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The Impact of Public Investment on the Conservation of Rau Reserve Forest: Cost Benefit Analysis Approach

Stephen Kirama
Martin Chegere

Abstract

This case study assesses the impact of public investment on conservation activities in the Rau Forest Reserve. It examines government spending in terms of personal emoluments, other charges, and development expenditure related to the RAU forest. Public spending is treated as the cost input, while benefits are estimated from the selected commercial agricultural products, valued using the market price approach. Using proxies, the dataset was extended from 2024 to 2035 to evaluate the long-term viability of investment. The analytical framework applied is Cost Benefit Analysis (CBA), specifically, employing the Net Present Value (NPV) and the Benefit Cost Ratio (BCR) metrics. The findings show that the benefits of public spending on the Rau Forest Reserve outweigh the associated costs. The NPV(NPV>0, and the BCR exceeds one, (B/C>1), indicating that public investment in the forest is economically justifiable. In short, benefits outweigh costs. The main implication is that the government should continue investing in the Rau Forest reserve and encourage adjacent communities to participate in its conservation. Currently, government spending is complemented by the efforts of the village game scouts, who assist in forest demarcation and serve as first responders in cases of fire or illegal activities. The study is limited by availability of comprehensive data, which constrains the rigour of the CBA-particularly in quantifying benefits. Future studies should consider applying multi-criteria analysis and contingent valuation methods to more accurately capture the full range of benefits associated with the public investment in the Rau Forest Reserve.

Keywords: Public investment; Forest conservation; Cost–benefit analysis; Environmental valuation; Natural resource management.

JEL classification: Q23, Q28, H54, Q51, D61

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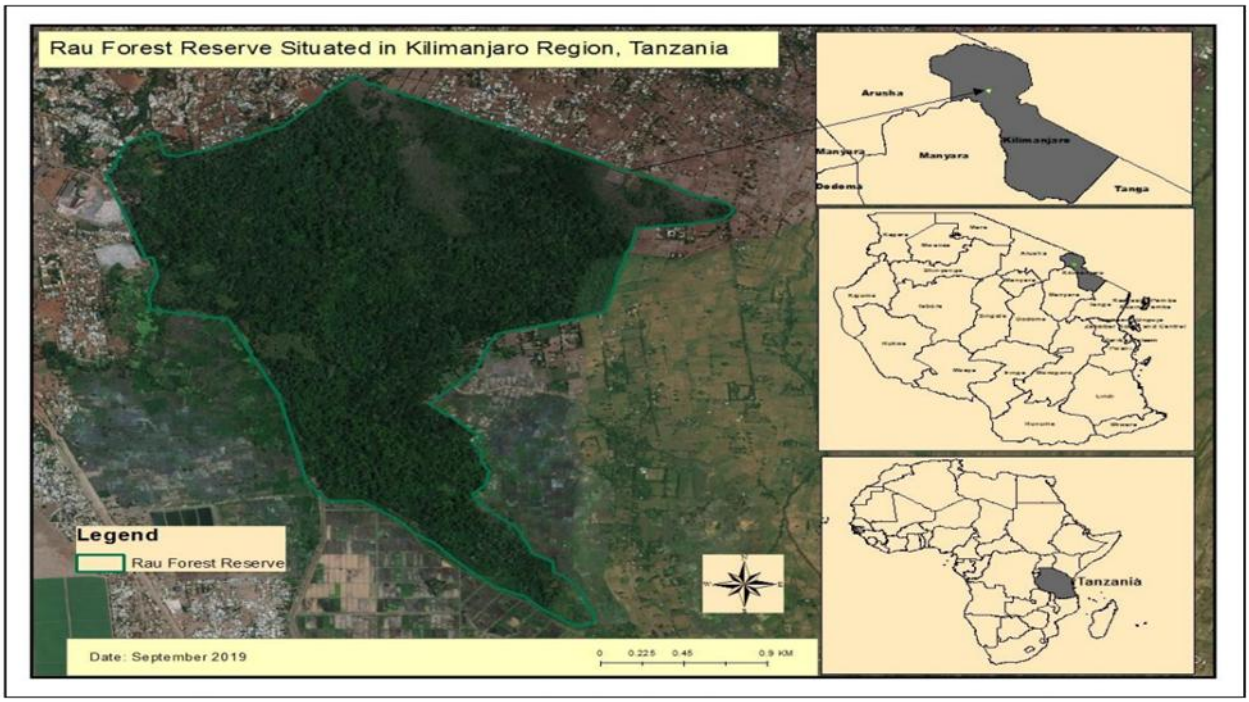
Rau Forest Reserve Situated in Kilimanjaro Region, Tanzania
Arusha
Manyara
Kilimanjaro
Manyara
Dodoma
Tanga
Tanzania
Legend
Rau Forest Reserve
Date: September 2019
0 0.225 0.45 0.9 KM

