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Role of Local Community in Gishwati Forest Reserve Rehabilitation and Its Implication on Local Community Livelihood

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Abstract

The main objective of this study was to assess the role of local community in Gishwati Forest Rehabilitation and its implication on local community livelihood. This study was conducted in Rutsiro District which is located in Western Province. Findings, showed that most of the local people they were not interested about the rehabilitation of Gishwati Forest Reserve because they don't gain a lot in the process and they are not consulted as one of the stakeholders. They showed the challenges faced by local communities in the forest rehabilitation and the main one was the poverty. Also, it showed the land cover, land use of the forest and forest change since 1986 to 2019. In addition, findings showed the impacts of forest rehabilitation on community livelihoods, according to the results negative impacts are many compared to positive impacts. Suggested solutions to overcome the mentioned challenges were: to improve local community livelihood, to be consulted before implementing any project concerning them, to give them trainings. As recommendation, the planning of forestry related programs or projects; the local community should play a big role by giving out their ideas on how they think it can be done and alternative sources of income of local community have to be planned because rehabilitation process halt their livelihood.

Keywords

Forest Rehabilitation, Gishwati Forest Reserve, Local Community, Livelihood

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1. Introduction

Globally, forests cover nearly one third of the land area and contain over 80% of terrestrial biodiversity [1]. Forests are important in the livelihoods of local communities mostly in developing countries; local communities depend on forests resources such as fuel wood, construction materials, medicine, and food [2]. But the forest habitat continues to decrease and the associated loss of biodiversity jeopardizes forest ecosystem functioning and the ability of forests to provide ecosystem services [1]. Research showed that Tropical forest area is disappearing at the rate of 13.5 million ha each year, due mainly to clearing for agriculture and shifting cultivation [3]. The reduction and degradation caused by anthropological activities affect not only the sustainable production of timber but also the global environment [3]. As the deforestation is a worldwide problem, many countries are concerned with the rehabilitation of the deterioted forests, researches showed that they are putting more efforts to find the suitable methods which can lead to the sustainable forest rehabilitation and management [4-7]. In tropical countries, establishing of protected areas was identified as a major method to decrease forests deterioration. Though, in many places it has shown that it is difficult because of high dependency of local community on forest resources [8]. In

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addition, insufficient help from the government, breakable management capacities and unproductive legal systems have increased the problems of protected areas management in developing countries [9]. In Africa, forest rehabilitation and conservation have been characterized by prohibiting of local community on the use of forest resources in protected areas [10]. And these protected areas were the source of livelihood of local community. As a result, the method of make forests protected areas has caused doubt and disagreement between the management of protected areas and the local communities and this has led to the encroachment of the forests [9].

In Rwanda, as one of African country, it adopted the method of protected areas in the early 1918 by the colonial government and in 1933 all remnants of mountain forests were set aside as protected forests [9]. By taking focus on Gishwati Forest Reserve as case study. Even though it is classified as protected area. It has been deteriorated by local community as they relied on its resources for their livelihood [11]. Rwandan government values the role of the forestry sector in the livelihoods of the population and economic development, it established policies which protect forest resources, and involved non-government organizations (NGOs), but it has not yet reached its full economic and ecological potential, because of local community who continue to encroach the forest [12]. Therefore, this paper intends to assess the local community dependency on Gishwati Forest Reserve. To evaluate the local community participation in rehabilitation of Gishwati Forest Reserve, and assess the impacts of Gishwati Forest Reserve rehabilitation to the local community livelihood.

2. Materials and Methods

2.1. Study Area Description

This study was carried out in Rutsiro District (RD) in North-western of Rwanda, where major part of Gishwati Forest Reserve (GFR) is located. This District is made up of 13 administrative Sectors, 62 Cells and 483 villages commonly known as Imidugudu covering a surface area of 1157.3 km².

