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Valuation of timber and forest plantations in Kenya

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Abstract

Purpose – This study examines the methods of valuation of timber and forest plantations in Kenya and challenges in the valuation process.

Design/methodology/approach – The study employed a case study research design. The selected case studies are the Elburgon, Kaptumo and Sitoi tea estate timber plantations within the western rainforest in the Rift Valley region of Kenya. Data were obtained from primary and secondary sources, and analysed using quantitative and qualitative approaches.

Findings – The results of the study revealed two categories of timber plantation valuation methods in Kenya, namely, the market and non-market methods. The dominant timber plantation valuation method is the income approach, where 46.51% of the valuers said they had used this method. Quantification of non-market timber benefits and the lack of data were the main challenges reported by the valuers. The study recommends the use of both market and non-market methods for the accurate and reliable estimation of the valuation of timber and forest resources in Kenya.

Research limitations/implications – The study findings are limited to the case study areas and restricted to timber and forest plantations. Further research could focus on other geographical areas and forest ecosystems in Kenya to offer conclusive insights into valuation methods and challenges.

Practical implications – Given the significant role and contribution of forest resources to the Kenyan economy, the results of the study will inform prudent forest management practices through (1) the accurate and reliable estimation of forest values and (2) the development of standards and guidelines for the valuation of these important natural resources.

Originality/value – Research on the valuation of forests and other natural resources in Kenya and other developing countries in Africa is quite limited. This is the first study to provide a detailed account of timber and forest plantation valuation methods in Kenya and challenges in the valuation process.

Keywords Timber plantations, Forest resources, Market and non-market timber benefits, Market and non-market valuation methods, Valuation challenges, Kenya

Paper type Research article

1. Introduction

Forests are important natural resources that provide a wide variety of vital services and benefits to people. Forests provide building materials, paper, energy and food, as well as several more intangible non-market services such as recreation, carbon sequestration, nutrient cycling, biodiversity conservation, soil protection and water regulation (Müller *et al*., 2020; Peters *et al*., 2023; Hassin *et al*., 2024; Nolander and Lundmark, 2024). These services are crucial to both human wellbeing and the stability of the global environment.

In many parts of Africa, communities depend directly on forest ecosystems for their daily livelihoods (Africa Natural Resource Centre[ANRC], 2018). Individuals and populations cluster around forest reserves to benefit from the resources that flow from forests. In 2019, over

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719 million people in rural Africa lived within 5 kms of a forest buffer, with another 500 million of them residing within 1 km (FAO, 2022). Within the East Africa region, forests play crucial roles in supporting livelihoods, particularly for rural communities where between 65% – 90% of households depend directly on forest resources for income and subsistence (Osewe *et al*., 2024). Additionally, these ecosystem services regulate water cycles that sustain agricultural productivity throughout the East Africa Region. In Kenya, the forestry industry maintains a significant contribution to the gross domestic product (GDP) of the country, where in 2016, the sector employed around 294,500 people and contributed US $ 89.72 million or 1.3% of the GDP (Kenya National Bureau of Statistics[KNBS], 2017). Forests provide the necessary raw materials utilized in timber and timber product enterprises throughout the country.

Valuation of timber and forest plantations involves determining the worth of both the standing trees and the forest as a whole, including the land and other non-timber benefits. Establishing the valuation of timber and forest plantations is crucial. Without an estimation of plantation values, there is little motivation to invest in forestry management and conservation, and without such investments, the physical state, functionality and benefits of trees and forests diminishes. Proper valuation is an important element in making the case for forestry or for recognizing when alternative land uses, such as agriculture and livestock, are better options (International Institute for Environment and Development[IIED], 2003). Failure or inadequate recognition and underestimation of the values of the many goods and services provided by forests at local, regional, national and global levels has been cited as one of the major causes of unsustainable forest management practices such as deforestation, degradation and transfer of forest land to other land uses (Zandebabasiri *et al*., 2025). From 1990 to 2020, Africa, for instance, lost approximately 14% of its forest cover due to deforestation driven mainly by land use changes (LUC) for agriculture expansion, fuel wood, charcoal production and human settlements (United Nations Development Programme[UNDP),2020). The East Africa region loses approximately 2.8% of its forest cover due to the same pressures. Valuation of forest resources is needed to justify and support forest conservation and protection efforts for sustainable social and economic development of Africa, the East African region and indeed all other developing and developed countries of the world.

Most studies have identified two major categories of forest and timber valuation methods, namely, the market and non-market methods (see, for example, Phillips *et al*., 2013; IIED, 2003, and Royal Institution of Chartered Surveyors[RICS], 2023). The market approaches based on the principle of substitution rely on comparable transactions of similar assets and the costs of replacing the plantation, as well as the discounted future income stream from the plantation to determine its value. Non-market methods focus on the non-timber benefits, such as the value of biodiversity, carbon sequestration, medicinal benefits and recreation. The choice of the appropriate valuation method for use in timber valuation depends on the purpose of valuation, availability of information and the valuer's knowledge and skill in the use and application of the method.

The market methods assume there is an active market for timber and timber products and that information on sales of similar assets is readily available. However, according to Josep *et al*. (2011), this is hypothetical and may not exist, especially for timber that occurs in different establishment phases and different geographical locations. Jukka (2006) observed that the use of market valuation methodologies to value timber plantations is curtailed by a limited understanding of the dynamics of timber plantations, timber products and benefits. In order to capture timber and forest plantation values entirely and accurately, Jukka's study stresses the need to apply market valuation methodologies in conjunction with non-market valuation approaches, which are capable of quantifying the non-market benefits from forest resources.

Research on the valuation of forests and other natural resources in Kenya and the East African region, and indeed most developing countries in Africa, is quite limited. A recent study (see Osewe *et al*., 2024) published in Frontiers in Ecology and Evolution noted that while East Africa research is making progress in understanding the economic value of forest ecosystems, gaps still remain in assessing the valuation of these vital natural resources. The study reviewed

forest ecosystem service valuations in Kenya, Uganda, Tanzania, Rwanda and found that while valuation efforts have increased in recent years, the scope of the assessments remains narrow. Most studies focus primarily on the tangible marketable benefits of forests such as timber, fuel wood and non-timber forest products (NTFPs) that communities can harvest directly, with little focus on non-market forest ecosystem services such as carbon sequestration, watershed protection, flood mitigation and biodiversity conservation, which have consistently been ignored and undervalued. The review identified a concerning trend where many studies relied heavily on market approaches, while complex methods needed in the valuation of non-market forest benefits are underutilized. This methodological limitation contributes to an incomplete economic understanding of forest ecosystems. In order to fill this methodological gap, the subject study sets to provide a full account of the valuation methods for timber and forest plantations in Kenya, and challenges in the valuation process.

2. Literature review

Valuation of forest resources entails the estimation of the economic benefits a particular forest resource may yield for its owners (Xu *et al*., 2025). While several theories underpin the valuation of forest ecosystems, the utility theory is most explicit in explaining the value of forest ecosystems services. Developed in the 18th and 19th centuries and modified in the 1970s, utility theory postulates that individuals derive satisfaction from the consumption of goods and services. Satisfaction creates demand and price for goods and services. The satisfaction is derived from both tangible goods and intangible services. The theory shifts the valuation of a complex ecosystem, timber and forest plantations included, from easily quantifiable or tangible raw output (timber), to a wholesome incorporation of all inherent direct and indirect benefits they give to human well-being (Hlaváčková and Šafařík, 2016).

There are many reasons why timber and forest assets are valued. In the United Kingdom and Ireland, the purposes for valuation of woodlands and forests include financial accounting and reporting, sales and acquisitions, leasing, loan security and taxation, among others (RICS, 2023). According to Syagga (1994), forests are valued like any other real estate property for sale, transfer of rights, book purposes, forest land rental assessment, compulsory land acquisition, taxation and calculation of royalties. In East Africa and Kenya, royalty is revenue to the government paid by farmers and forest merchants who are licensed to cut or harvest timber in forests, and is an important fiscal instrument used by governments to conserve and protect forests (Syagga, 1994).

Valuation is needed by governments to determine the royalties and other forms of charges and taxes on forests; it provides crucial information for private investors considering purchasing or managing timber plantations. Valuation helps in determining the financial viability of forestry operations and developing sustainable management plans, and informs policy decisions related to forest conservation, land use, and environmental regulations. It can be used to resolve disputes or conflicts related to forest ownership and management. Depending on the System of National Accounting (SNA) of the country, the valuation of timber and forest plantations can be used to estimate the contribution of these natural resource assets to the Gross Domestic Product.

The valuation process of any asset begins with instructions from the client to undertake the valuation. With respect to timber and forest plantation assets, instructions may come from the forest farmer who wants to know the worth of the forest assets; investors who want to establish timber plantation as an enterprise and its financial viability, and the government for conservation and tax purposes. Pearce and Moran (2013), classify timber valuation approaches into the arbitrary and analytical methods. Arbitrary methods are market-based and according to Syagga (1994), they don't have a scientific basis, and are guided by some arbitrary chosen yardstick. Examples of these methods include, fixed royalty rate, value-related charges and auction price or seller/buyer negotiation. The three methods are applied in calculating royalties. The royalties are charges established administratively by legislation, regulation,

codes and ordinances. In Kenya, the royalties are set under the Forests (Fees and Charges) Regulations, 2016. The royalties vary with the type of tree species, volume of tree, locality and quality of timber or other characteristics (Mbugua, 2003).

The fixed royalty method calculates royalties on the basis of the volume in cubic meters of logs from trees felled after deduction of any defect allowances (Mbugua, 2003). The method has the advantage of being simple and easy to apply and can be implemented at a relatively low cost. The government can set the royalty charge to encourage or discourage the utilization or harvesting of a particular tree species. The method, however, has the disadvantage of being less scientific since fixed royalty may not accurately reflect stumpage (standing timber) value, and the fixed charges are less responsive to inflation (Kimani, 2007). Value-related charges approach, on the other hand, assess royalties as a percentage of the selling price of the processed or converted timber product. This means that the royalty rates are determined after the processed timber product has been sold. The method has the advantage because the royalty charges are based on market prices realized from timber product sales, are more realistic and generate high revenue to the government. The method is more flexible and automatic in adjusting royalty charges to changing prices and inflation. The main disadvantage of the method is that it does not reflect the holistic timber values (Syagga, 1994). The auction prices or seller/buyer negotiation approach is based on direct seller/buyer negotiations, open or sealed bid auction or public log market prices (Munn and Franklin, 1995). The method is the most realistic, arbitrary approach and is preferred since it is flexible in establishing the valuation of timber and forest resources on the basis of supply and demand forces in the market. Furthermore, if competition among bidders is encouraged, auctions can be very effective in setting the level of charges to maximize government revenue and reflect stumpage value. The method, however, can be time-consuming when participants are slow or unwilling to raise their bids. Where there are no bidders, the auction may not even be possible. Also, negotiation can be demanding in terms of time and can put pressure on those concerned. Moreover, the method does not consider indirect benefits from the timber and forest resources.

Besides arbitrary methods, there are analytical methods that are also market-based. This consists of comparable transactions method, also known as the comparative sales method, cost approach, income or investment approach, conversion return approach and multi-parametric analysis approach. The first three methods are recognized by global valuation standards, including the International Valuation Standards (IVS), the Royal Institution of Chartered Surveyors (RICS) global valuation standards, RICS Professional Standard 2023 for the UK and Ireland, and the Food and Agriculture Organization (FAO) guidelines on forest valuations, specifically FAO Forest Paper 127. While the IVS and RICS global standards provide valuation guidelines for all categories of assets, the RICS professional standard 2023 and FAO Forest Paper 127 offer guidelines specific to valuations of woodlands and forest assets. While the detailed description of the standards is beyond the scope of this article, the standards generally promote transparency, consistency and accuracy in undertaking the valuation of assets.

The market approach using the comparable transactions method provides an indication of value by comparing the asset with an identical or comparable asset for which price information is available (International Valuation Standards Council[IVSC], 2025). In the case of timber and forest valuation, the approach involves analysis of sales data for similar timber and forest products and making necessary adjustments to arrive at the valuation of the subject forest product. The method is applicable in the valuation of forest products with market prices. Such products include the bare forest land, standing trees, pulp wood, timber logs, poles, fuel wood, charcoal and other non-timber forest products (NTFPs) that are traded in the market including edible fruits, medicinal plants, honey, dye and resins (IIED, 2003). The advantage of this method is that it is based on observable market prices of similar assets. The challenge and limitation of the method is the shortage of comparable transactions. Forest land sales are rare and tend to be handled by a small number of specialist agents and forest management companies who rarely disclose the results of the transactions. Forest properties, like any other

form of real estate, are also highly heterogeneous, that is, they vary according to location, tree species, age, stages of growth, timber yield and quality of trees. This makes comparison difficult. The method may not accurately estimate the value of non-market timber benefits. Notwithstanding these difficulties, the method is the preferred method of estimating the market value of forest assets (RICS, 2023).

The cost approach provides an indication of value using the economic principle that a buyer will pay no more for an asset than the cost to obtain an asset of equal utility (IVSC, 2025). The application of the method involves calculating the current replacement cost of an asset, that is, how much it would cost to produce or obtain a similar asset like the one being valued. With respect to forest assets, the cost approach is anchored on the assumption that timber and forest products are worth the tree establishment, management and husbandry costs that have been incurred (Pearce and Pearce, 2001). Simply, cost approach determines forest value as the estimated cost of establishing the trees to the current stage of maturity. This includes the costs for seedling and seedbed management, land preparation, planting cost, weeding and tending the trees. The costs of establishment can be obtained from actual or published costs. In Kenya, for example, the Kenya Forestry Research Institute (KEFRI) and the Kenya Forest Service (KFS) publish standard establishment costs for various species of trees. Since a forest comprises the tree crop and the underlying land, the tree establishment costs are then added to the value of bare forest land obtained from comparable land transactions to arrive at the valuation of the timber and forest plantation. The application of this method is limited to relatively younger immature forest crops, which are less than 10 years old and unlikely to contain any saleable timber (RICS, 2023). While the method is mostly applied in the valuation of marketable timber products, it can also estimate the value of non-market timber benefits. An example of the application of replacement cost in valuing non-market forest benefits is to estimate the value of soil nutrients lost due to increased erosion associated with logging or deforestation, in terms of the cost of fertilizer needed to restore the eroded nutrients. In addition, where logging or road construction in forest areas leads to increased runoff and soil sedimentation, the estimated costs of dredging or flood control can be used as a rough estimate of the non -market benefit of watershed protection (IIED, 2003). The method, however, has its limitations; firstly, it does not take into account the future income potential (both timber and non-timber income) and secondly, it does not perfectly reflect the state of the market because cost is generally not equal to value.

The income or investment approach provides an indication of value by converting projected cash flows into a single current value (IVSC, 2025). The method is premised on the capitalization or discounting of the net income that the timber plantation enterprise produces. The income capitalization process requires the selection of an appropriate rate of return or interest rate to convert the future income streams from the forest enterprise to the present value. This is necessary to reflect the time value of money of the incomes and therefore ensure accurate determination of valuation using the income approach. This approach is applicable for both young (pre-mature timber) and mature timber plantations being operated as a commercial farming enterprise. Where the timber is young, assumptions are made on optimum rotation age or maturity of trees, optimum timber production, and future revenues from the sale of the timber (IIED, 2003). The challenge of the method is obtaining accurate records of expenses and revenues of the farming enterprise, especially where they are not available or the operator is unwilling to disclose the records. It is also difficult to establish all the possible sources of income from the forestry enterprise. The selection of an appropriate discount rate is also a challenge. Since most non-timber forest products are either under-priced by the market or have no income, the method can under-value such products. Hence, the method is mainly applicable in the valuation of timber and forest products that either bring income or have the potential to generate income in the future.