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1. Introduction

The Rau Forest Reserve is steadily declining in size due to degradation, deforestation, cultivation, encroachment and the effects of unprecedented climatic change. The forest is no longer in its original state, as it was in the 1970s and early 1980s. Enforcement of preservation measures is becoming increasingly difficult, particularly as nearby villages that once relied on the forest for resources have lost access and, consequently, have little incentive to prevent others from further degrading the forests. Public spending on the conservation is limited, with competing demands from other priority sectors such as education and health. As a result, the forest has experienced severe ecological impacts: several traditional water streams within the Rau Forest Reserve have dried up, and Moshi now records one of the highest temperatures in Tanzania, with an annual increase of 0.38°C. The need to investigate and implement mitigation measures to address the effects of climate change are urgent, calling for increased public investment and incentives for forest preservation.

This situation demands a more detailed and strategic analysis of public investment in forest conservation. Given the competing uses of public resources, it is essential to justify such spending by demonstrating value for money. At present, it is necessary to assess whether the current levels of public spending are justifiable considering the benefits they generate.

It is on this basis that the study case was conducted to evaluate the effectiveness and viability of the public expenditure in the Rau Forest Reserve. Applying a discounting methodology, the study assesses whether investments in the forest are economically justified by the benefits they yield. Specifically, the study evaluates the impact of public investment in conservation activities at Rau Forest Reserve by examining government expenditure (including the recurrent, other charges and development expenditure) and comparing these outcomes of conservation efforts using a CBA approach. The findings are intended to inform policymakers – particularly within the Ministry of Tourism and Natural resources, specifically the Tanzania Forest Services (TFS)- and to encourage greater resource allocation to revitalise the Rau Forest Reserve.

The study uses public expenditure data from 2013 to 2023, sourced from secondary documents and interviews with the budget officers at the Ministry of Tourism and Natural Resources and the TFS. In addition, the study compiles and simulates future data on the costs and benefits of the forest to adjacent peri-urban communities[1], in order to assess the broader impact of public investment. Using proxy data, the scope of the analysis is extended to cover the period 2024 to 2035, allowing for an estimation of the present value of the costs and benefits over time.

[1] Mjimpya, Njoro, Msaranga, Mandaka Mnono, Pasua and Kaloleni

The communities adjacent to the forest are primary beneficiaries. Although, the forest is a protected area, with restrictions on use, local communities benefit from its water streams, which support irrigated agricultural. There is also emerging ecotourism activity, including logistics support, picnics and cycling tours managed by community groups. While tourism is increasing, it remains at an early stage of development and is currently community-led. As such, these activities have not yet been fully quantified and included in the current cost- benefit analysis.

2. Methodology

2.1 The Methodological Approach

The methodological approach used in this study is CBA[2]. CBA is based on evaluating both costs and benefits in monetary terms, discounted over a specific period of time. The CBA analysis[3] is a methodological approach that is used to assess the economic impacts of public investments projects. The CBA helps determine the value derived from public expenditure and serves as a valuable tool for decision making in the planning, evaluation, and prioritisation of public and private investments. At the project initiation stage, it can be particularly useful in ranking and prioritising the allocation of public funds (OECD, 2002). The CBA approach is implemented using various investment appraisal techniques including:

- Net Present Value (NPV)[4];
- Internal Rate of Return (IRR)
- Benefit Cost Ratio (BCR).