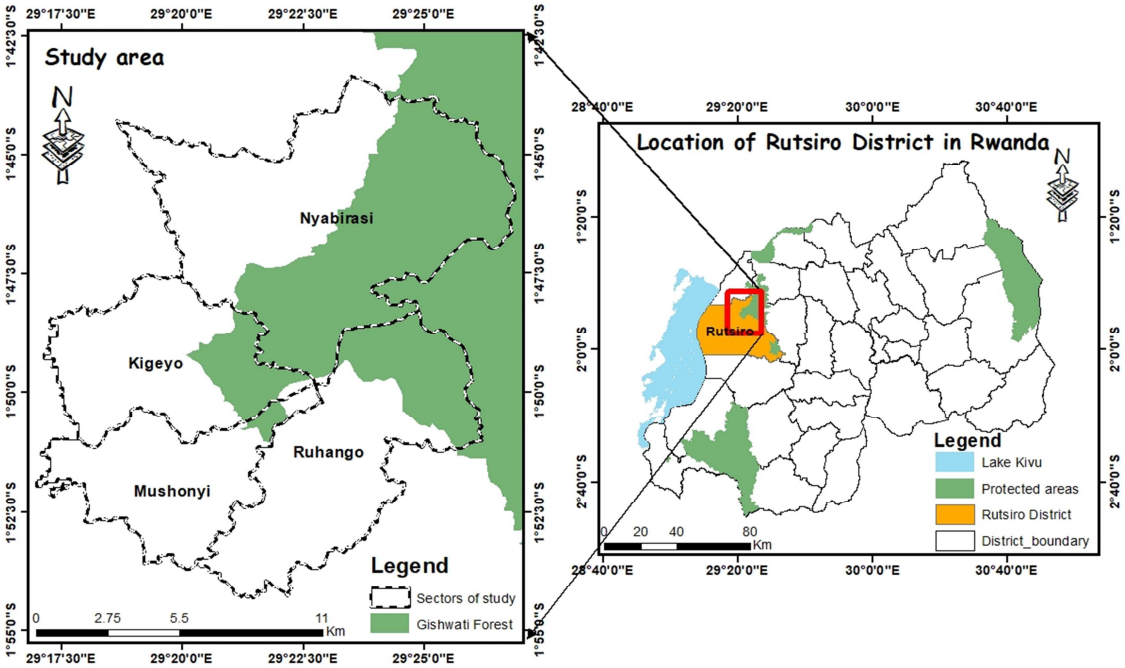

Figure 1. Geographical Map of Rutsiro District.

Gishwati Forest is a second mountain forest fragment located in south of the Volcanoes National Park in West of Rwanda (1˚49'S, 29˚22'E). The rainfall throughout the year of 1399 mm on average, annual average temperature is 17.4˚C and the temperature shrinkages 0.65˚C for every increase of 100 m of altitude. It is part of the Congo Nile Divide forest complex where we found Nyungwe forest and Mukura forest [13].

The study was conducted in four sectors which surround the forest which are Kigeyo, Ruhango, Nyabirasi and Mushonyi Sectors [12]. As not all cells of these sectors was adjacent to the forest only 7 cells touch the forest, the study took one cell from each sector because of limited time of the researcher, which made four cells for field study (Rukaragata, Mubuga, Rundoyi and Rurara). Rutsiro District had a total population of 324,654 habitants, including 154,044 males (47.4%) and 170,610 females (52.6%) all on a total area of 1,157.3 km² with a density of 281 inhabitants per sq.km. 60% of the population are below 25 years. Only 47% of the population of this District is acknowledged as non-poor and 53% is poor from which 26.1% was acknowledged as in extreme poverty [14].

The economy of the Rutsiro District is based primarily on agricultural production. According to the report from Rwanda Environment Management Authority (REMA), more than 90% of the population of Rutsiro are farmers and 49% of incomes is from agriculture. The major cash crops grown are coffee and tea and the main food crops are beans, maize, banana plantations, Irish potatoes, and cassava. For livestock, Rutsiro District practices farming livestock mostly traditional which gives low yield, the reared animals are cows, goats, sheep, pigs, and fish. In addition, for energy usage, number of people using electricity is one of the lowest of the country and most of the people use firewood as cooking energy [15].

2.2. Sample and Data Collection Techniques

Remote sensing satellite imagery has been used to get information on time-based trends and spatial distribution of land cover [16]. And Landsat imagery has been used in many researches on land cover and land use change as source of data because it has greater spectral and temporal resolution compare to many other global satellite imagers [17-19]. In this study, land cover classes were detected utilizing Landsat 5 Thematic Mapper, Landsat 7 Enhanced Thematic Mapper Plus, and Landsat 8 Operational Land Imager (OLI) acquired from 173 path and 061 row in 1986, 2003 and 2019 obtained from United State Geological Survey (USGS) [20]. Only free cloud cover images were selected and other was rejected for the analysis. Environment for Visualizing Images (ENVI 5.3) was used for Area of Interest creation, radiometric and atmospheric corrections, visual image interpretation, creating training sites, supervised classification using Maximum Likelihood classification method, change detection and post classification for accuracy assessment, Google earth was used for the validation of the 2019 land cover classes, while ArcGIS 10.5 was used for clipping, thematic map production, and comparative analysis.

