ASSESSMENTOFWOODYSPECIESDIVERSITY,STRUCTURE ANDREGENERATIONSTATUSOFSETEMANATURALFORES T,SETEMADISTRICT, SOUTHWESTETHIOPIA

MSCTHESIS

BY

BEKELETULU

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AssessmentofWoodySpeciesDiversity,StructureandRegenerationStatus ofSetemaNaturalForest,SetemaDistrict,SouthwestEthiopia

By

BekeleTulu

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MajorAdvisor:-DerejeDenu(PhD)

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I have incorporated the suggestion and modification given during the internal thesis defense and got the approval of my advisors. Hence, I hereby kindly request the Department to allow me to submit my thesis for external thesis defense.

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We, the thesis advisors, have verified that the student has incorporated the suggestions and modifications given during the internal thesis defense and the thesis is ready to be submitted. Hence, we recommend the thesis to be submitted for external defense.

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Name Signature Date

Co- advisor: Mulugeta Lemenih (PhD) _____ 26/09/2019

Name Signature Date

Decision/suggestion of Department Graduate Council (DGC)

_____

_____ _____ _____

Chair Person, DGC Signature Date

_____ _____ _____

Chair Person, CGS Signature Date

DEDICATION

This thesis is especially dedicated to my mother, Ayelech Abera and to all my family members, for their love and devoted partnership in the success of my work.

BIOGRAPHIC SKETCH

The author, Bekele Tulu Bayisa, was born on October 23, 1991 G.C in Shirka Woreda, Arsi zone, Oromia National Regional State. He completed his elementary education at Tijo Yaya primary school, secondary School at Shirka secondary School and preparatory school at Shirka preparatory school. He then joined Hawassa University in 2013/2014 and was completed with a B.Sc. degree of Agroforestryin June 2015/2016 with Great distinction. After graduation, he was employed in AssosaUniversity as assistant lecturer from August 2016.Minwhile he also got the chance to start postgraduate study in Forest and Nature Management.

STATEMENT OF THE AUTHOR

By my signature below, I declare and confirm that this Thesis is my own work. I have followed all ethical and technical principles of scholarship in the preparation, data collection, data analysis and completion of this Thesis. Any scholarly matter that is included in the thesis has been given recognition through citation.

This Thesis is submitted in partial fulfillment of the requirements for MSc. degree in Natural Resource Management (Specialized in Forest and Nature Management)at Jimma University. The Thesis will be deposited in Jimma University College of agriculture and veterinary medicine library and will available to borrowers under the rules and regulations of the library. I declare that this Thesis has not been submitted previously to any other institution for the award of any academic degree, diploma, or certificate.

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LISTOFACRONYMS

CBD ConventiononBiologicalDiversity

CSA CentralStatisticalAgency

DBH DiameteratBreastHeight

EFAP EthiopianForestryActionPlan

FAO FoodandAgricultureorganizationoftheUnitedNation

GBA GlobalBiodiversityAssessment

IUCN InternationalUnionforConservationofNature

IUFRO InternationalUnionofForestResearchOrganization

NBSAP NationalBiodiversityStrategyandActionPlan

SDA Setema Distrcit Administration

SCBD SecretariatoftheConventiononBiologicalDiversity

TEEB theEconomyofEcosystemandBiologicalDiversity

USAID UnitedStateAgencyforInternationalDevelopment

UNDESA UnitedNationDevelopmentofEconomicandSocialAffairs

WCM WorldConservationMonitoringSystem

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ABSTRACT

*Thisstudywasconductedon Setema NaturalForest,locatedin SetemaDistrict,JimmaZone,OromiaNational RegionalStatein SouthwesternEthiopia.Theobjectiveofthestudywastoassessthewoodyspeciesdiversity,structureandregenerationstatusoftheforest.Tocollectthevegetationdata,eighttransectswerelaidwithregularintervalof200mdistance.*Alongeachtransect,*plotsof20×20(400m^2)weresystematicallyestablishedat25minterval(elevation).Atotalof47speciesbelongingto44generaand31familieswererecordedandidentified.Fabaceaewasthemostdominantfamilyrepresentedbysixspeciesfollowedby Rubaceaerepresentedbyfivespecies and Euphourbaceaerepresentedbythreespecies.The basalareaoftheforestwas50.7m^{2}ha^{-1}.ThetotalIVIofallwoodytrees/shrubsintheforestwas295.57,ofwhich;Cordiaafricanacontributed 43.85IVI(14.8%)makingitthemostecologicallyimportantspeciesintheforest.Sixplantcommunitiesnamely:-Schefflera abyssinica–Podocarpusfalcatus Communitytype,Ficussur–Syzium guinensee Communitytype,Cordiaafricana–Albiziaschimperiana Communitytype,Clausenaanisata–Apodytesdimidiate Communitytype,Prunus Africana Millettiaferruginea Communitytypeand Polyscia sfulva--Ficussycomorus Communitytypewereidentified.Thedensitiesforseedlings,saplingsandmature woodytree/shrubwere1713.95,1166.42and1628individual'sha^{-1}respectively.Theregenerationstatusandpopulationstructureoftheforestindicatedthattherearehuman-induceddisturbancesintheareaandimmediateconservationactionsshouldbeimplemented.*

Keywords:*SetemaNaturalForest,woodyspeciescomposition,Regeneration*

1. INTRODUCTION

1.1. BackgroundInformation

Biodiversityofvariousecosystemsoftheglobeisnotequallydistributed(GibertandDeharveng,2002).Someregionsoftheworldlikethatoftropicshavehigherbiodiversityascomparedtootherplaces.Mostofthecountriesinthetropicsthatareendowedwithsuchhugebiodiversityhavepooreconomies,whichisthemajorchallengetoconservetheirbiodiversity.

Ethiopiaisoneofthetop25richestcountriesintheworldintermsofbiodiversity(Feyera,2006).Ethiopiaisoneofthefewcountriesin Africawherevirtuallyallmajortypesofnaturallydiversifiedvegetationsarerepresented,rangingfromthornybushesandtropicalforeststomountaingrasslandsduetoitswidevariationinclimate,topographyandsoils(Badege,2001).TheﬂoraofEthiopiaisveryheterogeneousandhasrichendemictaxa.Forestservesasasourceoffood,householdenergy,constructionandagriculturalmaterial,tourismandrecreationvaluesandmedicinesforbothpeopleandlivestock(Mamo*etal*.,2007).Forestsareimportanthabitatsintermsofthebiologicaldiversitytheycontainandtheecologicalfunctionstheyserve(SCBD,2001).AlthoughForestshavecrucialecosystemserviceinsoilandbiodiversityconservationandmitigationofclimatechange,theyarebeingdestroyedatanalarmingratelargelyduetohuman-relateddisturbances(Getnet *et al*.,2015).Ethiopians,particularlyintheruralareasofthecountry,arehighlydependentonforestresourcestofulfilltheirbasicneedssuchasfuelwoodforcooking,heating,foliageforlivestock,andtimberforshelterandnon-timberproductsincludingmedicine.Environmentaldegradationanddeforestationhavebeentakingplaceformanyyearsinthecountry.Especiallyduringthelastcentury,Ethiopia'sforesthasbeendecliningbothinsize(duetodeforestation)andquality(duetodegradation)(Gebrehiwot,2003.).Theclear-fellingacceleratesthelossofseedlingsandsaplingsaswellasdisturbsthenaturalconditionofthenaturalforestsandhencetheecosystem(Rahman*etal*.,2011).Assessmentsonfloristiccomposition,speciesdiversityandstructuralanalysisstudiesareessentialforprovidinginformationonspeciesrichnessofforests.Itisusefulforforestmanagementpurposeandhelpsinunderstandingforestecologyandecosystemfunctions(Burju*etal*.,2013).Knowledgeoffloristiccompositionandstructureofforestisalsousefulinidentifyingecologicallyandeconomicallyimportantplants,theirdiversitiesandprotectionmeasures(Addo-

Fordjour*etal.*,2009).Knowledgeaboutthepatternofnaturalregenerationisimportanttoanswertheb asicquestionofforestmanagement(StewartandVeblen,1982).

1.2. StatementoftheProblem

InEthiopia,sufficientdataarenotavailabletomakemanagementdecisionsontheeffectofdeforestati onandforestdegradation.Factualdataandestimationofforestresources,conservationofspeciesdive rsitywithinanecosystemrequiresanaccurateestimationanddeterminationofregenerationstatusasw ellasthespeciescompositionoftheforest.Thereforeinformationonforestspeciesdiversity,evaluatin gandmonitoringofcurrentstatusofregenerationandre-growthofspeciesthatprovidenecessaryinputforforestmanagementanddecision-makingisaprerequisiteforrelevantmanagementplanningofthefutureforestresourcesofthecountry. SetemaForestisoneofthelargenaturalforestsfoundinSetemaDistrict,JimmaZone,SouthwesternEt hiopia.Itislargeforestecosystemwhichisusedashabitatfordifferentbirdspeciesandwildlife.Howev er,thewoodyspeciesdiversity,structureandtheregenerationstatusoftheforesthasnotbeenstudied(d ocumented).Themainpurposeofthisresearchistocontributeinfillingthisgap.

1.3. ObjectiveoftheStudy

1.3.1. GeneralObjective

Thegeneralobjectiveofthisstudyistoassessthewoodyspeciesdiversity,compositionandstructureof SetemaNaturalForestwhichcouldserveasanimportantinputforconservationoftheforestinthestudy area.

1.3.2. SpecificObjectives

- ✓ AssessingthewoodyspeciesdiversityandrichnessofSetemaNaturalForest
- ✓ AssessingthewoodyspeciesstructureinSetemaNaturalForest
- ✓ IdentifyingthemainplantcommunitytypesinSetemaNaturalForest
- ✓ AssessingtheregenerationstatusofwoodyspeciesinSetemaNaturalForest

1.4. ResearchQuestion

- ✓ WhatthewoodyspeciesdiversityandrichnessofSetemaNaturalForestlookslike?
- ✓ WhatthestructureofSetemaNaturalForestlookslike?
- ✓ WhatarethemainplantcommunitytypesinSetema NaturalForest?
- ✓ WhattheregenerationstatusofwoodyspeciesinSetema NaturalForestlookslike?

1.5. SignificanceoftheStudy

- ✓ Quantificationoftreespeciesdiversityisanimportantaspecttoexaminethecurrentstatusofspeciesdiversityfortheguidanceofforestmanager.Thisresearchstudywillprovideavaluablereferenceforforestassessmentandimprovesourknowledgeinidentificationofecologicallyusefulspeciesandspeciesofspecialconcernlikeumbrellaandkeystonespecies.Itwillalsogiveinformation forpolicymakersregardingthemanagement,useofforests,patterns andratesofSetema NaturalForest

2. REVIEWOFTHERELATEDLITERATURES

2.1.OverViewofEthiopianForest

Ethiopiaisendowedwithdifferentforestbiodiversitywhencomparedwithdifferent countriesinAfricaduetoitshighplateauandmountainranges(Demel,2002).Thedifferentphysicalco nditionsandvariationinaltitudehaveresultedingreatdiversityofclimate,soiland differentvegetationcoversofthecountrywhichisassociatedwithpresenceofdifferentforestbiodiver sity(Zerihun,1999;Demel,2002).

Ethiopiaisalsoanimportantregionalcenterofbiologicaldiversity.Thediversified topographicfeaturessuchasraggedmountains,flattopedplateaus,incisedrivervalleysandrollingpla insaresomeofthereasonsforEthiopianhighbiodiversityandregionalcenterofbiologicaldiversities(Ensermuetal.,1992;Tewolde,1988).ThefloraofEthiopiaisveryheterogeneousandhasreachedende micspeciesofplantsduetothediversityinclimate,vegetationandterrain.Ethiopiahasabout6000spec iesofhigherplantsofwhichabout9%(excludingEritrea)areendemictoEthiopia(EnsermuandSebse be,2014).

Itisbelievedthatsubstantialportionofthelandareainhighlandsof Ethiopiawascoveredwithforestsha vingwidecoveragethanatpresent(Friis,1986).Thepresenceofanumberofisolatedforesttrees,eveno nthefarmlandsorpatchesofforestsaroundchurchyardsandreligiousburialgroundsinEthiopiaindic atethepresenceofforestsearlier(Tamirat,1993).

2.2. EcologicalandSocio-EconomicSignificanceofForests

2.2.1. EcologicalSignificanceofForests

Forestsprovideawiderangeofecologicalsignificance.Thereareanumberofservices thatforestprovides.Themajorservicesthatforestsprovideincludesregulationofwater regions,modulatingclimate,maintenanceofsoilquality,carbonsequestration, maintenanceofbiodiversityandhabitatforotherspecies(Dail,1997).AsstatedbyRamirez*etal*.,(200 1),forestsindirectlyinfluenceglobalclimate,serveaswildlifehabitat,providegeneticpoolforbioticd iversityandprovideecosystemservicesforwatershedprotectionanderosioncontrol.Inadditiontothi s,forestshelptomaintainthefertilityofsoil,usedasahabitatforwildlife,protectwaterresourcesandred ucenaturaldisasters,suchaslandslidesandflooding(WorldBank,2004).

2.2.2.Socio-EconomicSignificanceofForests

Humanbeingsaredependentonforestbiodiversityfortheirsubstanceshealthwellbeingandenjoyment.Forestalsohavebeenprovidingfood,recreation,spiritualsustenanceand commerciallytradedproductsrangingfrompharmaceuticaltotimber(Murthy*etal.*, 2002andWorldBank2004).Forestsprovideawiderangeofproductsandservices.The economicvaluesofforestsarethebasisofavarietyofindustriesincludingtimber, processedwoodandpaper,rubberandfruits.Theyalsocontainproductsthatare necessaryforruralcommunitiesincludingfuel,constructionmaterialsandmedicines (FAO,2005).Forestsplaypivotalroleassourceofenergy,forgrazingandnon-timber products.TheenergyconsumptionofruralEthiopiaismainlybasedonbiomasssource forwhichfuelwoodisbeingthehighestcomponent.TheruralEthiopianhouseholdsentirely dependentonbiomassfueltomeettheirenergyrequirementforcookingandheating.

2.3. CausesandConsequencesforEthiopianForestLoss

2.3.1. CausesforEthiopianForestLoss

HistoricaldocumentsindicatethatEthiopiahadexperiencedsubstantialdeforestation, soildegradationandanincreaseintheareaofbarelandoveryears.Theneedforfuel wood,farmland,humansettlement,shiftingcultivation,grazingarea,firewoodandlackof viablelandpolicyhavebeenindicatedasthemaincausesforforestbiodiversity degradationfrequentlyleadingtolossofforestcoverandbiodiversityloss(Ensermu andTeshome,2008).Deforestation,naturaldisasterssuchasvolcaniceruption,loggingandconvergingofforeststoagriculturallandsaccounts40%ofEthiopianforestloss(Tewolde,1988).Particularly,thecurrentcontributingfactorsacceleratingthedecliningofplantspeciesdiversityinEthiopiaarethesizeanddistributionpatternsofhumansanddomesticanimalpopulations,thelevelofresourceconsumption,understandingplantspeciesinnarrowsenseduetolowlevelofawareness,theattentionofplantspeciesconservationandlackofsustainable use of forests (Tesfaye, 2007).

InEthiopia,theexcessiveexploitationofnaturalpastureandforestswithoutminimum repair,theextensionofcultivationtomarginallandsbyclearingandburningfragile ecosystem,forestfire,lackofproperforestadministrationandforestmanagement,lack

ofcompatibleforestproclamationandotherlegislationandlackofconstantandsustainable institutionalorganizationhasresultedintotaldeforestationanddegradation.Lossoffertile cultivablelandandsoilfertilityexposingthecountrytodroughtandfamine(UNEP, 1995).Thecountry'shighforestandwoodlandscoveragehavebeendeclineinbothsize andquality.Thisisduetotheincreaseduseofforestlandsforfarmlands,unwiseuseand excessiveutilizationofforestproductswithoutconsideringfuturegeneration,ecological andeconomicconsequences(EFAP,1994).Theeverincreasingdemandforforestproductsandforest land,togetherwiththealarmingrateofpopulationgrowthhasputtheremainingpatchesofforestsonth evergeofextinction(Tamirat,1994).

2.3.2. ConsequencesforEthiopianForestLoss

Reductioninforestcoverhasanumberofconsequencesincludingsoilerosionandproductioncapacit y,absenceofcarbonsequestration,lossofbiodiversity,instabilityofecosystem,reducedavailability ofvariouswoodandnonwoodforestproductsandservices(AlemuandBluff,2007).Thedepletionofn aturalvegetationinmanypartsofthecountryhasalsoleadtothethreatanddeclineinnumberandareaof distributionofmanyplantspecies(Tesfaye,2000).Lossofforestbiodiversityinfluencesvegetationd ynamicsandtreedensityatlocalandregional level.

Environmentalproblemssuchassoildegradation,erosion,decreasingbiodiversityandloss ofpotentialnaturalresourcesarenegativeeffectsresultedfromforestbiodiversityloss.The generaldestructionofvegetationresultsinincreasedsoilerosion,lossofsoilfertility, lossofplantandanimalgeneticresources,climatechange,increasedrunoffthatleadsto flooding,reducedinfiltrationtothewatertableanddecreasedwatersupplytorivers duringdryseasons(EFAP,1994).

2.4. MeasuresTakentoPreventEthiopianForestLoss

Theconversionofnaturalvegetationandbiodiversitylossiscurrentlyoneoftheleading agendafornumbersofworldconservationorganizations,authoritiesandinterestgroups (UNDESA,2004).Sustainableforestmanagementhasbeenthemainfocusoftheworldwide

Forestrysectorsovermanyyears.Sustainableforestmanagementalsoaimsatbalancingsocial,econo micandenvironmentasobjectives.However,onlyabout5%ofthetotalforestareasindevelopingcoun triesaremanagedproperly(FAO,2001),whichisverylowwhencomparedwithdevelopedcountries(Girima,2005).Tominimizetherisk,sustainableforestmanagementhasbeenpracticedthroughapply ingconservationtechniques,amongtechniques,protectingforestareaswithrestrictedaccessforlocal communitieswhichhaveoftenbeenintroducedintheforesthelpstotackledeforestationanditseffects (Winberg,2010).