Net Present Value (NPV) Estimation Approach

This case study estimates the NPV of government spending on the Rau Forest Reserve over a period of twenty-two (22) years from 2013 to 2035. The period is divided into two segments:

- 2013 to 2023, using actual available data.
- 2024 to 2035, using estimated/simulated data.

The NPV estimation followed a five-step process, outlined as follows:

Step 1: Identification and Measurement of Annual Costs and Benefits

[2] Cost-benefit analysis (CBA) on conservation spending involves evaluating the costs and benefits associated with investing in conservation efforts aimed at protecting natural resources, ecosystems, and biodiversity
[3] Cost-benefit analysis is assessment of costs and benefits relating to project, policy or sector.
[4] Net Present Value is calculated by subtracting the total discounted costs from the total discounted benefits. A positive NPV indicates that the conservation project is economically viable.

The first step involved identifying and measuring the annual costs (C_1, C_2, C_3, … C_n), and annual costs (B_1, B_2, B_3, … B_n) incurred over the project period from 2013 to 2035.

Step 2: Determination of the Discount Rate (r)

A discount rate of 10% was applied as a rule of thumb to convert future costs and benefits into present values, allowing comparison over time.

Step 3: Computation of the Present Value of Costs

The present Value (PV) *of costs* is calculated using this formula:

$$P\,V_{costs} = \frac{C_1}{(1+r)^1} + \frac{C_2}{(1+r)^2} + \frac{C_3}{(1+r)^3}, \ldots + \frac{C_t}{(1+r)^t} \quad (1)$$

The TPV of costs is expressed as,

$$TPV_{costs} = \sum_{t=1}^{t} \frac{C_t}{(1+r)^t} \quad (2)$$

Step 4: *Computation of the Present Value of Benefits* Similarly, the PV of benefits is calculated using:

$$P\,V_{benefits} = \frac{B_1}{(1+r)^1} + \frac{B_2}{(1+r)^2} + \frac{B_3}{(1+r)^{13}}, \ldots + \frac{B_n}{(1+r)^n}$$

The TPV of Benefits is given by:

$$TPV_{benefits} = \sum_{t=1}^{t} \frac{B_t}{(1+r)^t} \quad (3)$$

Step 5: Calculation of NPV

The NPV is obtained by subtracting the total discounted cost from the total discount benefits:

$$NPV = \sum_{t=1}^{t} \frac{B_t}{(1+r)^t} - \sum_{t=1}^{t} \frac{C_t}{(1+r)^t} \quad (4)$$

This can also be expressed as:

$$NPV = \sum_{t=1}^{t=T} \frac{B_t - C_t}{(1+r)^t} \ . \quad (5)$$

Where?

t = time

T = total time of the project

r = rate of discount

B_t = benefits at the time *t* $\mathbf{C_t}$ = costs at time *t*.

Benefit-Cost Ratio (BCR)

To test the robustness of the NPV results, the study also calculated the BCR using the same data.

The BCR is a key indicator which is used in cost-benefit analysis that summarises the overall value for money of an investment. It is calculated as the ratio of the total discounted benefits to the total discounted costs, both expressed in monetary terms.

How is BCR Computed?

First, calculate the discounted value of benefits B at time *t*:

$$B = B_0 + \frac{B_1}{1+r} + \frac{B_2}{(1+r)^2} + \ldots + \frac{B_T}{(1+r)^T} \quad (6)$$

Then calculate the discounted value of costs, C at time *t*:

$$C = C_0 + \frac{C_1}{1+r} + \frac{C_2}{(1+r)^2} + \ldots + \frac{C_T}{(1+r)^T} \quad (7)$$

And then express the BCR as a ratio of Benefit to Cost as,

$$BCR = B/C \quad (8)$$

The project is considered economically feasible if BCR >1. This implies that the total benefits outweigh the total costs – consistent with, the NPV criterion of NPV > 0.

