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RELATION BETWEEN REGENERATION STATUS OF WOODY SPECIES AND SOIL PROPERTIES OF GATIRA GEORGE'S CHURCH AND GEMESHAT REMNANT FORESTS, NORTH EASTERN ETHIOPIA

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Abstract

Gatira George's and Gemeshat forests located in the Habru district North Wollo, Ethiopia are a type of remnant forests, characterized by the presence of many ingenious tree species. The aims of this study were to describe the natural regeneration of two forests in relation to soil properties and investigate if the variation in soil characteristics affects the regeneration status of the forest.For each site,a total of 60 and 9 quadrat, were established along line transects laid across Gemshat forest and Gatira Giorgis forest using stratified random sampling. At each site, one measuring 20 × 20 m plots were established for surveying regeneration of species (seedling < 1m height, sapling at a height between 1-2m and tree > 2m height). Regeneration status of the forests was correlated with chemical and physical soil analyses. The regeneration status of seedling in Gemeshat natural forest is higher in number of individual species ha-1 than Gatira George's forest, showing in Both forests the regeneration status in the order good> new> fair>poor and no. While, the variation in soil characteristic in Gatira George's church forest was higher than Gemeshat forest. This is due to Gatira George's church forest is no occurrence of land slide and soil erosion. Regeneration status of the present study showed significant in moisture content, organic carbon, and organic matter and available phosphorus and soil pH correlation with soil variables implies that consideration of forest soil fertility will improve the natural regeneration of the forests. Our study indicates that the conservation of church forest and natural forest can be effective in restoring native indigenous forests, and with time, both forest types may obtain an important role as source of seeds of indigenous woody species. However, the major natural & anthropogenic activates observed in Gemeshat forest include landslide, erosion, overgrazing, inappropriate land use, illegal cutting of tree for timber and fuel wood collection. Therefore, it needs effective management intervention to sustain goods &services from forests. Tree Species that showed no regeneration in both forests should deserve further investigation measures for appropriate conservation together with the involvement of the government and the local community.

Keywords: Gatira George's forest, Gemeshat forest, Regeneration status, Conservation

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1. Introduction

Ethiopia is one of the top 25 biodiversity-rich countries in the world as the major center of diversity and endemism for several plant species, due to its great geographical diversity, elevation, vegetation, soil types and also diverse climate (Abiyou et al., 2015a, Amogne, 2014). Woody plants constitute about 1000 species out of which 300 are trees (Bekele, 2016).According to MEFCC (2016), current Ethiopia's forest cover is 15.5 % which includes enormous areas of forest, dense wood lands, bamboo, and plantation forests of the country. The rate of deforestation and forest degradation activities have accelerated the loss of biological diversity (Sager and Singh, 2006). The annual deforestation rate ranges from 80,000 to 200,000 ha per year (Temesgen, 2015). According to the report of Desta (2001), about 20,000ha of forests are annually harvested in Amhara region for fuel, logging, and construction purposes. This has contributed to the current low forest area, i.e.; only 60,688 ha state natural forest and 2.4 million ha public forests, which are not properly demarcated and managed (DHV, 2001).

The study areas have been rich in flora, fauna and bird species (personal observation). However, remnant forest has been pressurized by the surrounding society through in appropriate land use, the increase in settlement expansion nearby dwellers and also an increase in deforestation in associated with landslide. Soil erosion is a serious problem in the study areas (Habru WOA, 2012). Some Indigenous trees like Podocarpus falcatus, Juniperus procera, Olea europaea L. subsp. cuspidata and others have regeneration variation across the study areas, implies the difference in the soil characteristics affects the plant distribution, diversity and regeneration in the area (Enright et al.,2005; Rohollah et al.,2015, Amare and Bhardwaj,2016). This is due to local people's high dependency on forests, rapid increase of population, forest degradation, and desertification. Other environmental problems, decrease in agricultural productivity and limited government budgets all together also make the researches on tree dynamics an urgent targeting research (Suleiman and Abel, 2006).