Three classes were identified according to their specific spectral signatures, known as dense forest, Dispersed forest and Shrub, and cultivated and open lands. Reclassification was then, undertaken to differentiate forest (Dense forest, Dispersed forest & Shrub) from non-forest (Cultivated & opened land), in order to well highlight the area regenerated and the area threaten by the deforestation i.e. forest gain and forest loss.

Coefficient matrix was applied in each year, the validation of the 1986 and 2003 land cover classes was performed using the true color 321 and 2019 land cover classes was performed using random points and checked on google earth, after the results is brought back to Environment for Visualizing Images (ENVI) software for accuracy assessment.

After the performance of the confusion matrix to validate the land cover classes, for 1986 and 2003 classifications, 90 ground truths ROI were derived in the same Landsat images by using 321 true color composite bands that is 3 red, 2 green, and 1blue bands. For 2019 classification, 45 points were randomly generated and checked on high resolution google earth for validation, after the results were brought back to Environment for Visualizing Images (ENVI) software for the confusion matrix analysis. The results showed that the overall accuracy and kappa coefficients are more than 80% in all years. In the light of the results found, the land covers identified were good and useful. Similar studies used this particular approach in the recent past and it was proven successful [21].

In this study, sample size n was determined using the equation (1), using the formula of Yamane.

$$n = \frac{N}{1+N\,(e)^2} \quad (1)$$

Where n = Sample size, N= Study population which is the total number of households of Rukaragata, Mubuga, Rundoyi and Rurara cells and (e), the margin error varies between 5% and 10%. For our case, the margin error of 10% was used, meaning that the confidence level were 90%.

$$\text{n}= \frac{4288}{1+4288\,(0.1)^2} = 97.72\sim 98 \quad (2)$$

The sample size was 98 households that live in four cells adjacent to Gishwati Forest Reserve in Rutsiro District.

In this study, purposive sampling method was used to select people in four sectors from thirteen sectors of Rutsiro District; also it was used to select four cells that form a sample area from seven cells which adjacent to the Gishwati Forest Reserve, where the study population is found. Proportionate sampling method was used to determine the number of households in each cells. The sample size proportion was determined using the equation (3).

$$ni = \frac{Ni \times n}{N} \quad (3)$$

Where ni = the sample size proportion to be determined, Ni = the population proportion in the stratum, n = the sample size, N = the total population.

Then, the proportion of population in each Sector is shown in the following table 1:

Table 1. Proportion of population in each Sector.

Sectors	Cells	Number of households	The proportion of population per cells to be interviewed
Mushonyi	Rurara	1306	30
Ruhango	Rundoyi	992	23
Nyabirasi	Mubuga	920	21
Kigeyo	Rukagaragata	1070	24
	Total	4288	98

In order to obtain the sampling intervals, the following

formula was used:

$$i = \frac{N}{n} \quad (4)$$

Assume that: i represent the sampling interval; N represents the total number of households in each Cell; n represents the purposive sampling (sample size at Cell level).

3. Results and Discussions

3.1. The local Community Dependency on Gishwati Forest Reserve

Prior to the field work of forest rehabilitation, the community must be approached to gain the full support [22], local people are reported to pay a crucial role in forest rehabilitation due to the special knowledge and engagement in forest resource [23]. During this research, the local community mentioned their interaction with forest resources before the rehabilitation process, Table 2 The local people in adjacent to Gishwati forest illustrated their dependency on forest such as farming, as reported in previous research [24] and mining activities [25].

Table 2. The local community dependency on forest.

Uses of forest	Frequency	Percent
Subsistence (farming, mining, hunting)	63	64.3
Timber	11	11.2
Non- timber products	8	8.2
Wood	16	16.3

The Findings illustrated that 64.3% of the respondent confirmed its dependency on the forest through hunting, farming and mining, however, 35.7% of respondents confirmed the link between their daily needs and forest resources such as non-timber, wood and timber products. The large parts of population who live near and adjacent of the forest are reported to depend on forest resource, table 2 Previous research illustrated that people who live in adjacent of the forests, always involved in agriculture, in the farming, use forest products (timber, fuel wood, bush foods, medicinal plants), in hunting for their own subsistence purposes and for income generation [26].