2.2. Assumptions Underlining the Cost-Benefit Analysis for the Rau Forest Reserve

Several assumptions underpin CBA for the Rau Forest Reserve:

i) A discount rate of 10% is applied. This is used both as a rule of thumb for the public projects and as a reflection of the prevailing real interest rate applied by the Bank of Tanzania.

ii) The study considers only direct benefits. Indirect benefits- such as the forest's role in climate change – are excluded from the analysis.

iii) The benefits assessed are limited to the agricultural outputs of selected commercial crops (e.g. rice and maize). Although tourism is increasing, it remains at an early stage and is therefore excluded from the present computation.

iv) Costs and benefits for the period 2024 -2035 are estimated using proxy data.

3. Data, Analysis and Findings

3.1. Data Estimation and Compilation

Two main datasets were used for the cost benefit analysis in this study. The first dataset relates to public investment in the Rau Forest Reserve for the period 2013 to 2035. The period was purposefully selected

as it spans across three phases of government leadership: the fourth government (2015-2015), the fifth government (2015-2020) and the current sixth government (2021 - 2023). Additionally, the period 2024 to 2035 was included to allow for forward-looking estimations covering the anticipated that seventh and eighth governments. This broader temporal coverage reflects the differing perspectives and priorities each government phase has had regarding public spending and investment.

Public spending data includes:

- Personal emoluments for staff working at Rau Reserve forests.
- Other charges costs (O/C) which cover various operational and maintenance activities such as forest patrols, emergency responses, road maintenance, tree planting (gap filling), boundary demarcation, weeding and fire protection, site assessment and planning, and other recurrent expenditures as documented by the forests management; and
- Development expenditure, which supports long-term conservation and infrastructure efforts.

The second dataset concern the benefits derived from the public investment in the Rau Forest Reserve. The primary aim is to assess whether public spending has yielded sufficient benefits to justify the investment – that is, to determine the value for money. Given that many of these benefits, whether actual or perceived, are not easily quantifiable in monetary terms, proxies were used to estimate them. This approach helps to capture benefits that may be indirect, intangible or difficult to observe directly.

Photo: Rice Plantations bordering the Rau Forest Reserve near Kaloleni Street.

However, given the time and resource constraints, the study case focused on the direct benefits observed by the communities adjacent to the forest, particularly in terms of agricultural productivity. The study considered key commercial crops - namely, rice, maize and a group of minor crops including sorghum, millet and various horticultural products, which were collectively categorised as *other agricultural products*. The average annual production (in tonnes) was compiled and valued using prevailing market

prices to estimate the direct "benefits" of proximity to the Rau Forest Reserve, particularly the benefits derived from the irrigation support by streams originating in or passing through the forest, such as the River Rau.

Data on costs and benefits were obtained from secondary sources, including official government in the budgets documents, as well as the from Key Interviews (KIs) conducted with stakeholders around the Rau Forest Reserve, including staff from TFS) and the Ministry of Tourism and Natural Resources.

The public investment data for the Rau Forest Reserve – taken as the cost component- included Personal Emoluments (PE); Other Charges and Development expenditure for the period 2013 to 2023, as published in Volume II of the national budget books by the Ministry of Tourism and Natural Resources Specifically, the public investment costs considered for the Rau Forest Reserve comprised:

1. Personal Emoluments and Other Charges;
2. Boundary demarcation of the forest of the forest;
3. Forest patrol activities; and
4. Tree gap planting within the reserve.

These are summarised in Table 1a below.

