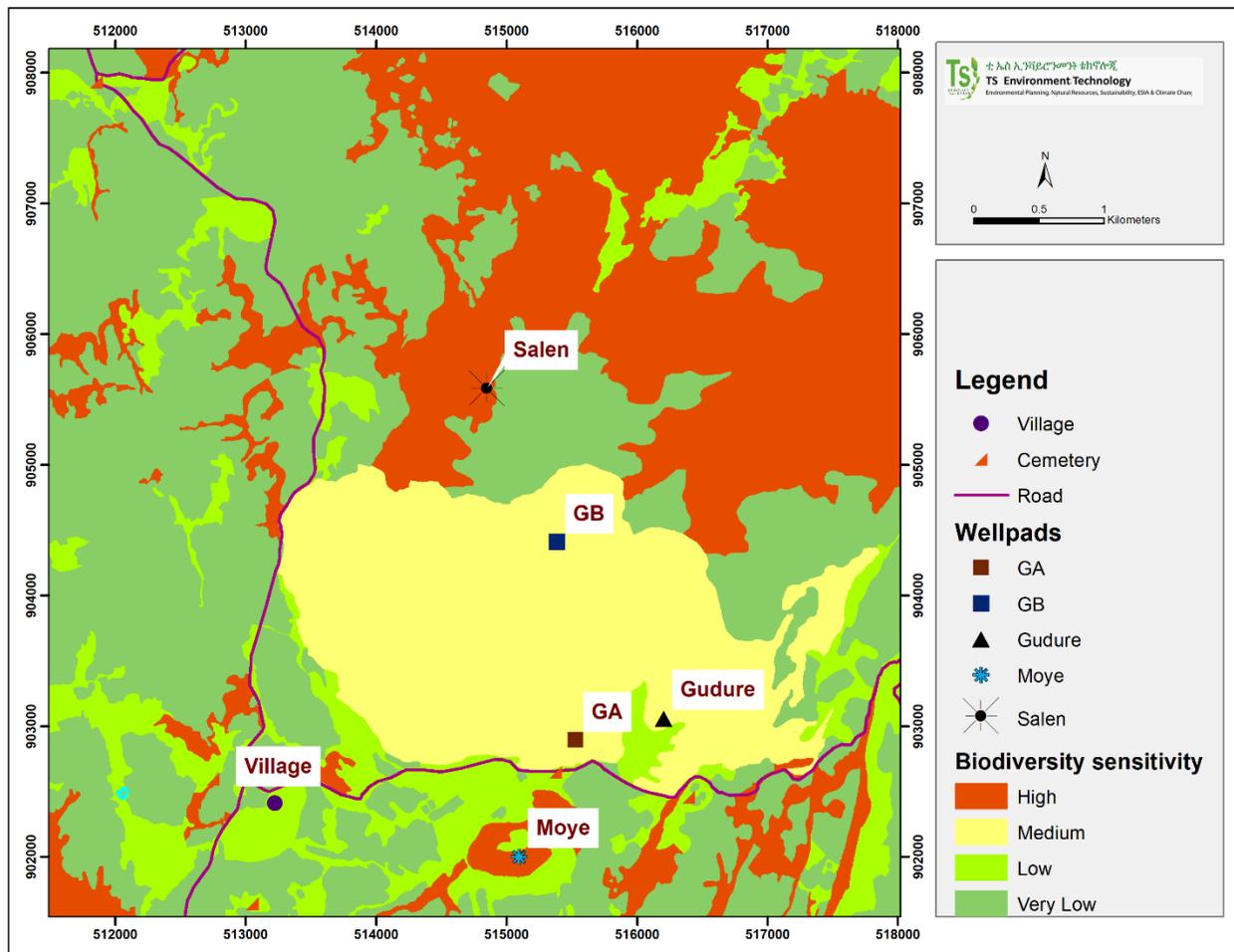


Figure 3-10: Biodiversity sensitivity map for Tulu Moye, Gnaro lava field area

3.3.9 Plant species composition

In general, 120 species belonging to 63 families were recorded both from the modified and disturbed habitats (Annex 1.). Out of these, 96 species were recorded from the natural habitat and 81 from the modified habitat. 59 species were found both in the modified and natural habitats and the remaining 60 species were recorded either from the modified or natural habits. Fabaceae is the most dominant family represented by 15 species, followed by Asteraceae with 11 species, Poaceae with 8 species, and Euphorbiaceae with 5 species. The families Anacardiaceae, Apiaceae, Apocymaceae, Commelinaceae, Rubiaceae, and Pteridaceae each contain 3 species. The remaining families contain 1 or 2 species each. *Impatiens rothii* (Figure 3.11), belonging to the family Balsaminaceae is the only endemic species recorded from the study area. In terms of growth habit 34 species are trees, 20 shrubs, 43 herbs, 8 grasses, 6 ferns, 2 sedges and 7 climbers. *Juniperus procera*, *Olea europaea subsp cuspidata*, *Rhus retinorrhoea*, *Olinia rochetiana*, and *Pittosporum viridiflorum* are the tree species most

frequently recorded from the study area. *Clutia abyssinica*, *Myrsine africana*, *Maytenus arbutifolia*, *Clerodendron myricoides*, *Osyris quadripartita* and *Euclea schimperi* are the common shrubs. *Erica arborea* is found on slopes at higher altitude. *Commelina forskaolii* and *Senecio lyratus* and the grasses *Cyanodon dactylon*, *Aristida adscensionis*, *Melinis repens*, *Festuca abyssinica* are mostly found covering the ground layer. *Clematis hirusuta* and *Jasminum grandiflorum* are the most commonly climber species.



Figure 3-11: *Impatiens rothii* (endemic) at 37 N 05116156, 0903026

3.3.10 Plant diversity

During the dry season assessment, 83 plant species belonging to 43 families were recorded from Tulu Moye, Tero Desta, Amude, Bite Daba, Hula Arba, Bite and Boka project area. In the present assessment, 77 plant species which were not recorded during the dry season assessment were recorded only from the Tulu Moye area. Most of these new records are herbaceous plants ferns and grasses. A good number of woody plants are also newly recorded.

Osyris lanceolata, *Ritygynia parvifolia*, and *Newtonia hildbrandii* which were reported in the dry season assessment are not recorded in the Flora of Ethiopia and Eritrea. The genus *Ritygynia* is only represented by *Ritygynia neglecta*. *Argemone mexicana* which was reported in the dry season assessment was not seen in the present during the present assessment. This species is in fact most conspicuous during the dry season (Table 3.6).