3.2. Gishwati Forest Reserve Land Covers Classes

Results of land cover within the 32 years' time interval showed that, in 1986, the dense forest, dispersed forest and Shrub and cultivated and opened land occupied respectively around 47%, 25% and 27% of the total forest area as presented in Table 3.

Table 3. The three land use and land cover classes in Gishwati from 1986, 2003 and 2019 area.

Land cover classes	1986	2003	2019
Dense forest	46.83262245	25.92241231	30.22851016
Dispersed forest and shrub	25.3664164	30.52581649	49.72955176
Cultivated and opened lands	27.80096115	43.5517712	20.04193808

Since 1986, Figure 2 (a), Gishwati forest has been exploited, people living in the surrounding of the forest have been encroaching the forest [27], adapting grazing land for castles [11, 27], finding medicine and poaching activities as reported in previous research in adjacent of National volcanoes [28].

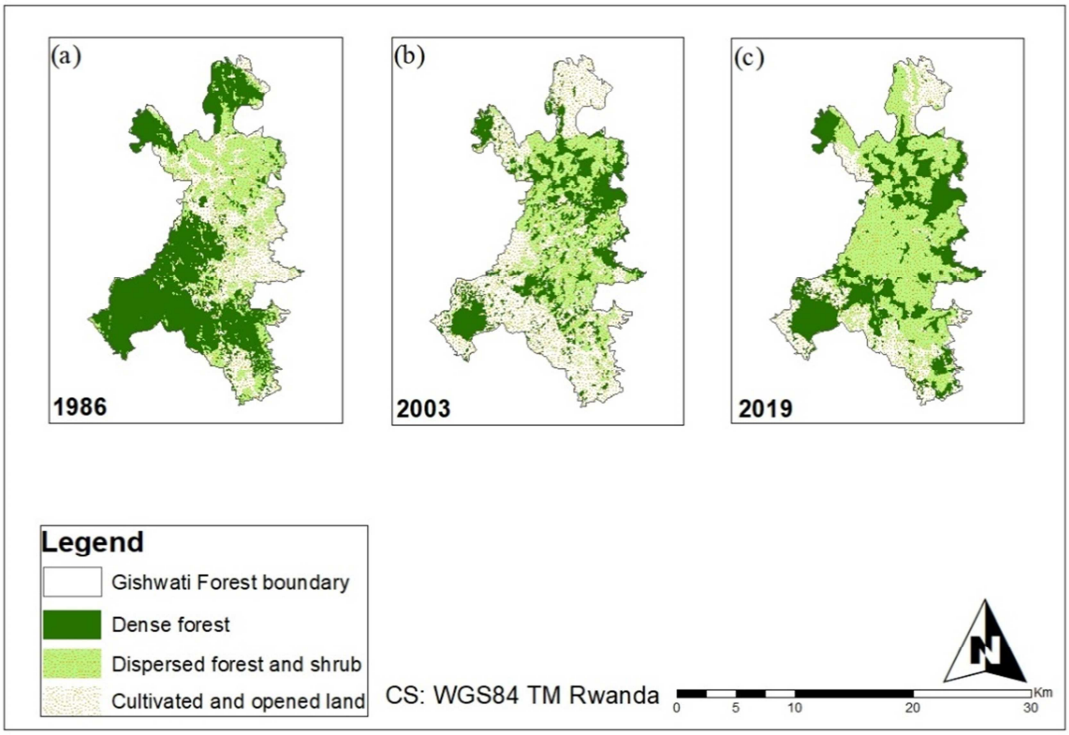

Figure 2. Land use and land cover thematic map of Gishwati Forest Reserve for the years 1986 (a), 2003 (b) and 2019 (c).

In Figure 2, each single land cover was classified and mapped in order to have a general look on the spatial distribution of the three identified land cover classes which are dense forest; dispersed forest and shrub and cultivated and opened lands. It was found that the spatial distribution varied over time, Table 3, because of human activities such as agriculture, mining exploitation, forest exploitation and illegal poaching. As reported by Chakravarty, Ghosh [29], human activities have been the main reason of deforestation of dense forest for subsistence farming [30]. It is also caused by insecurities and the initiatives of tea plantation [11].