Other analytical methods include the multi-parametric method, which recognizes that urban trees have multiple functions in addition to wood provision. This method, however, is restricted to urban trees and its major challenge has been how to ascertain the aesthetic

component of an urban tree (Barbier, 1992; Syagga, 1994). Conversion return method is recommended where profit margins from timber can be calculated from log price net gains and risk margins without prior determination of stumpage value (Kimani, 2007). The major challenge of this method is that it's only applicable to timber and timber products, which are tangible and hence can be exchanged in the market.

Forest and timber plantations can also be valued using non-market methods. These approaches are premised on the logic that forests and timber plantations have direct and indirect benefits that are not traded in the market. The direct non-market forest benefits and services include recreation, spiritual and cultural benefits, scientific research and education. Indirect non-market benefits include pollination, carbon storage, watershed and soil protection, preservation of soil fertility, purification of water sources and cleaning of air, among other similar benefits (Xu *et al*., 2025). Forests have potential future benefits or usability by humans referred to as option values. Forest resources have benefits beyond their current and future direct and indirect uses, known as non-use values. The non-use values include bequest value, altruistic value and existence value. Bequest value is the value people place on knowledge that forest resources will be available for future generations. Altruistic value is the value people place on knowledge that forest resources are available for other beneficiaries. Existence value is the value people place on simply knowing a resource exists, even if they never use it (RICS, 2023).

The non-market forest benefits present a significant challenge in forest valuation because of the lack of observable market prices and also due to their dependence on subjective factors such as ethics, religion, emotional experience, and aesthetic preference (Xu *et al*., 2025; Mameno *et al*., 2024). There are, however, methods that have been developed to estimate the valuation of non-market forest ecosystem services. These are the Travel Cost Method (TCM), the Hedonic Pricing Method (HPM), Contingent Valuation Method (CVM) and Total Economic Valuation (TEV) methods, among others (Nolander and lundmark, 2024; IIED, 2003; Xu *et al*., 2025).

Travel cost method is premised on the assumption that consumers value the experience of a particular forest site at no more than the cost of getting there, including all direct transport costs, as well as the opportunity cost of time spent travelling to the site. A well-designed survey is used to elicit the cost information from people who visit the site. The method is primarily used to value the non-market recreational benefits of forests (Liu *et al*., 2023). TCM is considered a more robust non-market method because it relies on real expenditures of travel. The method, however, has a limited scope of application. It cannot value marketable timber products, nor can it value the non-use values of forest ecosystems such as bequest value, altruistic value and existence value. TCM is data-intensive, requires extensive surveys on visitors' origins, travel modes and their socioeconomic characteristics. Furthermore, it is difficult to determine the monetary value of the time a visitor spends travelling to the site (IIED, 2003; RICS, 2023, Phillips *et al*., 2013).

The hedonic price method is premised on the assumption that the value of an environmental amenity can be revealed in the market prices of marketable goods such as real estate. The method uses statistical techniques to estimate the value of non-market forest amenity benefits, in terms of the changes in the price of real estate, caused by the changes in the level of the environmental amenity. The application of the method, therefore, requires data on transactions of real estate adjacent to a forest resource. It also requires knowledge of the statistical techniques needed to impute the non-market forest value from the observed market prices of land and property (IIED, 2023). One limitation of the application of the HPM method in developing countries is that private property markets are often thin, uncompetitive and poorly documented.

Contingent valuation method estimates the valuation of non-market forest benefits by asking beneficiaries or consumers of that resource, how much they are willing to pay (WTP) for the benefits or, alternatively, how much they are willing to accept (WTA), as compensation for the loss of the non-market forest benefit. The method uses consumer surveys to elicit the

necessary WTP and WTA information. The consumers' responses are then analysed to arrive at a rough estimate of the valuation of the benefits. Proponents of CVM argue that its theoretical foundations are firmer than those of other non-market valuation techniques because it directly measures true WTP or WTA. Moreover, it is the only generally accepted method for estimating non-use values for which price data do not exist and or links to marketed goods cannot easily be established (Diamond *et al*., 1994; IIED, 2003). CVM can also be used to estimate the value of marketable timber products and other direct use benefits of forests such as non-timber forest products, in terms of local people's WTA compensation for loss of access to those benefits. Critics, however, argue that CVM fails to measure consumer preferences accurately. Poorly designed or badly implemented surveys can influence and distort responses, leading to biases and inaccuracies in the valuation.

Total Economic Value, whilst not classified as a valuation method, is a term that refers to the entire set of benefits that people receive from an environmental resource. When used in forestry, the term refers to the range of direct and indirect market and non-market benefits, as well as non-use values that flow from a forest ecosystem. A holistic timber and forest valuation approach should thus endeavour to capture the entire range of benefits from the resource, through the use and application of methods that can estimate the TEV of the forest. This may require that both market and non-market methods are employed simultaneously in the valuation of forest resources for the accurate and reliable estimation of forest values. While some methods, like the CVM, can estimate both market and non-market benefits of forests, others, like the TCM, can only estimate non-market benefits.

Overall, the above review has shown that the valuation of timber and forest plantations is important. Valuation is essential to promote the productive use of forest land, enhance environmental sustainability and protection. Effective management of forest resources can be enhanced through the accurate and reliable estimation of forest values. More research efforts are needed to deepen the knowledge and understanding of forestry valuation methods.

While forest valuation research has received considerable attention in recent years, most studies have been in the developed countries in the United States, Europe, Asia and the Middle East. Di Franco *et al*. (2021) study provides an overview of scientific research trends in the field of economic valuation of forest ecosystem services(FES). According to the study results, the most active research outputs in this field are in the continents of Europe and Asia. Furthermore, the most widely used valuation approaches are the contingent valuation methods and the market price approaches. A study by Sharma and Cho (2021) analysed forest-based amenity values and carbon storage benefits in Knox County, Tennessee, in the United States using hedonic price models and other methods. Hlaváčková and Šafařík (2016) described the methodological procedure to determine the market value of the recreational function of forests in the Czech Republic. Zandebasiri *et al*. (2025) assessed the economic value of ecosystem services within a protected forest in Iran using the contingent valuation method and replacement cost methods. Xu *et al*. (2025) assessed the economic value of ecosystem services from forests in Chinese rural areas. Using the case study of Muyun She Nationality in Fuan City, China, the study found that the annual economic value of ecosystem services amounts to 397.9 million Yuan, approximately USD 57million, driven by forest by-products (32%) and rural tourism (31%). Another study in China by Liu *et al*. (2023) acknowledged that data accuracy, methodological limitations and quantification of intangible services were major challenges in forestry valuation. Mameno *et al*. (2024) identified the socially prioritized forest ecosystem services based on public preferences and assessed the value of such services in Japan. Findings revealed that the freshwater stock was the most valued FES, followed by carbon storage, while cultural services were the least important.

Few studies have focused on the developing countries in Africa, the East Africa region and Kenya. A recent study (see Osewe *et al*. (2024)) published in Frontiers in Ecology and Evolution reviewed forest ecosystem service valuations in the East African Countries of Kenya, Uganda, Tanzania, Rwanda, highlighting both progress and challenges in quantifying the true value of the region's forests. The study found that while valuation efforts have

increased in recent years, the scope of the assessments remains narrow. Okumu and Muchapondwa (2022) study on the economic valuation of forest ecosystem services in Kenya posits that communities regard highly and value improved forest cover, water quality and flood mitigation. Mkuzi *et al.* (2025) focused on the estimation of biomass. Eregae *et al.* (2021) study in Elgeyo Marakwet in Kenya found that watershed protection was the most valued FES. Osewe *et al.* (2025) evaluated the ecosystem services provided by Karura Forest Reserve (KFR) in Kenya. The study, among other objectives, sought to estimate the direct and indirect benefits from the forest ecosystem. The results of the study revealed that the total economic value of benefits from KFR amounts to USD 526,027 per annum. While these studies have provided valuable insights into valuation, they fail to delve into the entire forest ecosystem valuation methodology. The subject study adds to the limited body of research in Kenya and the East African region. Most importantly, the study provides a detailed account of timber and forest plantation valuation methods and challenges in the unique forest ecosystem case study areas within the Western rainforest in the Rift Valley region of Kenya.

3. Research design and methodology

The study adopted a case study research design. Case study design provides an in-depth analysis of a specific issue or phenomenon (Jackson, 2009). This design approach is selected to deepen knowledge and understanding of the valuation methods and challenges within the case study areas. The case study areas, namely, the Elburgon, Kaptumo and Sitoi tea estate timber plantations, are located within the western rainforest zone in the Rift Valley region in Kenya (see Figure 1). Kenya is an East African country with a forest cover of about 7.4% comprising timber plantations, woodlands and natural forests (Government of Kenya, 2018). The western rainforest is a vast land approximately 82,200 hectares, which is home to unique animals like the L'Hoest's monkey (Sayer *et al.*, 1992). As noted by Mwamodenyi and Omondi (2012), the zone is habitat to 400 butterfly species. The three case studies within this zone were purposively sampled owing to their rich and extensive bio-diversity, mixed land use practices and variety of forest benefits, including tangible traded products such as timber log, construction poles, charcoal and the non-market benefits, including tourist attraction, recreation, research and biodiversity. In Elburgon, for instance, apart from other land uses such as agriculture, fishing and mining, the forestry industry is a key economic activity with timber processing plants and tree nurseries established by large commercial saw millers and the local community. About 90% of the population in the area lives within a range of 0–5 km of the forests and uses the forests directly and indirectly (Waithiru, 2014). In Kaptumo, forestry is a major activity with three-quarters of households involved in tree planting and protection. According to Wambugu *et al.* (2015), about 99% of the homes in the area rely on wood as the

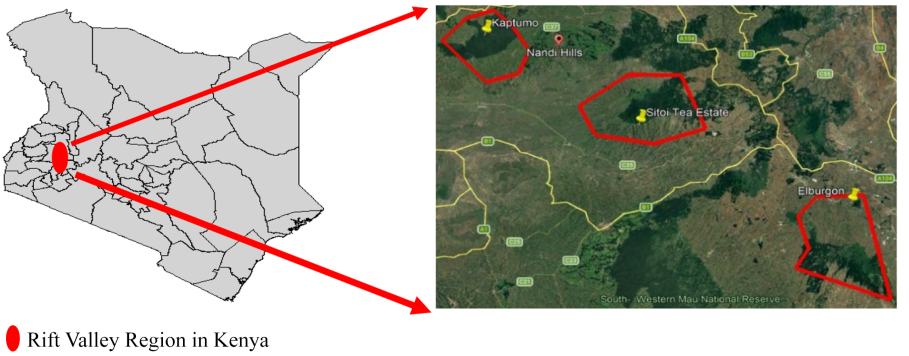

Figure 1. Map of Kenya showing the three case study areas (Elburgon, Kaptumo, Sitoi tea estate). Source: Google Maps, 2026

main source of energy. Sitoi tea estate is known for tea production for local use and export. However, besides tea production, forestry plays an important role in the area. The tea estate and timber plantation are owned and managed by a company known as Eastern Produce Kenya (EPK) Limited. The area has a rich mix of flora and fauna. According to EPK Survey (2018), there are 891 different species of plants and animals within the estate, including 125 butterflies' species, 47 dragonflies, 247 bird species, 96 tree species and shrubs and 376 wildflowers and herbs. The most popular tree species are the blue gum and African pine trees. Others include the Nile tulip, pink cedar and bastard yellowwood (*Afrocarpus falcatus*), grown for their ornamental features. Calliandra and Leucaena, which fall under the class of fodder shrubs, are grown for pasture for livestock feed in the Agro-forestry business.

The forest production and management practices in the three case study areas are standard and systematic and include seedling and seedbed management, land preparation, planting, weeding, fertilizer application, thinning and pruning, pest and disease control, harvesting and transportation to the market. The farmers and timber companies also adopt sustainable practices, where for every tree cut or felled, a replacement through planting of a new one is made. This is aimed at increasing the forest plantation benefits to address society's demands in a way that conserves forest environments for current and future generations.

The study population comprised all registered and practicing valuers in Kenya. These are the professionals authorized by law to undertake valuation in Kenya. The valuers are full members of the Institution of Surveyors of Kenya (ISK) and registered to practice valuation by the Valuers Registration Board (VRB) under the Valuers Act Cap 532 of the laws of Kenya. The ISK and VRB are the professional bodies mandated to register and regulate the practice and conduct of valuers, as well as promote their professional competencies and standards through capacity building initiatives, continuing professional development and education programs, development of valuation standards and guidelines, and advocacy(see ISK and VRB web sites https://isk.or.ke/& https://vrb.or.ke/), respectively. The valuers were chosen for this study because they possess the education, training and experience in valuation, and are authorized by law (Valuers Act Cap 532 laws of Kenya) to offer valuation services in Kenya.

The study adopted the Alreck and Settle (1995) formulae to calculate the sample size, as follows:

$$n = \frac{z^2 pqN}{e^2(N-1) + Z^2 pq}$$

Where.

n = sample of the population estimated to have characteristics being measured, assuming a 95% confidence level.

N = is the size of the population (there are 417 registered valuers in Kenya)

p = the proportion in the target population estimated to have the characteristics being measured (confidence level)

$$q = 1 - p$$

e = acceptable error (e = 0.05, since the estimated error of this research is ± 5% of the value). Z = the standard normal deviate at the required confidence level is 1.96.
Based on the formulae, the sample size (n) was calculated as follows:

$$n = \frac{1.96^2 \times 0.95(1-0.95) \times 417}{0.05^2(417-1) + 1.96^2 \times 0.95(1-0.95)} \text{ Hence, say n (valuers)} = 61$$

Both primary and secondary data were collected and analysed to achieve the objectives of the study. Primary data were obtained using open and closed-ended questionnaires administered to the 61 randomly sampled targeted respondent Valuers. 43 Valuers responded to the survey, giving a response rate of 70.49%. Further, oral interviews supplemented the questionnaires with a view to probing inadequate or unclear responses. Secondary data were obtained from documents such as books, journal articles, published and unpublished research works and conference papers. The data were analysed using descriptive statistics and content analysis. Findings were presented in tables and figures.

4. Data analysis and results

The analysis of the data and research findings is presented under the headings below.

4.1 Valuation approaches adopted

The results of the analysis of the data are presented in Table 1 and Figure 2 below. The analysis shows that, depending on the purpose of valuation, Valuers adopt different methodologies and approaches to arrive at timber and forest plantation values. The most popular method as per the field survey is the income approach, where 46.51% of the Valuers said they had used this method. Timber plantations are associated with the ability to generate a stream of income and this is the point of reference and interest for most of the players or investors interested in timber and forest farming. This, therefore, makes the use of the income or investment valuation method inevitable and most popular. Furthermore, according to the valuers interviewed, most of the purposes for which valuations are required are for leasing, sale and purchase, and investment purposes, which entail projections and analysis of cash flows, hence the popularity of the income approach. This was followed by cost and comparable transactions methods (25.58% and 18.60%), respectively.

The multi-parametric, conversion return, fixed royalty, value-related charges and auction price methods recorded 0% usage. Multi-parametric analysis method is applied to estimate the value of urban trees and the valuers indicated that their valuation work was limited to forest reserves and plantations outside towns and cities. Besides, forests within or near towns are mainly for recreation and not investment purposes that would necessitate the need for valuation. The other three methods are for the calculation of royalties and their assessments are mainly done by forest officers in the department of forestry in the government and not by valuers. Total Economic Value approach, where valuers combine market and non-market methods, stood at 6.98% of the valuation methodology adopted. While TEV is not classified as

Table 1. Methods of valuation of timber and forest plantations in Kenya

Purpose of valuation	Frequency	Percentage (%)
Comparable transactions method	8	18.60
Income approach	20	46.51
Cost method	11	25.58
Multi-parametric approach	0	0.00
Conversion return method	0	0.0
Fixed royalty approach	0	0.0
Value-related charges approach	0	0.0
Auction prices approach	0	0.0
Total economic value	3	6.98
Others	1	2.33
Total	*43*	*100*