Table 3.6: Plant species not recorded during dry season assessment

No.	Species	Family
1	<i>Acanthus polystachius</i>	Acanthaceae
2	<i>Hypoestes forskoolii</i>	Acanthaceae
3	<i>Amaranthus sp.</i>	Amaranthaceae
4	<i>Agrocharis schimperi</i>	Apiaceae
5	<i>Foeniculum vulgare</i>	Apiaceae
6	<i>Heteromorpha arborescens</i>	Apiaceae
7	<i>Cadaba sp.</i>	Apocynaceae
8	<i>Tylophora heterophylla</i>	Apocynaceae
9	<i>Gomphocarpus purpurascens</i>	Asclepiadaceae
10	<i>Periploca linearifolia</i>	Asclepiadaceae
11	<i>Asparagus racemosus</i>	Asparagaceae
12	<i>Kniphofia thomsonii</i>	Asphodelaceae
13	<i>Asplenium aethiopicum</i>	Aspleniaceae
14	<i>Bidens pilosa</i>	Asteraceae
15	<i>Conyza hypoleuca</i>	Asteraceae
16	<i>Crepis rueppellii</i>	Asteraceae
17	<i>Galinsoga quadriradiata</i>	Asteraceae
18	<i>Helichrysum schimperi</i>	Asteraceae
19	<i>Senecio lyratus</i>	Asteraceae
20	<i>Tageta minota</i>	Asteraceae
21	<i>Vernonia hochestteri</i>	Asteraceae
22	<i>Xanthium spinosum</i>	Asteraceae
23	<i>Impatiens rothii</i>	Balsaminaceae
24	<i>Cynoglossum amplifolium</i>	Boraginaceae
25	<i>Canarina eminii</i>	Campanulaceae
26	<i>Spergula arvensis</i>	Caryophyllaceae
27	<i>Chenopodium ambrosioides</i>	Chenopodiaceae
28	<i>Commelina Africana</i>	Commelinaceae
29	<i>Commelina forskoolii</i>	Commelinaceae
30	<i>Cyanotis barbata</i>	Commelinaceae
31	<i>Kalanchoe quartiniana</i>	Crassulaceae
32	<i>Kalanchoe sp.</i>	Crassulaceae
33	<i>Cyperus dichroostachyus</i>	Cyperaceae
34	<i>Fimbristylis longiculmis</i>	Cyperaceae
35	<i>Dioscorea alata</i>	Dioscoreaceae
36	<i>Euclea schimperi</i>	Ebenaceae
37	<i>Euphorbia hirta</i>	Euphorbiaceae

Table 3.7: List of Mammals that were exclusively recorded during Wet season

No.	Family Name	Common Name	Scientific Name	IUCN/AC, EW
1	Felidae	Serval cat	Leptailurus seval	LC
2	Felidae	Leopard*	Panthera pardus	CE
3	Bovidae	Greater kudu*	Tragelaphus strepsiceros	LC
4	Bovidae	Bush buck*	Tragelaphus scriptus	LC
5	Bovidae	Grey duicker*	Sylvicapra grimmia	LC
6	Bovidae	Bohor reed buck	Redunca redunca	LC
7	Procavilade	Bush hyrax*	Heterohyrax brucei	LC
8	Pteropodidae	Straw colored fruit bat	Eldon helvum	LC
9	Pteropodidae	Ethiopian Epauletted Fruit Bat	Epomophorus labiatus	LC
10	Pteropodidae	East-African Epauletted Fruit Bat	Epomophorus minimus	LC
11	Pteropodidae	Long-haired Rousette	Rousettus lanosus	LC
12	Minopteridae	Long fingered bat	Minoptera spp	LC
13	Rhinopomatidae	Rufous Mouse-eared Bat	Myotis bocagii	LC
14	Leporidae	African Savanna Hare	Lepus victoriae	LC
15	Leporidae	Scrub Hare *	Lepus saxatiis	LC
16	Muridae	Abyssinian Grass Rat*	Arvicanthis abyssinicus	LC
17	Muridae	Acacia rat *	Thallomys paedulus	LC

*) Species observed in the field

3.4.2 Avian fauna (Birds)

The bird study result at Tulu Moye Geothermal exploration and harvesting power plant area shows that a total of 81 bird species have been identified and recorded within the four days intensive survey. From the total 81 bird species, all of them are categorized as Least Concern according to the 2016 IUCN Red List category. Regarding their status two bird species Barn swallow and Eurasian Hoopoe are palearctic migrants, two other bird species are Intra-African migrants and the remaining 77 species are residents. Wattled Ibis, Abyssinian Slaty Flycatcher, White-winged Cliff Chat, Ethiopian Oriole and Black winged Lovebird are five bird species which are near endemic (endemic to Ethiopia and Eritrea) and Ruppell's Weaver is North East African endemic found in Ethiopia, Eritrea, Northern Somalia and Djibouti. No bird species was found as endemic status.

Other 15 species of birds (which makes the total list of birds of the area to 96) that are obtained from secondary data and are believed to occur in the area are either palaerctic migrants visiting the area during the European winter or residents which move from one place to another locally and were not seen during the study period. Of these 7 species of birds extracted from secondary sources: Black Kite, Common Kestrel, Tawny Eagle, Pied Wheatear, Isabeline



A) Kachowski's sand frog

B) African striped skink

Figure 3-19: Two of the species amphibians and reptiles encountered at the surveyed area.

Discussion with the local people, including elders, students and women who collect fuel wood from the wild, indicated that there are two types of snakes (one black and one pale coloured) in the Project area. However, literatures from previous studies indicate the potential occurrence of other species of amphibians and reptiles in the broader project area.

As the project area comprises a combination of the Rift Valley and the edge of the Eastern Rift, we expect the presence of more species at lower altitudes that are outside of the current survey area. The list of twelve amphibians, twelve lizards, fifteen snakes and two terrapins/tortoises that have been recorded at earlier years and mainly documented in Largen and Spawls (2010) are listed in Annex IV. The listing in Annex IV has been extracted based on geographic proximity and habitat similarity of the historic records to the broader project area at mid- and lower altitudes as far as Lake Ziway and Koka; and this listing can't be considered as definitive and confirmed information of occurrence of these species. Three of the listed species of amphibians are Ethiopian endemics, of which, the IUCN conservation status of Lake Zwai snout-burrower is "LC" (least concern), Kouni Valley striped frog is "VU" (vulnerable), and Erlanger's grass frog is "NT" (near threatened). Species that have been listed in reports of both the dry- and rainy season are marked in Annex IV.

Therefore, Hitosa Woreda environment, forest and climate change office and Hitosa Woreda administration and relevant offices have to take immediate measure to control expansion of farming activities at the expense of destroying the natural forest and displacing wild animals.