3.3. Land Cover Change Detection in Gishwati Forest Reserve

As emphasized by Basnet and Vodacek [16], it is important to understand the distribution and change of land cover because of its enormous implications to human well-being [16]. The current information on land cover and land cover change is vital for forest rehabilitation process. In addition, documentation on land cover change has to be more precise and emphasized, considering the global climate change [31].

Table 4. Land cover Change detection.

Period	Park (Area in%)		
	Dense forest	Dispersed forest and Shrub	Cultivated and opened lands
1986-2003	-20.91021014	5.159400084	15.75081005
2003-2019	4.30609785	19.20373527	-23.5098331
1986-2019	-16.60411229	24.36313535	-7.75902307

The land cover classification showed different situations of land cover changes where there is high change in Dense forest and cultivated and open land. From 1986 to 2003, dense forest reduced by approximately 20.9%. This decrease in forest cover was caused by the high increase of cultivated and open lands found within the forest with increase of 15.7%. The statistic of land cover changes in Gishwati forest reserve occurred between 1986 and 2019 is shown by Table 4. This is similar with the research on Nyungwe-Kibira Park where land cover changes were high in Forest and cultivated or open land [32].

3.4. Forest Covers Change Detection at Gishwati Forest Reserve

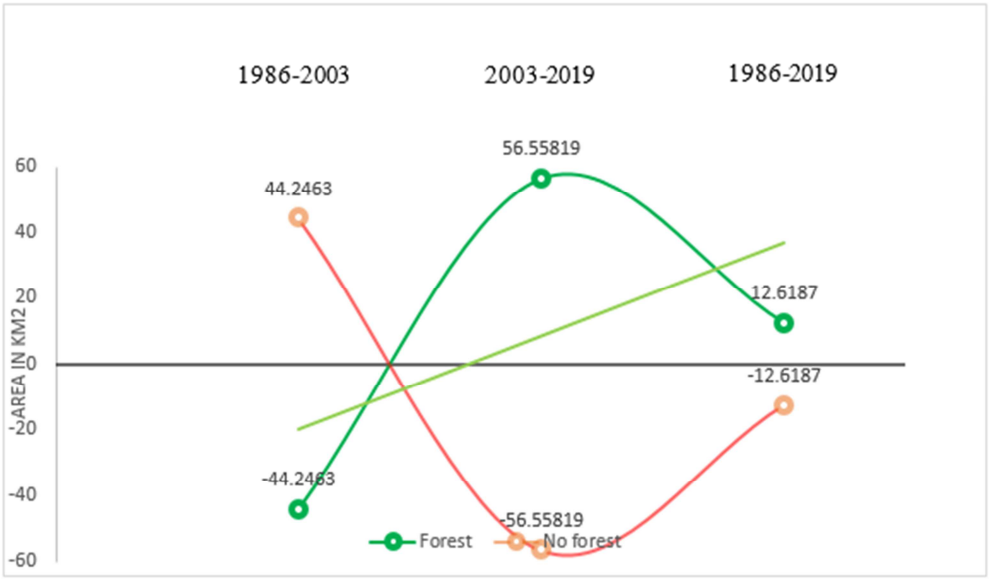

Figure 3. Forest cover change trends in Gishwati Forest Reserve (negative values = decrease, positive values = increase (values expressed in square Km).

The loss in Forest cover which represented (Dense forest, Dispersed forest & Shrub) equals to the gain of Non-forest cover which represented (Cultivated & opened land). The forest area has drastically experienced a decrease of 44.2 Km^2 within 1986 and 2003. Also between 2003 and 2019, the forest gained 56.5 Km^2. However, from 1986 to 2019, forest gained only 12.6 Km^2 compared to its initial state in 1986. This is caused by dramatically deforestation in the last three decades with less initiative to rehabilitate the forest, but the trend shows an apparent upward direction which means there are ongoing initiatives to rehabilitate the forest as illustrated in Figure 3.

Since 1980, the forest was cleared for large scale cattle ranching projects, mainly cattle grazing within the forest, pine plantation, cropland and settlement classified as cultivated and opened lands, resulted in the loss of a large part of the forest and in 1988, the pasture land was overextended to the south west; military zone in the northern part [13, 33]. During and after the 1994 Genocide against Tutsi in Rwanda, see figure 3 (a), there was a shortage of

land to resettle returnees and internally displaced people, then they cleared the forest to get free space for settlement and agriculture [12, 34].