Source(s): Authors

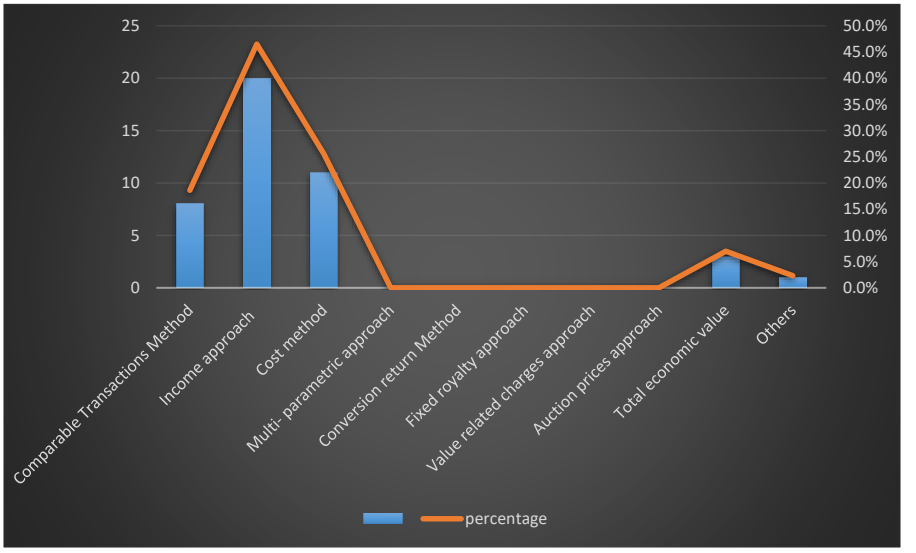

Figure 2. Methods of valuation of timber and forest plantations in Kenya. Source: Authors

a valuation method, the approach was preferred by the valuers because it assesses the full range of benefits within a forest ecosystem. According to the valuers interviewed, this approach was preferred for valuation for compensation purposes because of its potential in capturing other timber plantation benefits that do not enter the market or are not directly traded. Valuers argued that trees play multiple roles besides production of tangible goods such as logs, poles and firewood, hence the need to apply a holistic method that incorporates both market and non-market products accruing from any timber plantation. Specifically, valuers who had done valuations in the Kaptumo and Sitoi tea estate timber plantations indicated the TEV as the approach they had used due to the flow of indirect non-tradable benefits from these forest ecosystems.

4.2 Challenges of valuation of timber and forest plantations in Kenya

The analysis and findings are presented in Table 2 and Figure 3. The main challenges for timber plantation valuation, as reported by the valuers, are quantification of non-market timber

Table 2. Challenges of valuation of timber and forest plantations in Kenya

Challenges	Percentage
Lack of data	20.93
Establishing timber density	9.30
Depreciation calculation	6.98
Quantification of non-market timber benefits	32.56
Time value for money	6.98
Determination of interest rate	16.28
Clients' expectation on values	2.33
Time consuming	2.33
Heterogeneity of timber assets	2.31
Total	*100*

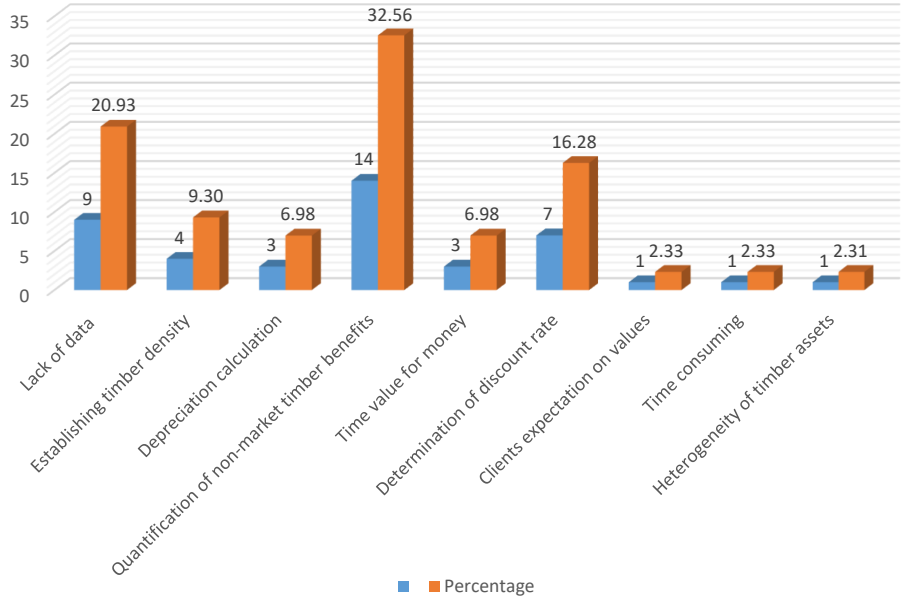

Figure 3. Challenges of valuation of timber and forest plantations in Kenya. Source: Authors

benefits and lack of data (32.56% and 20.93%), respectively. According to the valuers interviewed, knowledge of the dynamics of non-market timber benefits and forest ecosystem functions is still limited. This is further compounded by the non-tradability and lack of observable market prices for the non-market forest benefits. This observation is consistent with findings in the study by Xu *et al*. (2025) and Mameno *et al*. (2024). The valuers further noted that some farmers still relied on manual data storage, which could be subject to theft, loss or manipulation, posing serious challenge, and undermining the accuracy and reliability of the valuation process.