Very few remnant forests remain today due to human activities (Badege, 2001). Remnant forests are secondary forests composed of indigenous tree and shrubs still remaining in natural and church forests under conservation practice (Alemayehu et al., 2005, FRA, 2015). Remnant trees are spared from cutting when forests cleared for agricultural or grazing. They have a clear effect on the species diversity, composition, and ecology of the surrounding woody vegetation (Manette and Robin, 2014). Secondary forest is naturally regenerated forest with clearly visible indications of human activities (FRA, 2015). Church forests are serving as in- situ conservation and hotspot sites for biodiversity resources (Cardelus et al., 2013, Abiyou et al., 2015b).

Currently, forest species management on a sustainable basis is the main aim of conservation biodiversity (Myers and Harms, 2009). The soil characteristics affect forest structure, and vegetation variation (Dessie et al.,2017).The availability of accurate data on forest resources is an essential requirement for protection, conservation, management and planning for sustainable development (Sandalow,2000;FAO,2007).Forest soil play a leading role in vegetation composition along with the competitive effect and environmental parameters (Yadav and Sarma,2013).A study on the regeneration status are also vital to know past management and to set management intervention (Lindenmayer et al. 2006; Ermias et al., 2011). In this paper, we have studied regeneration status and soil properties of two different forests to establish a relation between regeneration and soil properties so as to set conservation measures and sustainable use of the forest resources.

2. Materials and Methods

2.1. Site and Forest Description

The studies were carried out on two sites namely Gemeshat forest and Gatira George's church forest, located in Habru district of North Wollo zone of Amhara Regional National State.Geographically,,Gatira George's is located between 10°31'24" to 11°03'58"N latitude and 39°51'14"to 39°58' 13"E longitude. Gatira George's church forest is estimated to cover an area of 2.4 hectare. The altitudinal ranges is from 2024 to 2061 meters above sea level (m.a.s.l.). While Gemeshat forest is located between 10°56'54"-10°85'52" E longitude and 39°57'.51"to 39°60'21"N latitude. Gemshat forest is estimated to cover an area of 527 hectares.The gemeshat forest altitudinal range is between 1996 m to 2433 m a.s.l (Figure 1).

The area receives a mean annual rainfall of 923 mm and its rainfall distribution is bimodal with the main rainy season July to September and the small rainy season at end of February to end of April. The average annual temperature is 27 ˚C(Shimelse, 2007).

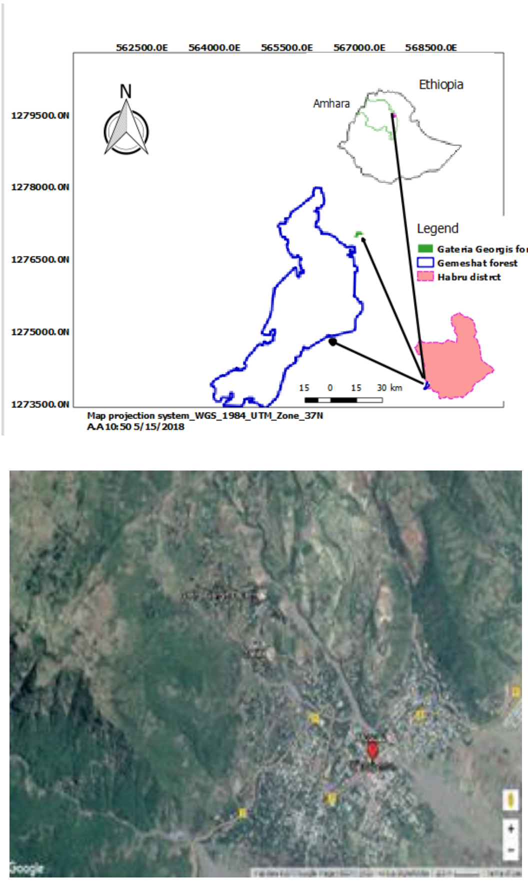

Figure 1. Map of the study areas constructed by taking GPS points and located using QGIS 2.18.

2.1.1. Gemeshat and Gatira George's forest

Gemeshat forest is protected by forest guards employed by Habru district administration. Currently, the forest area is covered by indigenous trees which accounts 527 ha for Gemshat forest and 2.4 ha for Gatira george's. People's livelihood is dependent on traditional agricultural practice of cultivating Onions, Tef and maize with unplanned irrigation by diverting water from the main stream (Jemal, 2011).