Regarding bird species, White-backed Vulture, Hooded Vulture and Ruppell's Vulture which are categorized as critically endangered, Lappet-faced Vulture which is categorized as endangered and Pallid Harrier which is categorized as near threatened bird species but which were not all seen during the study period are either opportunistic scavengers or flying across the area and are not utilizing the area permanently for food, shelter and as breeding ground. These bird species are not also a concern to Ethiopia. The African vultures as a whole are in good status in Ethiopia despite their threat concern in many parts of Africa.

Even though Gnaro Lava Field may be a candidate as an Important Bird Area (IBA) with a total of 18 records of biome affiliated birds it is not significant number and there is no restricted range species or congregations of any sort of migratory birds that provides the site more focus to qualify as an IBA.

The current survey in Herpetofauna has enabled to recognize the occurrence of at least a few species of amphibians and reptiles at Tulu Moye area. Potential occurrence of more species of herps is very likely, as snakes and other reptiles in particular could be less active during the relatively cold rainy season. Endemics, threatened species or illegally traded frogs and reptiles were not recorded in the study area. However, the planned development of the area for geothermal use will have to consider availability of safe micro-habitats for breeding of amphibians (that are less mobile and highly sensitive for dehydration) and less agile species of reptiles.

5.4 References of Herpeto-fauna survey

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ANNEX I

List of plant species recorded from modified and natural habitats

(1 = present, 0 = absent)

	Species	Family	Habit	Habitat type		IUCN Status
				Modified	Natural	
1	<i>Acacia abyssinica</i>	Fabaceae	Tree	0	1	LC
2	<i>Acacia albida</i>	Fabaceae	Tree	1	0	LC
3	<i>Acacia brevispica</i>	Fabaceae	Tree	1	1	LC
4	<i>Acacia etbaica</i>	Fabaceae	Tree	0	1	LC
5	<i>Acacia persiciflora</i>	Fabaceae	Tree	1	0	LC
6	<i>Acacia seyal</i>	Fabaceae	Tree	1	1	LC
7	<i>Acanthus polystachius</i>	Acanthaceae	Shrub	0	1	LC
8	<i>Adiantum poiretii</i>	Pteridaceae	Fern	1	1	LC
9	<i>Aloe macrocarpa</i>	Aloaceae	Herb	1	1	LC
10	<i>Amaranthus sp.</i>	Amaranthaceae	Herb	0	1	LC
11	<i>Aristida adscensionis</i>	Poaceae	Grass	1	1	LC
12	<i>Asparagus racemosus</i>	Asparagaceae	Herb	1	1	LC
13	<i>Asplenium aethiopicum</i>	Aspleniaceae	Fern	1	1	LC
14	<i>Asplenium sp.</i>	Aspleniaceae	Fern	0	1	LC
15	<i>Balanites aegyptica</i>	Balanitaceae	Tree	1	0	LC
16	<i>Bersama abyssinica</i>	Melanthaceae	Tree	0	1	LC
17	<i>Bidens pilosa</i>	Asteraceae	Herb	1	0	LC
18	<i>Buddleja polystachya</i>	Apocynaceae	Tree	1	1	LC
19	<i>Cadaba sp.</i>	Apocynaceae	Shrub	0	1	LC
20	<i>Calpurnia aurea</i>	Fabaceae	Shrub	1	1	LC
21	<i>Canarina eminii</i>	Campanulaceae	Herb	0	1	LC
22	<i>Canthium oligocarpum</i>	Rubiaceae	Tree	0	1	LC
23	<i>Carissa spinarum</i>	Apocynaceae	Shrub	1	1	LC
24	<i>Casimiroa edulis</i>	Rutaceae	Herb	1	0	LC
25	<i>Cassipourea malosana</i>	Rhizophoraceae	Tree	1	0	LC
26	<i>Celtis africana</i>	Ulmaceae	Tree	1	1	LC
27	<i>Chamaecrista mimosoides</i>	Fabaceae	Herb	0	1	LC
28	<i>Cheilanthes farinosa</i>	Sinopteriaceae	Herb	1	1	LC
29	<i>Chenopodium ambrosioides</i>	Chenopodiaceae	Fern	0	1	LC

	Species	Family	Habit	Habitat type		IUCN Status
				Modified	Natural	
30	<i>Clematis hirsuta</i>	Ulmaceae	Climber	1	1	LC
31	<i>Clerodendron myricoides</i>	Lamaceae	Shrub	1	1	LC
32	<i>Clutia abyssinica</i>	Euphorbiaceae	Shrub	1	1	LC
33	<i>Combretum molle</i>	Combretaceae	Tree	1	1	LC
34	<i>Commelina africana</i>	Commelinaceae	Herb	1	1	LC
35	<i>Commelina forskaolii</i>	Commelinaceae	Herb	1	1	LC
36	<i>Conyza hypoleuca</i>	Asteraceae	Herb	1	1	LC
37	<i>Craterostigma pumilum</i>	Scrophulariaceae	Herb	1	0	LC
38	<i>Crepis rueppellii</i>	Asteraceae	Herb	0	1	LC
39	<i>Crotolaria sp.</i>	Fabaceae	Herb	0	1	LC
40	<i>Croton macrostachyus</i>	Euphorbiaceae	Tree	1	1	LC
41	<i>Cyanodon dactylon</i>	Poaceae	Grass	1	1	LC
42	<i>Cyanotis barbata</i>	Commelinaceae	Herb	1	1	LC
43	<i>Cynoglossum amplifolium</i>	Boraginaceae	Herb	0	1	LC
44	<i>Cyperus dichroostachyus</i>	Cyperaceae	Sedge	1	0	LC
45	<i>Cyphostemma niveum</i>	Vitaceae	Climber	1	0	LC
46	<i>Dactyloctenium aegyptium</i>	Poaceae	Grass	0	1	LC
47	<i>Datura stramonium</i>	Solanaceae	Herb	0	1	LC
48	<i>Dioscorea alata</i>	Dioscoreaceae	Climber	1	0	LC
49	<i>Dovyalis abyssinica</i>	Flacourtiaceae	Shrub	1	1	LC
50	<i>Ehretia cymosa</i>	Boraginaceae	Tree	1	1	LC
51	<i>Ekebergia capensis</i>	Meliaceae	Tree	1	1	LC
52	<i>Entada abyssinica</i>	Fabaceae	Tree	1	1	LC
53	<i>Eragrostis sp.</i>	Poaceae	Grass	0	1	LC
54	<i>Erica arborea</i>	Ericaceae	Shrub	0	1	LC
55	<i>Euclea schimperi</i>	Ebenaceae	Shrub	1	1	LC
56	<i>Euphorbia hirta</i>	Euphorbiaceae	Herb	0	1	LC
57	<i>Euphorbia sp.</i>	Euphorbiaceae	Herb	1	0	LC
58	<i>Euphorbia tirucalli</i>	Euphorbiaceae	Herb	1	0	LC
59	<i>Festuca abyssinica</i>	Poaceae	Grass	0	1	LC
60	<i>Ficus ovata</i>	Moraceae	Tree	1	1	LC
61	<i>Ficus vasta</i>	Moraceae	Tree	1	1	LC
62	<i>Fimbristylis longiculmis</i>	Cyperaceae	Sedge	0	1	LC

