

6. SOILS, NATURAL VEGETATION AND WILDLIFE RESOURCES OF ETHIOPIA AND THE HORN

6.1. Introduction

The *past geological process and varied climatic events* ensued Ethiopia to have *varied soil and biological diversity*.

Distribution of wildlife and natural vegetation in Ethiopia and the Horn is controlled by many factors: *climate, soil types, drainage* are the most important.

Ethiopia also have many *unique endemic fauna and flora resources*.

6.2. Ethiopian Soils: Types, Degradation & Conservation

6.2.1. Major Components, Formation & Properties of Soils

Major components of soil: It consists of *Weathered Mineral Materials*(45%), *Organic Matter*(5%), *Air*(20 - 30%), & *Water*(20 - 30%).

Soil Formation: Soil formation is a *long-term process*. It could take *several thousands of years to form a single stratum of soil*.

Soil formation is also *complex* due to its *complex mixture of several constituents*,

The formation of a particular type of soil depends on:
climatic & topographic factors, parent material (rocks), living organism, vegetation cover and time.

Weathering- is the breakdown of rocks and minerals into *smaller pieces* (into soils) by:

- *frost action/action of rainwater*
- *fluctuation of extreme temperature, and*
- *biological activity*

There are **3 types of weathering** involving in soil formation:

- A. Mechanical (physical) weathering**
- B. Biological weathering**
- C. Chemical weathering**

A. Mechanical (physical) weathering

It is the *physical disintegration* of rock *by physical forces* without changing/altering compositions.

Physical disintegration causes *decrease in size*.

These physical forces include:

- *Differential stresses due to Extreme temperature fluctuation*
- *Action of Rain water/frost action(Expansion of freezing water), and*
- *Abrasion(Erosion by friction)*

I. Differential stresses: - due to ***heating & cooling***(Extreme temperature fluctuation) that break the rock.

Temperature fluctuation can cause ***expansion or contraction of rocks***. That is:-

When the ***temperature of rock increases***, the ***rock expands***.

When the ***temperature of rock decreases***, the ***rock contracts***.

This ***process of expansion & contraction*** is a ***physical stress that can cause cracking or breaking down rocks***.

II. Abrasion (Erosion by friction):-

Abrasion of rock is caused by the ***friction of water, wind, or ice*** carrying ***debris of sediments upon the rock***.

The continuous exposure to process ***slowly breaks down the surface of the rock***.

II. Action of Rainwater/frost Action:-

Frost action is due to the **expansion of freezing water**.

Frost action is the repeated **cycle of ice formation & ice melt** in the pore spaces and fractures of rocks **causing disintegration of the rock**.

When water in **rock pores/fractures freezes, its volume increases**. This can create pressure on rocks, and then **causing disintegration of the rock**. (See fig. below)



If this cycle of **freezing, expansion, & melting** continues, the rock will gradually **disintegrate**.

B. Biological Weathering

It involves the *weakening & subsequent disintegration* of rock by:

- *Plants* (growing of roots of plants)
- *Animals* (Burrowing Animals)&
- *Microbes* (Microscopic organisms, such as bacteria & fungi).

I. The growing of roots of plants (which is a biological process)- **can exert pressure on rock** → *disintegration of rocks.*

Biological weathering – by **plant roots that fracture rock**



II. Burrowing Animals- *can gradually cause breaking of rock materials.*

Biological weathering – by **Burrowing of Animals**



III. Microbial Activity- breaks down rock minerals by **altering rock's chemical composition**, thus making it more **susceptible to weathering**.

Microorganisms can produce **organic acids** which can dissolve **minerals**, thus making it more susceptible to weathering.

An example of **microbial activity** is **lichen (fungi & algae)**.

Fungi release chemicals that **break down rock minerals**.

As this process continues, holes & gaps continue to develop on the rock, exposing the rock further to **physical & chemical weathering**.



Figure: lichen covered rock

C. Chemical weathering

It is the ***weakening and subsequent disintegration of rock*** by ***chemical reactions***.

It involves the ***modification*** of the ***chemical & mineralogical composition*** of the ***weathered material***.

Major ***chemical reactions that cause chemical weathering*** include: ***Carbonation, dissolution/ solution, hydration/ hydrolysis and oxidation reactions***.

These processes(reactions) either form or destroy minerals, thus altering rock's mineral composition.

Carbonation:- When water reacts with carbon dioxide, it creates **carbonic acid**, which can dissolve **softer rocks or breaks down minerals in the rock**.

Solution/Dissolution: is the process of dissolving minerals by water.