Table 1a: Estimated Budget Spending on the Rau Forest Reserve (In Tsh. Million) (2013 to 2023)

Type	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
PE	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500
Patrols	500	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Boundary clearing	500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
Tree gap planting	500	300	500	500	500	500	700	700	750	750	800
Others	500	300	250	350	450	550	500	650	650	690	700

Source: Estimates from the Rau Forest Reserve Budget

Using proxies derived from the current Rau Forest Reserve budget, we also estimated the anticipated public spending on the forest for the period 2024 to 2035. This is presented in Table 1b below.

Table 1b: Estimated Budget Spending on the Rau Forest Reserve (In Tsh. Million)

Type	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
PE	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500
Patrols	500	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

Boundary clearing	500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
Tree gap planting	500	300	500	500	500	500	700	700	750	750	800	800
Others	500	300	250	350	450	550	500	650	650	690	700	700

Source: Estimated as proxies from the Rau Forest Reserve Budget

These public expenditures are aggregated to produce the total cost of spending on the Rau Forest Reserve for the period 2013 to 2023, as presented in Table 2a below.

Table 2a: Public Investment in the Rau Forest Reserve 2013 – 2023

Type	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Public Investment (Cost)	6500	6600	6750	6850	6950	7050	7200	7350	7400	7440	7500

Source: Estimates from the Rau Forest Reserve Budget

Similarly, anticipated costs for the period 2024 to 2035 were estimated using proxies and are presented in Table 2b below.

Table 2b: Public Investment in the Rau Forest Reserve 2024 – 2035

Type	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Public Investment (Cost)	5,500	6,600	6,750	6,850	6,950	7,050	7,200	7,350	7,400	7,440	7,500	7,500

Source: Estimates derived as proxies from the Rau Forest Reserve Budget

The estimated data on the benefits of the Rau Forest Reserve were compiled and calculated from various sources. Many of these figures are approximate estimates, intended to facilitate the CBA. The benefits have been primarily derived from the agriculture productivity in communities adjacent to the Rau Forest Reserve. Additional benefits include recreational activities and tourism earnings from forest walks, cycling, and picnics within the Reserve. There are also increased economic activities and employment opportunities linked to tourism, such as tour guiding, souvenir sales and bicycles hire services. However, for the purpose of this case study, revenues from tourism and nature-

related activities have not been included in the benefit calculations due to the sector's current infancy and informality.

Once the benefits were identified and quantified, a monetisation exercise was conducted by assigning monetary value to the productivity based on prevailing market price.

The benefits for the Rau Forest Reserve are primarily drawn from the agricultural production of the adjacent communities, comprising two villages-, Mandaka and Mabogini- and four streets-, Msaranga, Njoro, Kaloleni and Mji Mpya. The agricultural products considered are rice and maize.

Approximately 650 households engage in maize farming, with an average of four tonnes per household. In addition, around 350 households cultivate rice, with an average yield of five tonnes per household. Other crops account for two tonnes per household across the 1,000 households surrounding the forest. The total productivity is summarised in the table 3a below.

Table 3a: Rice and Maize Production (Metric tonnes) in Communities Adjacent to Rau Forest Reserve (2013 to 2023)

Type	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Rice)	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750
Maize	3250	3250	3250	3250	3250	3250	3250	3250	3250	3250	3250
Others crops)	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000

Source: Field Survey of sampled Households

Table 3b: Estimated Rice and Maize Production (Metric tonnes) in Communities adjacent to Rau Forest Reserve (2024 to 2025)

Type	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Rice	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750
Maize	3250	3250	3250	3250	3250	3250	3250	3250	3250	3250	3250	3250
Others crops	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000

Source: Field Survey of sampled Households

Using the market price approach, the monetary value (benefits) of the agricultural production outlined above is summarised in the table below for the period 2013 to 2023. These are approximate estimates, as they exclude non-monetary benefits. The average market price per tonne is estimated at *Tshs. 900,000 for maize,* Tshs. 2,000,000 for rice, and *Tshs. 150,000* for other crops. The category of other crops includes various types of beans, sorghum and potatoes[5].