	Species	Family	Habit	Habitat type		IUCN Status
				Modified	Natural	
63	<i>Foeniculum vulgare</i>	Apiaceae	Herb	1	1	LC
64	<i>Galinsoga quadriradiata</i>	Asteraceae	Herb	1	0	LC
65	<i>Geranium arabicum</i>	Geraniaceae	Herb	1	0	LC
66	<i>Gomphocarpus purpurascens</i>	Asclepiadaceae	Herb	1	1	LC
67	<i>Grewia ferruginea</i>	Tiliaceae	Shrub	0	1	LC
68	<i>Harpachne schimperi</i>	Poaceae	Grass	1	0	LC
69	<i>Helichrysum schimperi</i>	Asteraceae	Herb	1	1	LC
70	<i>Heteromorpha arborescens</i>	Apiaceae	Herb	1	1	LC
71	<i>Hypoestes forskollii</i>	Acanthaceae	Herb	1	1	LC
72	<i>Impatiens rothii</i>	Balsaminaceae	Herb	0	1	LC
73	<i>Jasminum grandiflorum</i>	Oleaceae	Climber	1	1	LC
74	<i>Juniperus procera</i>	Cupressaceae	Tree	1	1	LC
75	<i>Kalanchoe quartiniana</i>	Crassulaceae	Herb	1	0	LC
76	<i>Kalanchoe sp.</i>	Crassulaceae	Herb	0	1	LC
77	<i>Kniphofia thomsonii</i>	Asphodelaceae	Herb	0	1	LC
78	<i>Maesa lanceolata</i>	Myrsinaceae	Shrub	1	1	LC
79	<i>Maytenus arbutifolia</i>	Celasteraceae	Shrub	1	1	LC
80	<i>Maytenus senegalensis</i>	Celasteraceae	Shrub	1	1	LC
81	<i>Melinis repens</i>	Poaceae	Grass	1	1	LC
82	<i>Mollugo nudicaulis</i>	Molluginaceae	Herb	0	1	LC
83	<i>Myrsine africana</i>	Myrsinaceae	Shrub	1	1	LC
84	<i>Nuxia congesta</i>	Loganiaceae	Tree	1	1	LC
85	<i>Olea europaea</i> subsp <i>cuspidata</i>	Oleaceae	Tree	1	1	LC
86	<i>Olinia rochetiana</i>	Oliniaceae	Tree	1	1	LC
87	<i>Opuntia ficus-indica</i>	Cactaceae	Tree	1	0	LC
88	<i>Osyris quadripartita</i>	Santalaceae	Tree	1	1	LC
89	<i>Ozoroa insignis</i>	Anacardiaceae	Tree	1	0	LC
90	<i>Pallaea calomelanos</i>	Pteridaceae	Fern	0	1	LC
91	<i>Pavetta abyssinica</i>	Rubiaceae	Tree	1	1	LC
92	<i>Pennisetum sp.</i>	Poaceae	Grass	1	1	LC
93	<i>Periploca linearifolia</i>	Asclepiadaceae	Climber	0	1	LC

	Species	Family	Habit	Habitat type		IUCN Status
				Modified	Natural	
94	<i>Pittosporum viridiflorum</i>	Pittosporaceae	Tree	1	1	LC
95	<i>Plantago lanceolata</i>	Plantaginaceae	Herb	1	1	LC
96	<i>Portulaca oleracea</i>	Portulacaceae	Herb	0	1	LC
97	<i>Premna schimperi</i>	Lamiaceae	Tree	1	1	LC
98	<i>Psydrax schimperiana</i>	Rubiaceae	Tree	0	1	LC
99	<i>Pteris sp.</i>	Pteridaceae	Fern	1	1	LC
100	<i>Rhus retinorrhoea</i>	Anacardiaceae	Tree	1	1	LC
101	<i>Rhus vulgaris</i>	Anacardiaceae	Tree	1	1	LC
102	<i>Rumex nepalensis</i>	Polygonaceae	Herb	1	1	LC
103	<i>Salvadora persica</i>	Salvadoraceae	Tree	1	0	LC
104	<i>Satureja punctata</i>	Lamiaceae	Herb	0	1	LC
105	<i>Schefflera abyssinica</i>	Araliaceae	Tree	1	1	LC
106	<i>Senecio lyratus</i>	Asteraceae	Herb	1	1	LC
107	<i>Senna didymobotrya</i>	Fabaceae	Shrub	1	0	LC
108	<i>Sida schimperiana</i>	Malvaceae	Shrub	1	0	LC
109	<i>Solanum anguivi</i>	Solanaceae	Herb	0	1	LC
110	<i>Tageta minota</i>	Asteraceae	Herb	0	1	LC
111	<i>Taverniera abyssinica</i>	Fabaceae	Herb	1	1	LC
112	<i>Trichocladus ellipticus</i>	Hamamelidaceae	Shrub	1	0	LC
113	<i>Tylophora heterophylla</i>	Apocynaceae	Climber	1	0	LC
114	<i>Ureia hypselodendron</i>	Urticaceae	Climber	1	0	LC
115	<i>Vermiflux abyssinica</i>	Fabaceae	Herb	0	1	LC
116	<i>Vernonia hochestteri</i>	Asteraceae	Shrub	0	1	LC
117	<i>Vernonia sp.1</i>	Asteraceae	Shrub	0	1	LC
118	<i>Vernonia sp.2</i>	Asteraceae	Shrub	0	1	LC
119	<i>Vigna sp.</i>	Fabaceae	Herb	1	1	LC
120	<i>Xanthium spinosum</i>	Asteraceae	Herb	0	1	LC

ANNEX II

Mammals Species List Geothermal Exploration and Harvesting Power Plan at Gnaro Lava Field.

Conservation status and distribution within the project area. Including IUCN status, African convention status and Ethiopian protection status.