2.4.1. Participatory Forest Management

Participatory Forest Management (PFM) is a mechanism to protect forests and enhance the livelihoods of communities who use and benefit from them in the process (Winberg, 2010). PFM encompasses a wide range of different co-management arrangements with different levels of control from relatively conservative "benefit sharing" to genuine "community-based natural resource management" where local communities have full control over management of the resource and the allocation of costs and benefits (Schreckenberg, 2006). Forest resources and its management are increasingly observed to play a role in rural development, providing the resources necessary to drive local poor livelihoods improvement and poverty alleviation strategies (Islam & Sato, 2012) Participatory Forest Managements was introduced as one of the solutions to solve the problem of open access to forest resources and promote sustainable forest management in the country through community participation. Some experiences from around the world show that shifts from state-centered policies toward solutions at the local level, such as PFM, resulted in successful forest conservation and development (Gobeze *et al*., 2009).

Participatory Forest Management (PFM) was first introduced to Ethiopia thirteen years ago but the approach is expanding to cover more and more hectares of forest across the country. Introducing PFM in communities adjacent to forests in general brings considerable changes. The utilization of forest products is usually restricted and quotas for extraction are lowered to ecologically sustainable levels.The general consequence of introducing PFM is that the forest gains some degree of protection by the community and thus many of the

negative impacts that were previously affecting the forest decrease. This generally has positive impacts on the forest.

2.4.2. Ethiopian Forestry Action Programs (EFAP)

Ethiopia, as theforest sector plays a central role in realizing the country's commitment to achieve a Climate-Resilient Green Economy (Melaku, 2008). The CRGE strategy aims to build a middle-income and climate-resilient economy with a zero net increase over the 2010 baseline emission, in national greenhouse gas (GHG) emissions by 2030. The forest sector has the potential to contribute significantly to Ethiopia's climate mitigation ambitions, with the national REDD+ strategy estimated to contribute 50% of GHG emissions reduction between 2010 and 2030. Forests play a central role in maintaining Ethiopia's invaluable forest biodiversity, providing critical habitat for flora and fauna and also protect agricultural biodiversity.The Government of Ethiopia has prioritized reversing deforestation and forest degradation as a strategy for achieving sustainable economic growth. As Ethiopia continues to experience rapid economic growth, the role of the forest sector becomes increasingly important in achieving the Government's ambitious climate-resilient green growth goals. It is broadly recognized that forests provide vital ecosystem services including the regulation of water and climate through the role they play in the water and carbon cycles. Afforestation, reforestation and sustainable forest management for carbon stock enhancement and the protection and sustainable use of biodiversity is required to enhance the flow of ecosystem service and products (Mulugeta and Habtemariam, 2014). In the context of climate change, Ethiopia's forest and land use sector is unique in that properly planned and implemented investments to improve land and forest productivity can result in both mitigation and adaption benefits.

The Ethiopian Forestry action program comprised a set of complementary primary and supportive development programs. The primary development programs were:

- Tree and forest production program which intended to increase the sustainable supply of forest products and conservation services for land management

- Forest resources and ecosystem management program, which aimed to protect and develop the remaining natural forests and woodlands
- Forest Industries development program, which aimed to contribute to economic and industrial development using the principles of commercial viability and sustainable use of forest resources
- Wood energy development program, which aimed to reduce dependence on traditional fuels.

2.5. TheConceptofBiodiversity

Biodiversityisashortformofbiologicaldiversity;whichistodescribethetotalnumber,varietyandvariabilityoflivingorganismsaswellasthediversityoftheecosystemtheyarelivingin(CBD,2009;Krebs,2014;CBD,2016).Theconceptofbiodiversityisconsideredtobetheintegrationofbiologicalvariabilityacrossallscales,fromgeneticlevelthroughspeciesandecosystemstothelandscapesthattheyformandtheecologicalprocessesthatsupportthem(Walker,1992;PurvisandHector,2000).Theconservationalbiologistssaidthatbiodiversityisameasurableparameterrelevanttoanunderstandingofcommunitystructure,environmentalprocessesandecosystemfunctions(VanDyke,2008).Thediversityoftreespeciesisfundamentaltototalforestbiodiversity,becausetreesprovideresourcesandhabitatsforalmostallotherforestspecies(Sagar*etal*.,2003).

2.5.1. PlantSpeciesDiversity

Speciesdiversityisamultidimensionalconceptthatincludesspeciesrichness,abundanceandevenness(Villéger*etal*.,2008).Itisthemostcommonlyusedrepresentationofecologicaldiversityorkeycomponentsofecologicaldiversity(Hamilton,2005).Speciesdiversityisafunctionofthenumberofspeciespresent(speciesrichnessoranumberofspecies)andtheirrelativeproportion(evenness).Therehavebeentwoapproachestomeasurespeciesdiversity;onemethodhasbeentoconstructmathematicalindicesbroadlyknownasdiversityindices,andtheotherinvolvescomparingobservedpatternsofspeciesabundancetotheoreticalspecies abundance models.Bothofwhichincorporateinformationonthenumberofspecies(speciesrichness)andtherelativeabundancesofindividualswithineachspecies(speciesabundance)(Hamilton,2005).Speciesrichnesscanrefertothenumberofspeciespresentinagivenareaorinagivensample,withoutconsideringthenumberofindividualsexaminedineachspecieswhileevennessistherelativeabundanceofspecieswithinthesampleorcommunity(KentandCoker,1992

;Hamilton,2005).Maximizingspeciesrichnessisoftenanexplicitorimplicitgoalofconservationstudies(GotelliandColwell,2001).Itisoneofthemostimportantelementsinbiodiversity,becausethenumberofspeciesexistingatasiteisaquantitativemeasureofbiodiversityandallowscomparisonwithothersites.

2.5.2. SignificanceofBiodiversity

Biodiversityprovidesthesocietywithawidearrayofgoodsandservicesthatmaybeofdirect,indirect,orpotentialusetohumanity.Accordingto(McNeely*etal*.,1990)biologicalresourcesaresourcesoffood,clothing,shelterandmedicine.Thepresenceofgreatnumbersofspeciestypesareimportantforhumansthroughoutourplanet.Biodiversityhasbiological,economic,ecological,socio-culturalandaestheticvalues(Sophat,2004).Biologicaldiversityisakeyissueofnatureconservationandspeciesdiversityisoneoftheimportantcomponentsofthebiologicaldiversity(LePrestre,2017).InEthiopia,themajorityofthewoodyspecieshaveeconomicuses(Shambel,2011).Thishastendedtoanunsustainableutilizationoffewtreesandshrubspecies,suchastimberandfuelwoodspecies.

2.5.3. TheLossofBiodiversity

Despiteitsvarioususes,biodiversityisincreasinglybeinglostthroughouttheworld.Myers(1988)positedthattheworldwaslosingonespeciesperdayin1970s,andbythemid-1980s,thelosswouldincreasetoaboutonespeciesperhour.Bytheendof21century,theplanetearthcouldloseanywherefrom20to50%ofitsspecies.Ithasbeenestimatedthatinthelastcentury,about35%ofmangroves,40%offorestsand50%ofwetlandswerelost.Itwasassertedthatinjustfiftyyears,sixtypercentofecosystemservicescouldnotbeprovidedanymorewhilespecieslossis100to1,000timesthaningeologicaltimes.Thiswillgetworsewithclimatechangewhile80%oftheworld‟sforestisfullyorover-exploited(TEEB,2009).Lossofdiversityofgeneswithinspecies,specieswithinecosystemsandecosystemswithinaregionaffectstheabilityofecologicalcommunitiestoresistorrecoverfromdisturbancesandenvironmentalchange.Thisincludeslong-termclimaticchangeandalsowidenstheprobabilitythatfurtherenvironmentaldisturbancewillresultinseriousreductionsinthegoodsandservicesthattheEarth'secosystemscanprovide(GBA,1995).Thetreesandforestsof Ethiopiaareundertremendouspressurewithadrasticdeclineinforestcoverduetothecontinualpressuresofpopulationincrease,expansionofagricultureandlandusecompetition,landt

enureissues,andforestdegradationandconversion(USAID,2008).Ethiopiastillhasarichdiversitya ndimportanttotheworldinbothdomesticatedandwildplantandanimalspeciesthatoccurinvariablea nduniquemicroandmacro-ecosystems(FAO,1996;NBSAP,2005).Alossofbiodiversityduetodegradationoftheenvironment andotherthreatstocomponentsofecologicalsystemsisthemostseriousenvironmentalproblemsEthi opiaisfacingatpresent(FAO,1996;NBSAP,2005).Thislossinbiologicaldiversityultimatelyimplie seconomiclossestoacountryandtheworldasawhole.Theremovalofvegetationcoveralsoreducesth equantityofcarbonthatcanbesequesteredfromtheatmosphereandcontributetotheglobalwarming(EFAP,1994).

2.6. ImportanceofForestsForMaintainingBiodiversity

Forestisthehomeoftwo-thirdsofallplantsandanimalslivingonland,itisthemostbiodiversityrichterrestrialecosystems(Sch mitt,2009;FAO,2010;IUCN,2010).Itcomprisesdiversitywithinandamongspecies,andwithinand betweeneachoftheterrestrialandaquaticcomponentsofforestecosystems(CBD,1992).Manyofthe essentialbenefitswederivefromforestsareunderpinnedbyforestbiodiversity,asisthecapacityoffor eststoadapttopressures,includingclimatechange(Seppala,2009).Theservicesprovidedbyforestsc overawiderangeofecological,economical,socialandCulturalconsiderationsandprocesses.Hence, ecosystemfunctionsbringecosystemservicesthatbenefithumanbeing(Nasir*etal*.,2007).

2.7. NaturalForestRegeneration

Regenerationmaybepromotedbycertaintypesofforestmanipulationthatcanleadintentionallytone wandmoreproductivestagesofforestgrowth.Becauseofitsimportancetoforestmanagement,thedy namicsofregenerationafterexploitationhasreceivedparticularattention(Dieler*etal*.,2017).Thenat uralregenerationofforestinforestecosystemsisfundamentalforevolution(Ackzel,1994).Therateof establishmentofthediversity,distributionandcompositionoftheregenerationdependsonmanyfact ors.Thelightenvironmentisoneofthefactors,whichaffectsnaturalregenerationandgerminationofs eeds.Theimmediateandperhapsgreatesteffectsofcanopyopeningisanincreaseindurationandinten sityofdirectsunlighttolowerstrataoftheforest.Theamountofsunradiationreceivedbythegapdepen dsongapsize,shapeandorientation,localtopographyandtheheightofthesurroundingforest(Denslo w,1987).

Naturaldisturbancetoforestcanopiescreatebroadvarietiesofopportunitiesforthegrowthofnearbyplantsandestablishmentofnewones,largelybyincreasingtheamountoflightpenetratingintotheforest interior(Lawton,1990).Differentspeciesaresuccessfulingrowingupingapsofdifferentsize;therefore thesizeofgaphasanimportantinfluenceonspecies‘compositionandtheir‘spatialarrangementinth eforest.

Gapsizerangesfromthetiniestgapsformedbythenaturaldeathoftreesinanaturalforesttotheformatio noflargegapscreatedthroughintensivetreefelling.Differentspeciesresponddifferentlytodifferenti ntensityofcanopyopeningorgapformation.Dependingontherequirementofthespecies,sometreesp ecieswhicharelightdemandingcangrowbetteronopenareawhileothersrequireshadeforgrowing.T helifespanoftheseedalsoplaysasignificantroleintheprocessofregeneration.Seedlongevityislowin tropicaltrees,however,pioneerspecieshavebetterlongevity,asaresult,theforestseedbankisthemaj orsourceofregenerationforthepioneersthanforlatesuccessionspecies.Incontrasttopioneers,seeds ofmostprimaryspecieshaveshortlifespan;thereforegerminationofmanypioneerandsecondaryspe ciesaretriggeredmorebyforestdisturbances(Ferreira*etal.*,2017).

Somespeciesaretriggeredbylightintensitywhileothersdobetterundershade.Theinheritedcharacter isticsofseedphysiologyandmorphologyforexamplefrequencyandtimeofseedproduction,itsnatur eofdispersalandtheseedtype/group(OrthodoxandRecalcitrantseeds)influencegermination.Some seedsmayremainforacenturyinthesoilseedbankuntilfavorableenvironmentalconditionsforgermi nationaremet;othersdeteriorateeasilywithinfewweeksormonths(shortlife).Generallythecombina tionofallthisfactorsresultsinsuccessandfailureofregenerationofdifferenttreespecies.Regeneratio nsofdifferentspeciesinthenaturalforestreactdifferentlyunderdifferentenvironment,oratdifferentt imesinthesameenvironment.

2.8. ImportanceofRegenerationInformationinForestManagement

Tomitigateproblemsofdeforestation,forestdegradationandimprovethepotentialofforestregenerat ion,developmentofsustainableforestmanagementplansthatmaintainandconservetheecological,e conomicalandsocialbenefitoftheforestisbecomingamatterofglobal,regional,nationalandlocalco ncern.Biodiversityisafundamentalconceptinsustainabilitybecauseitviewspresentconditionsofre generationabundanceandrichnessfromtheperspectiveofthefuture.Knowledgeoftheforestresourc e,itsgeographicalenvironmentandtherequirementsofthedifferentspeciesinthestandareallessentia

lforproperplanningofsustainableforestmanagement.Tomeetthoserequirements,preciseandup-to-dateinformationregardingthestatusoftheforestresourcesandpotentialofforestregenerationinpoorlymanagedforestisimportanttoupgradeandtodesignpropermanagementforfutureimprovementoftheforeststand.Inordertounderstandwhatistrulyhappeningtoourforestland,weneedtomonitortheresourcestomeasureandpredictchange(IUFRO,1995).

Forestinventorieshavebeenundertakeninmanypartsoftheworldbutmostofthemwereconcentratedonproperlymanagedandprotectedareassuchasplantations(Thompson,1983).Whereverforestmanagementistobedevelopedandimplemented,itmustusuallybebasedoncomprehensiveinformationoftheresource,whichisimportantformonitoring,managinganddecisionmaking.Therearenumbersofimportantandcurrentissuesrelatedtospatialandtemporalinformationsuchastheextent,location,distribution,patternsofdeforestationandthereeffectsonpotentialofregenerationandspeciescompositionthatareworthinvestigatingfordevelopingsustainableforestmanagementplanandscientificresearches(Samsulwahab,2001).Thebetterweunderstandtheforest,thebetterwewillbeabletomanage,conserveandprotetthem(Sandalow,2000).

3. MATERIALSANDMETHODS

3.1. DescriptionoftheStudyArea

3.1.1. Locationofthestudyarea

The study was conducted on Setema block of Sigmo-Setema Natural Forest, located in Setema district, Jimma zone,OromiaRegional State,Ethiopia.Setema Forest is one of the Natural forests within Sigmo-Setema forest priority area.The study was conducted only on Setema block of Sigmo-Setema forest priority which is found in Setema district. The size of the forest is about 10,000 ha (OFWE, 2015).Setemadistrict isborderedonthesouthbyGera distrcit,onthewestbySigmo district,onthenorthbyIllubaborZoneandonthesoutheastbyGommadistrict (SDA, 2007). TheadministrativecenteroftheworedaisGatira.Thealtitudeofthisworedarangesfrom1,580to3,010 meters(7,380to9,880ft.)abovesealevel.ThehighestpointsareintheDamuSigamountainrange.Pere nnialriversincludetheOnja,Salako,GidacheandGebba.Asurveyofthelandinthisworedashowsthat 27.2%isarableorcultivable(20.8%wasunderannualcrops),13.1%pasture,55.1%forestandtherem aining4.6%isconsidereddegraded,builtupandunusable.Teffandcornareimportantcashcrops.Coff eeisalsoanimportantcashcropinthisworeda(lessthan20squarekilometers(7.7sq.mi)).About60%o ftheurbanand9.6%oftheruralpopulationhasaccesstodrinkingwater.

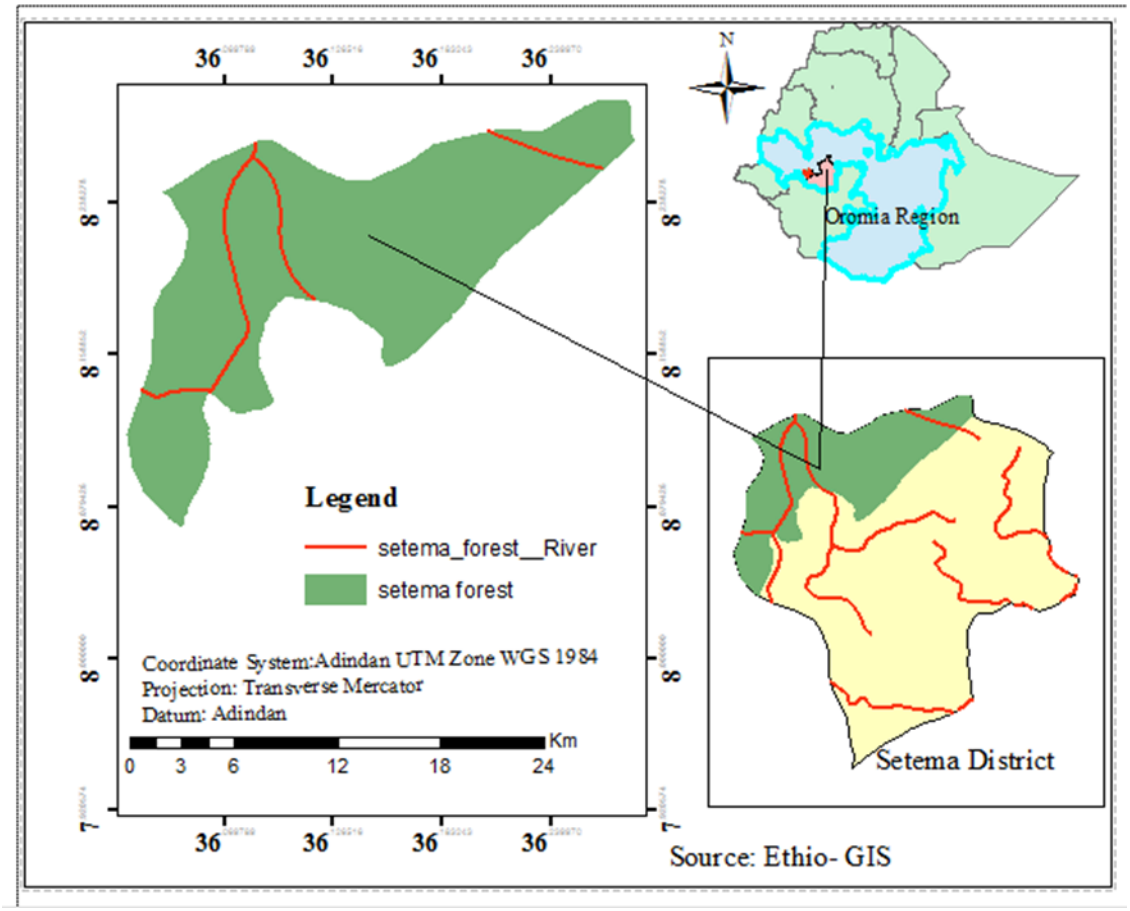


Figure 1. Map of study area showing Ethiopia, Oromia, Setema District and Setema Natural Forest

3.1.2. DemographicProfileoftheStudyArea

The2007nationalcensus(CSA,2007)reportedatotalpopulationof103,221forSetemaDistrict.Ofthis,50,744weremaleand52,477werefemale;4,729or4.58%ofitspopulationwereurbandwellers.Themajorityoftheinhabitantswere Muslim(96.91%)whereas2.67%ofthepopulationswereEthiopianOrthodoxChristianity.Withanestimatedareaof1,106.10squarekilometers,Setemadistricthasanestimatedpopulationdensityof106peoplepersquarekilometer,whichislessthantheZoneaverageof150.6.ThelargestethnicgroupreportedinthisdistrictwastheOromo(96.48%),whiletheAmharaandTigreconstitute2.22%and1.0%respectively.Allotherethnicgroupsmadeuptheremaining0.3%ofthepopulation.AfanOromoisspokenasthefirstlanguageby97.17%whereas1.75%speaksAmharicand0.97%speaksTigrinya;theremaining0.11%speaksallotherprimarylanguagesreported.

3.1.3. Landuse/LandCover

About100km^2(10,000ha)oftheareaiscoveredbyforest.BothNaturalandplantationforestswereobservedintheareaduringtheinventorywork.ThetypesofcropscultivatedareMaize,EnsetandTeff.Coffeeisalsoanimportantcashcropinthisdistrict(lessthan20squarekilometers).Intheforestarea,browsingandgrazing,clearingofforestforagriculturalland,woodcuttingforhouseconstructionandcharcoalmakingandtraditionalbeekeepingorhangingbeehivesonthetreesforhoneyproductionarethemajorlandusetype.

3.2. ResearchDesign

Eighttransectswerelaidwithregularintervalof200mdistance.Plotsof20mx20m(400m^2)wereplacedalongeachtransectat25melevation gradient.Fivesub-plots(oneateachcornerandoneatthecenter)withareaof3m×3m(9m^2)werelaidinthemainplots.Anotherfivesub-plotswiththesizeof1m×1m(1m^2)wereestablishedateachcornerandatthecenterofthelargeplot.Atotalof10plotswerelaidalongeachtransect.

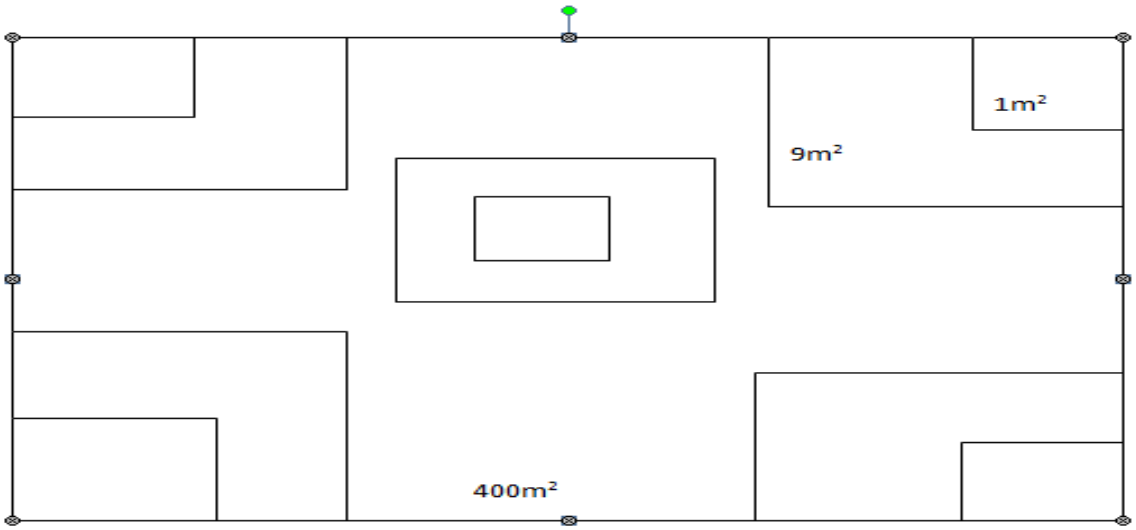


Figure 2. Design of various plots size

3.3. DataTypeandSources

Forthestudy,primarydatawereusedinordertoachievetheobjectivesofthestudy.Theprimarydatawereobtainedthroughfieldmeasurements.

3.4. VegetationDatacollection

DataonwoodyspeciesincludingDBHandheightwerecollectedfrom20m×20mplots.Regenerationdatawerecollectedfromthe3m×3m(Sapling)and1m×1m(seedling)sub-plots.Thedatacollectionwereafullinventoryofallwoodyspecieswithadiameteratbreastheight(DBH)of2.7cmandabove.TheDBHofwoodyplantswerecalculatedfrom the circumference measuredusing measuring tape.Theheightofalltreesweremeasuredusing Suuntoclinometers.Density,frequencies,basalarea,dominanceandIVIoftreesandshrubswerecalculatedafterindividualwoodyplantspeciesweremeasuredandcounted.

3.5. SpeciesIdentification

PlantidentificationwascarriedoutbyusingBotanicalkeysfrompublishedvolumesofFloraofEthiopiaandEritrea,volume1-8 andUseful trees and shrubs for Ethiopia (Azene Bekele, 1993).FreshspecimenswerecollectedandtakentoJimmaUniversityHerbarium.Thevoucherspecimensweredeposited atJimmaUniversityHerbarium.

3.6. DataAnalysis

3.6.1. SpeciesDiversityAnalysis

SpeciesdiversityandevennesswerecalculatedusingShannonWeinerdiversityindex.Itisthemostapplicableindexofdiversity(Greig-Smith,1983).Shannon'sIndexaccountsforbothabundanceandevennessofthespeciespresent.

TheShannonDiversityIndex(H')wascalculatedusingthefollowingformula:

$$H' = -\sum_{i=1}^{s} Pi \ln Pi$$

Where,S=thetotalnumberofspecies,Pi=theproportionofindividualsortheithspeciesexpressedasa proportionoftotalcover.Ln=Naturallogarism

Equitability

EquitabilityorEvennesswascalculatedfromtheratiooftheobserveddiversitytomaximumdiversity usingtheequation:-EH=H/Hmax=H/lns

Equitabilityassumesavaluebetween0and1with1beingcompleteevenness.Thehigherthevalueofev ennessindex,themoreeventhespeciesisintheirdistributionwithinthegivenarea.

3.6.2. MeasurementofSimilarity

Similarityindicesmeasurethedegreetowhichthespeciescompositionofquadrantsorsamplesisalike .Sorensenisoneofthemostcommonbinarysimilaritycoefficientswhichrelyonpresenceorabsenceo fdata(Xia*etal*.,2018).

Sorensen'scoefficientisexpressedas:Ss=2a/(2a+b+c)Where,

a=numberofspeciescommontobothsites

b=numberofspeciesuniquetosite1

c=numberofspeciesuniquetosite2

Often,thecoefficientismultipliedby100togiveapercentagesimilarityindex.

3.6.3. ImportantValueIndex(IVI)

ImportantValueIndex(IVI)isusefultocomparetheecologicalsignificanceofaspecies(DerejeDenu, 2006).ThehighvalueofIVIindicatesthatthespeciessociologicalstructureinthecommunityishigh.I mportancevalueindexcombinesdatafromthreeparameters(relativefrequency,relativedensityandr elativedominance).

IVI=RelativeDensity+RelativeFrequency+RelativeDominance

Density:-isthecountofindividualsperunitarea(ha)

$$\mathbf{D} = \frac{\text{Number of above ground stems of species counted}}{\text{Sampled area in hectare (ha)}}$$

$$\boldsymbol{Relative\ Density} = \frac{Density\ of\ a\ species}{Total\ density\ of\ all\ species} \times 100$$

RelativeFrequency:-

Isobtainedbycomparingthefrequencyofoccurrencesofallofthetreespeciespresent.Relativefrequencyiscalculatedasfollows.

$$Relative\ frequency = \frac{Occurrence\ of\ a\ species}{Total\ occurrence\ of\ all\ species} \times 100$$

$$\boldsymbol{Relative\ Basal\ Area} = \frac{Dominance\ of\ a\ species}{Total\ dominance\ of\ all\ species} \times 100$$

3.6.4. Basalarea

TheDBHofallwoodyspeciesinSetemaNaturalforestwasmeasuredat1.3mabovetheground.Thebasalareaforthewoodyspecieswasdeterminedfromthe DBHmeasurement.Basalareaiscalculatedfromthefollowingformula.

$$BA = \frac{\pi \mathrm{D}^2}{4}$$

WhereBA=Basalareainm^{2}perhectare

D=Diameteratbreastheight(cm)and$\pi = 3.14$

3.6.5. VerticalStratificationofVegetation

Theverticalstructureofvegetationiscategorizedfollowing Lamprecht(1989).

1. **Upperstorey**:thelayercomprisingthetreespecieswhichattainaheight>2/3ofthetopheightofagivenforest.
2. **Middlestorey**:Whenthestratumisformedbyindividualtree/shrubspecieswithaheight>1/3ofthetopheightinagivenforest.
3. **Lowerstorey:**Whenthestratumisformedbyindividualtree/shrubspecieswithaheight<1/3ofthetopheightinagivenforest.

3.6.6. PlantCommunityClassification

PlantcommunitytypesweredeterminedusingPC-ORDversion5.3forwindows(McCuneandMefford,2006).Hierarchicalclusteranalysiswasdonetoclassifyplantsintodifferentcommunitytypes.Thedistancemeasureusedinthisanalysiswas Euclideandistance.

3.6.7. Regenerationstatus

Thenumberofindividualsofeachtree,saplingandseedlingperhectarewerecalculatedfromthetotalnumberofindividualspeciesrecordedfromthesampledarea.TheregenerationstatusofSetemaNaturalForestwasassessedandcategorizedasfollows:

‘Good’,ifthepresenceofseedling>sapling>maturestrata;

‘Fair’,ifthepresenceofseedling>sapling<maturestrata;

‘Poor’,ifaspeciespresentonlyinthesaplingstage,butnotasseedlings(eventhoughsaplingsmaybelessthan,morethan,orequaltomature);

‘None’,ifaspeciesisabsentbothinsaplingandseedlingstages,butpresentasmature;and‘New’,ifaspecieshasnomature,butonlysaplingand/orseedlingstage(Chauhan*etal.*,2008).

4. RESULTANDDISCUSSION

4.1. FloristicComposition

Overall,atotalof47woodyplantspeciesbelongto43generaand31families(SeeAnnex1)werecollectedandidentified.Themostfrequentfamiliesintheareawere Fabaceae(*Albiziaschimperiana,Acaciaabyssinica,Acaciaetbaica,Calpurinaaurea,Lonchocarpuslaxiflorus,Millettiaferruginea*)andRubiaceae(*Ehretiacymosa,Galinierasaxifraga,PsychotriaorophilaandRytigynianeglecta*)followedbyEuphorbiaceae*(Crotonmacrostachyus,PhyllanthusovalifoliusandRicinuscommunis)*.Rutaceae,Myrsinaceae,AsteraceaeandAraliacieaeweremediumintheirfrequencyofoccurrences(twospecieseach)inthestudyarea.Ontheother hand,Rosaceae,Melianthaceae,Acanthaceae,Podocarpaceae,Myrtaceae,Celasteraceae,Verbenaceae,Oleaceae,Sterculiaceae,Moraceae,Sapindaceae,Arecaceae,Ulmaceae,Pittosporaceae,Icacinaceae,Anacardaceae,Simarobaceae,Tiliaceae,RhamnaceaeEbenaceae,Meliaceae,BurseraceaeandBoraginaceaeweretheleastfrequentFamilies(onespecieseach)inthearea.Thedistributionoftheplantspeciesintermsofthegrowthformsweretrees,33 species andShrubs,14 species (Figure 3).Twowoodyplantspecieswereobservedoutofquadratsinthestudyarea.Thesewere*Hageniaabyssinica*and*Juniperusprocera*(at100mdistancefromthequadrat).

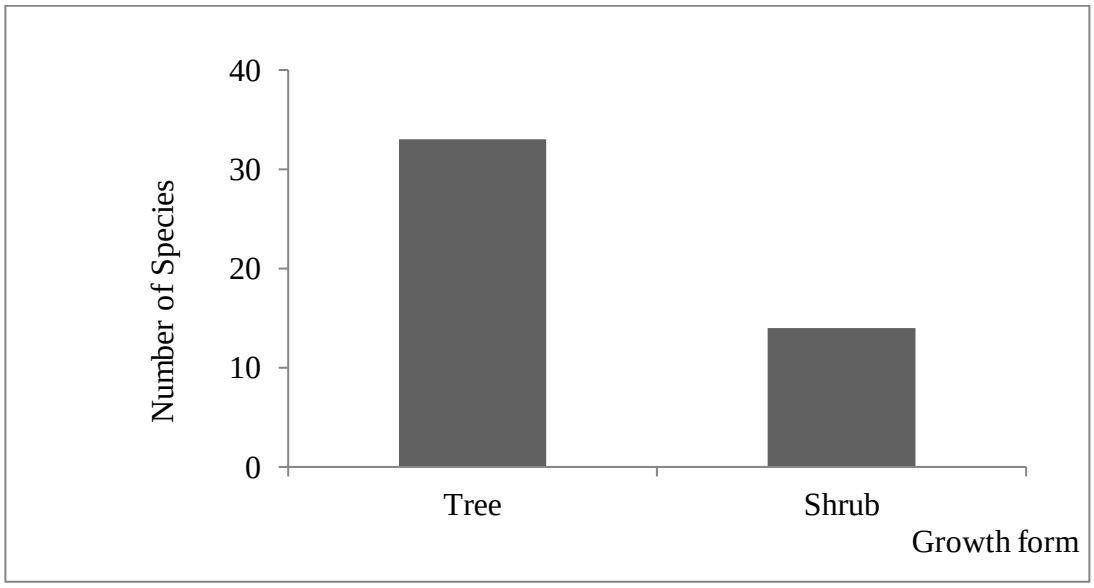


Figure 3.Growth form of Woody species in Setema Natural Forest

4.2. Endemism

AmongthespeciescollectedfromSetemaNaturalForest,twoplantspecies(*Millettiaferruginea*and*Veprisdainellii)*areendemictoEthiopia.Theyconstitute4.2%ofthetotalspeciesrecordedfromthestudyarea.

4.3. VerticalStructure

TheverticalstructureofthewoodyspeciesofSetemaNaturalforestgenerallycategorizedasshowninannex3.Hence,inthiscase,thetree/shrubspeciesexceedingaheightof24mbelongtotheupperstoreycomprisingabout18.55%ofthefloristiccomposition;thosetree/shrubspecieswithheightrangingbetween13-24mwerecategorizedtothemiddlestratumconsistingofabout33.91%ofthefloristiccompositionandthosetree/shrubspecieswithheightrangingbetween 3-12mwereclassifiedtothelowerlayerconsistingofabout47.54%inproportionfromthewoodyplantspeciesinventoriedinSetemaNaturalforest (Tabe 1).Despitethat,specieslike*Cordiaafricana,Prunusafricana,Ficussur*and*Crotonmacrostachyus*werenotspecifictoeachverticalstructure.Theyappearedineachstratum.AccordingtoDebissa(2009),suchkindsofspeciesarecalledspecieswithregularverticaldistribution.Ingeneral,theanalysisoftheverticalstructureofSetemaNaturalforestrevealsthatthemajorityofthefloristiccompositionisfoundinthelowerstratumofthevegetation.Thespecieswiththehighestheightin SetemaNaturalforestwas*Prunusafricana*withaheightof38m.

Table 1:- Vertical Stratification of woody species of Setema Natural forest in Density ha-1

Storey	Height(m)	Density(Noofstems/ha)	(%)
Lower	3-12	774	47.54
Middle	13-24	552	33.91
Upper	>24	302	18.55
Total		**1628**	**100**

Themostdominanttreespeciesintheupperstoreyofthestudyforestwere*Prunusafricana,Schefflera abyssinica,Crotonmacrostachyus,Podocarpusfalcatus,Albiziaschimperiana,Polysciasfulva,Cordiaafricana;FicussurandMillettiaferruginea*(annex3).Thisstoreyconstitutesabout18.55%ofthe

densityoftree/shrub.Treesintheheightrangebetween13-24mrepresentedthemiddlestorey.Themostdominantspeciesinthisstoreywere*Prunusafricana,Cordiaafricana,Scheffleraabyssinica,Crotonmacrostachyus,Albiziaschimperiana,Allophylusabyssinicus,Ekebergiacapensis,Ficussycomorus,Celtisafricana,Apodytesdimidiate,Oleacapensis,Acaciaabyssinica,Syzygiumguineense,Pittosporumviridiflorum,Veprisdainellii,Dracaenasteudneri,Bruceaantidysentrica*and*Clausenaanisata.*Thisstoreyconstitutesabout33.91%ofthedensityoftree/shrub.Somespeciesfoundintheupperstoreywerealsofoundinmiddlestorey.Thelowerstoreycontainsabout47.54%ofthedensitywiththedominancyof*Galinierasaxifraga,Lonchocarpuslaxiflorus,Rhusglutinosa,Vernoniaturbinate,Acaciaetbaica,Phoenixreclinata,Vernoniaamygdalina,Phyllanthusovalifolius,Maytenussenegalensis,Vernoniaauriculifera,Premnaschimperi,Grewiaferruginea,Embeliaschimperi,Rhamnusprinoides,Bersamaabyssinica,Calpurinaaurea,Oxyanthusspeciosus,Ricinuscommunis,Maesalanceolata,Psychotriaorophila,Rytigynianeglecta,Justiciaschimperiana,Euclearacemosa*and*Ehretiacymosa.*Ingeneraltreedensitiesinlower,middleandupperstoreywerefoundtobe774/ha,552/haand302/harespectively.