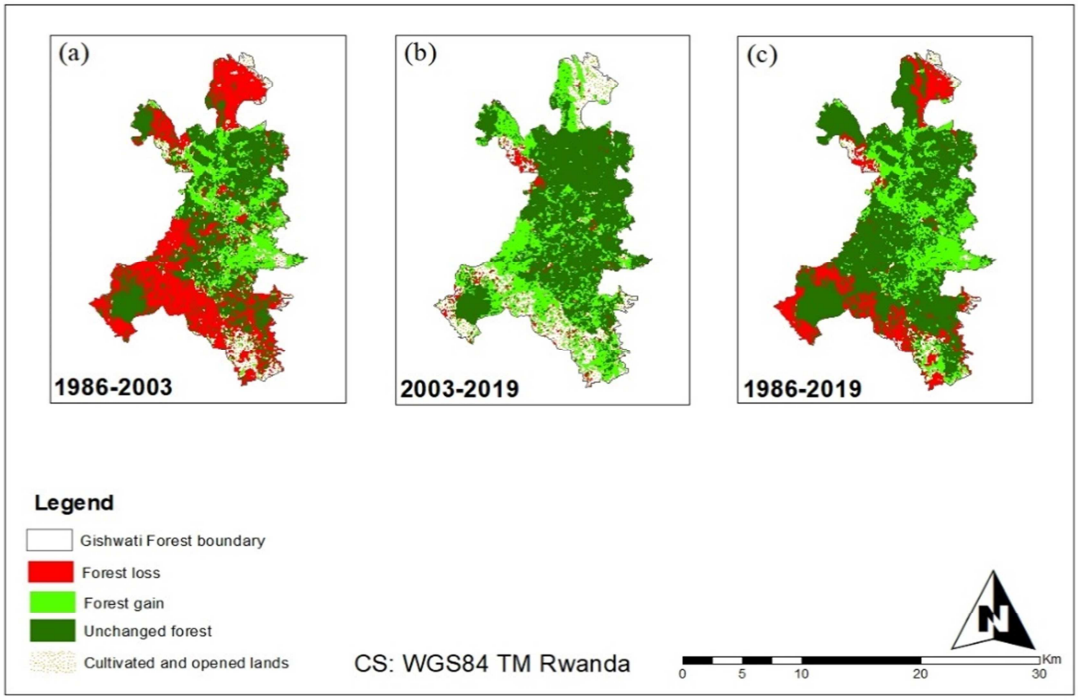

Figure 4. Forest cover change results between 1986-2003 (a), between 2003-2019 (b) and between 1986-2019 (c).

The dense forest and dispersed forest and shrub increased since 2003 and cultivated and opened lands decreased, Figure 4 (b). This was due to the regeneration phase and the application of severe law that protect the forest from deforestation with involvement of surrounding population, the government institutions, non-governmental organisations and local community initiative to protect and rehabilitate the forest and the projects aimed to rehabilitate the forest like The Landscape Approach to Forest Restoration and Conservation (LAFREC), which aimed to enhance environmental services and climate resilient livelihoods through forest rehabilitation of Gishwati and Mukura Forest Reserve and their landscape and make Gishwati and Mukura Forest Reserve as National Park in 2016 [11, 15]. From Figure 4 (c), forest cover increased within Gishwati but still show a red colour, which reflect to the deforestation was at a high rate in the two last decades and the regeneration and rehabilitation process did not reach to its initial state taken in 1986, Figure 3. This is in same line with the research on effects of armed conflict on forest conservation in Rwanda, it showed the great loss of the forest in the period of (1986–2003) and great gain of forest in the period (2003–2011), with government involvement in forest rehabilitation [34].

3.5. The Participation of Local Community in the Rehabilitation of Forest

As Fay [35] mentioned, the important pre-condition for achieving sustainable forest management and rehabilitation which reflects to the control of land and forest to the local community. The forest rehabilitation project to be successful achieved, the participation of local communities is important [36]. However, in some extent, the forest rehabilitation present a setback due deprive of local community their interaction with forest resource [37]. If the local community are not convinced the project is for them, they will not play a big role, the encroachment will always be there but if they get some incentive or share benefits which come from tourism, they are motivated to protect the forest and its biodiversity [28].

Table 5. Role of local community in the rehabilitation of forest.