Determination of appropriate interest rates and establishing tree density came third and fourth, respectively (16.28% and 9.30%) as bottlenecks in timber plantation valuation. Time value of money and depreciation calculation also contributed to the challenges facing timber plantation valuation in Kenya at 6.98%. Valuers interviewed noted that the cost of establishing a timber plantation and operation costs are key to value determination using the valuation methods, especially the cost approach and the income method. However, to accurately estimate timber valuation, incomes and costs have to be capitalized or discounted to present value due to the time value of money and, therefore, the need to select an appropriate interest rate for discounting. Valuers noted that selecting an appropriate rate of return is a challenge because most timber farmers do not keep accurate records of their timber business. In addition, due to the heterogeneity of timber assets, comparing rates of return between different timber plantations may result in an error in the valuation.

Other challenges reported were client's expectation on the valuations, time consumption, as well as heterogeneity of timber assets. Even though these were ranked least at 2.33% and 2.31%, respectively, valuers indicated that their impacts still have a bearing on the timely completion of the valuation exercise. Another challenge was that timber plantation valuation is a tedious process since a valuer has to obtain detailed information ranging from timber and forest establishment costs, comparable transactions data, revenue and expenses data, rates of return, issuance of questionnaires to determine willingness to pay or accept, amongst others. This takes a lot of time and contributes to the delay in the valuation process.

5. Discussion

The study identified four main valuation methods used in the valuation of timber and forest plantations in Kenya, namely: cost, income, comparable transactions and total economic value. The major factors determining the choice of either of the methods are the purpose of valuation and data availability. Income approach is the most common method used in timber plantation valuation because timber farms are associated with the ability to generate a stream of income. With properly kept revenue and expenses data, the income approach is straightforward as it involves capitalizing or discounting the net income with the appropriate interest rate to ascertain the present worth. The major challenge of this method is how to determine the appropriate interest rate. Comparable transactions and cost methods are also common; however, the major bottleneck to these methods is their inability to capture non-tradable timber benefits. Timber assets are not homogeneous; thus, one timber plantation may not be a replica of another, which limits the use of the comparable transactions method and cost method. Total economic value, although not classified as a valuation method, is a preferred approach because it takes into account the full range of benefits within a timber plantation as an integrated system and accounts for both societal and environmental values flowing from the forest ecosystem. The method is, however, time-consuming and difficult to implement, requiring detailed information ranging from market data on sales of forest products, data on willingness to pay or accept, amongst others. This is a tedious and costly process. The multi-parametric, conversion return, fixed royalty, value-related charges and auction price method recorded 0% usage. The valuers indicated that they are rarely engaged in valuations for trees and forest reserves within or near urban areas. Similarly, they are not engaged in valuation for the calculation of royalties since this service is offered by forest officers employed by the government. Despite the weaknesses and challenges of the methods, to attain the holistic forest and timber plantation valuation, there is a need to employ a combination of both the market and non-market valuation methods. This would result in the valuation of forest resources that accounts for the full benefits of the forest ecosystem. The multi benefits and values that flow from a tree are aptly captured in the image in Figure 4 below.

Figure 4. A representation of the multi benefits and values of a tree in one image. Source: La Nova Burundi in East Africa (2019)

6. Conclusion

Timber and forest products are important natural resources. The valuation of these resources is important to promote their conservation and protection for sustainable development. There are two major categories of valuation methods used to assess the values of timber and forest plantations in Kenya. These are: market and non-market methods. Both approaches should be employed to arrive at a holistic valuation that reflects the market and non-market benefits and values flowing from forest ecosystems. The success of the application of the methods depends on how well they are executed. This depends on availability of information, valuer's knowledge and skill, judgement and practical experience. The main valuation challenges are the quantification of non-market forest benefits and the lack of data.

To address the challenges in forestry valuation and methods, valuers recommend the need for training and capacity building to enhance skills and knowledge on the use and application of the methods. The professional bodies, mainly the Institution of Surveyors of Kenya and the Valuers Registration Board, should include timber and forest assets valuation in their continuing professional development (CPD) programmes in order to update valuers on the changing trends in the forestry and natural resource sector and valuation. The CPD training programmes should include tailor-made short courses to cover essential aspects in forestry, such as knowledge of seedlings and seedbed management, understanding of different tree species, their optimum rotation age, tree pest and disease control, and the ecological functions of forests, among others. The professional bodies can also support valuers to attend and participate in local and international workshops, seminars and conferences with themes in forest conservation, management and valuation. To promote accuracy and consistency in valuations, the professional bodies should formulate standards and guidelines for forestry valuation with a focus on valuation approaches that incorporate both market and non-market timber and forest benefits. More collaboration and consultation with forest experts and farmers is needed to understand and quantify the non-market benefits and values that emanate from forest and timber plantations.

There is a need to deploy modern technology to obtain, store data and enhance speed and accuracy in the analysis of valuation information. More specifically, farmers should be encouraged to develop a computerized database management system (DBMS) to enhance safety, access and retrieval of forest data. DBMS suitable for timber and forest plantation should include information such as: land size, species of trees, tree density, spacing of the trees, dates for standard tree production and management practices such as land preparation, planting, weeding and thinning; timber yields, revenues and expenditures, among other important forest management data. DBMS ensures that the data stored is accurate and can easily be retrieved and cross-referenced. This is necessary to enhance the speed and accuracy of valuations for effective timber and forest plantation management and decision-making.

The study results and recommendations will promote forestry valuation practice in Kenya. The findings are, however, limited to the selected case study areas and restricted to timber and forest plantations. Continued research that examines other types of forest ecosystems in different geographical areas in Kenya is needed to provide conclusive insights into forest valuation methods and challenges.

Author contributions

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