4.3.1. Frequency

Theresultofthestudyshowedthatthevariationofthespeciesfrequencyranges between0.4–4.9% (Figure 4).Thisimpliesthatthereishighhomogeneityinspeciesdistributionintheare a.Thespecies'frequencyclasseswere;classA(0.4-1.3%),classB(1.4-2.3%),classC(2.4-3.3%),classD(3.4-4.3%)andclassE(4.4-5.3%).Amongthese,*Syzygiumguineense*(4.9%)wasthemostfrequentlyappearingorthemostwidelydistributedwoodyplantspeciesinthearea(classE).Moreover,*Bersamaabyssinica,Albiziaschimperiana,Prunusafricana,Cordiaafricana,Galinierasaxifraga,Maytenussenegalensis*and*Vernoniaauriculifera*werethesecondmostfrequentspeciesinthearea(classD*).Maesalanceolata,Crotonmacrostachyus,Polysciasfulva,Clausenaanisata,Psychotriaorophila,Premnaschimperi,Rytigynianeglecta,Veprisdainellii,Ficussur,Apodytesdimidiata*and*Ehretiacymosa*wererelativelythethirdmostfrequent(ClassC)woodyspeciesinthearea.*Dombeyatorrida,Vernoniaturbinate,Ficussycomorus,Lonchocarpuslaxiflorus,Rhusglutinosa,Scheffleraabyssinica,Justiciaschimperiana,Pittosporumviridiflorum,Bruceaantidysentrica*and*Celtisafricana*werethefourthrankintheirfrequency*(ClassB).*Ontheotherhand,*Allophylusabysinicus,Millettiaferruginea,Rhamnusprinoides,Calp*

*urinaaurea,Embeliaschimperi,Ekebergiacapensis,*Oxy*anthusspeciosus,Euclearacemosa,Phoe nixreclinata,Oleacapensis,Grewiaferruginea,Dracaenasteudneri,Ricinuscommunis,Acaciaetb aica,Vernoniaamygdalina*and*Phyllanthusovalifolius*weretheleastfrequentwoodyspeciesinthear ea(classA).Hence,thereisalowvariationinspeciesdistributionbetweentheabovementionedclassof speciesthatshowedthehighestandthelowestfrequency.Nevertheless,themajorityofthespeciesfall betweenthefrequencyrangeof0.4-
1.3%(ClassA).Inotherwords,whenthedistributionsofspecieswereinterpretedintermsoffrequency classes,itisonlyonespecies,*Syzygiumguineense*,whichbelongedtotheEfrequencyclass(4.4-
5.3%).Further,asillustratedinFigure3,7specieswereincludedunderfrequencyclassD(3.4-
4.3%),11specieswerecategorizedunderfrequencyclassC(2.4-
3.3%)and12specieswereunderfrequencyclassB(1.4-
2.3%).Therefore,thefallingofhighestpercentage(ornumberofspecies)underlowvaluefrequencycl assimpliesthatthedistributionofspeciesintheareaisnotgenerallyhigh.

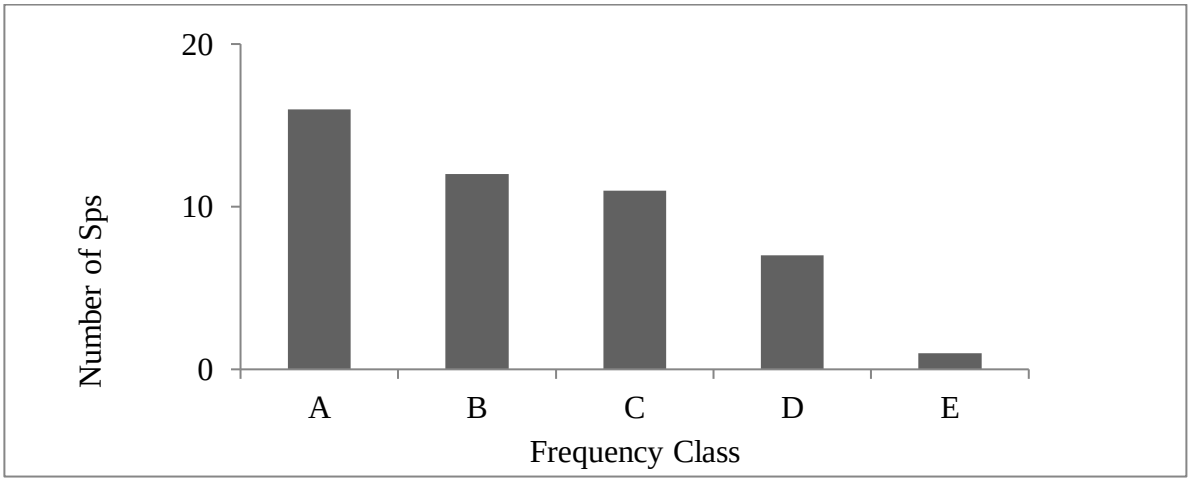


Figure 4. Number of species by frequency class

4.3.2. Density

Density is an important parameter for determining regeneration status of a forest.Thespeciesdensityinthearearangesbetween7-
77stemperha.Therangeoftherelativedensityofthespeciesisalsobetween0.41-
4.56%.Theleastspeciesdensitywasfor*Dracaenasteudneri*(7)whilethehighestspeciesdensitywasf or*Syzygiumguineense*(77).ThisresultPointedoutthatthereislittlevariationamongtheindividualtre e/shrubspeciesindensityperha.Inthestudyarea,thetotalspeciesdensityperhawas1628.Tosummari

ze,thedensityandSpeciesdensityclassofeachspecieswasorganizedinfigure5.Here,themajorityoft hespecies(31.91%)belongedtothefirstdensityclass(A(7-21)).

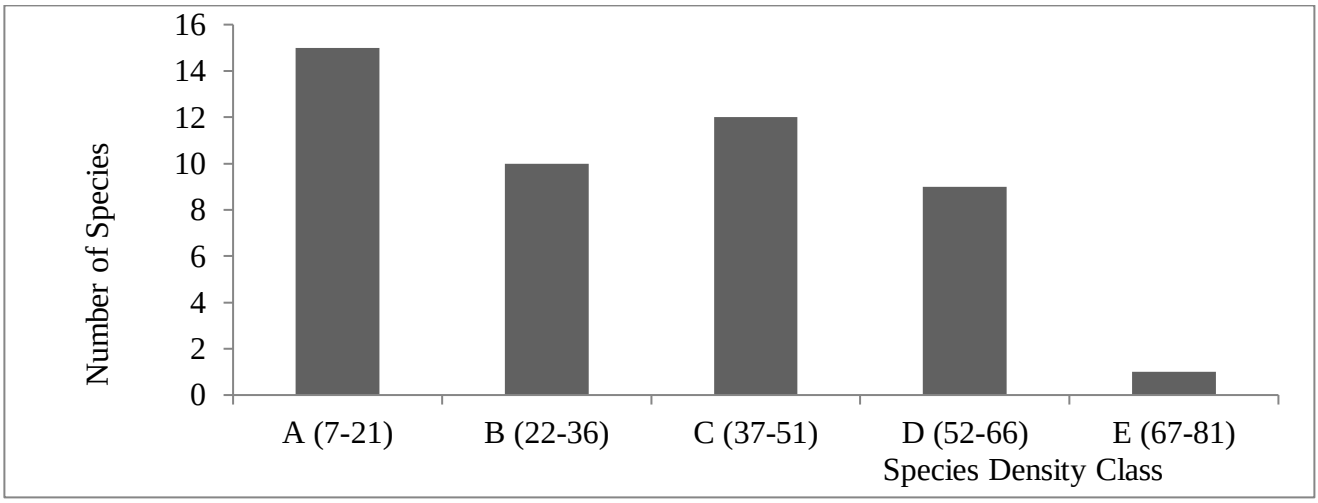


Figure 5. Species density class

4.3.3. DiameteratBreastHeight(DBH)

Foreaseofthecomparisonandinterpretation,thediameterclasswasformedintosevengroupsas:I(2.7 -7.6cm);II(7.7-12.6cm);III(12.7-17.6cm);IV(17.7-22.6cm);V(22.7-27.6 cm);VI(27.7-32.6cm)andVII(>32.6cm).The minimum DBH of trees and shrubs found in the area was 2.7cm.

Theresultoftheanalysisofthediameterdataindicatedthatabout44.68%(21species)ofthetree/shrubs pecieswerethosespecieswhichhavefallenindiameterclassI,followedbydiameterclassII,whilethel eastnumberofspecieswerefoundinthediameterclassofVII(1species(Fig6)).Itisonlyonespecies(*C ordiaafricana*)thatappearedinDiameterclassVII.Thelownumberofwoodyspeciesinhigherdiamet erclassmightbeduetoselectiveuseofthematuretreesinthehigherDBHclassfordifferentpurposeslik ehouseconstruction,timberandcharcoalmaking.

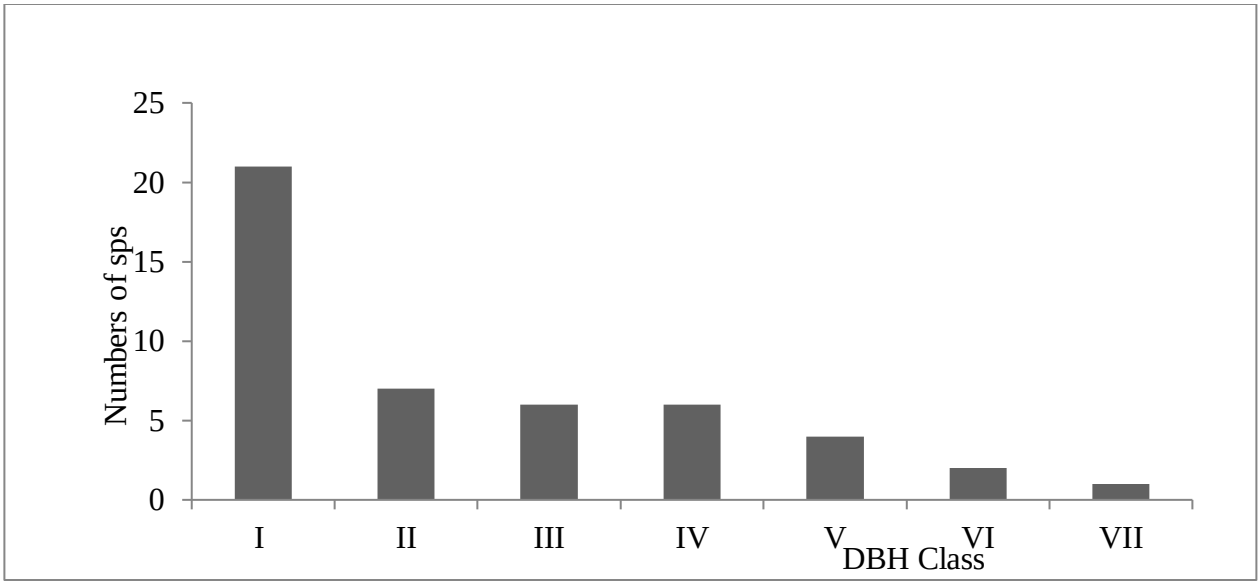


Figure 6. Species DBH class

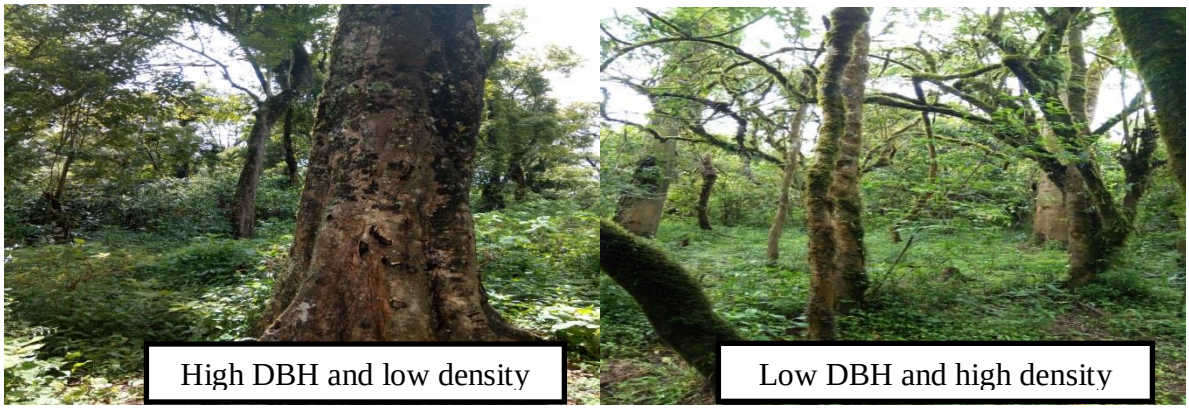


Figure 7. Density comparison with DBH

4.3.4. Speciespopulationstructure

Thepatternofdiametersize-classdistributionhasbeenusedtorepresentthe populationstructureofaforest(Debissa,2009).Thisisbecausethepatternof diameterclassdistributionconnotesthegeneraltrendsofpopulationdynamicsand recruitmentprocessofagivenspecies.

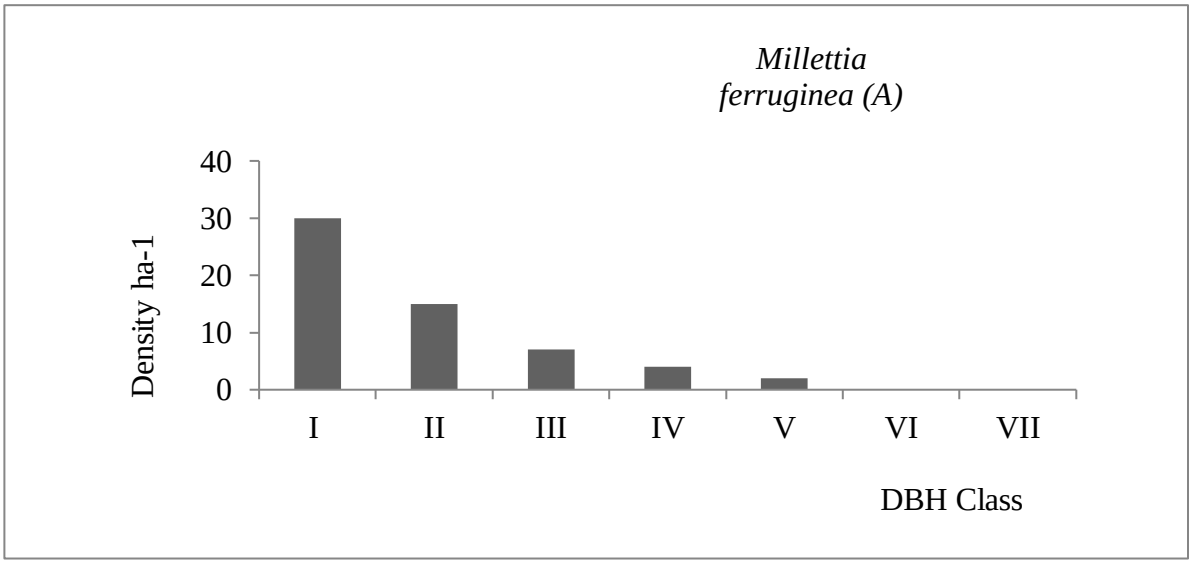
Thevegetationstructureofthestudyareareavealsfive(5)patterns,dependingonDBHClass:Theseare:

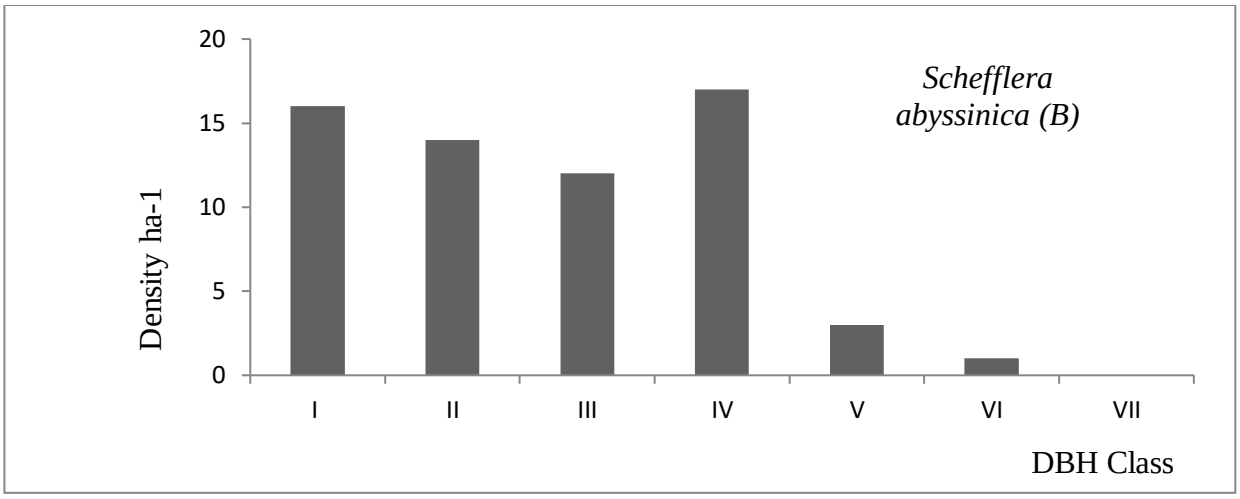
-

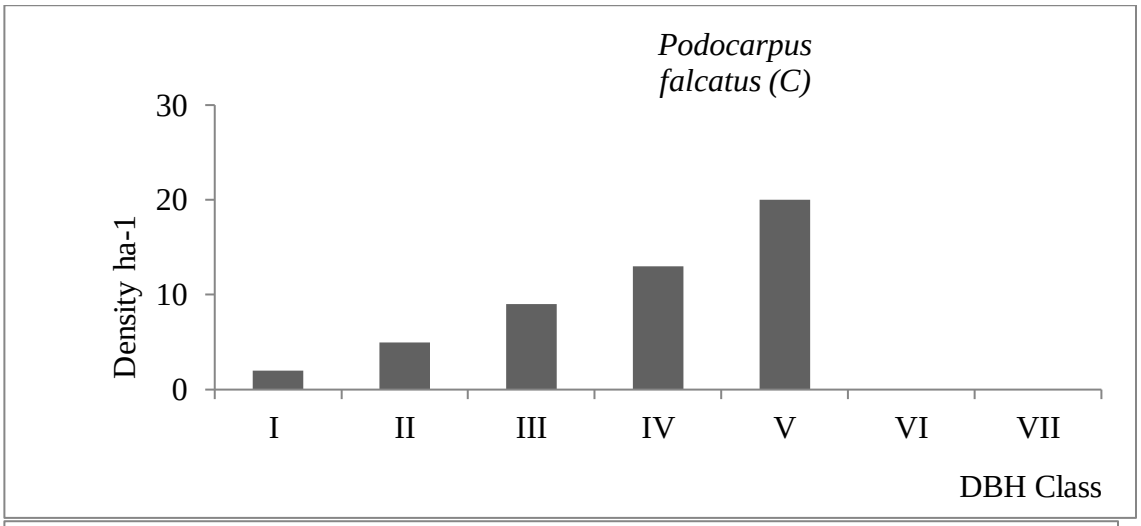
1. **InvertedJ-shape**(A):Thisshowsapatternwherespeciesfrequencydistributionhasthehighestfrequencysta