Eg - Limestone & rocks high in salt dissolve when exposed to water.

Oxidation:- It is the reaction of **water & rock minerals with oxygen**, thus changing the mineral composition of the rock. When minerals in rock oxidized, they **are rust & become less resistant to weathering**.

Hydrolysis /Hydration - is a chemical reaction caused by water.

E.g: When minerals are hydrolyzed, **clay minerals** are produced (**clay**- the smallest-sized soil particles).

Soil Properties: Soils have two basic properties:

I. Physical properties:

Properties such as ***texture, structure & porosity*** are physical soil properties.

These properties affect ***air and water movement*** in the soil.

II. Chemical Properties:

Soil properties like ***availability of minerals, electrical conductivity, soil pH, etc.*** are chemical properties of soils.

6.2.2. Major Soil Types in Ethiopia

Soils of Ethiopia are basically derived from *crystalline, volcanic and Mesozoic sedimentary rocks*.

Sedimentary rocks- are important for Ethiopian soil formation- since easily weathered.

According to latest classification by FAO there are **18 soil types** in Ethiopia.

Major soils (11 soils) cover about **87.4%** of the land area of Ethiopia.

Major types of soils in Ethiopia are discussed in terms of their:

A. Environmental condition i.e. parent material, climatic conditions, topography & the way they were formed.

B. Characteristic i.e. Significant chemical & physical properties.

C. Agricultural suitability in relation to **texture, structure, topography, moisture-storage capacity**, etc.

D. Occurrence: general location of the soil types.

Soil	Env'tal condition	Characteristic	Agricultural suitability	Occurrence
Nitisols	Develop on <i>gently sloping ground.</i> Basically associated with- <i>highlands of Ethiopia where RF is high</i>	<i>-Strongly weathered</i> soils. <i>-High leaching</i> due to high RF. <i>-Reddish-brown color</i> - is b/c of high concentration of <i>iron (ferric) oxides</i> due to leaching. <i>-Leaching makes it rich in non-soluble minerals:</i> Iron, Aluminum & <i>poor in soluble minerals:</i> potassium & calcium	Far more Productive than most other tropical soils	-Parent materials include <i>trap series volcanics, volcanic ash, & metamorphic rocks.</i> Dominantly found in: ■ <i>W^{rn}</i> highlands (Wellega), ■ <i>SW^{rn}</i> highlands (Kaffa, Illuababora), ■ <i>S^{rn}</i>, Central and <i>E^{rn}</i> highlands

Soil	Env'tal condition	Characteristic	Agricultural suitability	Occurrence
Acrisols	Mostly associated with <i>high RF highland areas</i>	-Lost most of the base nutrients & are characterized by low productive capacity.	-The most <i>inherently infertile soils</i> b/c of chemically & organically degraded soil.	Found along with nitosols in some pockets of SW^{rn} highlands where there is high RF.

Soil	Env'tal condition	Characteristic	Agricultural suitability	Occurrence
Vertisols	Soils of highlands & moderate climates.	Heavy clay soils:- swelling when wet, & cracks when dry	Easily degraded, but has very high natural fertility, so that difficult to manage	Developed from volcanic basalt, trachyte & pyroclastic materials, sedimentary rocks, colluvial & alluvial plains. Found in NW^{rn} , Central & SE^{rn} highlands (mainly in Gojjam, Shewa, Arsi, Bale and Hararghe).

Soil	Env'tal condition	Characteristic	Agricultural suitability	Occurrence
<i>Lithosols, Cambisols & Regosol</i>	-Rugged topography & steep slopes, & Areas of low RF	<i>-shallow & coarse textured—hence have low water holding capacity</i>	-Most areas covered by these soils have <i>limited agricultural use.</i> -Mostly <i>left under the natural plant cover & used for grazing.</i>	<i>found in:</i> -Central Highlands, West Hararghe highlands). -<i>Areas of low RF(Rift Valley) Danakil & eastern Ogaden</i>

Soil	Env'tal condition	Characteristic	Agricultural suitability	Occurrence
Xerosols Yermosols and Solanchaks	<i>Desert soil, Available in arid & semi-arid areas- so that subjected to wind erosion,</i>	-High salt content & low/poor organic (humus) content due to scanty vegetation. - Poor humus & nitrogen, but rich in phosphorus & potash	<i>-very fertile if irrigated,</i>	<i>Found in: -Ogden&NE^{rn} escarpments (xerosols)</i> <i>-Ogaden & Salty Afar plains (Yermosols & Solanchaks)</i>

Soil	Env'tal condition	Characteristic	Agricultural suitability	Occurrence
Fluvisols	Associated with deposits that take place in depression & lower valleys. <i>Associated with fluvial (river), marine (sea), lacustrine (lake) deposits.</i>	Recent alluvial deposits in depressions that are <i>formed by deposition of eroded materials from highlands</i>	-Fertile & their fertility is always renewed b/c of deposition of new soil materials. -Much prized for intensive agriculture (large scale irrigation agriculture)	<i>-Lower regions of rivers like- Omo, Awash, Abay, Akobo, Baro and lakes region (main Ethiopian rift)</i>
Luvvisols	Developed in areas where <i>wet and dry seasons occur in alternation</i>	Leaching is not very high	Have good chemical nutrients & are among best agricultural soils, so, they are intensively cultivated.	Found in <i>Lake Tana area, parts of N^{rn}, Central & E^{rn} Highlands & S^{rn} lowlands</i>

6.2.3. Soil Degradation in Ethiopia

Soil degradation is defined as a ***change in any or all of soil status.***

It is the ***deterioration of the physical & chemical properties of soil, as well as biological constituents.***

There are **three major types** of soil degradation:

I. Physical Degradation: Refers to the deterioration of the physical properties of soil. This includes:

A. Compaction: *Densification* of soil caused by the ***elimination or reduction of structural pores*** – by erosion/ run off.

Soils prone to ***compaction*** are ***susceptible to runoff and erosion.***

B. Soil erosion: The process of ***wearing away & moving down of soil components*** due to ***erosion, leaching and other agents of erosion.***

It is a ***three-phase process*** consisting of the ***detachment of soil particles, transportation and deposition.***

II. Biological Degradation:

Major types of biological degradation are:

- Reduction in ***soil organic matter content***,
- ***Decline in biomass carbon***(an elements which are important for growth of plant), and
- ***Decrease in activity and diversity of soil fauna*** (i.e; decomposers).

Mainly caused by:

- ✓ ***Indiscriminate & excessive use*** of agro-chemicals, and
- ✓ ***Soil pollutants***

III. Chemical Degradation:

Major causes of chemical degradation are:

- ***Nutrient depletion*** is a major cause of chemical degradation.
- ***Excessive leaching*** (removal of soil minerals) → ***Iron concentration*** in soils can cause a ***decline in soil pH & reduction in base saturation***.
- ***Buildup of some toxic chemicals*** that is injurious to plant growth.

Causes of soil Degradation in Ethiopia:

Soil degradation may result from: *Natural & Human-induced (anthropogenic) causes.*

I. Natural causes: Topographic and climatic factors- such as steep slopes, frequent floods, tornadoes(storm with strong winds), high-velocity wind and high-intensity rains are among natural causes of soil degradation.

II. Anthropogenic causes of soil degradation: are some *Major anthropogenic causes of soil degradation are:-*

- ✓ Deforestation and overexploitation of vegetation,
- ✓ Overgrazing,
- ✓ Indiscriminate use of agrochemicals, and
- ✓ Lack of soil conservation practices

6.2.4. Soil Erosion Control Measures

The aim of soil conservation is to *reduce erosion to a level at which the maximum sustainable level of agricultural production & grazing activity can be obtained* from an area of land *without unacceptable environmental damage*.

Since erosion is a *natural process*, it cannot be prevented, but it can be reduced to *a maximum acceptable level or soil loss tolerance*.

There are **two major** soil erosion control mechanisms:

- *Biological Control measures*
- *Physical control measures*

I. Biological Control measures:

It includes:

- ***Vegetative strips***: Two or more crops on the same field.
- ***Plantation/Afforestation***: planting trees in areas not used for cultivation.
- ***Reforestation***: replanting of trees after cutting forests.

These are used to prevent ***splash erosion, reduces the velocity of surface runoff, and increases infiltration, etc.***

II. Physical control measures:

Includes ***Terracing, construction of check dams, trenches(ditch), contour ploughing, soil bunds(shelter-belts & windbreaks in desert area).***

6.3. Natural Vegetation of Ethiopia

6.3.1. Introduction

Natural vegetation(NV) refers to a plant cover over area with little or no human interference/human action.

Distribution of **NV** in Ethiopia *mainly controlled by factors* such as: **Altitude, Climate(temperature & RF) & Drainage.**

For instance:

Lowlands due to their **low RF & high temperature** have **harsh environment** and are characterized by **xerophytic plants** (plants which are adapted to drought and high temperature).

Highlands due to their **cooler temperature & adequate moisture** are characterized by **afro- alpine & sub-afro-alpine plants (plants which are adapted to very cold & frost climate).**

Ethiopia possesses an estimated number of **6000 species** of plants, of which **10% are endemic.**

6.3.2. Major Natural Vegetation Types of Ethiopia

Based on ***altitude***, ***vegetation in Ethiopia*** can broadly classified the into ***five groups***.

1. *Afro-alpine and sub-afro alpine Region*
2. *Forest Region*
3. *Woodland Savannah Region*
4. *Steppe Vegetation Region*
5. *Semi-Desert Vegetation Region*

1. Afro-Alpine and Sub Afro-alpine

Ethiopia has the largest extent of Afro-alpine & sub afro-alpine vegetations in Africa.

I. Afro-Alpine:

It is also known as **high mountain vegetation- b/c** found on mountains having an **elevation ranging b/n 3,200 & 4,620 m.a.s.l.**

Afro-alpine habitat covers nearly **1.3%** of the total landmass of Ethiopia.

Annul precipitation ranges **b/n 800 & 1,500 mm** with sleet or snow.

Experienced **Temperature-** records of **0°C & below**(negative).

Bale & Semein mountains are typical examples of **afro-alpine vegs.**

Vegetation types in this region consists dominantly of **tussock grasslands, scrub, scattered mosses and lichens.**

Giberra (**Lobelia rhynchopetalum**) is dominant species in the **Afro-alpine.**

II. Sub-Afro-Alpine:

Sub-afro-alpine region is found at elevation ranges ***b/n 3,300 and 4,000 m.a.s.l***

This region is dominated by ***woodland***, often degraded to ***scrub stages and wet grasslands***.

Asta (Erica arborea) is dominant species in the ***Sub-afro alpine region***.

2. Forests

In Ethiopia, forests are found at **different elevations: 450 to 3,500m in humid parts and 2,300 to 3,300 m in arid parts.**

Forest region also characterized by **variation in mean annual RF that range b/n 200 mm and 2,200 mm.**

Based on variation in **RF & altitude** **two** broad classification of forests: **High land forests & low land forests.**

Highland forests include:

- **Kosso** (*Hagenia Abyssinia*),
- **Tid** (*Juniper procera*)
- **Kerkha** (*Arundinaria Alpina*),
- **Zigba** (*Podocarpus falcatus*),
- **Keraro** (*Aningeria adolfi-friedericii*)
- **Weyra** (*Olea africana*)

Lowland forests- includes **Baphia** (*acacia trees*).

It also includes **Riverine/gallery forests- forests that** are found along river banks like along lower course of **Awash, Wabishebele & Ghenale rivers.**

Dominant species include **Ficus sur** (*sholla*) and **acacia trees.**

3. *Woodland savanna*:

Found at *altitude range b/n 250-2300 m & mean annual RF ranges b/n 200 and 1,400 mm.*

Are known for *their xeromorphic characteristics*- that *shads their leaves* during dry season.

Broadly classified into 3 divisions:

- *Juniper procera* (Tid)
- *Acacia woodlands*: Grass grow with shrubs and acacia trees, and Konter.
- *Mixed deciduous woodlands*: Are Grass mixed with deciduous trees that shed their leaves during the dry season.

4. Steppe and Semi Desert Regions:

Found in ***arid & semiarid*** parts of Ethiopia where ***temperature is very high and RF is very low*** (100–500 mm for steppe & 50–300 mm for semiarid areas).

Steppe vegetation found at elevations of ***100 to 1,400 m.a.s.l***

Semi-deserts vegetation at ***130 m.b. s. l to 600 m.a.s.l.***

Xerophytic (i.e. drought-resisting plants) such as ***short shrubs, scattered tufts of grass species and a variety of acacias*** are some of the examples in this region.

6.3.3. Degradation of Natural vegetation

Over the past century, Ethiopia has dense forest coverage (**40%**) but it is disappearing at an alarming rate for different reasons.

Major causes for *disappearance* of the natural vegetation in Ethiopia includes:

- Clearing of forests for cultivation
- Timber exploitation practices – For furniture making.
- Charcoal burning and cutting for fuel
- Extensions of coffee and tea production areas
- Overgrazing
- Expansion of settlements both rural and urban, and
- Clearing for construction.

6.3.2. Natural Vegetation Conservation

Three main approaches are used for **biodiversity conservation**:

1. **Protection:** Through designation & management of protected areas (conservational areas) include: **National parks, Sanctuaries & community conservation areas(game reserve).**
2. **Sustainable forest management:** involving sustainable harvesting of forest products to provide a source of financial income.
3. **Restoration or rehabilitation:** It is an activity of assisting the recovery of a forest ecosystem that has been degraded, damaged, or destroyed.

6.4. Wild Life Resources of Ethiopia

6.4.1. Introduction

Ethiopia has about:

➤ **860 avian species** (16 endemic species & 2 endemic genera),

➤ **279 species of mammals** (31 endemic species & 6 endemic genera).

Among 31 endemic species: **Walia Ibex, Gelada Baboon, Mountain Nyala, Ethiopian Wolf, Starck Hare-** require urgent conservation action.

➤ **201 species of reptiles** (14 endemic species),

➤ **23 species of amphibians** (all are endemic species),

➤ **150 freshwater fish** (6 endemic species).

Wild animals in Ethiopia can be classified into **5 major groups**:

- 1. Common wild animals** (those animals that are found in many parts of the country (**e.g. hyenas, jackals**)).
- 2. Game (lowland) animal: Has 2 groups:**
Herbivores like giraffes, wild asses, zebras etc.
Carnivores like lions, leopards, and cheetahs
- 3. Tree Climbing animals or arboreal** (which include *monkeys, baboons*).
- 4. Variety of birds** in the Rift Valley lakes:
- 5. Rare animals- gelada baboon, Semien fox, walia- ibex** (in Semien Massifs) and **Nyala** (in Arsi-Bale massifs).

Importance of Wildlife

Importance of wildlife can be categorized as ***ecological, economic and investigatory importance.***

Wild animals can be used for:

- Scientific and educational researches (valuable information for medical purposes).
- *physical and mental recreation (aesthetic value)*
- *promotion of tourism (economic value)*
- Domestication -
- *maintaining ecological balance*

6.4.2. Wildlife Conservation

To prevent the destruction of wildlife:

- ***National parks,***
- ***Sanctuaries,***
- ***Community conservation areas(game reserve), and***
- ***Others like, botanical gardens, wildlife reserves etc. have been established in different part of the country.***

What is the difference among the three ?

I.National(NP): Are conservational areas for wild animals in which ***legal hunting is allowed, with some restrictions.***

Restrictions are like ***killing of endemic animal is not allowed.***

II. Community Reservation areas(Game reserve): This is similar with NP except that – in game reserve ***legal hunting is allowed only for tourists with license.***

III. Sanctuaries- Are conservational area for wild animals. Here legal hunting is prohibited(not allowed to kill the wild animals).

Some of the ***national parks*** are ***unique in their wild animals they have.***

E.g.

- 1. Abiyatta-Shalla lakes National Park*** is predominantly ***bird sanctuary, like flamingos and pelicans.***
- 2. Omo, Mago, and Gambela National Parks*** have ***hippopotamus and crocodiles*** in rivers and lakes.
- 3. Semien and Bale Mountains National Parks*** have ***rare animals*** like ***Walia ibex, Semien fox, gelada baboon and Nyala.***

Table: National Parks of Ethiopia

S.No	Name	Region	Year est.	Area in sq.km
1	Kafeta Shiraro	Tigray	1999	5000
2	Semien Mountains	Amhara	1959	412
3	Alatish	Amhara	-	-
4	Bahir Dar Blue Nile River Millennium	Amhara	2008	4729
5	Borena Saynt	Amhara	2008	4325
6	Yangudi-Rassa	Afar	1969	4731
7	Awash	Oromiya and Afar	1958	756
8	Dati Wolel	Oromiya	2010	1031
9	Bale Mountains	Oromiya	1962	2200
10	Yabello	Oromiya	1978	1500
11	Abijata Shala	Oromiya	1963	887
12	Arsi Mountains	Oromiya	2012	-
13	Geralle	Somali	1998	3558
14	Gambella	Gambella	1966	4650
15	Nechsar	SNNPR	1966	514
16	Omo	SNNPR	1959	3566
17	Mago	SNNPR	1974	1947
18	Maze	SNNPR	1997	202
19	Gibe Sheleko	SNNPR	2001	248
20	Loka Abaya	SNNPR	2001	500
21	Chabra Churchura	SNNPR	1997	1190

Challenges Facing Wildlife of Ethiopia

Here are some of the major challenges that Ethiopian *protected areas* are facing;

- ➡ Limited awareness on the importance of wild life
- ➡ Expansion of human settlement in protected areas.
- ➡ Overgrazing
- ➡ Illegal wildlife trade
- ➡ Excessive hunting
- ➡ Tourism and recreational pressure
- ➡ Mining and construction material extraction
- ➡ Forest fire – frequent wild fire.