The estimated monetary value of agricultural production by communities surrounding the Rau Forest Reserve are therefore summarised as follows:

Table 4a: Monetary value of the agricultural production by Communities Adjacent to Rau Forest Reserve (in Tsh Million)

Type	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Rice	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500
Maize	2925	2925	2925	2925	2925	2925	2925	2925	2925	2925	2925
Others crops	300	300	300	300	300	300	300	300	300	300	300

Source: Field Survey of sampled Households

Similar trend is anticipated for the period 2024 to 2035, and the projected monetary value of agricultural production by communities adjacent to the Rau Forest Reserve is presented in Table 4b below.

Table 4b: Projected Monetary value of agricultural production by Communities adjacent to Rau Forest Reserve (in Tsh Million)

Type	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Rice	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500
Maize	2925	2925	2925	2925	2925	2925	2925	2925	2925	2925	2925	2925
Others crops	300	300	300	300	300	300	300	300	300	300	300	300

Source: Field Survey of sampled Households

To estimate the total benefits derived from agricultural production- while making the bold assumption of excluding non-monetary benefits (i.e. On-commercial agricultural inputs) of the Rau Forest Reserve- we sum the total benefits in Tsh millions as follows. The key assumption underlying this calculation is that

[5] At this stage, tourism earnings have been excluded from the analysis, despite experiencing rapid growth –, from fewer than100 visitors in 2013 to nearly 13,000 tourists in 2023. A similar upward trend is anticipated for the period 2024 to 2035.

benefits increase at an annual growth rate of 10. While this is a strong assumption, it provides a useful basis for computing the NPV.

Table 5a: Benefits of the Rau Forest Reserve 2013 – 2023 (in Tsh. Million)

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Benefits	6725	7397.5	8137.25	8950.95	9846.45	10831	11914	13106	14416	15858	17443

Source: Field Survey of sampled Households

Similarly, the benefits for the 2024 to 2035 were assumed to remain more less constant, given that, no significant changes in the land ownership are anticipated and that forest encroachment is expected to be effectively controlled. The project benefits are presented in Table 5b below.

Table 5b: Estimated Benefits of the Rau Forest Reserve 2024 – 2035 (in Tsh. Million)

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Benefits	19,187	21,106	23,216	25,537	28,091	30,900	33,990	37,389	41,128	45,241	49,250	53,260

Based on these data and related proxies, the following sections present the cost-benefit analysis of public spending on the Rau Forest Reserve for the period 2013 to 2035. The methodology and key findings are outlined in the sections below.

3.2. Analysis and Findings

The benefits and costs of the project accrue at different points in time. To account for this, both must be discounted using a discount factor. By applying discounting, this case study expresses future capital costs and net benefits in terms of present values (Campbell (2014).

The process of discounting is both critical and common in cost-benefit analysis, especially in environmental and conservation contexts. The discount rate *(r)*reflects the time value of money and represents the rate at which the shadow price of future expenditure declines relative to its value today. In essence, it captures the principle that a unit of spending in the future is worth less than the same amount spent today.

In this analysis both NPV[6] and BC are used, incorporating the time value of money. A discount rate of 10%, based on current market data from the Bank of Tanzania is applied. Using equation (6), the N PV is calculated as follows:

$$NPV = \sum_{t=1}^{t=22} \frac{B_{22} - C_{22}}{(1+0.1)^{22}}$$

[6] The difference between the discounted benefits and the discounted costs is called the Net Present Value (NPV). When NPV> 0, it indicates that the investment benefits outweigh the costs and, in that regard, the project is worth undertaking- subject to the availability of resources.

This yields an NPV **of TSh132,372.1** million, which is positive. A positive NPV indicates that the benefits of public spending on the Rau Forest Reserve outweigh the costs over the analysis period.

Similarly, the BCR was estimated using the equation (8):

BCR= Total Discounted Benefits (B)/Total Discounted Costs (C)

BCR = 239,744.8/107,372.7 = 2.23

Since the BCR is greater than1, this further demonstrates that the benefits exceed the costs. These results for NPV and the BCR are summarised in Table 6 below.

