

A Factor Analytic Approach for Sustainable Urban Forest Conservation in Nairobi City

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Abstract

Urban forests face numerous threats and competing needs in the ever-expanding urban landscapes despite their benefits to urban environments. They therefore need protection through sustainable conservation which is guided by the attitudes of urban residents. This is because attitudes and values attached to something predict its protection. This study therefore sought to investigate attitudes urban residents in Nairobi have towards urban forests through a factor analysis of attitudes on a 7-point Likert psychometric scale collected using a ranking questionnaire developed through literature review on urban forests and analysis of user attitudes. Six underlying factors were extracted with a factor loading of greater than 0.5, constituting the concepts used to provide a framework for the conservation of urban forests. The findings demonstrated favourable attitudes towards urban forests in Nairobi, with most residents believing that urban forests are beneficial and need protection. Consequently, this study recommends protecting the existing urban forest ecosystems while expanding and increasing its quality, biodiversity, and habitat richness through the proposed sustainable urban forest conservation framework.

Keywords

Attitudes, Conservation, Conservation Framework, Factor Analysis, Nairobi, Urban Forest

1. Introduction

Natural ecosystems within urban settings are necessary for providing ecosystem services (Göktuğ et al., 2015; Jang-Hwan et al., 2020). The urban forest ecology is one of these ecosystems that is widely recognised as being an important component (Göktuğ et al., 2015; Muslih et al., 2022; Roeland et al., 2019; Wang et al.,

2022). The need for more sustainable approaches to planning and managing wildlife in urban areas is becoming increasingly urgent as the percentage of the world's population living in cities rises (Dobbs et al., 2011). The process of urbanisation affects urban ecology (de Lourdes Saavedra-Romero et al., 2021; Dharma & Zakaria, 2022; Jang-Hwan et al., 2020). Therefore, the absence of ecological attention throughout the planning stages of development is the cause of environmental issues. It is also noteworthy that, internationally, only a small number of urban development plans give environmental integrity, sustainability, biological diversity, and conservation of urban landscapes the attention they deserve to protect urban nature and sustain biodiversity (Barron et al., 2016; Paracchini et al., 2014). But in numerous nations and towns, thorough investigations on the diversity of plant species and their interactions with anthropogenic and environmental factors have been carried out (Ordóñez & Duinker, 2010).

Other recent studies have examined and highlighted the significance of urban forests, their importance in the urbanising world and the urgent need for their conservation. These studies include (Baumeister et al., 2022; Devisscher et al., 2022; Dharma & Zakaria, 2022; Jang-Hwan et al., 2020; Roeland et al., 2019; Tuffour-Mills et al., 2020). These studies demonstrated the importance of urban forests, their value and the urgent need to protect them as a shared natural resource.

2. Methods

In this study, questionnaires developed through literature review on urban forests and analysis of user attitudes were applied using field survey instruments that consisted of attitudinal statements questionnaire items. An attitudinal survey gives information on respondent perceptions (emotions, feeling, attitudes) of their experience in each study. In such a study, a scale consisting of a set of selected statements or manifest items expected to assess or reflect theoretical latent variables, constructs, or factors is used to rate the attitudes. An attitudinal survey questionnaire was adopted for assessing attitudinal preferences among urban forest visitors towards urban forests in Nairobi. This data collection tool comprised 40 attitudinal statements designed to understand attitudes towards the urban forest environment better. Additionally, this study employed a methodological evaluation to assess Nairobi residents' perceptions of urban forests. Najd et al. (2015) contend that the preferred approach has been frequently applied in studies on people's perceptions of and attitudes about various surroundings. This strategy has been demonstrated to be a legitimate and appropriate way to identify the underlying components influencing perceptions, such as attitude, content, and the spatial configuration of the landscapes in each setting.

Mansfield et al. (1977) concurs further that people's emotive response and judgment are related to how they perceive their environment. Therefore, research on environmental perception can explain how people's behaviour is affected by their surroundings and vice versa. According to the model and theory of preference, