Ethiopian Forestry Development
Forest Disaster Protection

Forest fire training manual(Draft)

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Acronyms

BAER ……Burned Area Emergency Response

BMNP ……Bale Mountain National Park

CIMA…….Research Foundation, International Center for Environmental Monitoring, is a non-profit research organization.

CBDM……..Community-Based Disaster Management

DPPC……..Disaster prevention and preparedness commission

EFD……Ethiopian Forestry Development

EWD……..Early warning department

EWS……..Early warning system

FFP…….. Forest Fire prevention

MyDewetra….Forest Fire Early warning platform/tool/

SMNP……Semen Mountain National Park

TOT…….Training of Trainers

1 Introduction

Wild fire is a fire in a wild area (such as a forest) that is not controlled and that can burn a large area very quickly. A wildfire, forest fire, bushfire, wild land fire or rural fire is an unplanned, uncontrolled and unpredictable fire in an area of combustible vegetation. Depending on the type of vegetation present, a wildfire may be more specifically identified as a bushfire, desert fire, grass fire, hill fire, peat fire, steppe fire, vegetation fire, or savannah fire. Some natural forest ecosystems depend on wildfire. Wildfires are uncontrolled, rapidly spreading, and raging huge flames enhanced with wind action and firebrands that can wipe out an extensive forest or vegetation land area within minutes. Wildfires are among forces of nature that cause huge devastation to humans and environment.

The protection of the forest resource base is one of the most important tasks for forest management. Fire is often considered as the most and dangerous sources that attack the forest resources which also extend its impact on the people living inside and/or adjacent to the forest area. Centuries ago, warring parties set fires in Ethiopia's high forests to chase out their enemies (Lemessa and Perault 2001), and feudal lords cleared forests on mountaintops to establish settlements from which they could observe enemies in the distance (Teketay 2001). There is a long history of using fire to clear forests to establish new settlements and open up new farming land. Based on historical evidences forest fire in Ethiopia, indicates that high forests of Ethiopia remain victims of war and conflicts. Yodit/Gudit (849-897 A.C.) ordered her army and the local people to set fire to forests stretching from Tigray to Gonder and Wello in suspected hiding grounds for the soldiers of Emperor Dilnaad. Similarly, Grange Mohamed (1527-1542 A.C.) ordered his troops to clear and burn all the forests stretching from the eastern lowlands to the central highlands to make access to battlefields easier and to destroy strategic hiding grounds of the soldiers of Emperor Libne Dingil and clergies (Wolde Selassie, 1998).

Whatever the causes may be, fires in different parts of Ethiopia damage every year large areas of forests. Despite the country's long time experience in using fires, there are no available statistics on the causes, risks and extent of damage caused by forest fires. Prior to the forest fires in 2000, the last major outbreak was in 1984 when the fires damaged approximately 308,200 ha of forests

(George and Mutch, 2001). After almost three months of large scale wildfires that consumed over 300,000 ha natural forests, Ethiopia is still not prepared and does not give adequate attention to efficiently protect its last natural forest resources (Dechassa Lemessa, 2001).

Wildfires are common in the western lowlands, which are dominated by woodland, bamboo and grassland. These fire-adapted ecological systems are characterized and shaped by frequent natural and anthropogenic fires. Grasslands are especially prone to fire between March and May. People clear large areas for commercial farms, and burn crop residues rather than using them as fodder; these fires sometimes spread into woodlands. Trans-boundary fires cross to and from Sudan and South Sudan. Wildfires also occur in the forests of southern Ethiopia, which have little previous fire history.

1.1 Background

In Ethiopia farmers have been using fire as a means of production or as a farming tool for a long time. Every year, just before the short rainy season, when farmers start preparing their land, it is common to see deliberately set fire here and there. Every year, just before the short rainy season starts, very large areas of lowland, woodland and grassland formations are affected by fires, particularly in the drier parts of the country. There were also fires set irresponsibly/accidentally, in most lowlands of the country, Gambella and Benishangule Gumiz. However, it was very common that most of the fires are attended, managed and controlled by the community members who set it.

Recently, as preventive action the directorate working on forest fire has been structured in the Ethiopian Forestry Development (EFD). By this directorate forest manual on prevention and protection has been developed and updated continuously. Additionally, awareness creation following global forest fire watch and MyDewetra platform has been conducted to make alert the community by the staffs. Regions were supported by early warning check list in order to minimize risks. Trainings for different religious bodies on building common perception on the prevention of forest fire; Provision of TOT training for regional staffs to raise motivation, mobilization & participation of local community on the prevention of forest fire; Prepare & disseminate different broachers & leaflets & using mass medias for alerting the wider communities; Forest fire protection task force has been established, even though all not sustainably functional. Afforestation was made via mass mobilization to rehabilitate Semen

Mountain National Park (SMNP), by doing so 25 ha of land are planted by FLR options with in the park. Similarly, the protected Bale Mountain National Park (BMNP) was also on the process of restoration.

2 Objective

The main objective of the manual is to reduce the number of fires and minimize the hazards that are associated with them.

2.1 Specific objectives

- Identify the various fuel types in their home area and describe their burning characteristics.
- Understand relates to fire suppression activities.
- Identify the areas of special protection that need to be considered in planning.
- Identify the fire suppression resources that exist in their home area.
- List the steps in developing a fire prevention plan.
- Prepare a fire prevention action plan

3 Scope of manual

This manual is prepared mainly support the regions to use as a reference while providing trainings to the lower level structures.

4 Method of establishing baseline data

The baseline study involves gathering and evaluating information from existing sources and collecting field data. The existing sources of information (secondary data) may include databases, reports, and local community. Primary data is generated through field works, which include monitoring and surveys. Many research methods can be used in baseline studies, including those described above in the programme planning section such as surveys, interviews, or focus groups. Visual items, including photographs, maps and diagrams, are important pieces of data and are often underused in a baseline study.

5 Causes of wild land forest fire

Fires in Ethiopia are by a large majority of human origin, i.e., caused by accident, negligence or intention. Unattended Campfires: Camping is a fascinating experience and I bet most people love camping as a way of connecting with nature and to experience some good time outdoors. However, during camping or outdoor activities people normally leave lit fires or combusting materials unattended to which can ignite wildfires. Fire is used to clear rangelands of unpalatable dry grasses, invasive bushes and parasites, namely tick, that affect livestock, and to encourage the growth of fresh, palatable grasses for livestock grazing; to clear fields of crop residues and other unwanted vegetation during land preparation; and to clear forest and bush land for settlements and crop production or for tea or coffee plantations.

Human acts of carelessness such as leaving campfires unattended and negligent discarding of cigarette butts result in wildfire disasters every year. Deliberate acts of arson, burning of debris, and fireworks are as well other substantial causes of wildfires. Fire is also used to facilitate access; to drive away wild animals and rodents that damage crops, and snakes, parasites, toxic caterpillars and predators harmful to people and livestock; to harvest wild honey; and to clear the stumps of illegally cut trees, or during illegal charcoal making in woodland and dry forests. Fires set for these purposes frequently spread out of control. The lack of negotiated benefit-sharing arrangements for park revenue leads to tension with surrounding communities, whose livelihoods have been undermined by the loss of access to water, pasture and trees within park boundaries.

Wildfires result from a complex set of social, political and economic circumstances. These are rooted in interrelated factors such as rural poverty, growing population pressure and low agricultural productivity, the absence of operational land-use policies, and weak capacity in forest tenure and law enforcement (Lemessa and Perault 2001).

Wildfires also occurring as a result of natural causes vary from one region to another depending on the vegetation, weather, climate and topography. There are only two main natural causes which are lightning and volcanic eruptions.

6 Types and Classifications of Forest Fires

6.1 Fire types

There are three basic types of forest fires: ground, surface, and crown fire. During a wildfire, it's not uncommon to have all three types of fire. Except for ground fires, a vegetation fire is propagated mainly by convection and radiation. Fire spotting can accelerate the fire spread. Various types of fires are distinguished in accordance with the layers they are spreading:

a. ***Surface fires*** burn surface litter, other loose debris of the forest floor, and small vegetation; a surface fire may and often does, burn taller vegetation and tree crowns as it progresses.
b. ***Crown fires*** advance through the tops of trees or shrubs more or less independently of the surface fire and are the fastest spreading of all forest fires.
c. ***Ground fires*** consume the organic material beneath the surface litter of the forest floor; ground fires are the least spectacular and the slowest-moving, but they are often the most destructive of all forest fires and also the most difficult to control.

6.2 Fire classifications

There are five basic classifications of fuel and extinguishers, and extinguishers are labelled with either letter-shaped or pictorial symbols that indicate what types of fires they are intended for.

Class A:

Class A fires involve ordinary combustible materials, such as cloth, wood, paper, rubber, and many plastics. Extinguishers with an A rating are designed to extinguish fires involving these ordinary combustible materials.

Class B:

Class B fires involve flammable and combustible liquids such as gasoline, alcohol, oil-based paints, lacquers. Therefore, extinguishers with a B rating are designed to extinguish fires involving flammable and combustible liquids.

Class C:

Class C fires involve energized electrical equipment. Extinguishers with a C rating are designed for use with fires involving energized electrical equipment.

Class D:

Class D fires involve combustible metals, such as magnesium, titanium, and sodium. Extinguishers with a D rating are designed to extinguish fires involving combustible metals.

Class K:

Class K fires involve vegetable oils, animal oils, or fats in cooking appliances. Extinguishers with a K rating are designed to extinguish fires involving vegetable oils, animal oils, or fats utilized in commercial cooking appliances.

7 Fire behaviour

All fires have at least one thing in common: An original ignition point. Fire behaviour includes such things as how fast a fire burns (rate of spread), how hot it burns (fire intensity), the presence of fire whirls, and ember production and spotting. In a structure fire, Building Factors, Smoke, Air Track, Heat, and Flame (B-SAHF) are critical fire behaviour indicators.

8 Heat transfer (fire regime)

For combustion to be sustained and for fires to spread, heat must be transferred from one fuel particle to the next. This happens in 3 different ways: Combustion/conduction, radiation and, convection.

8.1 Combustion

Combustion is the transfer of heat from one particle of fuel directly to another. It is a fast and exothermic oxidative reaction that releases heat, requiring an oxidizing agent to burn the fuel. In the case of a forest fire this oxidizing agent is the air in the atmosphere with the vegetation being the fuel. Wood is a poor conductor of heat, so conduction is the least important means of heat transfer in terms of wild land fire behaviour.

8.2 The conduction

It is the result of molecular movement. It is related to the composition and the temperature of the environment. It can only happen in a material that is solid, liquid or gaseous. The heat spreads from the warm to the cold body.

8.3 Thermal Radiation

It is a type of energy transfer in form of electromagnetic waves with or without particles. All bodies with an absolute temperature above 0 K (= –273°C) emit an electromagnetic radiation, where the radiation frequency is a function of the temperature. The quantity of the transferred

energy from one body to another body augments with the increase of the temperature difference between these two bodies. Heat transfer during a forest fire is mainly by electromagnetic infrared radiation.

8.4 Convection

Convection is the process of "hot air is rising". It is what makes smoke columns raise and assists in upslope fire. It is potentially the most dangerous of the three heat transfer methods. It is a heat transfer by macroscopic movements of a fluid (gas in the case of a fire) who's mass transports the containing heat. In vegetation fires, combustion produces hot gases which mix with the also heated ambient air. These hot gases are lighter and go up quickly. They bring a great quantity of heat to fuels located above (crown), desiccate them and raise their temperature up to the ignition point. The wind, by pushing hot gases ahead of the flaming front - even in the lower layers of the vegetation - accelerates the fire spread.

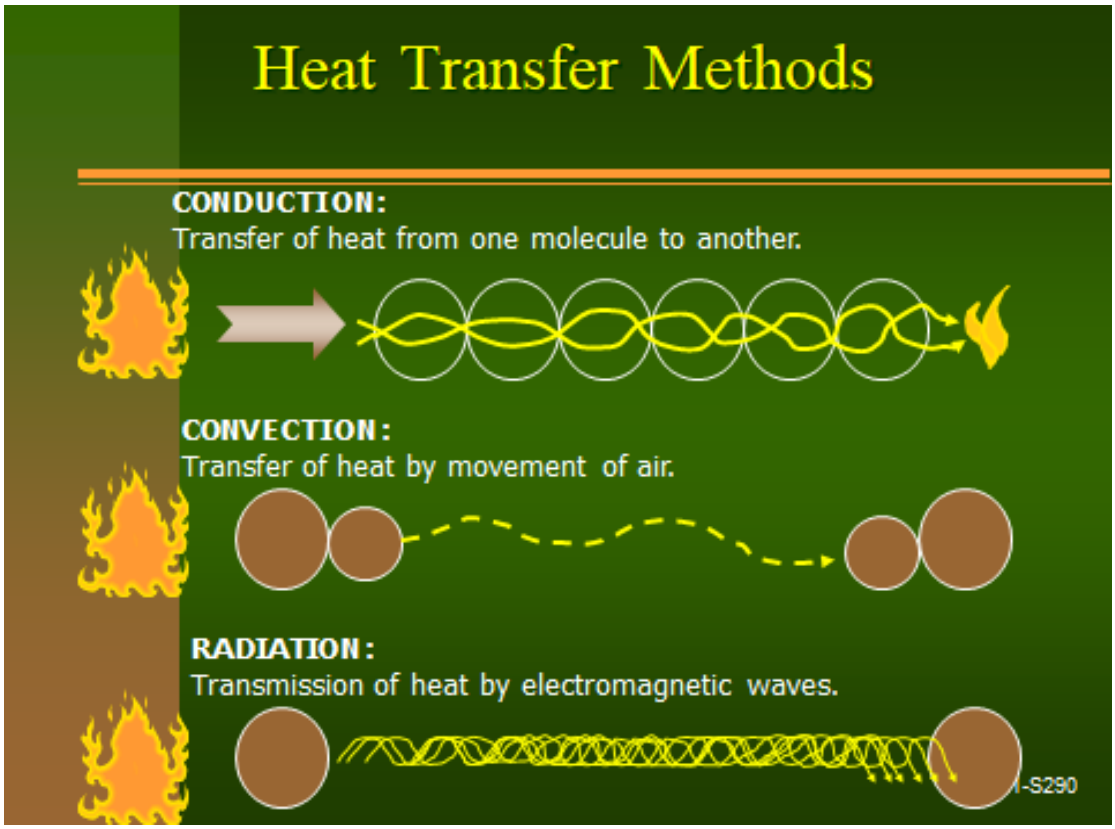

Figure 1 Heat transfer Method

Fires behave differently. Some burn slowly and evenly; others are extremely hot, burning fiercely and quickly. Different fires have different coloured flames. The mechanisms of fire spread are distinguished in three phases: Combustion of vegetation material with heat emission; Heat transfer towards the fuel ahead of the fire front by conduction, thermal radiation and convection; Heat absorption by the plant before the flaming front and its ignition. It is an energy exchange process between two points in space that occurs when a temperature difference exists between these two points.

9 Previous efforts in terms of fire management

In Ethiopia, wildfire has played a fundamental role in the evolution of dry land ecological systems, and fire is a common element in the ecology of rangelands, savannahs', shrub land, woodlands and dry forests. The frequency and impacts of wildfires have increased in recent decades especially in the western and south western woodlands and national parks, due to increased human activities. Prohibiting the use of fire in the rangelands of southern Ethiopia since the 1980s is blamed for allowing bush to encroach into grasslands, with severe effects on biodiversity and pastoral livelihoods.

The 2018 National Forest Law states that forest developers and users must protect forests from fires and must report fire occurrence at once to responsible bodies; the law can impose sentences of 1 to 10 years for setting fires in forests (FDRE 2018). However, the law does not specify
Climate change with more frequent and severe drought is an important factor in the increase in the number and intensity of wildfires.

Human pressure and intensified drought have seen Ethiopia recurrently affected by severe wildfire emergencies since 2019. Severe wildfires have affected most ecosystems, including humid forests and protected areas and sites receiving international funding, including under the REDD+ programme. In 2019, major wildfires in Simien National Park, a UNESCO World Heritage Site, took more than a month to be effectively controlled and then only after international support was obtained. Wof Washa forest was severely affected in 2021, when 14,688 ha were burned

Ethiopian Forestry Development (EFD), an autonomous federal body, is eager to address gaps in capacity and establish a coherent and effective fire management strategy. After forest fires in 2021, EFD took the lead in bringing together regional task teams to enhance the coordination of fire fighting efforts. EFD worked with Italy's CIMA Foundation to develop a forest fire early-warning system using the myDEWETRA tool to organize and distribute remote sensing data in bulletins shared with regions (CIMA Foundation n.d.). This project, which ended in 2021, involved a capacity-building component. EFD has called for development partners to assist with new collaborative initiatives.

10 Policy, Strategy, Institutional arrangement

The federal government of Ethiopia set a national target to restore 15 million hectares of degraded and deforested lands by 2030. However, there is neither forest policy nor forest fire policy in place. There is no management plan for the remaining forest resources and no systematic fire management structure at any level except forest fire control committees which is not operational mainly due to lack of financial allocation.

There is also little economic incentive for efficient forest management and conservation, and farmers and communities have no interest or reason to conserve forests and protect their environment. People in rural areas illegal immigrants in particular, consider forests to be free unoccupied areas and settle there to grow crops.

11 Fire triangle

A fire needs three elements - heat, oxygen and fuel.

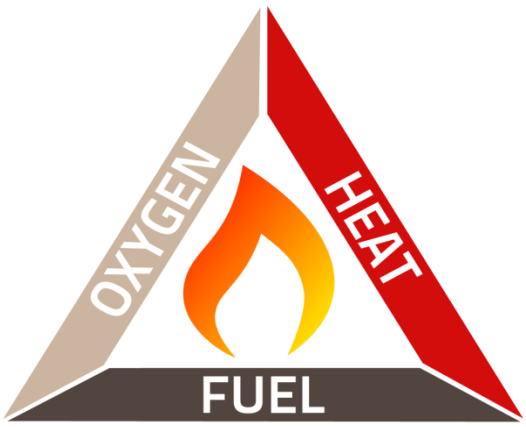

Figure 2 Fire Triangle

Without heat, oxygen and fuel a fire will not start or spread. A key strategy to prevent fire is to remove one or more of heat, oxygen or fuel. The risk assessment should include detail on all three elements to minimise the risk of a fire starting/ spreading.

Unstable institutional structure of forestry at all levels is also another constraint. In addition, the use of many of the forest areas as a common property resource regardless of their suitability to sustain agriculture has contributed to the destruction of forest by fire.

12 Major gaps in fire management capacity

These gaps in capacity need to be addressed in order to develop effective fire management:

- Limited data on trends in fire frequency and intensity, and high-risk areas;
- Lack of a national forest fire management strategy that defines the mechanisms to prevent, detect, report and suppress fires;
- Lack of a national land-use policy and plan;
- Limited coordination between the forest law and laws in other sectors;
- Few forest management plans, which are necessary to implement the revised National
- Forest Law;
- Weak enforcement of existing laws;
- Poor coordination and communication between various actors at various levels of government in and between regional states; and
- Lack of fire fighting equipment and trained fire fighters, with a heavy reliance on international support and using local citizens and security personnel only for fire suppression.

To address these gaps and develop a national strategy, the following actions are needed:

- identify and address the root causes of wildfires;
- gather data on fire risk and fire occurrence;
- update the map of high-risk areas and the chronology of wildfire incidences;
- carry out efficient measures to prevent wildfire;
- establish and implement a mechanism to rapidly detect and suppress wildfires;
- build technological, financial, logistical and human capacity to forecast, detect, report and suppress forest fires and undertake post-fire rehabilitation measures;

- institutionalize mechanisms for networking, collaboration and coordination of actors at all levels;
- build on indigenous knowledge of wildfire prevention and management;
- ensure the participation of local administrations and communities in developing and implementing fire management plans; and
- Allocate the required resources to develop and implement management plans.

13 Global, regional, national concern, cultural traditional (best) practices

Climate change affects wildfires by exacerbating the hot, dry conditions that help these fires catch and spread. As global temperatures rise, we expect the size, frequency and severity of wildfires to increase in the years ahead. Research shows that changes in climate create warmer, drier conditions, leading to longer and more active fire seasons. Increases in temperatures and the thirst of the atmosphere due to human--caused climate change have increased aridity of forest fuels during the fire season. For example, many places have experienced changes in rainfall, resulting in more floods, droughts, or intense rain, as well as more frequent and severe heat waves. The planet's oceans and glaciers have also experienced changes—oceans are warming and becoming more acidic, ice caps are melting, and sea level is rising.

The burning for agricultural practices like shifting cultivation accounts for forest burned areas where it is practiced like in the Amazon forests. Fire regime transition can occur due to human landscape management, fire suppression, overgrazing, invasive plants, and climate change (Bowman et al.2009). Historical fire suppression can accumulate more fuels and may result in more severe wildfire events (Gedalof et al., 2005). (Jin, 2010). The patterns of urbanization are sinking the boundaries between urban and are wildland areas and becoming increasingly blurred in many parts of the world. The Wildland-Urban Interface (WUI) has become the frontline of wildfire disasters.

Forest fires across the globe are increasing. In many regions of the world, forest fires are natural processes and can have beneficial effects on forests. However, the recent trends of forest fires are giving a different picture. Some fires are too severe, occurring in habitats where they were very limited, unseasonal, or even more intense and frequent. In these cases, forest fires pose a serious

threat to forest ecosystems and well-being of humans. Globally only around 4 % of all forest fires have natural causes such as lightning. In all other cases, humans are responsible for the fires be it directly or indirectly, deliberately or due to carelessness (Hirschberger, 2016).

The National Fire Protection Association's NFPA 1730 Standard on Organization and Development of Fire Prevention Inspection and Code Enforcement, Plan Review, Investigations and Public Education Operations outlines how fire prevention programs are to be operated, but also outlines means of evaluation for fire prevention programs (NFPA, 2016). NFPA 1730 recommends beginning any fire prevention program with a community risk assessment, which identifies those in need and helps to focus resources and establish target groups for fire prevention program delivery (NFPA, 2016). The community risk assessment includes; geography, demographics, socioeconomics, building stock, fire experience and known hazards, which should be re-evaluated every 5 years. Reports and records must be maintained in accordance with national standards and best practices, including statistical data. This data is analysed periodically to ensure that the target is reached and that a desired effect is measured.

Traditional cultural practices reflect values and beliefs held by members of a community for periods often spanning generations. Traditional cultural expressions (TCEs), also called "expressions of folklore", may include music, dance, art, designs, names, signs and symbols, performances, ceremonies, architectural forms, handicrafts and narratives, or many other artistic or cultural expressions.

14 Fire management approach

There is an increasing recognition that fire management should involve an integrated approach ("integrated fire management" – IFM) with five key elements;

- Review (monitoring and analysis);
- Risk reduction (prevention);
- Readiness (preparedness);
- Response (suppression); and
- Recovery.

Often, wildfires do not stop at the edges of forests, and they may also originate outside forests. IFM, therefore, should encompass other, non-forest land uses and vegetation types, such as

agriculture, rangelands, savannahs, peat lands, protected areas and wild land–urban interfaces. Fire management should be integrated in a broad landscape approach that applies the five elements of IFM. In regions where fire is an important management tool, forest managers should use it in a responsible, controlled manner so as to avoid damage to human lives, assets and ecosystems.

Many communities have used fire as a management tool for centuries and have developed considerable traditional fire knowledge and management practices. Such knowledge and practices are valuable resources for IFM and should be the base for Community Based Fire Management Approaches.

In general, all stakeholders should be actively involved in the planning and implementation of IFM strategies, and fire prevention and suppression should be undertaken jointly. Stakeholders include policymakers in the forest and other relevant sectors, forest and other land managers, forest owners, communities living in and close to forests, civil defence services, and fire services.

Management options: Management Options means options granted or issued by the Issuer pursuant to the Management Option Plan. Management Options means the options granted to certain key employees of the Company or any of its Subsidiaries for the purchase of not more than five percent (5%) of the Common Stock on a Fully Diluted Basis. As a management options respect the following rules;

- Obey local laws regarding open fires, including campfires.
- Keep all flammable objects away from fire.
- Have fire fighting tools nearby and handy.
- Never leave a fire unattended.
- Carefully dispose of hot charcoal.
- Drown all fires.
- Carefully extinguish smoking materials.

15 Fire prevention

Human activities are the leading cause of wild land fires. That is why fire prevention education is so important. Informing people of fire prevention methods is one way we can try to reduce the devastation resulting from wild land fires.

There are three key elements to a wild land fire prevention program;

15.1 Education;

- ✓ Informing the public on fire prevention.
- ✓ Raising public awareness.
- ✓ Changing public attitudes and behaviors to support fire prevention.

15.2 Engineering;

- ✓ The implementation of fire prevention tactics.
- ✓ A means of separating heat sources from fuels.
- ✓ Reducing or eliminating fuels when heat sources remain.
- ✓ Shielding fuels from heat sources to prevent contact**.**

15.3 Enforcement

- ✓ Ensures compliance with local, state, and federal fire codes and regulations.
- ✓ Ensures compliance with fire cause determination.
- ✓ Ensures compliance with law enforcement action.

16 Pre-suppression activities

Activities of pre-suppression include;

- ❖ overall planning, recruitment and training of fire personnel,
- ❖ procurement and maintenance of fire fighting equipment and supplies,
- ❖ Fuel treatment and creating, maintaining, and improving a system of fuel breaks, roads, water sources, and control lines.

Pre-suppression also includes all the actions that are required in fire fighting for the successful suppression of a fire with the exception of fire prevention. This includes all kinds of preparation such as the development the organization, planning, cooperation and mutual aid arrangements with other authorities, personnel recruitment, and training. Fire suppression will only be as

effective as the quality and the continuity of the pre-suppression operations. A lot of work is required in the area of pre-suppression.

Regional and local fire plans should include all the recruitment of personnel, the purchase of equipment, and all the activities needed in forest fire suppression.

Three types of attack methods:

- Direct Attack is working on the fire edge
- Indirect Attack is working some distance from the fire
- Parallel Attack is from the flanks

Figure 3 Methods of attacking Fire

Figure 4 Methods of attacking Fire

All must have an anchor point! And must bring the Backfire with them!

Fire is a good friend of man if and when properly utilized but it will turn into a man-made hazard when neglected. Fire is a rapid oxidation of matter accompanied by heat or flame. Many People

are injured and die because of fires, which there are some instances that it could be prevented. There are also losses of Property because there is no time to neither gather valuables nor make a phone call, since fire spreads in seconds and a residence can be engulfed in flames in just five minutes. Consequences in fire bring strong impacts to the victims.

It is important to understand the basic characteristics of fire for self-protection. Poisonous gases produced by fire make a victim disoriented and tired. Heat and smoke from fires are more dangerous than the flames itself. Inhaling the super-heat air can burn the lungs and the victim may fall into a slumber sleep instead of being awakened by a fire. Actions to be taken to prevent forest fire include camp fires should be extinguished before leaving. Smoking in the forest should be avoided as it might set fire on dry leaves and twigs.

Among the numerous strategies of how to prevent wildfires from spreading, the most effective one is never to let it happen. Forest fire prevention and control are possible with effective agricultural and forest management plans, alongside public awareness, responsibility, and concern. Try to prevent the start of the fire, acting on the agents that cause the ignition.

17 Wild fire suppression

Wildfire suppression is a range of fire fighting tactics used to suppress wildfires. Fire fighting efforts in wild land areas require different techniques, equipment, and training from the more familiar structure fire fighting found in populated areas. Working in conjunction with specially designed aerial fire fighting aircraft, these wildfire-trained crews suppress flames, construct fire lines, and extinguish flames and areas of heat to protect resources and natural wilderness. Wildfire suppression also addresses the issues of the wild land–urban interface, where populated areas border with wild land areas.

18 Community based fire management program

Community based fire management approaches can play a significant role in fire management, especially in most parts of the world where human-based ignitions are the primary source of wildfires that affect livelihood, health and security of people. The activities and knowledge communities generally practice are primarily those associated with prevention. They include

planning and supervision of activities, joint action for prescribed fire and fire monitoring and response, applying sanctions, and providing support to individuals to enhance their fire management tasks. Communities can be an important, perhaps essential, component in large-scale fire suppression, but should not be expected to shoulder the entire burden. The community based disaster management approach focuses on building the capacity of communities to assess their vulnerability to both human-induced and natural hazards and develop strategies and resources necessary to prevent and mitigate the impact of identified hazards as well as to respond, rehabilitate and reconstruct following their onset.

Community-Based Disaster Management (CBDM) initiates a process involving sequential stages that can be operationalized to reduce disaster risk. Processes of CBDM are guided by principles of subsidiarity, economies of scale, equity, heterogeneity, and public accountability. The different stages in CBDM are;

- Disaster/vulnerability assessment,
- risk reduction planning,
- early warning systems,
- post-disaster relief, and
- Participatory monitoring and evaluation.

CBDM bottoms-up approach with intensive, micro interventions at the local level, ward or village level with the intention of generating confidence, awareness, knowledge, partnership, and ownership for planning and rolling out local disaster management plans encompassing all levels of disaster management continuum.

19 Firing Tactics:

- Firing should be against the wind and/or slope.
- Favourable weather conditions should always be in place before firing operations begin. Fuels outside control line can be wet down ahead of firing to prevent spotting.
- Do not advance firing faster than holding forces can keep up with.
- Always have safety zones and escape routes identified prior to initiating firing operations.

19.1 Strip Firing:

- Involves setting fire to one or more strips of fuel and allowing the strips to burn together.
- Lighting numerous strips allows faster ignition.
- Width and location of strips in relation to slope or wind direction regulates firing intensity.

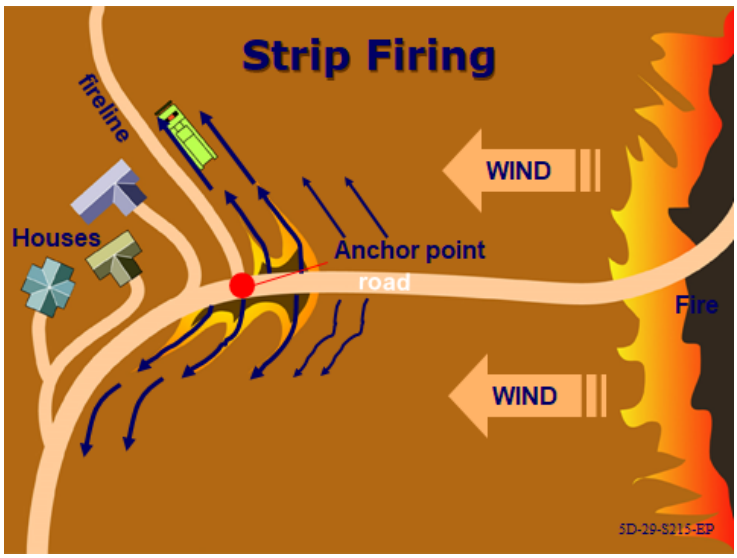

Figure 5 Strip firing method

19.2 Ring Firing:

- **Generally used for indirect attack and backfiring operation or to burn out around structures.**
- **Involves circling the perimeter of an area with a control line and firing the entire perimeter.**
- **Generally doesn't provide a good anchor point to commence firing.**
- **Escape routes and safety zones must be established.**

Figure 6 Ring firing method

20 Fire suppressions methodologies

(Direct attack, indirect attack, flanking)

Different types of fire suppression systems include:

- Dry fire suppression systems that extinguish fire by interrupting chemical reaction at the fire triangle. All fires can be extinguished by cooling, smothering, starving or by interrupting the combustion process to extinguish the fire. Fire fighters control a fire's spread (or put it out) by removing one of the three ingredients fire needs to burn: heat, oxygen, or fuel. They remove heat by applying water or fire retardant on the ground (using pumps or special wild land fire engines) or by air (using helicopters/airplanes). Any treatment applied **directly** to burning fuel such as wetting, smothering, or chemically quenching the fire or by physically separating the burning from unburned fuel.

Figure 7 Local fire suppression in Ethiopia

- The ***indirect*** technique is usually applied on high-intensity fires where fire fighters cannot approach the front of the fire due to heat and/or smoke conditions. An example would be the use of heavy equipment cutting line and allowing the fire to burn up to the break without burning over.
- Flanking fire suppression is attacking a fire by working along the flanks either simultaneously or successively from a less active or anchor point and endeavouring to connect two lines at the head.

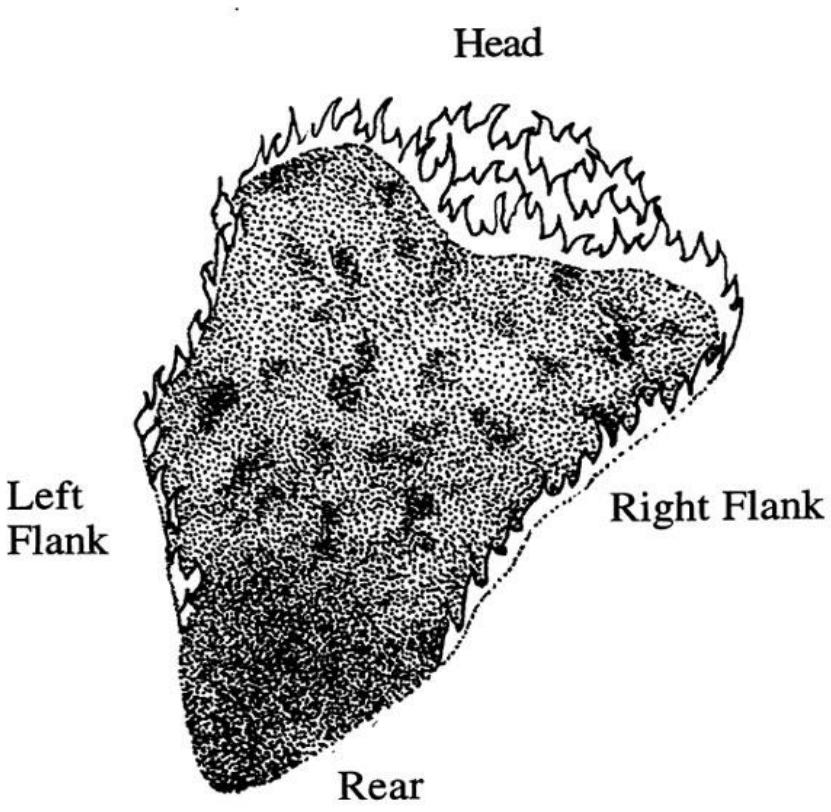

Figure 8 Flanking suppression methods

Source: Colorado fire Camp, where to attack fires.

21 The Influences of Weather, Slope, Wind, and Topography on wildfire

Wildfires require the alignment of a number of **weather** factors, including temperature, humidity, and the lack of moisture in fuels, such as trees, shrubs, grasses, and forest debris. All these factors have strong direct or indirect ties to climate variability and climate change. Weather includes; temperature, relative humidity, atmospheric stability, wind speed and direction and Precipitation.

21.1 Slope

Slope directly affects flame length and rate of spread. If the fuels and wind are constant, a steeper slope results in increased flame length and rate of spread. In fact, for every 10 degree increase in slope a fire will double in speed. This is because the slope provides a similar effect to the wind, effectively laying the flames down into the slope and pre-heating the vegetation, allowing it to ignite more rapidly. Slope can determine how quickly a fire will move up or down hills. For example, if a fire ignites at the bottom of a steep slope, it will spread much more quickly upwards

because it can pre-heat the upcoming fuels with rising hot air, and upward drafts are more likely to create spot fires. The aspect determines the dryness of slopes, and thus the combustibility of the vegetation.

21.2 Wind

Wind can influence fire behaviour by: Moving moist air away from fuels, causing them to dry out faster. Carrying burning embers that have been lifted aloft by convection air and starting spot fires ahead of the perimeter.

21.3 The topography:

In the wildfire environment topography plays an integral part in determining how a fire will develop and spread across a landscape. The topography also influences the impact of wind on fire behaviour and spread.

- ✓ Aspect - Direction a slope faces
- ✓ Slope - Steepness.
- ✓ Position of Fire - Top, middle, or bottom of slope.
- ✓ Shape of Country - Narrow canyons & box canyons.
- ✓ Elevation - Relates to curing of fuels, precipitation, length of fire season, etc.

In general, in order to be able to respond to a wildfire without delay and at the most appropriate location by deploying fire fighting forces at strategic points, it is necessary to be able to predict the fire behaviour in a given zone with the help of parameters such as topography, vegetation and wind.

Certain weather causes forest fires by itself, but human activities aggravate the situation even more. For example, typical natural forces setting forests on fire are as follows:

- High temperatures raise the flammability of dry grass, leaves, trunks, or pine tar;
- Strong winds speed up wildfire spreading;
- Climate change and droughts intensify and prolong forest fire seasons.
- Lightning provokes ignition in dry forest trees.

Therefore, in wildfire prevention, it is crucial to know wildfire hazards due to natural factors. While planning regular operations and thinking of how to prevent a wildfire from happening, foresters should consider current and upcoming weather conditions and their danger to forests.

When it is too hot or windy, sparkles from the working equipment or vehicles may ignite the dry grass or leaves and leap to large territories due to winds, causing wildfires. Being aware of the current and upcoming forest fire hazards or detecting smoke on time is always essential in preventing wildfires.

As fuel characteristics, factors that make up fuels such as compactness, loading, horizontal continuity, vertical arrangement, chemical content, size and shape, and moisture content have influences on wildfire strength and spread.

There are many different types of maps (Topographic map, thematic map, general reference map…**)** which are usually classified according to what they are attempting to show. However, it must be noted that there are many different ways to interpret the types of maps. There are two main types of maps - political maps and physical maps. Physical maps show the shape of the land - hills, lakes, forests, the coast and so on. Political maps show how the land is used by people - counties, provinces, countries, town boundaries, etc. Similarly, in case of fire prevention and suppression, one common point of view is that there are two main types of maps:

- Those which summarise the actual landscape (topographic and general reference maps); and
- Those which describe on specific features using the landscape as a background or for context (all other maps – usually called thematic maps). For ease of describing functionally quite different maps; and to explain what can be confusing differences; we have opted to use a greater number of map types.

22 Fire management plan

A fire safety management plan details your arrangements to implement, control, monitor and review fire safety standards and to ensure those standards are maintained. It provides decision support to aid managers in making informed decisions on the management of wild land fires. Fire management include physical and biological description (e.g. topographic features, fuel types, special conditions that may result in extreme fire behaviours, access, Fire Regime , high value

concerns, special areas), jurisdictional boundaries (e.g. adjacent or intermingled federal, private, tribal, state, county ownership), communities and other values at risk to include;

- Threatened & Endangered species (Endangered species are those plants and animals that have become so rare they are in danger of becoming extinct. Threatened species are plants and animals that are likely to become endangered within the foreseeable future throughout all or a significant portion of its range.)
- Cultural concerns (These cultural concerns include a desire for positive social-image (e.g., honour), as well as values regarding preferred relations between the individual and the group (e.g., vertical individualism and horizontal collectivism).
- Areas of special concern (Area of special concern means an area of definite boundaries delineated through public process, where the Health Officer determines additional requirements for on-site sewage systems which may be necessary to reduce potential failures, or minimize negative impact of on-site systems upon public health)
- Water quality (Water quality describes the condition of the water, including chemical, physical, and biological characteristics, usually with respect to its suitability for a particular purpose such as drinking or swimming)
- Invasive species
- Infrastructure (power lines, fences, etc.)
- fire behaviours and weather descriptions,
- Past fire behaviours and perimeter histories, control problems.

A 'fire regime' is the term given to the general pattern in which fires naturally occur in a particular ecosystem over an extended period of time. Scientists classify fire regimes using a combination of factors including frequency, intensity, size, pattern, season, and severity.

Areas within the plan can be further divided into smaller areas if there is enough of a difference in how that land is affected by fire and actions you would take on that land would be different. Smaller areas within a Fire Management Plan are explained as Fire Management Units.

Preparedness in fire management plan including;

- training, qualifications, readiness,
- cooperative or mutual aid fire management agreements,

- Size up (Size-up is the on-going evaluation of problems confronted within a fire situation. Size-up starts with the receipt of an alarm and continues until the fire is under control. This process is carried out many times and by many different individuals at each fire or emergency event). Fire size up is related to fire suppression it is an indicator weather to apply direct attack indirect attack and this needs to be described under one topic.
- Initial response and extended response procedures,
- Early Warning procedures records management,

A fire management plan helps to keep track of fires and to share that information; Water sources, communication plan, available resources, equipment, Personnel, available Maps, access routes, detection how to ask for and get assistance

23 Mopping up operation

Mopping up operation is the act of extinguishing a fire after it has been brought under control. Mopping up can stay longer depending on the type of forest burned dense wood fire can stay more than one month under soil e.g. Acacia species mopping up should be done for l more than one month. For our wild land fire fighters, mopping-up describes the hard physical labour process of extinguishing or removing burning material near control lines down to the mineral soil, felling fire damaged trees, and cooling ash pits to make a fire line less likely to escape or to reduce residual smoke.

Mop Up Guidelines:

- Make sure the fire line is secure!
- If the fire is small, mop up the entire burned area,
- On larger fires, mop up an agreed distance in front the perimeter,
- This distance is variable based on fuels and expected weather,
- If personnel are scarce, extinguish hot spots first,
- Don't forget to check for spot fires periodically.

While checking for spot fires the fire has been thoroughly patrolled and checked inside and outside the fire perimeter for spot fires and

- ✓ No unburned patches of fuel are left.
- ✓ All fire is out of logs, stumps, roots, etc.

✓ All rotten material and duff pockets have been re-checked to ensure they are dead out.

Fires mopped up at night have been checked the following morning. The entire fire edge on the head, rear, and flanks has been checked. Only the Incident Manager will declare the fire "**OUT**"

Figure 9 Pictorial expression of mopping up operation

Figure 10 Pictorial expression of mopping up operation

24 Fire monitoring and fire patrol

Regular monitoring is required to check possible hazards and patrol fire after suppressed. The four types of fire detectors are heat, optical (ionisation), photoelectric, and ionisation/photoelectric. The differences in each of these are how they detect fires, heat being from temperature, and the other three being from smoke. The best detector is the combination ionisation/photoelectric. Smoke alarms detect fires by sensing small particles in the air using a couple of different kinds of technologies. Once they detect those particles above a certain threshold, they signal the alarm to sound so that you and your family can get to safety.

In case of fire patrol an inspection through the vessel carried out by a crew member on the watch at certain intervals so that an outbreak of fire may be promptly detected.

Things to Consider when Patrolling;

- ✓ How far in from the control line will you check for hot spots?
- ✓ Are you responsible for checking the entire area or only a portion?
- ✓ What information should you report to your fire line supervisor?
- ✓ Work in pairs using a systematic approach

When patrolling, check for Spot Fires outside the control line;

(Spot fires occur when embers land on the unburned side of a fire line. This Watch Out depicts an engine crew attempting to contain several spot fires which are increasing in size while the main fire is also growing.)

Figure 11 Frequent Spot fires across the line

Particularly where you know the following to be true:

- ✓ Snags or torched-out trees exist near the fire line
- ✓ Winds blew across the fire line in this area
- ✓ Rotten logs and tree roots were found hidden beneath the fire line in the soil
- ✓ Flashy fuels exist on the outside of the fire line in this area.

25 Equipment and safety Instruments

25.1 Hand Tools

- Pulaski: a combination axe and grubbing tool on an axe handle. Used to cut/chop small trees, roots, and logs; dig fire line, and scrape burning debris.
- Panga: a versatile, sharp cutting blade used for chopping limbs, branches, and small trees. Also used for cutting grass and brush at the ground level
- Shovel: an excellent tool for digging, throwing dirt, scraping/clearing line, and chopping fine roots. Used extensively in mop-up.

- Fire flapper: a rubber flap attached to a handle used to smother fire with a rubbing motion. (Beating will only serve to spread fire).
- McCloud or Council Rake: - a combination rake and scraping tool used to clear leaves and duff drag burning material back into the fire and clearing other material from the fire line.
- Backpack Pump: a 20 litter rigid or collapsible container equipped with a short hose and trombone pump used to squirt water on hot spots and cool the fire.
- Burlap bag: An excellent tool when wetted to beat down the fire and cool the flaming edge in light fuels. Soak the burlap bag in water prior to use; Swing the bag with a swatting motion to beat down fire along the flaming edge; Keep the bag moist, otherwise it will only spread sparks and fire and may catch on fire itself.

Figure 12 Pictorial expression of list of fire safety equipment's

Figure 13 Operational readiness

Personal protective equipment, commonly referred to as "PPE", is equipment worn to minimize exposure to a variety of hazards. Examples of PPE include such items as gloves, foot and eye protection, protective hearing devices (earplugs, muffs) hard hats, respirators and full body suits.

25.2 Firing Devices:

It is important that fire fighters have some means of burning out fuels, establishing black line, and setting backfires when needed. A firing device should be part of the personal safety equipment carried by each fire fighter.

25.3 FUSEE:

It is a relatively inexpensive and effective device used for burning out control lines and backfiring on wildfires. Basically, FUSEE is the same as road blazes.

CAUTION! The phosphorous compound which makes up the FUSEE, when ignited, is subject to splattering and can cause severe burns if not handled properly

25.4 Drip Torch:

The Drip Torch uses a mixture of liquid fuels which will flame when ignited. The fuel flows through a spout to the wick which becomes saturated with fuel and will burn continuously when lit, permitting the person using the torch to cast burning liquid to ignite the fuel.

Figure 14 Method of suppressing fuel using instrument

26 Post fire rehabilitation

This phase may include restoring burned habitat, reforestation, other planting or seeding, monitoring fire effects, replacing burned fences, interpreting cultural sites, treating noxious weed infestations, and installing interpretive signs.

Once home check for the following: Check grounds for hot spots, smouldering stumps, and vegetation. Check the roof and exterior areas for sparks or embers. Check the attic and throughout your house for any hidden burning sparks or embers. After a fire, foliage-free soil doesn't absorb water easily. These burn scars increase runoff and provide a pathway for the transport of debris and sediment to rivers, lakes, and reservoirs. Along with the debris, elevated levels of nutrient concentrations increase in water body.

Figure 15 Post fire recovery action plan

References

1. B. Million 2000, Fire Management Requirements in Ethiopia-The need for international support, Ministry of Agriculture, Addis Ababa, Ethiopia.
2. Bowman et al. 2009, review what is known and what is needed to develop a holistic understanding of the role of fire in the Earth system, (p. 481)
3. Centre for Forestry Education and Training, Ministry of Forestry. Republic of Indonesia, International Tropical Timber Organization (ITTO) ITTO PROJECT PO 89/90 (F) HUMAN RESOURCES DEVELOPMENT
4. CIMA Foundation. n.d. Forest Fires Early Warning System in Ethiopia.
5. Dechassa Lemessa, June - September 2001; UN-Emergencies Unit for Ethiopia & Matthew Perrault, Brown University, Providence, USA; Assessment Study
6. Eyob Tadesse (MSc) and Beyene Seboko (MSc), November, 2013, TRAIINIING MANUAL ON:: FOREST//WIILDLAND FIIRE PREVENTIION AND CONTROL FOR SUSTAIINABLE FOREST MANAGEMENT HAWASSA UNIIVERSIITY, WONDO GENET COLLEGE OF FORESTRY AND Natural RESOURCES,
7. FDRE, (2018). Forest Development, Conservation, and Utilization Proclamation. Proclamation No. 1065/2018, Addis Ababa: Federal Democratic Republic of Ethiopia. Parkland Agroforestry of Ethiopia;
8. Forest fire prevention for the community, pd89-90-3(F) e-Forest Fire Prevention for Community.pdf
9. Gedalof, Z. (2011). Climate and Spatial Patterns of Wildfire in North America. In:
10. George, C.W. [2001] Forest Resources Div. eng; Mutch, R.W, FAO, Rome (Italy).

11. Getachew Abate, June 2003, EARLY WARNING ACTIVITIES IN ETHIOPIAN Early Warning Department, Disaster Prevention & Preparedness Commission
12. Jin Y, Jia C, Huang SW, O'Donnell M, Gao X. Jul 2010, Multifunctional nanoparticles as coupled contrast agents. Nat Common. 27; 1:41. doi: 10.1038/ncomms1042. PMID: 20975706; PMCID: PMC3205955.
13. Lemessa and Perault, 2001; Forest Fires in Ethiopia: Reflections on Socio-Economic and Environmental Effects of the Fires in 2000: An Assessment Study June-September, 2001
14. McKenzie, D., Miller, C., Falk, D. (eds) The Landscape Ecology of Fire. Ecological Studies, vol 213. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-0301-8
15. National forest foundation web-searching; Published in January, 2001 by WWF, Fire management Manual
16. Robert P. Bailey, Forest Supervisor, 1993, Forest Fire Prevention and Suppression Guidelines for Industrial Activities
17. Rufi'ie, (2014): Forest Fire Prevention for Community; Centre for Forestry Education and Training; Ministry of Forestry. Republic of Indonesia; International Tropical Timber Organization (ITTO)
18. Satendra and Kaushik, 2014 A.D. Forest Fire Disaster Management. National Institute of Disaster Management; Ministry of Home Affairs, New Delhi.
19. Serafín Castellano Gómez, Regional Minister of Governance, () Manual of good practices in forest fires prevention Strengthening Forest Fire Management, Ethiopia. Final report of inception mission
20. Teketay, D. (2001) Deforestation, Wood Famine, and Environmental Degradation in Ethiopia's Highland Ecosystems: Urgent Need for Action. Northeast African Studies, 8,

53-76. http://dx.doi.org/10.1353/nas.2005.0020F.A.O. (Food and Agriculture Organization of the United Nations), August 1999, International Handbook on Forest Fire Protection

21. Wetlands International, (2021) Manual for the Control of Fire in Peat lands Forest Programme, PO. Box 254/BOO – Bogor 16002, Jl. A. Yani 53 – Bogor 16161 Indonesia,
22. Wolde Selassie, 28 May 1816 (c.1736 -) was Ras of the Tigray province between 1788-1816,
23. www.cimafoundation.org/foundations/projects/etiopia.html.
24.