NB: LC= Least concern; AC =African convention on the conservation of natural resources; B= Class B species totally protected, but may be hunted, killed, captured or collected under special authorization granted by the competent authority in contracting state, EW= Ethiopian wildlife conservation and utilization council of ministers regulations, PS= Protected species, * = Species observed in the field, others are based on literature and key local informants

Geothermal Exploration and Harvesting Power Plan at Gnaro Lava Field. Mammals survey Result

	Family Name	Common Name	Scientific Name	IUCN/AC, EW	Tulu Moye
1	Felidae	Serval cat	Leptailurus seval	LC	1
2	Felidae	Leopard*	Panthera pardus	CE	1
3	Hyenidae	Spotted Hyena*	Crocuta crocuta	LC	1
4	Canidae	Common Jackal*	Canis aureus	LC	1
5	Viverridae	Common Genet	Genetta genetta	LC	1
6	Viverridae	African Civet*	Civettictis civetta	LC	1
7	Mustelidae	Honey Badger (Ratel)	Melivora capensis	LC	1
8	Herpestriidae	White tailed mongoose*	Ichneumia albicauda	LC	1
9	Suidae	Common Warthog*	Phacocoerus africanus	LC	1
10	Bovidae	Greater kudu*	Tragelaphus strepsiceros	LC	1
11	Bovidae	Bush buck*	Tragelaphus scriptus	LC	1
12	Bovidae	Grey duicker*	Sylvicapra grimmia	LC	1
13	Bovidae	Oribi	Ourebia ourebi	LC, B	1
14	Bovidae	Klipspringer*	Oreotragus oreotragus	LC, B	1
15	Bovidae	Bohor reed buck	Redunca redunca	LC	1
16	Procavilidae	Ethiopian Rock hyrax*	Procavia habessinica	LC	1
17	Procavilade	Bush hyrax*	Heterohyrax brucei	LC	1
18	Orycteropolidae	Aardvark*	Orycteropus afer	LC, B, PS	1
19	Cercopithecidae	Grivet monkey*	Cercopithecus aethiopsis	LC	1
20	Cercopithecidae	Anubis (Savanna) baboon*	Papio Anubis	LC	1
21	Scuiridae	Stripped Ground squirrel*	Euxerus erythropus	LC	1
22	Pteropodidae	Straw colored fruit bat	Eldon helvum	LC	1
23	Pteropodidae	Ethiopian Epauletted Fruit Bat	Epomophorus labiatus	LC	1
24	Pteropodidae	East-African Epauletted Fruit Bat	Epomophorus minimus	LC	1

	Family Name	Common Name	Scientific Name	IUCN/AC, EW	Tulu Moye
25	Pteropodidae	Egyptian fruit bat	Rousettus aegyptiacus	LC	1
26	Pteropodidae	Long-haired Rousette	Rousettus lanosus	LC	1
27	Minopterae	Long fingered bat	Minoptera spp	LC	1
28	Megadermatidae	Heart nosed bat	Cardioderma cor	LC	1
29	Rhinopomatidae	Rufous Mouse-eared Bat	Myotis bocagii	LC	1
30	Leporidae	African Savanna Hare	Lepus victoriae	LC	1
31	Leporidae	Scrub Hare *	Lepus saxatiis	LC	1
32	Hystricidae	Crested Porcupine*	Hystrix cristata	LC	1
33	Bathyergidae	Necked mole rat*	Hetrocephalus glaber	LC	1
34	Murinae	Unstriped Grass rat*	Arvicanthis cf.abysinicus	LC	1
35	Murinae	Multimammate rat	Mastomys natalensis	LC	1
36	Murinae	Common mice*	Mus spp	LC	1
37	Muridae	Abyssinian Grass Rat*	Arvicanthis abysinicus	LC	1
38	Muridae	Multimammate Mouse	Mastomys natalensis	LC	1
39	Muridae	Acacia rat *	Thallomys paeulcus	LC	1

ANNEX III

List of Birds of Tulu Moye Geothermal Exploration and Harvesting Power Plan at Gnaro Lava Field.

Ser. No	Common Name	Scientific Name	Abundance	Regional Status	IUCN Red List Category	Biome Affiliation
1	Black-headed heron*	<i>Ardea melanocephala</i>	-	R	LC	-
2	Hammerkop*	<i>Scopus umbretta</i>	-	R	LC	
3	Wattled Ibis	<i>Bostrychia carunculata</i>	U	R, NE	LC	AH
4	Black Kite*	<i>Milvus migrans</i>	-	PM	LC	-
5	Hooded Vulture*	<i>Necrosyrtes monachus</i>	-	R	EN	-
6	Lappet-face Vulture*	<i>Torgos trachiolotus</i>	-	R	CE	-
7	White-backed Vulture*	<i>Gyps africanus</i>	-	R	CE	-
8	Ruppell's Griffon Vulture*	<i>Gyps Rueppellii</i>	-	R	CE	-
9	Pallid Harrier*	<i>Circus macrourus</i>	-	PM	NT	-
10	Dark Chanting Goshawk*	<i>Melierax metabates</i>	-	R	LC	-
11	Augur Buzzard*	<i>Buteo augur</i>	-	R	LC	-
12	Tawny Eagle*	<i>Aquila rapax</i>	-	R, PM	LC	-
13	African Harrier Hawk	<i>Polyboroides typus</i>	r	R	LC	-
14	Common Kestrel*	<i>Falco tinunnculus</i>	-	PM	LC	-
15	Helmeted Guineafowl	<i>Numida meleagris</i>	f	R	LC	-
16	Scaly Francolin	<i>Pternistis squamatus</i>	r	R	LC	-
17	Blue Spotted Wood Dove	<i>Turtur afer</i>	f	R	LC	-
18	Speckled Pigeon	<i>Columba quinea</i>	f	R	LC	-
19	Red-eyed Dove	<i>Streptopelia semitorquata</i>	c	R	LC	-
20	Ring-necked Dove	<i>Streptopelia capicola</i>	u	R	LC	-
21	Dusky Turtle Dove	<i>Streptopelia lugens</i>	f	R	LC	AH
22	Laughing Dove	<i>Streptopelia senegalensis</i>	u	R	LC	-
23	Black-winged Lovebird	<i>Agapornis taranta</i>	c	R,NE	LC	AH