Table 6: The Net Present Value (NPV) and the Benefit Cost Ratio Results

Year	Cost	Benefits	Discount Factor (5%)	Discounted Costs	Discounted Benefits	Net Benefits	Discounted Net Benefits
1	6,500.0	6,725.0	0.9524	6,190.5	6,404.8	225.0	214.3
2	6,600.0	7,397.5	0.9070	5,986.4	6,709.8	797.5	723.4
3	6,750.0	8,137.3	0.8638	5,830.9	7,029.3	1,387.3	1,198.4
4	6,850.0	8,951.0	0.8227	5,635.5	7,364.0	2,101.0	1,728.5
5	6,950.0	9,846.5	0.7835	5,445.5	7,715.0	2,896.5	2,269.4
6	7,050.0	10,831.0	0.7462	5,260.8	8,082.3	3,781.0	2,821.4
7	7,200.0	11,914.0	0.7107	5,116.9	8,467.1	4,714.0	3,350.2
8	7,350.0	13,106.0	0.6768	4,974.8	8,870.7	5,756.0	3,895.9
9	7,400.0	14,416.0	0.6446	4,770.1	9,292.7	7,016.0	4,522.6
10	7,440.0	15,858.0	0.6139	4,567.5	9,735.4	8,418.0	5,167.9
11	7,500.0	17,443.0	0.5847	4,385.1	10,198.6	9,943.0	5,813.5
12	8,100.0	19,187.3	0.5568	4,510.4	10,684.2	11,087.3	6,173.8
13	8,700.0	21,106.0	0.5303	4,613.8	11,193.0	12,406.0	6,579.2
14	9,300.0	23,216.0	0.5051	4,697.1	11,725.7	13,916.0	7,028.5
15	9,900.0	25,537.7	0.4810	4,762.1	12,284.1	15,637.7	7,522.0
16	10,200.0	28,091.5	0.4581	4,672.7	12,869.0	17,891.5	8,196.3
17	10,500.0	30,900.6	0.4363	4,581.1	13,481.8	20,400.6	8,900.7
18	10,800.0	33,990.7	0.4155	4,487.6	14,123.8	23,190.7	9,636.2
19	11,100.0	37,389.8	0.3957	4,392.6	14,796.4	26,289.8	10,403.8
20	11,300.0	41,128.8	0.3769	4,258.9	15,501.0	29,828.8	11,242.1
21	11,600.0	45,241.7	0.3589	4,163.7	16,239.2	33,641.7	12,075.4
22	11,900.0	49,250.0	0.3410	4,068.6	16,977.3	37,454.6	12,908.7
23	12,000.0	53,260.0	0.3230	3,973.5	17,715.5	41,267.5	13,742.0
				107,372.7	**239,744.8**	**NPV**	**132,372.1**
						BCR	**2.23**

Source: Authors Computations

The NPV is positive (NPV>0), indicating that public spending on the Rau Forest Reserve yields greater benefits than cost. This is further supported by the BCR, which is greater than one (BCR>1), demonstrating that the benefits outweigh the costs of investment.

The analysis does not account for inflation in the computation of NPV and BCR. This is based on the reasoning that when both cash outflow and inflow are equally affected by inflation, the inflationary effects cancel each other out.

When inflation is anticipated, both the stream of returns and the discount rate rise accordingly. Expressed in nominal terms, the NPV of the return stream remains equivalent to that in real terms:

$$PV = R_0 + \frac{(1+\pi)R_1}{(1+\pi)(1=r)} + \frac{(1+\pi)^2 R_2}{(1+\pi)^2(1+r)^2} + \ldots + \frac{(1+\pi)^T R_T}{(1+\pi)^T(1+r)^T} \quad \text{...(9)}$$

This is equivalent to equation:

$$PDV = R_0 + \frac{R_1}{1+r} + \frac{R_2}{(1+r)^2} + \ldots + \frac{R_t}{(1+r)^t} \cdots \frac{R_N}{(1+r)^N} \quad \text{.. (10)}$$

Hence, using either real or nominal values yields the same result, provided consistency is maintained. When using real values for returns, the discount rate must also be expressed in real terms (r- π). As a result, the standard NPV estimations do not explicitly account for inflation. 4.