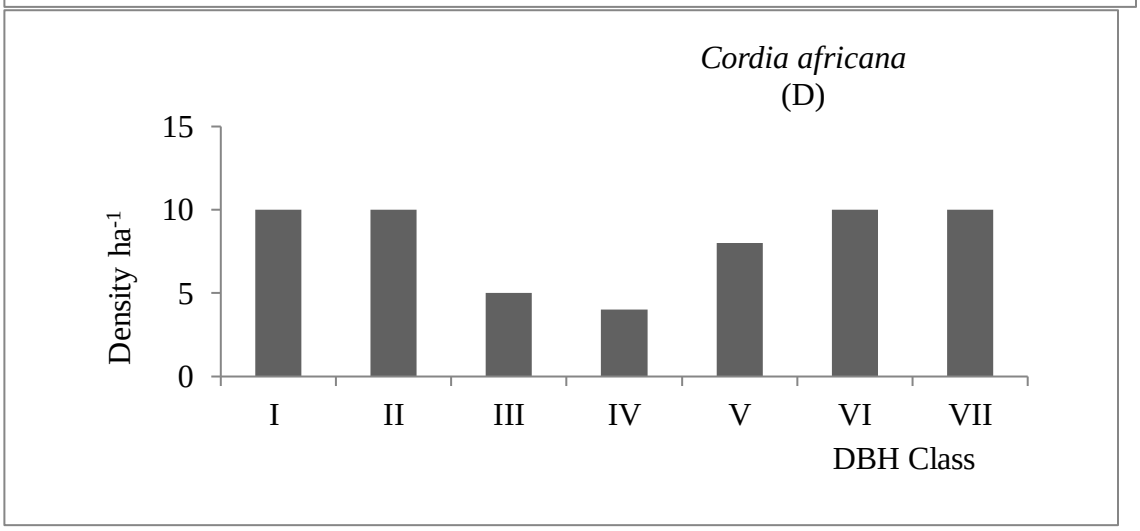
rtingfromlowerdiameterclassesandgraduallydecreasetowardsthehigherDBHclassesincaseof A(*Millettiaferruginea*).

2. **Irregular (B)**:- This type of frequency distribution was shown by Schefflera abyssinica. Vegetation structure of this species does not show any regularity in density across different DBH classes.
3. **J-shape (C and F):** Density of Podocarpus falcatus and Croton machrostachyus increase with DBH class showing a J-shape pattern and there is no species in Class VI and VII. This might be due to closed canopy of the forest that reduces the amount of rainfall and solar radiation that reaches the forest floor to induce germination of the seeds and recruitment into mature trees
4. **U-shape (D)**: This pattern of frequency distribution was a high DBH class in the first and decreases in the middle classes and then eventually increases in the next DBH class as shown in Cordia africana. This type of distribution class may be because of the removal of the oldest DBH for construction, charcoal and other purposes.
5. **Bell-shape**(E):Thispatternoffrequencydistributionislowinlow DBHclasses,andshowssomeincrementstartingfromclassItoIV(middle)andagainshowssomedecrementinsomemiddleclassestohighDBHclasses*(Prunusafricana)*.




Schefflera abyssinica (B)
Density ha-1
20
15
10
5
0
I
II
III
IV
V
VI
VII
DBH Class


Podocarpus falcatus (C)
Density ha-1
30
20
10
0
I
II
III
IV
V
VI
VII
DBH Class


Cordia africana (D)
Density ha-1
15
10
5
0
I
II
III
IV
V
VI
VII
DBH Class

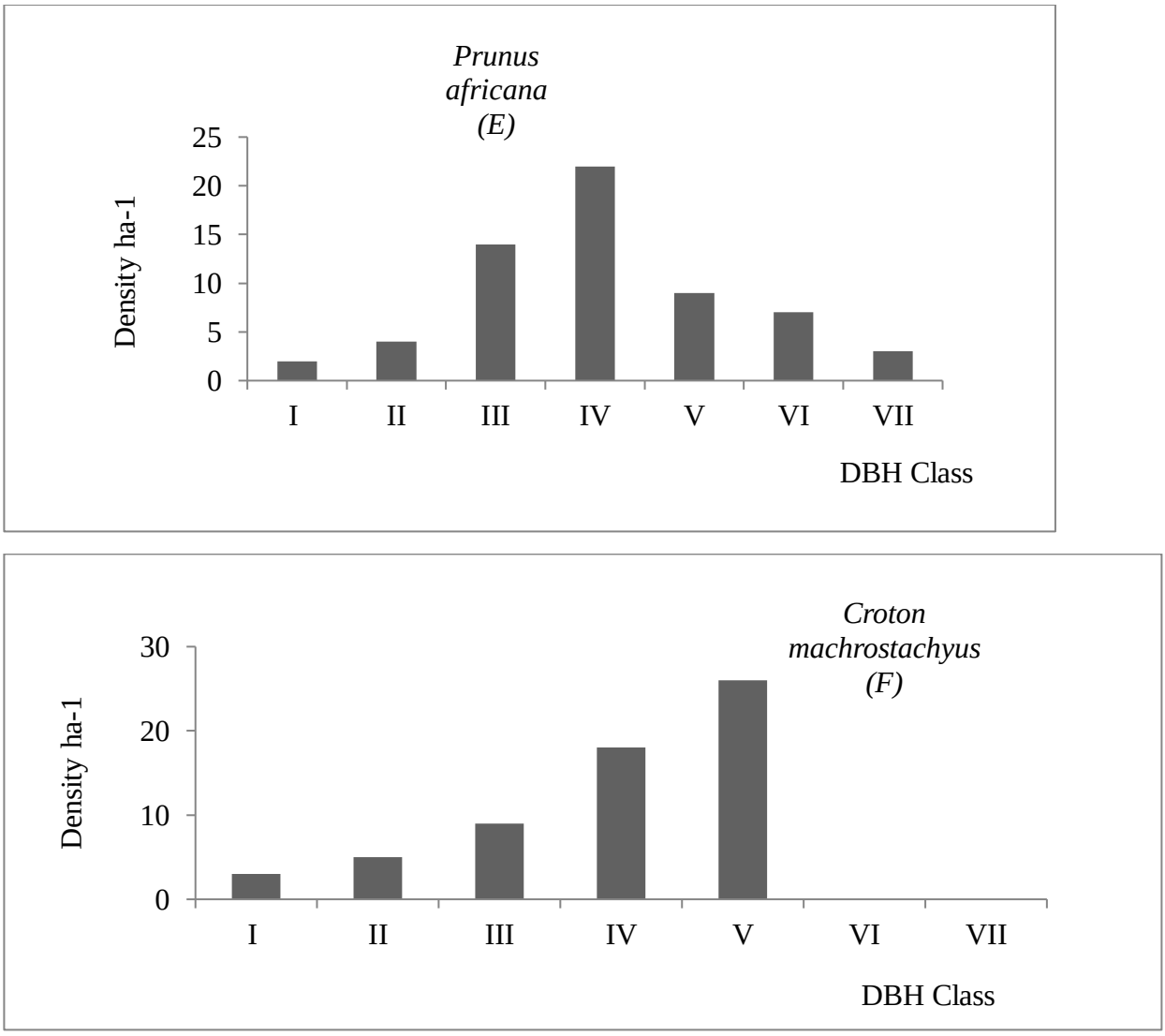


Figure 8.Density per hectare of 6 selected plant species across different DBH Classes in Setema Natural Forest (DBH Class: - I (2.7-7.6cm); II (7.7-12.6cm); III (12.7-17.6 cm); VI (17.7-22.6cm); V (22.7-27.6 cm); VI (27.7-32.6cm) and VII (>32.6cm))

4.3.5. StandHeightProfile

Indeterminingthestandheightprofile,theheightclasswasformedintosixgroupsas:A(3-8m);B(9-14m);C(15-20m);D(21-26 m);E(27-32m)andF(33-38m).Theresultoftheanalysisoftheheightprofiledataindicatedthatabout44.68%ofthetree/shrubspeciesarethosespecieswhichhavefalleninheightclassA;6.38%inheightclassB;21.28%inheightclassC;10.64%inheightclassD;14.89%inheightclassEand2.13%inheightclassF(Figure9).Thisdepictsthatthemajorityofthespeciesbelongedtothelowerheightclass.

Thepossiblereasoncouldbeselective use of the mature trees in the higher height class for different purposes like house construction and timber

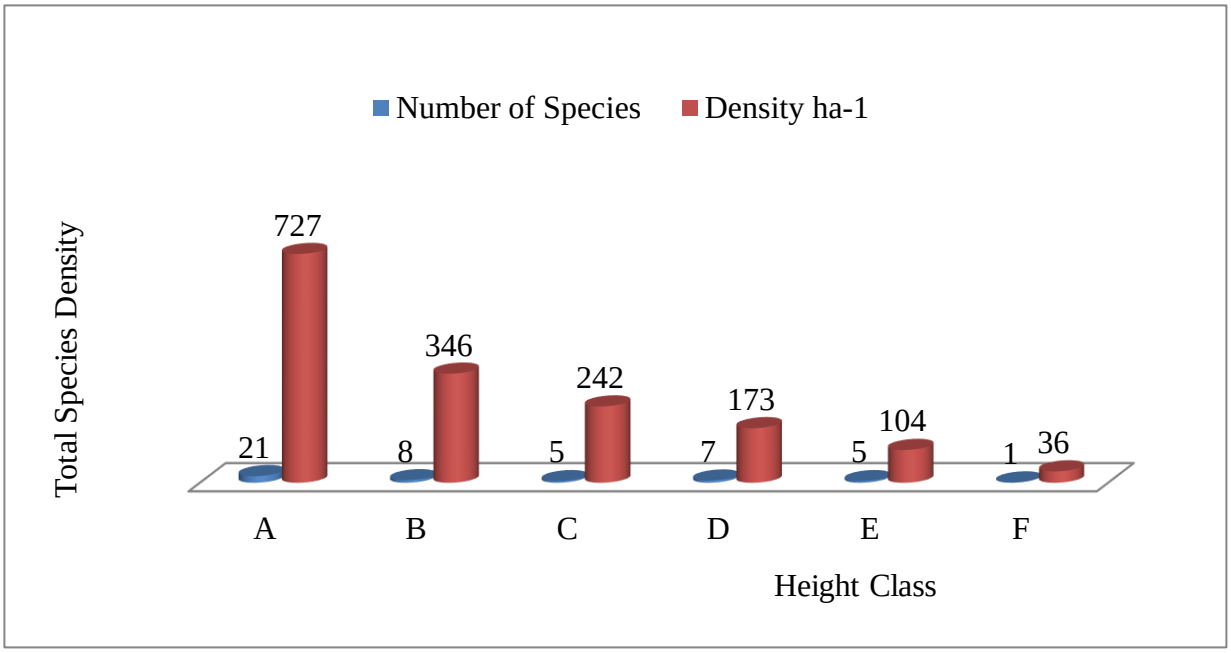


Figure 9. Number of species and density per hectare by height class

4.3.6. BasalArea

Basalareaprovidesabettermeasureoftherelativeimportanceofthespeciesthansimplestemcount.Therefore,specieswiththelargestbasalareacanbeconsideredasthemostimportantwoodyspeciesintheforest(Lamprecht,1989).Thetotalbasalareacalculatedforthestudyareawas**50.741**m^2/haforwoody plants≥2.7cminDBH(annex4). Accordingly,*Cordiaafricana*isthespecieswithhigherbasalarea (18.7m^2/ha)duetoitshigherDBHsizeand*Dracaenasteudneri*isthespecieswithlowerbasalarea (0.005m^2/ha) duetoitslowerDBHsizerelatively. The second most important plant species is *Prunus Africana*, with a basal area of 4.72m^2/ha (Table2). Others top ten plant species are Podocarpus*falcatus* with 2.82m^2/ha,*Albizia schimperiana*with2.6m^2/ha,*Ficus surwith* 2.5m^2/ha,*Millettia ferruginea*with2.34m^2/ha, *Polyscias fulva*with2.06m^2/ha, *Croton macrostachyus with* 1.73m^2/ha,*Apodytes dimidiate* with 1.64m^2/haand*Schefflera abyssinica*with 1.6m^2/ha.

Table 2:- Basal Area of top ten woody Species in Setema Natural Forest

No.	Species	Density/ha	BA(m^2/ha)	RBA(%)
1	*Cordiaafricana*	57	18.7	45.94
2	*Prunusafricana*	61	4.72	11.6
3	*Podocarpusfalcatus*	49	2.82	6.93
4	*Albiziaschimperiana*	61	2.6	6.39
5	*Ficussur*	40	2.5	6.14
6	*Millettiaferruginea*	20	2.34	5.75
7	*Polysciasfulva*	48	2.06	5.06
8	*Crotonmacrostachyus*	49	1.73	4.25
9	*Apodytesdimidiata*	41	1.64	4.03
10	*Scheffleraabyssinica*	29	1.6	3.93
Total		**455**	**40.71**	**100**

The basal area of Setema Natural forest is the eighth of the twelve basal areas of the forests under comparison. Kimphe Lafa (114.4m^2/ha), Wof-Washa (64.32m^2/ha), Menna Angetu (94.22m^2/ha, Menagesha Amba Mariam (84.17m^2/ha), Masha Anderacha (81.9m^2/ha, Bibita (69.9m^2/ha) and Aleta-Bolale (53.33m^2/ha) have higher basal area than Setema natural forest (Table 3).On the other hand, all the rest forests under comparison; Gole (49.2m^2/ha), Bonga (45.20m^2/ha), Denkoro (45.00m^2/ha) and Menagesha–Suba (36.10m^2/ha) have basal area lower than Setema natural forest. The result revealed that the Basal area of the woody species in Setema Natural Forest is relatively medium.This may be due to the presence of plant species with lower stems than the mentioned forests.

Table 3:- Basal Area Comparison

No.	Forest	BA	Source
1	KimpheLafa	114.40	KadirAliyi*etal.*(2015)
2	Wof-Washa	64.32	GebremikaelFisaha*etal*(2013)
3	MennaAngetu	94.22	ErmiasLulekal*etal.*(2008)
4	MenageshaAmbaMariam	84.17	AbiyouTilahun*etal.*(2011)
5	MashaAnderacha	81.9	KumelachewYeshitelaandTayeBekele(2003)
6	Bibita	69.90	DerejeDenu(2006)
7	Aleta-Bolale	53.33	WoldeyohanneEnkossa(2008)
8	Gole	49.20	MesfinBeleteandTamiruDemis(2018)
9	Bonga	45.20	AbaynehDerrero(2003)
10	Denkoro	45.00	Ayalew *et al*. (2006)
11	Menagesha–Suba	36.10	Tamrat Bekele
12	**Setema**	**50.741**	**Currentstudy**

4.3.7. ImportantValueIndex(IVI)

Theimportantvalueindexofthespeciesindicateshowdominantisthespeciesina certainareaandhencehelpstocompareecologicalimportanceofthespeciesin vegetation(CurtisandMcIntosh,1951).Thisindexgenerallycombinesthreeparametersoristhesum oftheRelativedensity,RelativefrequencyandRelativebasalarea(relativedominance)foreachwood yspecies.Inthestudyarea,thespeciesIVIvariesbetween0.85-43.85asshownintablebelow(Table4).Itislowestfor*Dracaenasteudneri*andhighestfor*Cordiaafric ana*.Thisrevealsthatinthisnaturalforest,thespeciesrelativefrequency,densityanddominancediffer accordingly.Inprinciple,whenacertainspeciesreceivesthelowestIVI,itentailsasitrequireshighprio rityforconservationwhilethosespecieswiththehighestIVIrequireonlymonitoringandmanagement priorityforconservation.Asaresult,specieslike*Dracaenasteudneri,Phoenixreclinata,Oleacapens is,Grewiaferruginea,Euclearacemosa,Ricinuscommunis,Vernoniaamygdalina,Phyllanthusova lifoliusandRhamnusprinoides*requirehighpriorityforconservation.Theremaining38speciesneed managementandmonitoringefforts.