Ser. No	Common Name	Scientific Name	Abundance	Regional Status	IUCN Red List Category	Biome Affiliation
24	White-cheeked Turaco	<i>Tauraco leucotis</i>	r	R	LC	AH
25	Jacobin Cuckoo	<i>Clamator jacobinus</i>	u	AM	LC	-
26	Red-chested Cuckoo	<i>Cuculus solitarius</i>	f	R	LC	-
27	African Emerald Cuckoo	<i>Chrosococcyx capreus</i>	r	R	LC	-
28	Klaas's Cuckoo	<i>Chrosococcyx klaas</i>	r	R	LC	-
29	Diederick Cuckoo	<i>Chrysococcyx cuprius</i>	r	AM	LC	-
30	White-rumped Swift	<i>Apus caffer</i>	r	R	LC	-
31	Speckled Mousebird	<i>Colius striatus</i>	f	R	LC	-
32	Blue-breasted Bee Eater	<i>Merops variegatus</i>	u	R	LC	-
33	Eurasian Hoopoe	<i>Upupa epops</i>	r	R	LC	-
34	Yellow-fronted Tinkerbird	<i>Pogoniulus chrysoconus</i>	c	R	LC	-
35	Cardinal Woodpecker	<i>Dendropicus fuscescens</i>	r	R	LC	-
36	Black Saw-Wing	<i>Psalidoprocne pristoptera</i>	f	R	LC	-
37	Barn Swallow	<i>Hirundo rustica</i>	u	PM	LC	-
38	Grey Wagtail*	<i>Motacila cinerea</i>	-	PM	LC	-
39	Long-billed Pipit	<i>Anthus similis</i>	u	R	LC	-
40	Red-shouldered Cuckoo Shrike	<i>Campephaga phoenicea</i>	r	R	LC	-
41	Common Bulbul	<i>Pycnonotus barbatus</i>	c	R	LC	-
42	Ruppell's Robin Chat	<i>Cossypha semirufa</i>	f	R	LC	AH
43	Pied Wheatear*	<i>Oenanthe pleschanka</i>	-	PM	LC	-
44	Abyssinian Wheatear	<i>Oenathus lugens</i>	f	R	LC	-
45	Isabelline Wheatear*	<i>Oenanthe isabellina</i>	-	PM	LC	-
46	Mocking Cliffchat	<i>Thamnolaea cinnamomeiventris</i>	u	R	LC	-
47	White-winged Cliffchat	<i>Thamnolaea semirufa</i>	f	R	LC	AH

Ser. No	Common Name	Scientific Name	Abundance	Regional Status	IUCN Red List Category	Biome Affiliation
48	Little Rock Thrush	<i>Monticola rufocenerius</i>	f	R	LC	AH
49	Ground Scraper Thrush	<i>Psophocichla litsitsirupa</i>	r	R	LC	-
50	African Thrush	<i>Turdus pelios</i>	c	R	LC	-
51	Buff-bellied Warbler	<i>Phyllolais pulchella</i>	r	R	LC	-
52	Yellow-bellied Eremomela	<i>Eremomela icteropygialis</i>	r	R	LC	-
53	Brown Woodland Warbler	<i>Phylloscopus umbrovirens</i>	f	R	LC	AH
54	Rattling Cisticola	<i>Cisticola chiniana</i>	r	R	LC	-
55	Stout Cisticola	<i>Cisticola robustus</i>	f	R	LC	-
56	Tawny-flanked Prinia	<i>Prinia subflava</i>	f	R	LC	-
57	Grey-backed Camaroptera	<i>Camaroptera brachura</i>	c	R	LC	-
58	Abyssinian Slaty Flycatcher	<i>Melaenornis chocolatinus</i>	f	R, NE	LC	AH
59	Northern Black Flycatcher	<i>Melaenornis edolioides</i>	r	R	LC	-
60	African Paradise Flycatcher	<i>Terpsiphone viridis</i>	f	R	LC	-
61	Black-headed Batis	<i>Batis minor</i>	f	R	LC	-
62	White-rumped Babbler	<i>Turdoides leucopygia</i>	f	R	LC	AH
63	White-winged Black Tit	<i>Parus leucomelas</i>	u	R	LC	-
64	Scarlet-chested Sunbird	<i>Chalcomitra senegalensis</i>	r	R	LC	-
65	Tacazze Sunbird	<i>Nectarinia tacazze</i>	u	R	LC	AH
66	Variable Sunbird	<i>Cinnyris venustus</i>	c	R	LC	-
67	Common Fiscal	<i>Laniusc collaris</i>	r	R	LC	-
68	Sulphur-breasted Bush Shrike	<i>Telophorus sulphureopectus</i>	u	R	LC	-
69	Black Crowned Tchagra	<i>Tchagra senegalus</i>	f	R	LC	-
70	Northern Puffback	<i>Dryoscopus gambensis</i>	u	R	LC	-
71	Slate-colored Boubou	<i>Laniarius funebris</i>	r	R	LC	-
72	Ethiopian Boubou	<i>Laniarius aethiopicus</i>	c	R	LC	-
73	Ethiopian oriole	<i>Oriolus monacha</i>	u	R,NE	LC	AH

Ser. No	Common Name	Scientific Name	Abundance	Regional Status	IUCN Red List Category	Biome Affiliation
74	Fork-tailed Drongo	<i>Dicrurus adsimilis</i>	r	R	LC	-
75	Fan-tailed Raven	<i>Corvus rhipidurus</i>	u	R	LC	-
76	Red-winged Starling	<i>Chychognathus morio</i>	u	R	LC	-
77	Greater Blue-eared Glossy Starling	<i>Lamprotornis chalybaetus</i>	f	R	LC	-
78	Red-billed Oxpecker	<i>Buphagus erythrohynchus</i>	u	R	LC	-
79	Swainson's Sparrow	<i>Passer swainsonii</i>	f	R	LC	AH
80	Yellow-spotted Petronia	<i>Petronia pyrgita</i>	r	R	LC	-
81	White-browed Sparrow Weaver	<i>Plocepasser mahali</i>	r	R	LC	-
82	Baglafaecht Weaver	<i>Ploceus baglafaecht</i>	u	R	LC	AH
83	Ruppell's Weaver	<i>Ploceus galbula</i>	c	R	LC	-
84	Village Weaver	<i>Ploceus cucullatus</i>	f	R	LC	-
85	Northern Red Bishop	<i>Euplectes franciscanus</i>	f	R	LC	-
86	Red-collared Widowbird	<i>Euplectes ardens</i>	f	R	LC	-
87	Fan-tailed Widowbird	<i>Euplectes axillaris</i>	r	R	LC	-
88	Yellow-bellied Waxbill	<i>Coccopygia quartinia</i>	u	R	LC	-
89	Red-checked Cordon Bleu	<i>Uraeginthus bengalus</i>	f	R	LC	-
90	Red-billed Firefinch	<i>Lagonosticta senegala</i>	f	R	LC	-
91	Village Indigobird	<i>Viduata chalybeata</i>	r	R	LC	-
92	African Citril	<i>Serinus citrinelloides</i>	f	R	LC	AH
93	Reichenow's Seed Eater	<i>Serinus reichenowi</i>	f	R	LC	-
94	Streaky Seed Eater	<i>Serinus strialatus</i>	f	R	LC	AH
95	Brown Rumped Seed Eater	<i>Serinus tristriatus</i>	u	R	LC	AH
96	Cinnamon-breasted Bunting	<i>Emberiza tahapisi</i>	c	R	LC	

Sequence and taxonomy follow Dowsett *et al.* (2014).