Parameters	Frequency	Percent
Security of the forest	20	20.4
Planting trees	9	9.2
Participation in Management	0	0
Participation in decision making	0	0
Providing indigenous knowledge	2	2
Doing nothing	67	68.4

Research showed that in early 19th century before introduction of modern forest management, local community used indigenous knowledge to manage forests and associated ecosystems in ways that continued their livelihoods and cultures without endangering the capacity of these ecosystems to provide for future generations [38]. This means the use of indigenous knowledge is very important in rehabilitation; it can be adopted by the planners responsible for rehabilitation process by consulting local community.

This was not the case in this study as shown by Table 5, where only 2% respondents provided indigenous knowledge, table 5. The large number of respondents 68.4%, was not interested in forest rehabilitation process. This is a big threat to forest rehabilitation, because previous research showed how local community play a vital role in forest rehabilitation process and management [37, 39-41]. Research showed that local community can be interested in forest rehabilitation if they get series of financial incentives to participate in reforestation activities [42].

3.6. Impacts of Forest Rehabilitation on Community Livelihoods

There are many positive impacts of forest rehabilitation on local community livelihood including carbon sequestration, climate regulation, incentive from tourism, reduction of flooding, trainings and benefit sharing with the state [43, 44]. Even though forest rehabilitation is a good initiative, it has some setbacks on local community livelihood like displacement of people, reduction of farming land, reduction of timber and non-timber products, hunger to people who used to hunt in the forest and declining in mining activities [45-47].

Table 6. The Positive Impacts of forest rehabilitation process on local community livelihood.

Positive impacts	Frequency	Percent
Trainings opportunities	10	10.2
Job opportunities	13	13.3
Incentive from tourism	6	6.1
Provision of social facilities	8	8.2
Formation of cooperatives	4	4.1
Rainfall formation	24	24.5
No positive impacts	33	33.6

The Findings illustrated that 33.6% of respondents, did not ascertain the impacts of forest rehabilitation process on their livelihood, Table 6. This can lead to the encroachment of the forest [28]. However, the big part of respondents acknowledged positive impacts of forest rehabilitation such as trainings opportunities, job opportunities, and incentive from tourism, provision of social facilities, formation of cooperatives and rainfall formation, Table 6. The previous research showed the link between forest rehabilitation and socio-economic of local community improvement which led to the sustainable forest rehabilitation [48].

Table 7. The Negative Impacts of forest rehabilitation on community livelihoods.

Negative impacts	Frequency	Percent
Decline in subsistence (Farming, mining, hunting)	46	47
Decline in timber	6	6.1
Decline in wood	31	31.6
Lack of non- timber products	15	15.3

The table 7 showed negative impacts resulted from forest rehabilitation process on community livelihood as illustrated by the respondents. Previous research on Gishwati, indicated that the rehabilitation projects regularly generated livelihood insecurity for the tens of thousands of people living in and around Gishwati [11].

4. Conclusion

The aim of this study was to assess the role of local community in Gishwati Forest Reserve Rehabilitation and its implication on local community livelihood, the finds showed that most of the local people are not interested in the rehabilitation of Gishwati Forest Reserve. It showed also that poverty has a large portion in hindering the rehabilitation of Gishwati Forest Reserve. The land use and land cover of Gishwati forest illustrated the change of forest which was classified into dense forest; dispersed forest and shrub and cultivated and open lands, the increase in one class lead to the decrease in other class. It showed the forest cover change since 1986 up to 2019. From 1986 to 2019, forest cover increased within Gishwati due to forest rehabilitation, however, the forest didn't reach its full rehabilitation state compare to the initial state taken in 1986, however the forest area has drastically experienced a high loss between 1986 and 2003 which mostly was caused by human activities. In the period between 2003 and 2019, the forest regained a large area and the area dedicated to agriculture decreased since 2003. In addition, the research revealed that the decline in subsistence was regarded as the major negative impact to local community livelihood because they were relying on mining, hunting and farming, for the positive impact, many of respondents said they don't see any positive impacts from the rehabilitation process was, but some mentioned rainfall formation, creation of some cooperatives, job opportunity, training opportunities and incentive from tourism. This paper demonstrated that rehabilitation process was linked to economic development of local community. Therefore, the rehabilitation of Gishwati Forest Reserve is a great cause for of the all stakeholders including State, Government Institutional, Non-Government Organizations (NGOs), and local community living in neighbourhood of the Gishwati Forest Reserve. It needs to be protected, as the consequences are obvious if there is no collaboration of each partner.

Conflict of Interests

The authors have not declared any conflict of interests.

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