Wildlife: As information gained from forest foreman, forest guards, and local community indicates the forests are home for many wild animals and bird species. The mammals are Geleda (Theropithecus gelada),Spotted hyena (Crucuta crocuta), common Jackal (Canis aureus), Abyssinian hare (Lepush abessinicus), Kilpspringer (Oreootragus oreotragus) and bird species covered by Abyssinian langclaw, white winged swallow chat, yellow fronted parrot, Harwood's Francolin, Abyssinian cat bird and Black-headed Siskin respectively.

2.2. Sampling Design

A systematic sampling method was employed for vegetation data in both Gatira George's and Gemeshat forest. A quadrat size of 20×20 m was used for both remnant forests located on the same agro-ecology following altitudinal gradient (Figure 2). Sample plots along three line transect in Gatira george's forest were laid systematically in a concentric way at every 50m along transect lines, which were 50m apart from each other. In Gemeshat forest, the sample plots were established systematically along ten lines transects at every 100m interval between quadrates and transects (Haileab et al., 2011). The distance between transects equally for each study sites by entering 20m from the edge of the forest. The total sample plots for church and Gemeshat forests were 9 and 60 respectively. The difference in the distance between transects line of the remnant forests were to capture the difference existed in forest area and altitudinal gradient and to increase precision of woody species diversity, structure, regeneration and soil characteristics. Sample plot of 20×20 m (400 m^2) was for trees having a height >2m and DBH>2cm.Five sub plot of 5×5m (25 m^2) were laid for shrubs with height 0.5-2m (FRA, 2015). Five smaller plot of 2×2m (4 m^2) also used for seedling DBH <2cm and height < 2m and sapling =1-2m with DBH <2cm and seedling height <1m (Tesfaye et al., 2017) at the four corners and one at the center for tree regeneration study. Nested plots of 1×1 m representing five soil samples corresponding to each sample plots were pooled to get two composite soil samples of 138 sample soil plots (0-15 cm and 15-30 cm). Gemeshat forest is owned by Ethiopian Orthodox Church while Gemeshat forests belong to the government. The altitudinal ranges for Gemehsat and Gatira George's forest are in 1996-2433m and 2013-2065m a.s.l respectively.

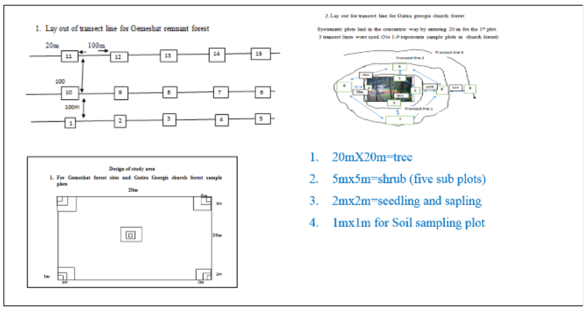

Figure 2. Design of sampling layout 1) For Gemeshat forest 2) for Gatira Georgs forest.

2.3. Data Collection

2.3.1. Regeneration study

The data on regeneration status of woody species in Gatira George's and Gemeshat forests were collection from October 29,2017 to January 14, 2018.In each quarat, the identity and the number of individual species regeneration encountered in both forests were recorded and their growth habit described.

The collection of regeneration of the woody species was first named using folk taxonomy as field identification. Then, formal taxonomic identification to species level was made later using photographed sample plants and compared with published volumes of the flora of Ethiopia and Eriteria (Hedberge and Edwards, 1989) and NDA (Natural Database for Africa) software. Moreover, for specimens being difficult to identify in the field, voucher samples were collected, pressed, and submitted for proper identification and botanical nomenclature at the National Herbarium, at Addis Ababa University.

For the purpose of the regeneration status of the study areas, seedlings, saplings and mature trees/shrubs were defined as plants with heights less than 1 m, 1–2 m height with DBH <2cm and greater than 2 m height, and DBH >2cm respectively. For regeneration status of sample species in the forest was analyzed by comparing seedling with sapling and sapling with matured trees data using the methods adopted by (Tesfaye et al., 2017). Seedling and saplings of trees and shrubs were counted to estimate the regeneration status of the forest.

2.3.2. Soil sample collection

Soil samples (0-15 cm and 15-30 cm soil depth) were collected from 60 and 9 random points (totally 120 and 18 soil samples at two depth) in each of the Nested plots of 1m× 1m using a soil auger. The soil samples were immediately transferred to moisture cans, double-sealed in polythene bags and transported to the laboratory, where they were weighed, oven-dried and re-weighed to estimate the in-situ variations in soil moisture status of the forest sites.