Table 4:- IVI of top ten woody species in Setema Natural Forest

No.	Species	RD	RDO(RBA)	RF	IVI
1	*Cordiaafricana*	3.37	36.88	3.6	43.85
2	*Prunusafricana*	3.61	9.31	3.85	16.77
3	*Syzygiumguineense*	4.56	4.62	4.9	14.08
4	*Albiziaschimperiana*	3.61	5.13	3.9	12.64
5	*Podocarpusfalcatus*	2.9	5.57	3	11.47
6	*Crotonmacrostachyus*	2.9	4.7	3.1	10.7
7	*Polysciasfulva*	2.84	4.07	3	9.91
8	*Ficussur*	2.37	4.92	2.54	9.83
9	*Bersamaabyssinica*	3.73	1.41	4	9.14
10	*Apodytesdimidiata*	2.4	3.24	2.6	8.26

RDO=Relativedominance,RD=RelativeDensity,RF=RelativeFrequency,IVI=ImportantValueIndex,RBA=RelativeBasalArea

4.4. RegenerationStatus

Thedensityandcompositionofseedlingsandsaplingsindicatethestatusofregenerationoftheforest.Theregenerationstatuswasrecordedfor42woodyspeciesinthearea.Noregeneration(bothseedlingandsapling)wasfoundfor*Phoenixreclinata,Grewiaferruginea,Dracaenasteudneri,Vernoniaamygdalina*and*Embeliaschimperi*inthearea.Moreover,theseedlingsdensitywas1713.95/ha,thesaplingwas1166.42/haandthedensityofmaturetree/shrubwas1628/ha(Table5).Theratioofseedlingandsaplingtomaturetree/shrubis1.05and0.71respectively.Theresultrevealsthepresenceofmoreseedlingsthanmaturetrees/shrubsandsaplings.Thefindingofthisstudyrevealsthattheregenerationstatusofwoodyspeciesof Setemanaturalforestisfairsincethedensityofseedlings>saplings<Maturetrees/shrubs.Twospecies;*Crotonmacrostachyus*and*Rytigynianeglecta*havehighregenerationpotentialwith11.67%and8.75%seedlingscountrespectively.Ontheotherhand,*Oxyanthusspeciosus*hasthelea stregenerationpotentialofallspecieswith0.15%seedlingscount.

Table 5:- Density ha-1 of seedling, sapling and mature tree/shrub species in Setema Natural Forest

No.	SpeciesName	Habitat	T/SD/ha	SdD/ha	SpD/ha
1	*Bersamaabyssinica*	Tree	63	100	50.31
2	*Clausenaanisata*	shrub	49	30.31	20.31

3	*Vernoniaauriculifera*	tree	54	75	44.69
4	*Crotonmacrostachyus*	tree	49	200	38.75
5	*Maesalanceolata*	shrub	52	38.12	41.88
6	*Premnaschimperi*	shrub	42	23.75	14.06
7	*Rytigynianeglecta*	shrub	41	150	10.62
8	*Podocarpusfalcatus*	Tree	49	14.67	3.44
9	*Albiziaschimperiana*	Tree	61	44.67	0.94
10	*Syzygiumguineense*	Tree	77	80.32	52.19
11	*Maytenussenegalensis*	shrub	54	62.81	5.6
12	*Galinierasaxifraga*	Tree	58	48.12	23.12
13	*Dombeyatorrida*	Tree	35	41.25	20.94
14	*Veprisdainellii*	Tree	39	42.81	49.69
15	*Ficussur*	Tree	40	54.67	39.06
16	*Allophylusabyssinicus*	Tree	21	15.94	10
17	*Calpurinaaurea*	shrub	18	23.75	0
18	*Polysciasfulva*	Tree	48	45.94	41.25
19	*Phoenixreclinata*	Tree	12	0	0
20	*Justiciaschimperiana*	shrub	29	20.31	6.88
21	*Oxyanthusspeciosus*	shrub	17	2.5	24.34
22	*Oleacapensis*	shrub	13	4.38	35.31
23	*Celtisafricana*	Tree	22	19.69	27.19
24	*Grewiaferruginea*	shrub	9	0	0
25	*Euclearacemosa*	shrub	14	3.75	0
26	*Dracaenasteudneri*	shrub	7	0	0
27	*Scheffleraabyssinica*	Tree	29	41.25	27.19
28	*Pittosporumviridiflorum*	Tree	24	6.56	30.62
29	*Vernoniaturbinata*	shrub	37	42.81	4.34
30	*Apodytesdimidiata*	Tree	41	42.81	45
31	*Psychotriaorophila*	shrub	48	114	30.62
32	*Rhusglutinosa*	Tree	32	10.94	12.81
33	*Ricinuscommunis*	shrub	13	16.25	0
34	*Millettiaferruginea*	Tree	20	10.94	35
35	*Bruceaantidysentrica*	Tree	23	30.31	14.34
36	*Ekebergiacapensis*	shrub	19	7.19	0
37	*Acaciaetbaica*	Tree	14	14.69	16.88
38	*Acaciaabyssinica*	Tree	26	20.31	23.12
39	*Vernoniaamygdalina*	shrub	11	0	0
40	*Phyllanthusovalifolius*	shrub	15	3.44	7.19
41	*Rhamnusprinoides*	shrub	14	12.19	16.56
42	*Ficussycomorus*	Tree	33	35	65.31
43	*Cordiaafricana*	Tree	57	60.94	121.56
44	*Embeliaschimperi*	Tree	62	0	0
45	*Lonchocarpuslaxiflorus*	Tree	34	10.31	48.75
46	*Prunusafricana*	tree	61	77.19	82.81
47	*Ehretiacymosa*	Tree	42	14.06	23.75
Total			**1628**	**1713.95**	**1166.42**

T=Tree,S=Shrub,D=Density,Ha=Hectare,Sd=Seedling,Sp=Sapling

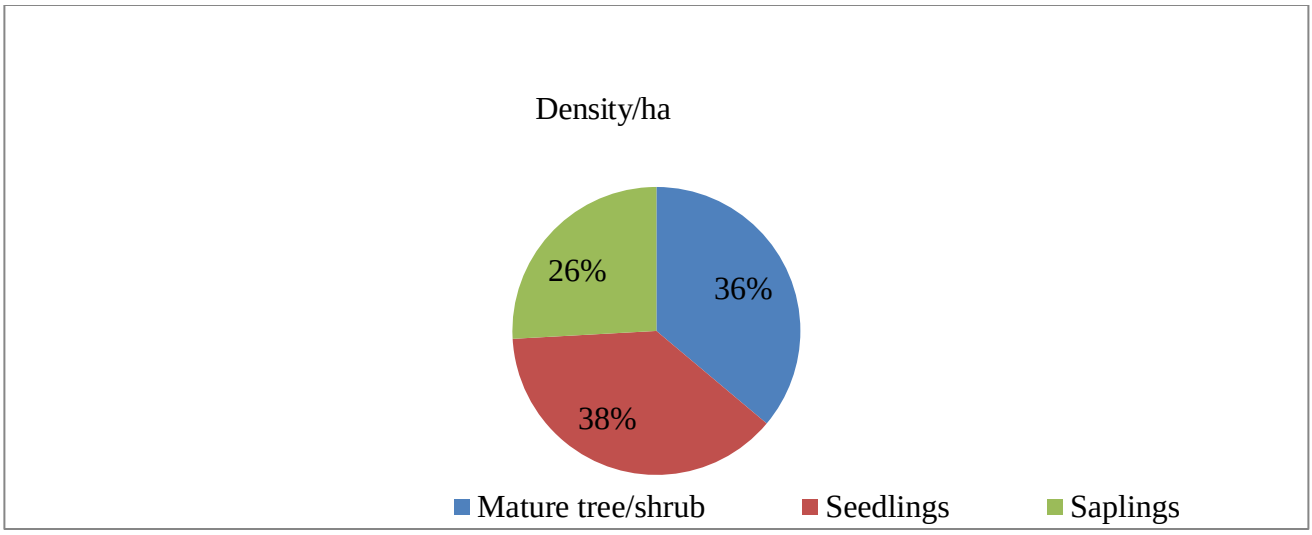


Figure 10. Percentage of regeneration status in density/ha of Setema Natural Forest

Figure 11. Comparision of regeneration status between sample plots

4.5. WoodyPlantspeciesdiversityandequitability

Thewoodyplantspeciesdiversityandequitabilityinthestudyforestwasanalyzedby Shannon-Weinerdiversityindexandequitability(evenness)index.TheoverallShannonWeinerdiversityindexofthestudyforestis1.99 (annex 7).ThediversityanalysisindicatesthatSetemanaturalforesthasmediumdiversityofwoodyspecies. Thespeciesevennessvaluerangesbetween0and1.Whenitis0,theareaisdominatedbysinglespeciesa

ndwhenitis1,thespeciesareevenlydistributedinthearea.Theanalysisresultalsoindicatedthattheaverageevennessvalueofthestudyforestis0.52;showingmoreorlessevenrepresentationofindividualsoffmostwoodyspeciesinthesampledplots.

4.6. Vegetationcommunityclassification

Sixplantcommunitytypesweredistinguishedfromdatamatrixof47speciesand80sampleplotsusinghierarchicalclusteranalysisofPC-ORD5.31windowversionsbasedontheirsimilarityvalues.Thenameforeachcommunitytypewasgivenbasedonhighsynopticvaluesofthetreeand/orshrubspeciesofcoverestimate.Accordingly,thefollowingcommunitytypeswereidentified.

***1. Schefflera abyssinica-Podocarpus falcatus*Communitytype**

Thiscommunitytypewasfoundataltituderangingbetween2000-2250m.a.s.l.Itwasresultedfrom18plotsand42species.*Schefflera abyssinica* and *Podocarpus falcatus* were the dominant species. Plant species found in this community were *Cordia africana, Apodytes dimidiata, Croton macrostachyus, Albizia schimperiana, Bersama abyssinica, Galinier asaxifraga, Ficus sur, Celtis africana, Prunus africana, Syzygium guineense, Vepris dainellii, Allophylus abyssinicus, Polyscias fulva, Dombeya torrida, Millettia ferruginea, Bruce a antidysentrica, Ficus sycomorus, Lonchocarpus laxiflorus, Embelia schimperi, Ehretia cymosa, Pittosporum viridiflorum, Rhus glutinosa, Acacia abyssinica, Olea capensis, Clausena anisata, Vernonia turbinate, Acacia etbaica, Premna schimperi, Vernonia auriculifera, Grewia ferruginea, Maesa lanceolata, Phoenix reclinata, Ricinus communis, Dracaena steudneri, Euclea racemosa, Rytigynia neglecta, Vernonia amygdalina, Phyllanthus ovalifolius, Rhamnus prinoides, Calpurina aurea, Ekebergia capensis, Oxyanthus speciosus, Justicia schimperiana, Maytenus senegalensis* and *Psychotria orophila.*

2. *Ficus sur-Syzygium guineense*Communitytype

Thiscommunitytypewasfoundbetweenaltitudesof2182-2249m.a.s.l.andrepresentedby7plotsand35species.*Ficus sur* and *Syzygium guineense* were the dominantinthetreelayerofthecommunitytype.Speciesfoundinthiscommunitywere*Cordia africana, Croton macrostachyus, Albizia schimperiana, Bersama abyssinica, Galinier asaxifraga,, Celtis africana, Prunus africana, Allophylus abysinicus, Polyscias fulva, Dombeya torrida, Millettia ferruginea, Bruce a antidysentrica, Ficus sycomorus, Schefflera abyssinica, Podocarpus falcatus, Ehretia cymo*

sa,Pittosporumviridiflorum,Rhusglutinosa,Acaciaabyssinica,Clausenaanisata,Premnaschimperi,Vernoniaauriculifera,Phoenixreclinata,Ricinuscommunis,Euclearacemosa,Rytigynianeglecta,Vernoniaamygdalina,Rhamnusprinoides,Calpurinaaurea,Ekebergiacapensis,Oxyanthusspeciosus,JusticiaschimperianaandPsychotriaorophila.

3. *Cordiaafricana-Albiziaschimperiana*Communitytype

Thiscommunitywasdistributedbetweenaltitudesof2174-2244m.a.s.landcontained21plotsand44species.*Cordiaafricana*and*Albiziaschimperiana*werethedominanttreespeciesofthecommunity.Speciesfoundinthiscommunitywere*Crotonmacrostachyus,Bersamaabyssinica,Galinierasaxifraga,Ficussur,Celtisafricana,Prunusafricana,Syzygiumguineense,Veprisdainellii,Allophylusabyssinicus,Polysciasfulva,Dombeyatorrida,Millettiaferruginea,Bruceaantidysentrica,Ficussycomorus,Lonchocarpuslaxiflorus,Embeliaschimperi,Ehretiacymosa,Pittosporumviridiflorum,Rhusglutinosa,Acaciaabyssinica,Oleacapensis,Clausenaanisata,Schefflera abyssinica,Podocarpusfalcatus**,***Vernoniaturbinate,Acaciaetbaica,Vernoniaauriculifera,Grewiaferruginea,Maesalanceolata,Phoenixreclinata,Ricinuscommunis,Dracaenastedudneri,Euclearacemosa,Rytigynianeglecta,Phyllanthusovalifolius,Rhamnusprinoides,Calpurinaaurea,Ekebergiacapensis,Oxyanthusspeciosus,Justiciaschimperiana,Maytenussenegalensisand*Psychotriaorophila.*

4. *Clausenaanisata-ApodytesdimidiataCommunitytype*

Thiscommunitywasdistributedbetween2190-2245m.a.s.landrepresentedby5plotsand27species.*ClausenaanisataandApodytesdimidiata*werethedominanttreespeciesofthiscommunity.*Cordiaafricana,Apodytesdimidiata,Crotonmacrostachyus,Albiziaschimperiana,Bersamaabyssinica,Prunusafricana,Syzygiumguineense,Veprisdainellii,Allophylusabyssinicus,Polysciasfulva,Schefflera abyssinica,Podocarpusfalcatus,Millettiaferruginea,Bruceaantidysentrica,Ficussycomorus,Lonchocarpuslaxiflorus,Embeliaschimperi,Ehretiacymosa,Pittosporumviridiflorum,Acaciaabyssinica,Oleacapensis,Clausenaanisata,Vernoniaturbinate,Premnaschimperi,Vernoniaauriculifera,VernoniaamygdalinaandMaytenussenegalensis*werespeciesfoundinthiscommunity.

5. Prunusafricana–MillettiaferrugineaCommunitytype

Thiscommunitywasdistributedbetween2197-2238m.a.s.l.andrepresentedby21plotsand42species.*PrunusafricanaandMillettiaferruginea*werethedominanttreelayersofthiscommunity.*Cordiaafricana,Apodytesdimidiata,Crotonmacrostachyus,Albiziaschimperiana,Bersamaabyssinica,Galinierasaxifraga,Ficussur,Celtisafricana,Prunusafricana,Syzygiumguineense,Veprisdainellii,Allophylusabyssinicus,Polysciasfulva,Dombeyatorrida,Ficussycomorus,Lonchocarpuslaxiflorus,Ehretiacymosa,Rhusglutinosa,Acaciaabyssinica,Oleacapensis,Clausenaanisata,Vernoniaturbinate,Scheffleraabyssinica,Podocarpusfalcatus*Acaciaetbaica,*Premnaschimperi,Vernoniaauriculifera,Grewiaferruginea,Maesalanceolata,Phoenixreclinata,Ricinuscommunis,Dracaenasteudneri,Euclearacemosa,Rytigynianeglecta,Vernoniaamygdalina,Phyllanthusovalifolius,Rhamnusprinoides,Calpurinaaurea,Oxyanthusspeciosus,Justiciaschimperiana,MaytenussenegalensisandPsychotriaorophila*werethetree/shrubspeciesfoundinthiscommunitytype.

6. *Polysciasfulva–Ficussycomorus*Communitytype

Thiscommunitywasfoundbetween2092-2241m.a.s.landcontained8plotsand33species.*PolysciasfulvaandFicussycomorus*werethedominanttreespeciesofthiscommunity.Speciesfoundinthiscommunitywere*Cordiaafricana,Apodytesdimidiata,Ficussur,Celtisafricana,Prunusafricana,Syzygiumguineense,Dombeyatorrida,Bruceaantidysitrica,Podocarpusfalcatus,Lonchocarpuslaxiflorus,Embeliaschimperi,Ehretiacymosa,Pittosporumviridiflorum,Rhusglutinosa,Clausenaanisata,Vernoniaturbinate,Premnaschimperi,Vernoniaauriculifera,Grewiaferruginea,Maesalanceolata,Phoenixreclinata,Euclearacemosa,Rytigynianeglecta,Vernoniaamygdalina,Phyllanthusovalifolius,Rhamnusprinoides,Calpurinaaurea,Ekebergiacapensis,Justiciaschimperiana,MaytenussenegalensisandPsychotriaorophila*