4. Discussion of Findings

A cost–benefit analysis of the public spending on Rau Forest Reserve was conducted to evaluate economic viability and value for money of investment over a 22-year period, divided into two phases, 2013 -2023 and 2024 -2035. Actual and projected costs and benefits were identified and monetised using prevailing and estimated market prices.

The appraisal shows that public investment in the Rau Forest Reserve aligns well with the benefits accrued. A positive NPV (NPV>0) confirms the profitability of investment. The BCR (BCR>1), calculated at2.23, implies that every unit of expenditure generate 2.23 units in benefits.

A BCR greater than one indicates that the discounted benefits exceed the discounted cost, affirming the financial viability (FAO&UNHCR, 2018). Similarly, a positive NPV validates the investment decision. The analysis remains robust, despite data limitations. However, several weaknesses of the CBA method are noted:

- Lack of flexibility: CBA does not account for uncertainty or flexibility once the investment is made.
- Difficulty in forecasting: accurately projecting future costs and especially intangible benefits is challenging.
- Omission of unanticipated costs: CBA may fail to capture unforeseen expenses.
- No standard discount rate: the selection of an appropriate discount rate remains subjective.

These limitations suggest that sensitivity analysis could help in testing the robustness of the findings.

It is also evident that forest encroachment contributes to land use and cover change in the Rau Forest Reserve. Portions of the forest are increasingly being converted into agricultural parts, settlements, and grazing areas, leading to gradual forest degradation (Massawe etal., (2022.

Despite these challenges, the findings show that public spending yields substantial benefits for the Rau Forest Reserve. Both NPV and BCR indicators confirm that the benefits outweigh the costs. To sustain these positive outcomes, continued and possibly increased public investment is necessary.

5. Conclusion

Although the study was limited by the availability of comprehensive data, the results clearly highlight the importance of public investment in the Rau Forest Reserve. The assumption that both costs and benefits grow over time -though optimistic- supports the conclusion that sustained public spending is essential for conserving public goods and natural resources. Had all the costs and benefits dimensions been captured, it is unlikely that the findings would diverge significantly from the above findings. In view Policymakers should, therefore, recognise the value of continued investment in the forest reserve.

Furthermore, the role of adjacent communities is pivotal. Beyond benefiting from the reserve, these communities serve as first responders to incidents such as wildfires, help with forest demarcation, and report illegal activities -highlighting their integral contribution to forest preservation.

It is important to stress that the purpose of CBA is to complement, not replace, traditional financial analysis by assessing the wider economic benefits and costs to the so community as a whole (Feldstein,1964).

6. Areas for further Study

The appraisal analysis of public spending on the Rau Forest Reserve, has been based on a number of assumptions, some of which may have influenced the results. For example, the benefits assessed were limited to agricultural production in the area. In light of this, future studies on the Rau Forest Reserve should consider a broader range of methods to quantify benefits. One such method is the contingent valuation approach which captures the willingness of adjacent communities to participate in conservation efforts.

To complement the CBA, future studies could also employ the Multicriteria Analysis (MCA). Given that some costs and benefits cannot be easily expressed in monetary terms MCA offers a suitable alternative. It allows for the assessment of various criteria with different dimensions of value. Unlike CBA, which requires all inputs and outputs to be monitised, MCA enables evaluations using quantitative and qualitative data. The method involves developing a composite measure based on the weighted sum of criteria and scores. The best alternative is the one that achieves the highest score on this composite index. In this sense, the MCA provides greater flexibility than traditional CBA.

Finally, future studies should explore public spending on the forest in more depth, particularly by disaggregating climate-related financing. This would allow for the establishment of climate budget tagging, which could enable a more targeted and effective analysis of public investment in the forest conservation.

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