Relative frequency: c = common; f = frequent (fairly common); u = uncommon; r = rare.

Status (Redman *et al.* 2009, Dowsett *et al.* 2014): R = Resident; PM = Palearctic migrant; NE = Near- endemic, NEAE=North East African endemic

IUCN Red List category (IUCN Red List 2016): CE, Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened, LC= Least Concern

Biome: AH = Afro tropical highlands biome affiliation (EWNHS 1996).

* Bird species obtained from secondary data either recorded during the study of the wider project area or from other sources of previous studies

ANNEX V

Bird Species not occurring in the Project impact Area at Tulu Moye but reported during the dry season Survey.

Ser. No	Common Name	Species Name	Remarks
1	Shoebill	<i>Balaeniceps rex</i>	This bird is at Gambela National Park and not at Lake Ziway.
2	Water Thicknee	<i>Burhinus vermiculatus</i>	The distribution range of this bird is not in or around Tulu Moye.
3	White-bellied Go-away Bird	<i>Corythaixoides leucogaster</i>	This is a low land speceise and very unlikely at Tulu Moye
4	Square-tailed Nightjar	<i>Caprimulgus fossii</i>	This bird species does not occur in Ethiopia.
5	African Grey Hornbill	<i>Tochus nasulus</i>	This bird is a low land species and very unlikely at Tulu Moye.
6	Von der Decken's Hornbill	<i>Tockus deckeni</i>	This bird is a low land species and very unlikely at Tulu Moye.
7	Spot-flanked Barbet	<i>Tricholaema lacrymosa</i>	This bird species does not occur in Ethiopia.
8	Chin Spot Batis	<i>Batis molitor</i>	This bird species does not occur in Ethiopia.
9	Brown-crowned Tchagra	<i>Tchagra australis</i>	This bird species does not occur in Ethiopia.
10	Rosy-patched Bush Shrike	<i>Rhodophoneus cruentus</i>	Distribution range is unlikely in the project area at Tulu Moye.
11	White-necked Raven	<i>Corvus albicollis</i>	This bird species does not occur in Ethiopia
12	Black-headed Apalis	<i>Apalis melanocephala</i>	This bird species does not occur in Ethiopia
13	Pale Prinia	<i>Prinia somalica</i>	Distribution range of this bird species is not in the project area.
14	Yellow-breasted Apalis	<i>Apalis flavicta</i>	Distribution range of this bird species is not in the project area.
15	Banded Parisoma	<i>Parisoma boehmi</i>	Distribution range is in the south and never in the project area.
16	Brown-tailed Rock Thrush	<i>Cercomela scotocerca</i>	This bird species does not occur in Ethiopia
17	Spotted Palm Thrush	<i>Cichladusa guttata</i>	Distribution range is unlikely in the project area at Tulu Moye.
18	White-browed Scrub Robin	<i>Cerchotrichas leucophrs</i>	Distribution range is unlikely in the project area at Tulu Moye.
19	Amethyst Sunbird	<i>Chalcomitra amethystina</i>	This bird species does not exist in Ethiopia
20	Bush Petronia	<i>Petronia dentata</i>	Distribution range is very unlikely in the project area at Tulu Moye.
21	Grey-headed Sparrow	<i>Passer griseus</i>	The distribution of this bird is in north western Ethiopia.
22	Heuglin's Masked Weaver	<i>Ploceus heuglini</i>	This bird species does not exist in Ethiopia
23	Yellow-mantled Widow Bird	<i>Euplectes macrora</i>	The distribution range of this bird species is west of the Rift Valley
24	Yellow fronted Canary	<i>Crithagra mozambica</i>	This is a lowland species in western Ethiopia

ANNEX V

Bird Survey Transects at Tulu Moye Geothermal Exploration and Harvesting Power Plan project area

Transect Code	UTM co-ordinates	Latitude/Longitude	Altitude	Transect Length
Drill Surrounding-Drill Surrounding1	X516198 Y902433 X514565 Y902660	N 8° 9'50.4" E39°7'49.2" N 8° 9'57.9" E39°7'56.0"	2208m 2159m	1.67 km
Artu Shako-Tero Desta	X514253 Y902665 X513280 Y904463	N8°9'58.032" E39°7'48.8" N8°10'56.59" E39°7'14.03"	2157m 2046m	3.10 km
Gnaro5-Gnaro9	X513439 Y904472 X514339 Y902756	N8° 10'56.9" E39°7'59.2" N8° 10' 01.0" E39°7'48.6"	2067m 2173m	4.0 km
Drill Pad11-Drill Pad12	X516113 Y902720 X516150 Y903172	N 8° 9'59.8" E39 8'46.6" N 8°10'14.5" E39°8'47.8"	2216m 2265m	1 km
Drill Pad13-Drill Pad14	X516151 Y902742 X516270 Y903451	N8° 10' 00.5" E39° 8' 47.9" N 8° 10' 23.6" E39° 8' 51.7"	215m 2200m	1.5 km
Drill Pad 21-Drill Pad 24	X515990 Y902603 X514522 Y902776	N 8° 9'55.9" E39°8'42.5" N 8° 10'01.7" 39°7'54.6"	2209m 2186m	1.48 km

ANNEX VI

List of all GPS co-ordinates taken for the Rapid Biodiversity Study at Tulu Moye Geothermal Exploration and Harvesting Power Plan