The soil samples collected were air dried and mixed before grounded with mortar and pestles and sieved with 2mm meish sieve before soil analysis at Laboratory of Sirinka Agricultural research center.

Soil pH were determined using soil pH (Soil pH meter).Soil organic carbon was determined by the dichromate oxidation method. Soil Organic carbon (SOC) and Organic matter was determined using the methods (Walkley and Black, 1934).

Total N (Kjeldahl method) and available P by (Olsen et al., 1954).The organic matter content (OM) was determined by calculating Soil OC from the relationship of OM % i.e. OM%=SOC×1.724 (I.e. the Warkley and Black method) as suggested by (Jackson, 1964).

2.4. Statistical Analysis

The regeneration and soil data were analyzed Using SPSS version 20 and Microsoft Excel, 2010. The result of the analysis was summarized and presented using tables, pie chart and bar graphs. The regeneration status of sample species in the forests were analyzed by comparing seedling with sapling and sapling with matured trees data. All tree species regeneration status in the study areas were classified according to (Khumbongmayum et al., 2006) in to:

1. Good regeneration if density of seedling > sapling> tree,
2. Fair regeneration, if seedling > sapling < adults
3. Poor regeneration, if a species survives only in the sapling stage, but not as seedlings (saplings may be <, > or = adults)
4. "None", if it is absent both in sapling and seedlings stages, but found only in adults
5. "New'', if a species has no adults, but only saplings and/or seedlings.

The data obtained from the soil analysis was also subjected to an independent t- test for each sample depth separately to detect in the soil attributes on the regeneration percent of tree species differed significantly between Gatira George's and Gemeshat forest, respectively.

Pearson linear correlation was calculated to determine correlation between the tested soil properties at two soil depth and percent of regeneration status of the two forest sites.

3. Result

3.1. Regeneration Status of the Forests

The total densities of seedling, sapling, and trees in Gatira Georg's forest were 705 stems/ha, 243 stems/ha and 208 stems/ha. The ratio of the seedling to sapling is 2.9, sapling to the tree (1.17) and seedling to mature tree is also 3.38. Whereas, the total densities of seedling, sapling, and trees in Gemeshat forest sites on average had 2383 individuals/ha, 1194/ha and 994/ha. The ratio of the seedling to sapling is (1.99) sapling to the tree (1.2) and seedling to tree (2.39).Thus, in both forests, the number of seedling >sapling> tree (Figure 3).

The good regeneration status was 25 % and 41 % observed Gatira George's and Gemeshat forest respectively. Fair regeneration was also 6.25 % and 19 % observed from Gatira George's and Gemeshat forest respectively. The poor regeneration accounts 12.5% and 6.25% in Gatira George's and Gamest forest. This implies more regeneration of tree in Gemeshat while more poor regeneration in Gatira George's forest.Because of the lack of available seed. Juniperus procera and Olea europea are tree species that performed good regeneration status in both forests. While Podocarpus falcatus showed fair regeneration status in Gatira George's and Gemeshat forests. Olinia rochetiana, Maytenus arbutifolia showed fair regeneration in Gemeshat forest (Appendix part).

As shown in (Figure 4), the mean over all regeneration status of tree species was highest in the order good regeneration (25%)>new regeneration (43.75%)>fair regeneration (6.25%) > none regeneration (12.5 %)>poor regeneration (9%) in Gatira Georgis forest. While, good regeneration (41%)>new regeneration (25%)>fair regeneration (19 %) >none regeneration (12.5 %)>poor regeneration (12.5%) in Gemeshat forest (Figure 5). The result implies keeping the forests from livestock and human disturbance that affects regeneration decrease, and hence good, fair and new regeneration in the remnant forest increase the species diversity, structure and regeneration in the near future.

3.2. Soil Characteristics

Physico-chemical properties of the two forest soils were significantly different. Gatira George's forest and Gemeshat forests have neutral to slightly acidic soil pH (6.78 and 6.4). Soil moisture of Gatira George's forest soil was significantly higher in comparison to soils of Gemeshat forest. Organic carbon, organic matter and available phosphorus were significantly higher at Gatira George's forest than Gemeshat forest (Table 1). This is due to less soil erosion and no landslide and well protected forest from spiritual's view point.

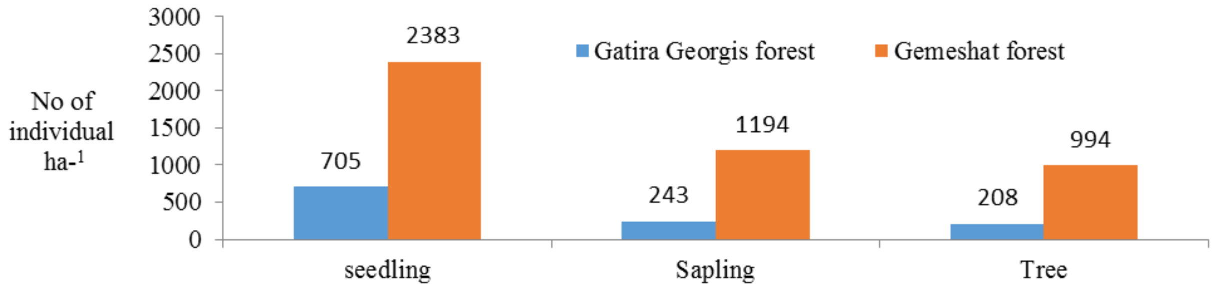

Figure 3. Tree life forms density ha-1 in remnant forests in North Wollo, Ethiopia

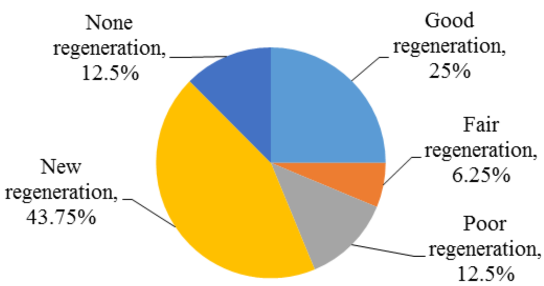

Figure 4. Overall regeneration status of tree species in the Gatira Georgis forest

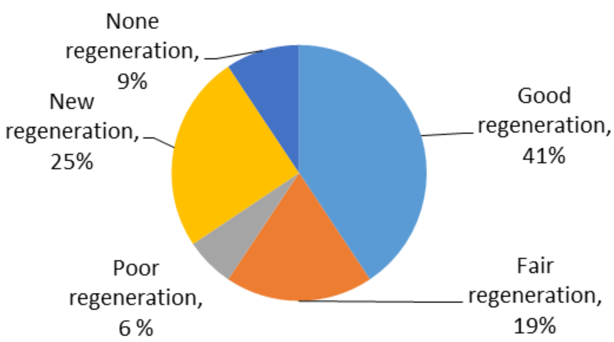

Figure 5. Overall regeneration status of tree species in the Gemeshat forest

Table1. Soil physico-chemical properties of Gatira George's and Gemeshat forests.

Soil parameters	Gatira Georgis forest	Gemeshat forest	P-values
Moisture content (%)	26.4±1.5	15±1.04	0.00
Soil pH	6.78± 0.03	6.4± 0.06	0.044
OC (%)	2.76±0.1	2.16±0.07	0.004
OM (%)	4.76±0.17	3.72±0.13	0.003
Total N (%)	0.42± 0.03	0.36±0.01	0.151
Available P(Ug g^{-1})	50±1.5a	37±1.04b	0.00

N= nitrogen phosphorous, OC= organic carbon, OM= organic matter.

3.3. Correlation between Vegetation and Soil Variables

Pearson's correlation coefficients between six soil attributes effect (Moisture content, soil pH, organic carbon, organic matter, total nitrogen and available phosphorous) on regeneration status of Gatira George's forest and Gemeshat forest were studied (Table 2 and Table 3). Among the six variables, soil pH and Available phosphorus were negatively correlated with regeneration percent at (r= -0.54 and r= -0.53 at p<0.01) and (r= -0.73 and r= -0.25 at p < 0.01 and 0.05 respectively) at 0-15cm and 15-30 cm soil depth respectively. However, organic carbon and organic matter were positively correlated (r=0.55 and 0.56, at p<0.05 and p<0.01 respectively) with regeneration percent in 0-15cm and 15-30 cm soil depth at Gatira George's forest (Table 2).