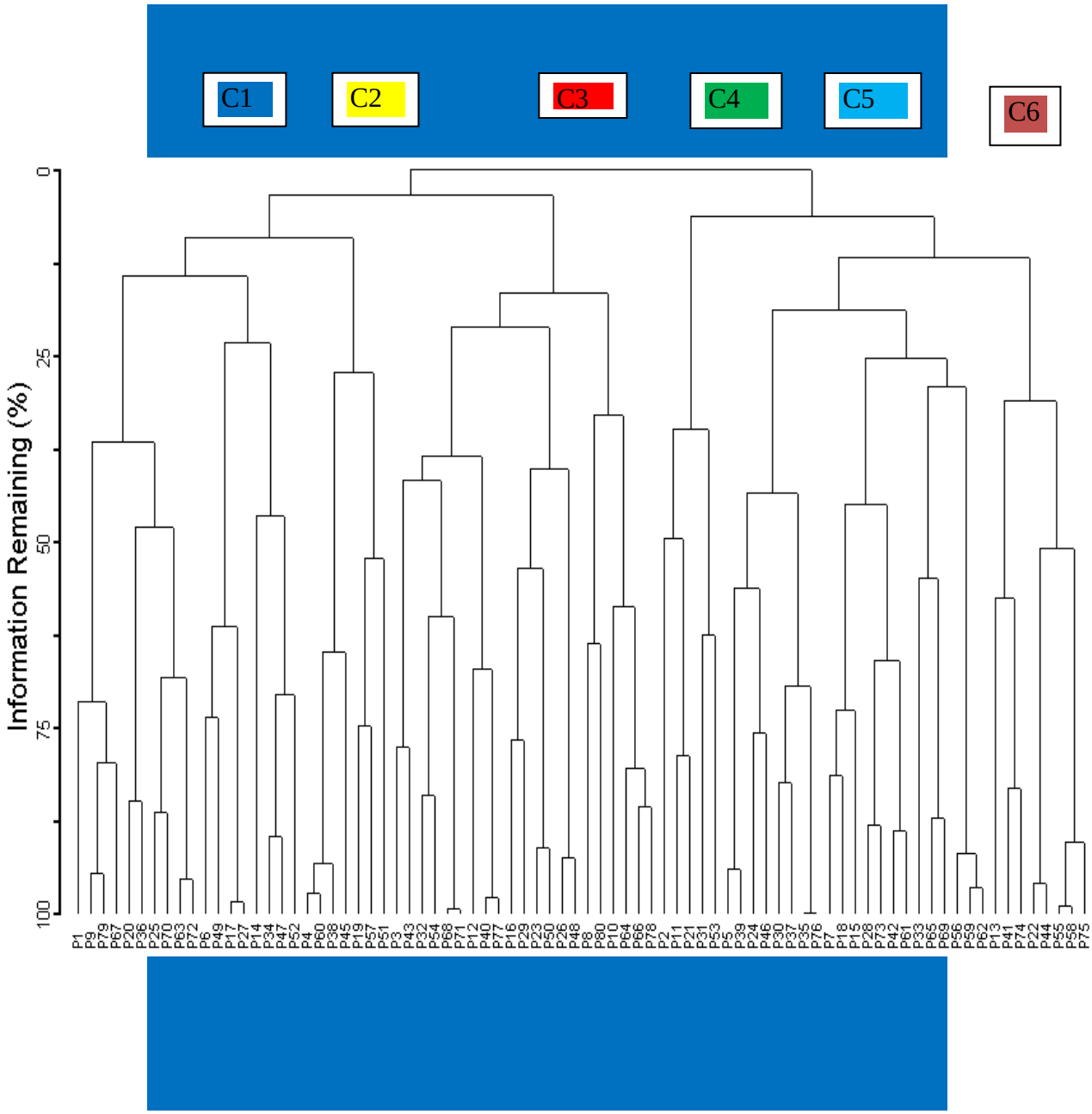


Figure 12. Dendrogram showing six plant communities in Setema Natural Forest

Table 6. Synoptic table of Community types

Listofspecies	C1	C2	C3	C4	C5	C6
Acaciaabyssinica	0.50	0.86	0.00	0.60	1.42	0.00
Acaciaetbaica	0.56	0.00	0.67	0.00	0.54	0.00
Albiziaschimperiana	1.30	2.29	**2.76**	1.60	1.77	0.00
Allophylusabyssinicus	1.94	3.00	1.38	0.60	1.14	0.00
Apodytesdimidiata	2.05	1.57	2.35	0.00	0.90	4.50
Bersamaabyssinica	1.56	6.80	2.57	5.00	1.67	0.00
Bruceaantidysentrica	0.94	0.00	1.23	1.60	0.00	1.25
Calpurinaaurea	1.40	0.86	1.05	7.20	0.95	0.75
Celtisafricana	1.00	2.29	1.90	0.80	2.67	1.37
Clausenaanisata	1.56	1.43	2.23	0.40	1.71	1.00
Cordiaafricana	3.22	2.57	**4.190**	0.00	7.47	3.13
Crotonmacrostachyus	0.56	2.28	2.43	0.00	8.28	0.00
Dracaenasteudneri	0.11	0.00	0.19	7.20	0.05	0.00
Dombeyatorrida	0.83	1.71	2.04	3.60	1.52	2.50
Ehretiacymosa	1.61	2.00	2.14	5.80	0.81	2.00
Ekebergiacapensis	0.22	0.28	0.33	1.80	0.00	0.75
Embeliaschimperi	0.28	0.00	0.24	0.00	0.00	0.25
Euclearacemosa	0.83	0.57	0.19	0.40	0.67	0.75
Ficussur	1.67	**8.28**	2.62	0.00	0.33	2.00
Ficussycomorus	1.44	1.42	1.52	1.00	1.33	3.65
Galinierasaxifraga	1.90	2.28	2.05	0.20	2.90	0.00
Grewiaferruginea	0.22	0.00	0.33	0.40	0.09	0.37
Justiciaschimperiana	0.28	1.14	0.76	0.00	0.81	1.37
Lonchocarpuslaxiflorus	0.44	0.00	0.62	3.20	1.90476	0.25
Maesalanceolata	1.61	0.00	1.09	0.00	1.79	0.75
Maytenussenegalensis	0.22	0.00	0.33	0.00	0.47	0.50
Millettiaferruginea	1.50	1.14	0.14	2.00	0.00	0.00
Oleacapensis	0.72	0.00	0.67	0.00	0.47	0.00
Oxyanthusspeciosus	0.11	0.42	0.00	0.00	0.81	0.00
Phoenixreclinata	0.39	0.57	0.38	0.00	0.14	0.25
Phyllanthusovalifolius	0.11	0.00	0.28	0.40	0.14	0.25
Pittosporumviridiflorum	1.05	1.70	1.00	3.60	0.00	0.37
Podocarpusfalcatus	**3.56**	0.14	2.28	0.00	3.81	2.37
Polysciasfulva	2.44	0.71	1.19	0.00	2.47	7.00
Premnaschimperi	0.17	0.42	0.47	1.00	0.42	0.75
Prunusafricana	2.83	3.85	1.57	0.80	4.04	3.50
Psychotriaorophila	0.72	1.00	0.85	2.60	0.19	0.62
Rhamnusprinoides	0.22	0.42	0.52	5.00	0.57	1.25
Rhusglutinosa	0.61	3.14	1.38	500	1.33	3.12

Ricinuscommunis	0.17	0.28	0.67	0.00	0.38	0.00
Rytigynianeglecta	0.89	1.00	1.14	0.00	1.04	0.75
Scheffleraabyssinica	**8.05**	6.00	0.19	0.00	1.71	0.00
Syzygiumguineense	2.39	**7.42**	1.57	0.00	3.43	0.75
Veprisdainellii	3.22	0.00	2.28	0.00	2.09	0.00
Vernoniaamygdalina	0.05	0.28	0.00	0.40	0.76	0.12
Vernoniaauriculifera	0.56	0.57	0.52	6.80	0.90	0.37
Vernoniaturbinata	0.61	0.00	0.19	7.20	0.38	1.00

4.7. SpeciesDiversityinEachPlantCommunity

Thehighestspeciesrichnesswasrecordedfromcommunity3(44)followedbycommunity1(42),whil etheleastspeciesrichnesswasrecordedfromcommunity4(Table7).Lowlevelofdisturbancehascont ributedtothethehighestspeciesrichnessincommunitythree.Itismainlycoveredwithshrubsandlessn eededtreesforconstructionandcommercialpurposes.Ontheotherhand,thereasonforthelowestspec iesrichnessincommunity4wasduetohumandisturbances.Specially,*Prunusafricana*inthiscommu nitywasnon-

selectivelyharvestedforconstruction.Thespeciesevennesswasalsogreaterincommunity3followe dbycommunity5,whilecommunity6hasrelativelytheleastevennessvalue.Accordingly,theanalysi sresultrevealedthatthenumbersofeachspeciesincommunity4weremoreclosetoeachotherthanther estcommunitieswhereastheclosenessofthenumbersofeachspeciesincommunity6wasrelativelyle ss.

Table 7:- Comparison of diversity indices in six communities of Setema Natural Forest

	Communities					
Diversityindices	C1	C2	C3	C4	C5	C6
Taxa	42	35	44	27	42	33
Individuals	1053	534	1242	395	1392	422
Shannon	2.07	1.98	2.16	1.72	2.25	1.76
Evenness	0.83	0.83	0.88	0.82	0.84	0.80

4.8. Community'sSimilarity

Thesimilarityofcommunity1withcommunity2was88%,withcommunity3itwas82%,butrelativel ysharedlessnumberofspecieswithcommunity4(72%),community5(71%)andcommunitysix(72 %).Theresultofsimilarityanalysisbetweencommunitiesrevealedthatthespeciesin Setemanaturalf orestaremoreorlesshomogeneouslydistributedintheforest.

Table 8:- Sorensen's coefficient of similarity between the plant communities of Setema Natural Forest

Community	1	2	3	4	5	6
1	1	_	_	_	_	_
2	0.88	1	_	_	_	_
3	0.82	0.5	1	_	_	_
4	0.72	0.48	0.67	1	_	_
5	0.71	0.57	0.72	0.60	1	_
6	0.72	0.76	0.54	0.53	0.69	1

4.9. ForestDisturbance

Duringtheinventory,disturbancebyhumanandLivestockwasobserved.Ofthese,humaninterference(especiallyagriculturalexpansion)wasthemajorfactorobservedinthearea.NumbersofStumpsandfreshanimals'dungwereobservedinsomepartsoftheforest.TraditionalhivesandFirewoodcollectionwerealsoobservedintheforestduringtheinventory.Browsingandgrazingarethemajorattributingfactorstowardsthedisturbanceoftheforest.

5. CONCLUSION

Fromthestudyarea,47woodyspeciesbelongingto44generaand31familieswereidentified.Ofthesefamilies,thethreemostspeciesrichfamilieswereFabaceae,RubaceaeandEuphorbiaceae.

Fromtheanalysisofverticalstratification,theupperlayercomprisedoftreeslike*Prunusafricana,Cordiaafricana,Scheffleraabyssinica,Crotonmacrostachyus,Podocarpusfalcatus,Albiziaschimperiana,Polysciasfulva,Millettiaferruginea*and*Ficussur*.ThisstudyindicatedthatSetemaNaturalForestconsistsofspecieslike*Podocarpusfalcatus,Prunusafricana,Crotonmacrostachyus,Scheffleraabyssinica,Millettiaferruginea,PolysciasfulvaandFicussur*whicharecharacterizedbyhighbasalarea.Thereweresixplantcommunitytypesidentifiedfrom SetemaNaturalForestwithdifferentdegreesofspeciesrichness,evennessanddiversity.

Theresultofthisstudyrevealedthatthetotaldensityperhectareofalltrees/shrubswithheight≥3mand DBH≥2.7cmwere1628/ha.About21tree/shrubspecies(44.68%)weredistributedintheDBHclassI(2.7-7.6cm).Onlyonespecies,CordiaafricanawasfallunderDBHclassVII(>32.6cm).

Thetotalbasalareacalculatedforthestudyareawas50.7m^2/haandthebasalareaoftoptentreespecieswas40.71m^2/ha.Thetoptenspecieswithhigherbasalareawere*Cordiaafricana,Prunusafricana,Podocarpusfalcatus,Albiziaschimperiana,Ficussur,Millettiaferruginea,Polysciasfulva,Crotonmacrostachyus,Apodytesdimidiata*and*Schefflerabyssinica.*

Thespecies'IVIvariedbetween0.85and43.85.Itislowestfor*Dracaenasteudneri*andhighestfor*Cordiaafricana.*Thetotalspecies'IVIwas295.57.ThetoptenspecieswithhigherIVIwere*Cordiaafricana,Prunusafricana,Syzygiumguineense,Podocarpusfalcatus,Bersamaabyssinica,Crotonmacrostachyus,Polysciasfulva,Ficussur,Albiziaschimperiana*and*Apodytesdimidiata.*

Theregenerationstatusrecordedfor42speciesindicatedthattheseedlingsdensityperhectarewas1713.95,thesaplingperhectarewas1166.42andthedensityofmaturetree/shrubperhectarewas1628.Thus,thefindingofthisstudyrevealsthattheregenerationstatusofwoodyspeciesofSetemanaturalforestisfair.

6. RECOMMENDATION

SetemaForestisoneoftheNaturalforestswithinSigmo-SetemaforestpriorityareainEthiopia.AppropriatemanagementstrategyisEssentialtoconservethis naturalforest.Thisstudywasconductedonlyononeblockof Sigmo-SetemaForestpriorityarea.ThestudyofthewholeSigmo-Setemaforestisrecommendedtoknowthecurrentstatusofthevegetationofthearea.

Furtherstudieslikediversityofherbaceousplantsandlianasandanalysisofsoilsamplingareneededto fillthegapofthisworksinceitwasonlyonwoodyspecies.

VegetationofSetemaNaturalforestwasdisturbedthroughselectivecutting,browsingandgrazing.T hesefactorsfurtheraffectthe forestregenerationstatusandtherebytheecosystemoftheforestasawhol e.Therefore,thisforestneedstobeconservedandutilizedinsustainableway.

DifferentprogramslikeParticipatoryForestmanagementprogramsshouldbehostedandappliedsoth atlocalcommunitiesandconcernedgovernmentofficesadoptresponsibilityforthemanagementand conservationoftheforestandbecometheuseroftheeconomicprofitoftheforest. GovernmentshouldaddressCapacity-buildingandawarenesscreationonforestconservationforlocalcommunity. Finally,thoughitisnotpartofthisstudy,localcommunityusetheforestfordifferentpurposeslikecutti ngtreestomaketraditionalhivesandhunginghivesagainonbranchesoftreesintheforest,formedicina lvalues,forhomeconstruction,fortimberandforhomefurnitures.Thus,furtherethno-botanicalstudyonSetemaNaturalForestishighlyrecommended

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8. ANNEX

Annex 1. Families, genera and species found in the study area

No.	Family	NoofGenera	(%)	Nospecies	(%)

1	Rosaceae	1	2.27	1	2.13
2	Melianthaceae	1	2.27	1	2.13
3	Rutaceae	2	4.55	2	4.26
4	Myrsinaceae	2	4.55	2	4.26
5	Acanthaceae	1	2.27	1	2.13
6	Asteraceae	3	6.82	3	6.38
7	Araliaceae	2	4.55	2	4.26
8	Euphorbiaceae	3	6.82	3	6.38
9	Rubiaceae	4	9.09	5	10.64
10	Podocarpaceae	1	2.27	1	2.13
11	Fabaceae	4	9.09	6	12.77
12	Myrtaceae	1	2.27	1	2.13
13	Celasteraceae	1	2.27	1	2.13
14	Sterculiaceae	1	2.27	1	2.13
15	Moraceae	1	2.27	1	2.13
16	Sapindaceae	1	2.27	1	2.13
17	Arecaceae	1	2.27	1	2.13
18	Ulmaceae	1	2.27	1	2.13
19	Pittosporaceae	1	2.27	1	2.13
20	Icacianaceae	1	2.27	1	2.13
21	Anacardaceae	1	2.27	1	2.13
22	Simarobaceae	1	2.27	1	2.13
23	Ebenaceae	1	2.27	1	2.13
24	Meliaceae	1	2.27	1	2.13
25	Burseraceae	1	2.27	1	2.13
26	Boraginaceae	1	2.27	1	2.13
27	Rhamnaceae	1	2.27	1	2.13
28	Dracenaceae	1	2.27	1	2.13
29	oleaceae	1	2.27	1	2.13

30	Tiliaceae	1	2.27	1	2.13
31	Verbenaceae	1	2.27	1	2.13
Total	**31**	**44**	**100**	**47**	**100**

Annex 2. Woody Species collected from Setema Natural Forest(T = Tree, S = Shrub)

No.	ScientificName	FamilyName	VernacularName(A/O)	Habit	Remark
1	*Acaciaabyssinica*Hochst.exBenth	Fabaceae	Laaftoo	T	
2	*Acaciaetbaica*Schweinf.	Fabaceae	Dodota	T	
3	*Albiziaschimperiana*Oliv.	Fabaceae	Ambabesa	T	
4	*Allophylus abyssinicus* (Hochst.) Radlkofer	Sapindaceae	Seo	T	
5	*Apodytesdimidiate* E. Mey. ex Arn.	Icacianaceae	Wandabiyo	T	
6	*Bersamaabyssinica*Fresen	Melianthaceae	Lolchisa	T	
7	*Bruceaantidysentrica*J.FMill	Simarobiacee	Komanyo	T	
8	*Calpurinaaurea*(Lam.)Benth	Fabaceae	Cheka	S	
9	*Celtisafricana*Burm.f.	Ulmaceae	Qayi	T	
10	*Clausenaanisate* (Willd.) Benth.	Rutaceae	Ulumayi	T	
11	*CordiaafricanaLam*	Boraginaceae	Waddeessaa	T	
12	*Crotonmacrostachyus*Del.	Euphorbiacee	Bakkanniisaa	T	
13	*Dracaenasteudneri*Engl.	Dracaenaceae	Lankuso(Showiye)	S	
14	*Dombeyatorrida(*J. F. Gmel.) P. Bamps	Sterculiaceae	Adaannisa	T	
15	*EhretiacymosaThonn.*Thonn.	Rubiaceae	Ulaga	T	
16	EkebergiacapensisSparm	Meliaceae	sombo	T	
17	*Embeliaschimperi*Vatke	Myrsinaceae	Hanqu	T	
18	Euclearacemosa	Ebenaceae	miessa	S	
19	*Ficussur*Forssk.	Moraceae	Harbuu	T	
20	*Ficussycomorus*	Moraceae	Lugo	T	
21	*Galinierasaxifraga*(Hochst.) Bridson	Rubiaceae	Mito	T	
22	*Grewiaferruginea*A.Rich.	Tiliaceae	Tumane(lankisa)	S	
23	*Hageneaabyssinica*(Bruce) J. F. Gmel.	Rosaceae	Heto	T	++
24	*Juniperusprocera*	Cupressaceae	Gatira	T	++
25	*Justiciaschimperiana* (Hochst. ex Nees) T. Anders.	Acanthaceae	Xummuugaa	S	
26	*Lonchocarpuslaxiflorus*	Fabaceae	Ororo	T	
27	*Maesalanceolate* Forssk.	Myrsinaceae	Abayi	S	
28	*Maytenussenegalensis*	Celasteraceae	Kombolcha	S	