Ser.No.	UTM co-ordinates	Latitude/Longitude	Altitude
1	X516198 Y902433	N 8° 9' 50.4" E39°7'49.2"	2208m
	X514565 Y902660	N 8° 9' 57.9" E39°7'56.0"	2159m
2	X514253 Y902665	N8°9'58.032" E39°7'48.8"	2157m
	X513280 Y904463	N8°10'56.59" E39°7'14.03"	2046m
3	X513439 Y904472	N8° 10' 56.9" E39°7'59.2"	2067m
	X514339 Y902756	N8° 10' 01.0" E39°7'48.6"	2173m
4	X516113/Y902720	N 8° 9' 59.8" E39 8' 46.6"	2216m
	X516150/Y903172	N 8° 10' 14.5" E39°8'47.8"	2265m
5	X516151 Y902742	N8° 10' 00.5" E39° 8' 47.9"	2215m
	X516270 Y903451	N 8° 10' 23.6" E39° 8' 51.7"	2200m
6	X515990 Y902603	N 8° 9' 55.9" E39°8'42.5"	2209m
	X514522 Y902776	N 8° 10' 01.7" 39°7'54.6"	2186m
7	X515445/Y903397	N8°10' 21.9" E39° 8' 24.8"	2255m
8	X514991 Y903345	N8° 10' 20.2" E39°8'09.9"	2209m
9	X513549 Y904579	N8° 11' 00.3" E39°7'22.8"	2044m
10	X514049 Y904127	N8°10' 45.6" 39°7'39.2"	2143m
11	X514440 Y903573	N8° 10' 27.6" E39°7'51.9"	2185m
12	X513943 Y902538	N8° 9' 53.9"/E 39° 7' 35.68"	2162m
13	X513045 Y902878	N8° 10' 4.98" E39° 7' 6.33"	2104m
14	X516068 Y903166	N 8° 10' 14.3" E39° 8' 45.1"	2256m
15	X515445 Y903397	8°10'21.9" E39°8'24.8"	2255m
16	X514991 Y903345	N8° 10'20.2" E39° 8' 09.9"	2229m
17	X516026 Y902858	N 8° 10'4.3" E39° 8' 43.7"	
	X516298 Y902751	N 8° 10'0.8" E39° 8' 52.6"	
	X516187 Y902574	N8° 9'55.05" E39° 8' 49.0"	
	X515927 Y902694	N8° 9'58.9"/ E 39° 8' 40.5"	
18	X515970 Y902661	N 8° 9' 57.88" E 39°8'41.9"	
	X516063 Y902619	N8° 9' 56.52" E39°8'44.96"	
	X516011 Y902539	N8° 9' 55 24" E39° 8'40.03"	
		N8° 9' 53.91" E39° 8'43.26"	
19	X516112	N 8° 9' 59.8" E39° 8' 46.6"	
	Y902719		
20	X 515989	N8° 10'21.9" E 39° 8' 24.8"	
	Y902599		

ANNEX VII

List of Herpetofauna (Amphibians and Reptiles) that are thought to potentially occur at and around Tulu Moye at mid- and low-altitudes (data extracted from Largen and Spawls, 2010).

NB. LC= List concern, **VU =**Vulnerable, **NT =** Near threatened

S.N.	Common name	Scientific name	IUCN status
Frogs			
1	Egyptian square-marked toad ³	<i>Sclerophrys regularis</i>	LC
2	Asmara toad ³	<i>Sclerophrys asmarae</i>	LC
3	Keith's toad ³	<i>Sclerophrys kerinyagae</i>	LC
4	Lake Zwai snout burrower ⁴	<i>Hemisus microscaphus</i>	LC
5	Kachowski's sand frog ¹	<i>Tomopterna kachowskii</i>	LC
6	Common reed frog ³	<i>Hyperolius viridiflavus</i>	LC
7	Kouni Valley striped frog ⁴	<i>Paracassina kounhiensis</i>	VU
8	Peracca's clawed frog ³	<i>Xenopus clivii</i>	LC
9	Angola river frog ³	<i>Amietia angolensis</i>	LC
10	Mascarene grass frog ³	<i>Ptychadena mascareniensis</i>	LC
11	Erlanger's grass frog ⁴	<i>Ptychadena erlangeri</i>	NT
12	Natal dwarf puddle frog ³	<i>Phrynobatrachus natalensis</i>	LC
Lizards			
1	Black-necked ridgeback agama ^{1,2}	<i>Acanthocercus atricollis</i>	LC
2	Eritrean rock agama ²	<i>Acanthocercus annectens</i>	LC
3	Side-striped chameleon ³	<i>Trioceros bitaeniatus</i>	LC
4	Gracile chameleon ²	<i>Chamaeleo gracilis</i>	LC
5	Kenya dwarf gecko ³	<i>Lygodactylus keniensis</i>	LC
6	Common long-tailed lizard ²	<i>Latastia longicaudata</i>	Unknown
7	Peters' writhing skink ³	<i>Lygosoma afrum</i>	Unknown
8	Ragazzi's bronze skink ³	<i>Lygosoma ragazzii</i>	Unknown
9	Long-tailed skink ³	<i>Trachylepis megalura</i>	Unknown
10	Five-lined skink ³	<i>Trachylepis quinquetaeniata</i>	Unknown
11	African striped skink ^{1,2}	<i>Trachylepis striata</i>	Unknown
12	Nile monitor ²	<i>Varanus niloticus</i>	Unknown
Snakes			
1	African rock python ²	<i>Python sebae</i>	Unknown
2	Brown house snake ³	<i>Lamprophis fuliginosus</i>	Unknown
3	Striped Ethiopian snake ³	<i>Pseudoboodon lemniscatus</i>	Unknown
4	Sandford's Ethiopian snake ³	<i>Pseudoboodon sandfordorum</i>	Unknown
5	Cape file snake ³	<i>Gonionotophis capensis</i>	LC

S.N.	Common name	Scientific name	IUCN status
6	Geoffroy's racer ³	<i>Platyceps florulentus</i>	LC
7	Ethiopian hook-nosed snake ³	<i>Scaphiophis raffreyi</i>	Unknown
8	White-lipped herald snake ²	<i>Crotaphopeltis hotamboeia</i>	Unknown
9	Boomslang ²	<i>Dispholidus typus</i>	Unknown
10	Hissing sand snake ³	<i>Psammophis sibilans</i>	Unknown
11	Grey-billed skaapsteker ³	<i>Psammophylax variabilis</i>	Unknown
12	Black mamba ²	<i>Dendroaspis polylepis</i>	LC
13	Egyptian cobra ³	<i>Naja haje</i>	LC
14	Rhombic night adder ³	<i>Causus rhombeatus</i>	Unknown
15	Puff adder ²	<i>Bitis arietans</i>	Unknown
Terrapins and Tortoises			
1	Helmeted terrapin ³	<i>Pelomedusa subrufa</i>	Unknown
2	Leopard tortoise ³	<i>Stigmochelys pardalis</i>	LC

¹ Species that were encountered during the rainy season at Tulu Moye area

² Species that were reported for the dry season for the whole project area and also reported in the current survey as potentially occurring in the project area

³ Species that was not listed during dry season survey and based on literature review that are potentially occur at the project area

⁴Ethiopian endemic

Unknown These are species for which either assessment of conservation status or taxonomic revision is underway, or information is not available on IUCN Red List website