Moisture content is the only soil attributes that showed negative correlation with regeneration status of Gemeshat forest (r= -0.49 and r=-0.32 at p<0.01 and P<0.05 respectively). Topsoil layer had significantly greater in pH, OC, OM and TN than sub soil at Gemeshat forest. Hence, the correlation among the selected soil properties also varies with soil depth. This section offers information on the relationship among the soil properties with depth. However, moisture content was positively correlated in Gemeshat forest with soil pH (r=0.36 and r=0.53 at p <0.01) at 0-15cm soil depth. Moisture content also positively correlated with organic carbon and organic matter (r=0.52, r=0.46 and r=0.52, r=0.45 both at p<0.01) at 0-15cm and 15-30 soil depth. However, moisture content also negatively correlated with total nitrogen (r=0.68 and r=0.32 both at p<0.05) at 0-15cm and 15-30cm soil depth respectively. Organic carbon in Gemeshat forest was correlated positively with organic matter and total nitrogen at the 0-15cm soil depth having r=1 and r=0.61 at p<0.05(Table 3).

Discussion

The ratio value indicates that the number of seedling and sapling being regenerated in the forest is more than three times of the matured trees in the forest. The ratio of seedling, sapling and tree value indicates that the number of seedling and sapling being regenerated in Gatira George's forest is more than three times of the matured trees in the forest. Whereas, the ratio of seedling, sapling and tree value indicates that the number of seedling and sapling being regenerated in Gemeshat forest is twice the matured trees. The present study on both forests are similar to the research done in the Afar regional state on Hallideghie wild life reserve reported by (Ahamed et al., 2017)

The mean over all regeneration status of tree species was highest in the order good regeneration >new regeneration >fair regeneration > none regeneration >poor regeneration in Gatira Georgis forest. While, good regeneration >new regeneration >fair regeneration >none regeneration >poor regeneration (in Gemeshat forest.Hence,the result has implication for increasing species diversity and regeneration in the near future. The present finding is unique in having the more percent of good regeneration followed by new regeneration and then fair regeneration makes different from trees and shrubs only found at seedling and sapling stage from Berber forest found at Bale zone reported by (Tesfaye et al., 2017).

Pearson's correlation coefficients between six soil attributes revealed, among the six variables, soil pH and Available phosphorus were negatively correlated with regeneration percent at the top and bottom of soil. However, organic carbon and organic matter were positively correlated with regeneration percent in 0-15cm and 15-30 cm soil depth at Gatira George's forest. Whereas, moisture content is the only soil attributes that showed negative correlation with regeneration status of Gemeshat forest. This negative relation of moisture content and regeneration of woody species in Gemehat forest implies the less the water to soil availability in the forest influences the regeneration and survival of seedling inside the forest. The present finding is also supported by the study on the growth of tropical forest community reported by (Ceccon et al., 2004). Topsoil layer had significantly greater in pH, OC, OM and TN than sub soil at Gemeshat forest. Hence, the correlation among the selected soil properties also varies with soil depth. This section offers information on the relationship among the soil properties with depth. However, moisture content was positively correlated in Gemeshat forest with soil pH at the top soil. Moisture content also positively correlated with organic carbon and organic matter at both soil depths. However, moisture content also negatively correlated with total nitrogen at both soil depths. Organic carbon in Gemeshat forest was correlated positively with organic matter and total nitrogen at the top soil implies the site is rich in organic carbon, organic matter and total nitrogen even leaching problem due to erosion and land slide reduces at different period of time. Gatira george's forest showed significant difference in moisture content, soil pH, Organic carbon, Organic matter, total nitrogen, and available phosphorus compared to Gemeshat forest. Other study also supported the difference in the nutrient availability will influence the type of forest community as reported by (Singh et al., 2010).The present study soil physicochemical properties are similar as compared from soil properties of dry tropical forests reported by (Chaturved et al., 2012, Singh et al., 2012).

The natural regeneration of woody species is better in Gatira George's forest than Gemeshat forest as there is difference in the availability of soil nutrients; soil moisture and mainly negative soil pH in Gatira George's forest enhance the regeneration of woody species. The present finding is similar to the research reported by

(Tabitha, 2014; Amare and Bhardwaj, 2016).