29	*Millettiaferruginea(*Hochst.)Bak	Fabaceae	Askra	T	***
30	*Oleacapensis*L. subsp. macrocarpa (C. A. Wright.) Verdc.	oleaceae	gagama	T	
31	*Oxyanthusspeciosus*subsp. stenocarpus (K. Schum.) Bridson	Rubiaceae	imbrangojaldessa	S	
32	*Phoenixreclinata*Jacq.	Arecacea	Meexxii	T	
33	*Phyllanthusovalifolius*Forssk.	Euphorbiaceae	Qacamaa	T	
34	*Pittosporumviridiflorum*Sims	Pittosporaceae	Sole	T	
35	*Podocarpusfalcatus*	Podocarpaceae	Birbirsa	T	
36	*Polysciasfulva*(Heim.)Harms	Araliaceae	Kaariyoo	T	
37	PremnaschimperiEngl.	Verbenaceae	urgessa	S	
38	*Prunusafricana (*Hook. f.) Kalkm.	Rosaceae	Mukagurraacha	T	
39	*Psychotriaorophila*Petit	Rubiaceae	Mito	T	
40	*RhamnusprinoidesL'Herit*	Rhamnaceae	Gesho	S	
41	*Rhusglutinosa*A.Rich.	Anacardiaceae	Xaaxessaa	T	
42	*Ricinuscommunis*L.	Euphorbiacee	Kobo	S	
43	*Rytigynianeglecta*(Hiren)Robyns	Rubiaceae	MitoSare	S	
44	*Schefflera abyssinica* (Hochst. ex A. Rich.) Harms	Araliaceae	Gatama	T	
45	*Syzygiumguineense*(Wild)D.C.	Myrtaceae	Baddessa	T	
46	*Veprisdainellii*(Pichi-Serm)Kokwaro	Rutacea	Hadhessa	T	***
47	VernoniaamygdalinaDel	Asteraceae	Eebicha	S	
48	*Vernoniaauriculifera*Heim.	Asteracea	Reji	T	
49	*Vernoniaturbinata*Oliv.&Hiern	Asteracea	Rejiiguracha	S	

++representsspeciesoutofsampleplots
***representsEndemicSpecies

Annex 3. Vertical structure of the woody plant species in Setema Natural Forest

No.	SpeciesName	Maximum Height(m)	Upper Storey(25-38)	Middle Storey (13-24)	LowerStorey(3-12)	Proportion (%)
1	*Prunusafricana*	38				
2	*Scheffleraabyssinica*	30				
3	*Ficussur*	30				
4	*Podocarpusfalcatus*	25				
5	*Albiziaschimperiana*	25				**19.15**
6	*Polysciasfulva*	25				
7	*Cordiaafricana*	25				
8	*Crotonmacrostachyus*	25				
9	*Millettiaferruginea*	25				
10	*Allophylusabyssinicus*	22				
11	*Ekebergiacapensis*	22				
12	*Ficussycomorus*	22				
13	*Celtisafricana*	22				
14	*Apodytesdimidiata*	18				
15	*Oleacapensis*	17				
16	*Acaciaabyssinica*	17				**29.79**
17	*Syzygiumguineense*	15				
18	*Dombeyatorrida*	15				
19	*Pittosporumviridiflorum*	15				
20	*Veprisdainellii*	15				
21	*Dracaenasteudneri*	15				
22	*Bruceaantidysentrica*	14				
23	*Clausenaanisata*	13				
24	*Galinierasaxifraga*	11				
25	*Lonchocarpuslaxiflorus*	10				
26	*Rhusglutinosa*	10				
27	*Vernoniaturbinate*	10				

28	*Acaciaetbaica*	10				
39	*Phoenixreclinata*	10				
30	*Vernoniaamygdalina*	10				
31	*Phyllanthusovalifolius*	10				
32	*Maytenussenegalensis*	8				
33	*Vernoniaauriculifera*	8				
34	*Premnaschimperi*	7				
35	*Grewiaferruginea*	7				
36	*Embeliaschimperi*	7				
37	*Rhamnusprinoides*	7				
38	*Bersamaabyssinica*	6				**51.06**
39	*Calpurinaaurera*	6				
40	*Oxyanthusspeciosus*	6				
41	*Ricinuscommunis*	5				
42	*Maesalanceolata*	5				
43	*Psychotriaorophila*	4				
44	*Rytigynianeglecta*	4				
45	*Justiciaschimperiana*	4				
46	*Euclearacemosa*	4				
47	*Ehretiacymosa*	3				

Annex 4. Analysis of Regeneration Status of the study area

No	ListofSpecies	Seedling/ha	Sapling/ha	maturetree/ha	Total/ha
1	*Acaciaabyssinica*	20.31	23.12	26	69.43
2	*Acaciaetbaica*	14.69	16.88	14	45.57
3	*Albiziaschimperiana*	44.67	0.94	61	106.61
4	*Allophylusabyssinicus*	15.94	10	21	46.94
5	*Apodytesdimidiata*	42.81	45	41	128.81
6	*Bersamaabyssinica*	100	50.31	63	213.31
7	*Bruceaantidysentrica*	30.31	14.34	23	67.65
8	*Calpurinaaurea*	23.75	0	18	41.75
9	*Celtisafricana*	19.69	27.19	22	68.88
10	*Clausenaanisata*	30.31	20.31	49	99.62
11	*Cordiaafricana*	60.94	121.56	57	239.5
12	*Crotonmacrostachyus*	200	38.75	49	287.75
13	*Dracaenasteudneri*	0	0	7	7
14	*Dombeyatorrida*	41.25	20.94	35	97.19
15	*Ehretiacymosa*	14.06	23.75	42	79.81
16	*Ekebergiacapensis*	7.19	0	19	26.19
17	*Embeliaschimperi*	0	10	62	72
18	*Euclearacemosa*	3.75	0	14	17.75
19	*Ficussur*	54.67	39.06	40	133.73
20	*Ficussycomorus*	35	65.31	33	133.31
21	*Galinierasaxifraga*	48.12	23.12	58	129.24
22	*Grewiaferruginea*	0	0	9	9
23	*Justiciaschimperiana*	20.31	6.88	29	56.19
24	*Lonchocarpuslaxiflorus*	10.31	48.75	34	93.06
25	*Maesalanceolata*	38.12	41.88	52	132
26	*Maytenussenegalensis*	62.81	5.6	54	122.41
27	*Millettiaferruginea*	10.94	35	20	65.94
28	*Oleacapensis*	4.38	35.31	13	52.69
29	*Oxyanthusspeciosus*	2.5	24.34	17	43.84
30	*Phoenixreclinata*	0	0	12	12
31	*Phyllanthusovalifolius*	3.44	7.19	15	25.63
32	*Pittosporumviridiflorum*	6.56	30.62	24	61.18
33	*Podocarpusfalcatus*	14.67	3.44	49	67.11
34	*Polysciasfulva*	45.94	41.25	48	135.19
35	*Premnaschimperi*	23.75	14.06	42	79.81
36	*Prunusafricana*	77.19	82.81	61	221
37	*Psychotriaorophila*	114	30.62	48	192.62
38	*Rhamnusprinoides*	12.19	16.56	14	42.75

39	*Rhusglutinosa*	10.94	12.81	32	55.75
40	*Ricinuscommunis*	16.25	0	13	29.25
41	*Rytigynianeglecta*	150	10.62	41	201.62
42	*Scheffleraabyssinica*	41.25	27.19	29	97.44
43	*Syzygiumguineense*	80.32	52.19	77	209.51
44	*Veprisdainellii*	42.81	49.69	39	131.5
45	*Vernoniaamygdalina*	0	16.88	11	27.88
46	*Vernoniaauriculifera*	75	44.69	54	173.69
47	*Vernoniaturbinata*	42.81	4.34	37	84.15
Total/ha		**1713.95**	**1166.42**	**1628**	**4508.37**

Annex 5. IVI of woody species vegetation in Setema Natural Forest

No.	Species	RD	RDO(RBA)	RF	IVI
1	*Bersamaabyssinica*	3.73	1.41	4	9.14
2	*Clausenaanisata*	2.9	2	3	7.9
3	*Vernoniaauriculifera*	3.2	0.62	3.45	7.27
4	*Crotonmacrostachyus*	2.9	4.7	3.1	10.7
5	*Maesalanceolata*	3.08	0.14	3.33	6.55
6	*Premnaschimperi*	2.49	0.06	2.66	5.21
7	*Rytigynianeglecta*	2.43	0.05	2.58	5.06
8	*Podocarpusfalcatus*	2.9	5.57	3	11.47
9	*Albiziaschimperiana*	3.61	5.13	3.9	12.64
10	*Syzygiumguineense*	4.56	4.62	4.9	14.08
11	*Maytenussenegalensis*	3.2	0.1	3.4	6.7
12	*Galinierasaxifraga*	3.43	3.14	3.65	10.22
13	*Dombeyatorrida*	2.07	0.84	2.22	5.13
14	*Veprisdainellii*	2.31	2.74	2.46	7.51
15	*Ficussur*	2.37	4.92	2.54	9.83
16	*Allophylusabyssinicus*	1.24	1.09	1.3	3.63
17	*Calpurinaaurea*	1.06	0.04	1.15	2.25
18	*Polysciasfulva*	2.84	4.07	3	9.91
19	*Phoenixreclinata*	0.71	0.05	0.75	1.51
20	*Justiciaschimperiana*	1.71	0.11	1.8	3.62
21	*Oxyanthusspeciosus*	1	0.02	1	2.02
22	*Oleacapensis*	0.77	0.02	0.83	1.62
23	*Celtisafricana*	1.3	1.01	1.39	3.7
24	*Grewiaferruginea*	0.53	0.01	0.6	1.14
25	*Euclearacemosa*	0.83	0.04	0.9	1.77
26	*Dracaenasteudneri*	0.41	0.01	0.43	0.85
27	*Schefflera abyssinica*	1.72	3.13	1.8	6.65
28	*Pittosporumviridiflorum*	1.42	0.17	1.5	3.09
29	*Vernoniaturbinata*	2.2	0.13	2.34	4.67

30	*Apodytesdimidiata*	2.42	3.24	2.6	8.26
31	*Psychotriaorophila*	2.84	0.07	3	5.91
32	*Rhusglutinosa*	1.89	0.19	2	4.08
33	*Ricinuscummunis*	0.77	0.03	0.8	1.6
34	*Millettiaferruginea*	1.18	0.95	1.27	3.4
35	*Bruceaantidysentrica*	1.36	0.44	1.43	3.23
36	*Ekebergiacapensis*	1.12	0.03	1.23	2.38
37	*Acaciaetbaica*	0.83	0.07	0.91	1.81
38	*Acaciaabyssinica*	1.54	0.75	1.6	3.89
39	*Vernoniaamygdalina*	0.65	0.01	0.67	1.33
40	*Phyllanthusovalifolius*	0.89	0.05	0.55	1.49
41	*Rhamnusprinoides*	0.83	0.02	0.9	1.75
42	*Ficussycomorus*	1.95	1.58	2.1	5.63
43	*Cordiaafricana*	3.37	36.88	3.6	43.85
44	*Embeliaschimperi*	3.67	0.07	1.1	4.84
45	*Lonchocarpuslaxiflorus*	2.01	0.11	2.1	4.22
46	*Prunusafricana*	3.61	9.31	3.85	16.77
47	*Ehretiacymosa*	2.49	0.62	2.66	5.77
Total		**100**	**100**	**100**	**295.57**

Annex 6. Basal Area of each of 47 species in setema Natural Forest

No.	Species	Densityha-1	DBH(cm)	BA	RBA
1	*Bersamaabyssinica*	63	18.7	1.73	3.41
2	*Clausenaanisata*	49	16.2	1	2
3	*Vernoniaauriculifera*	54	8.6	0.31	0.62
4	*Crotonmacrostachyus*	49	17.1	1.12	2.22
5	*Maesalanceolata*	52	4.2	0.07	0.14
6	*Premnaschimperi*	42	3.1	0.03	0.06
7	*Rytigynianeglecta*	41	2.9	0.03	0.05
8	*Podocarpusfalcatus*	49	27.1	2.82	5.57
9	*Albiziaschimperiana*	61	23.3	2.6	5.13
10	*Syzygiumguineense*	77	19.7	2.34	4.62
11	*Maytenussenegalensis*	54	3.5	0.05	0.1
12	*Galinierasaxifraga*	58	18.7	1.6	3.14
13	*Dombeyatorrida*	35	12.5	0.43	0.84
14	*Veprisdainellii*	39	21.3	1.49	2.74
15	*Ficussur*	40	28.2	2.5	4.92
16	*Allophylusabyssinicus*	21	18.3	0.55	1.09
17	*Calpurinaaurea*	18	3.7	0.02	0.04
18	*Polysciasfulva*	48	23.4	2.06	4.07
19	*Phoenixreclinata*	12	7.3	0.05	0.05
20	*Justiciaschimperiana*	29	5	0.06	0.11
21	*Oxyanthusspeciosus*	17	2.9	0.01	0.02
22	*Oleacapensis*	13	3.5	0.01	0.02
23	*Celtisafricana*	22	17.3	0.52	1.01
24	*Grewiaferruginea*	9	3.4	0.008	0.01
25	*Euclearacemosa*	14	4.6	0.02	0.04
26	*Dracaenasteudneri*	7	3.2	0.005	0.01
27	*Scheffleraabyssinica*	29	26.4	1.58	3.13
28	*Pittosporumviridiflorum*	24	6.7	0.08	0.17
29	*Vernoniaturbinata*	37	4.8	0.07	0.13

30	*Apodytesdimidiata*	41	22.6	1.64	3.24
31	*Psychotriaorophila*	48	3.2	0.04	0.07
32	*Rhusglutinosa*	32	6.2	0.1	0.19
33	*Ricinuscummunis*	13	3.7	0.01	0.03
34	*Millettiaferruginea*	20	17.5	0.48	0.95
35	*Bruceaantidysentrica*	23	11.2	0.22	0.44
36	*Ekebergiacapensis*	19	3.3	0.01	0.03
37	*Acaciaetbaica*	14	5.7	0.03	0.07
38	*Acaciaabyssinica*	26	13.7	0.38	0.75
39	*Vernoniaamygdalina*	11	3.1	0.008	0.01
40	*Phyllanthusovalifolius*	15	4.7	0.02	0.05
41	*Rhamnusprinoides*	14	2.9	0.01	0.02
42	*Ficussycomorus*	33	17.6	0.8	1.58
43	*Cordiaafricana*	57	64.65	18.7	36.88
44	*Embeliaschimperi*	62	2.7	0.03	0.07
45	*Lonchocarpuslaxiflorus*	34	4.7	0.06	0.11
46	*Prunusafricana*	61	31.4	4.72	9.31
47	*Ehretiacymosa*	42	9.8	0.32	0.62
Total		**1628**	**584.25**	**50.741**	**100**

Note:BA=BasalAreaRBA=RelativeBasalArea

Annex 7. The diversity of the species evenness and richness in Setema Natural Forest

Plots	Species Richness	Total abundance in each plot	H'	EH (Evenness)
1	13	56	1.98	0.51
2	16	44	1.62	0.42
3	19	56	2.31	0.6
4	12	67	2.34	0.6
5	15	61	3.41	0.89
6	17	53	1.91	0.5
7	11	53	2.11	0.55
8	18	50	1.73	0.45
9	20	57	2.31	0.6
10	16	51	1.91	0.5
11	17	56	1.32	0.34
12	23	47	1.67	0.43
13	20	55	3.12	0.81
14	19	47	2.13	0.55
15	18	46	1.93	0.5
16	13	76	1.72	0.45
17	13	54	1.73	0.45
18	13	54	1.93	0.5
19	12	54	1.89	0.49
20	14	53	2.37	0.61
21	15	51	2.43	0.63
22	12	50	2.11	0.55
23	13	55	1.82	0.47
24	14	56	1.87	0.48
25	11	55	2.13	0.55
26	10	57	2.15	0.55
27	15	58	1.78	0.46
28	15	54	1.32	0.34
29	16	55	1.62	0.42
30	17	65	1.12	0.29
31	12	61	1.86	0.48
32	12	65	1.56	0.4
33	14	63	1.32	0.34
34	17	68	1.11	0.28
35	14	59	2.13	0.55
36	18	52	1.74	0.45
37	18	70	1.72	0.45
38	18	45	1.85	0.48
39	18	56	1.42	0.37
40	16	49	1.91	0.5
41	15	54	1.23	0.32
42	14	611	1.75	0.45
43	15	53	2.11	0.55
44	15	53	2.15	0.56

45	16	53	1.23	0.32
46	17	54	1.78	0.46
47	12	51	2.32	0.6
48	12	50	1.32	0.34
49	13	55	1.34	0.35
50	12	58	1.92	0.5
51	13	47	1.25	0.32
52	14	48	1.52	0.39
53	12	49	2.52	0.65
54	13	54	2.42	0.63
55	13	47	1.32	0.34
56	12	49	1.79	0.46
57	16	54	2.43	0.63
58	12	54	1.92	0.5
59	17	56	2.12	0.55
60	16	71	3.23	0.84
61	16	70	2.29	0.59
62	16	67	1.76	0.46
63	15	61	1.97	0.51
64	18	71	1.52	0.39
65	10	58	1.76	0.46
66	10	54	1.71	0.44
67	10	61	2.11	0.55
68	11	56	2.09	0.54
69	12	56	1.92	0.5
70	13	49	2.31	0.6
71	12	58	1.73	0.45
72	12	49	1.87	0.49
73	14	56	2.89	0.75
74	16	50	3.12	0.81
75	14	61	3.25	0.84
76	11	56	2.45	0.64
77	10	54	2.57	0.67
78	11	58	2.31	0.6
79	12	70	3.12	0.81
80	10	68	3.01	0.78
Total		**5038**	**159.84**	**41.43**
Average			**1.998**	**0.52**

Annex 8. Communities with their respective plots in Setema Natural Forest

Numberofplotsineachcommunity										Totalplots	Altitude(inm)
C1	P1	P9	P79	P67	P20	P36	P25	P70	P63	18	2000-2250
	P72	P6	P49	P17	P27	P14	P34	P47	P52		
C2	P4	P60	P38	P45	P19	P57	P51			7	2182-2249
C3	P3	P43	P32	P54	P68	P71	P12	P40	P77	21	2174-2244
	P16	P29	P23	P50	P26	P48	P8	P80	P10		
	P64	P66	P78								
C4	P2	P11	P21	P31	P53					5	2190-2245
C5	P5	P39	P24	P46	P30	P37	P35	P76	P7	21	2197-2238
	P18	P15	P28	P73	P42	P61	P33	P65	P69		
	P56	P59	P62								
C6	P13	P41	P74	P22	P44	P55	P58	P75		8	2192-2241
Tot.										80	

Note:C1=Community1,C2=Community2,C3=Community3andC4=Community4

C5=Community,C5=Community6