Table 2. Correlation analysis between soil characteristics and the regeneration percent of the tree species at Gatira George's forest

	Regeneration %	MC%		Soil pH		OC%		OM%		Total N %		Available p (ppm)	
		0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm
Regeneration %	1												
MC% 0-15cm	-0.21	1											
15-30cm	-0.16		1										
Soil pH 0-15cm	-0.54**	0.22		1									
15-30cm	-0.53**		-0.04		1								
OC% 0-15cm	0.55*	0.16		-0.19		1							
15-30cm	0.079		0.001		-0.07		1						
OM% 0-15cm	-0.56**	0.159		-0.19		1.00**		1					
15-30cm	0.08		0.001		-0.07		1.00**		1				
Total N 0-15cm	0.05	-0.04		-0.32		-0.08		-0.08		1			
15-30cm	-0.005		0.002		0.21		0.85**		0.53*		1		
Avail P (ppm) 0-15cm	-0.73**	0.034		0.604*		-0.52*		-0.53*		-0.15		1	
15-30cm	-0.25*		-0.1		0.60*		-0.21		-0441		0.04		1

**= correlation is significant at the 0.01 level (2-tailed), *= correlation is significant at the 0.05 level (2-tailed).

4. Conclusion

The relation between the regeneration and soil characteristics is studied in Gatira George's church and Gemshat natural forest site. The result of the study areas indicated that the regeneration status of seedling in Gemeshat natural forest is higher in number of individual species ha-1 than Gatira George's forest. This result has also an implication for increasing species diversity and regeneration of species in the near future, if both forests are protected well. While, the soil characteristics vary in depth between the two forest sites. The variation in soil characteristic in Gatira George's church forest was higher than Gemeshat forest. This is due to Gatira George's church forest is no occurrence of land slide and soil erosion.

Table 3. Correlation analysis of soil characteristics on the regeneration of tree species at Gemeshat forest (at 0-15 and 15-30cm soil depth)

	Regeneration %	MC%		Soil pH		OC%		OM%		Total N %		Available p (ppm)	
		0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm	0-15cm	15-30cm
Regeneration %	1												
MC%0-15cm	-0.49**	1											
15-30cm	-0.32*		1										
pH 0-15cm	-0.12	0.36**		1									
15-30cm	-0.17		0.14		1								
OC% 0-15cm	-0.14	0.52**		-0.04		1							
15-30cm	-0.16		0.46**		-0.11		1						
OM% 0-15cm	-0.14	0.52**		-0.04		1.00**		1					
15-30cm	-0.16		0.45**		0.11		1.00**		1				
N 0-15cm	0.18	-0.68**		0.09		0.61**		0.61**		1			
5-30cm	-0.32		0.32*		0.57**		0.01		0.62**		1		
Avail P 0 15cm	-0.11	0.01		0.08		-0.14		-0.14		0.01		1	
15-30cm	-0.25		0.12		0.14		0.13		-0.13		0.17		1

**= correlation is significant at the 0.01 level (2-tailed), *= correlation is significant at the 0.05 level (2-tailed).
MC = moisture content, pH= soil pH, OC= organic carbon, OM= organic matter, TN= total nitrogen, P= available phosphorus.

The correlation between the regeneration status and some of the soil characteristics like soil pH and organic matter, Organic carbon and phosphorus, and also moisture content in Gatira George's and also in Gemeshat forest indicated negatively, positively, and also negatively correlated with the regeneration of woody species in each forest sites respectively. Therefore, these results imply that consideration of forest soil fertility will improve the natural regeneration of the forests. Moreover, the conservation of church forest and natural forest can be effective in restoring native indigenous woody species, and with time, both forest types may obtain an important role as source of seeds of indigenous woody species. It can be also concluded that the protection of the remnant forests has a positive effect on restoring the species regeneration and soil fertility in the future. However, the major natural & anthropogenic activates observed include landslide, erosion, overgrazing, inappropriate land use, illegal cutting of tree for timber and fuel wood collection. Therefore, it needs effective management intervention to sustain goods &services from forests. Landslide is more common in Gemeshat forest and its soil moisture is serious problem, soil conservation measures should be done in order to maintain the soil moisture for the enhancement of keeping the regeneration of woody species in the forest.

Tree Species that showed no regeneration in both forests should deserve further investigation measures for appropriate conservation together with the involvement of the government and the local community.

Conflict of interest

The authors declare that there is no conflict of interest.

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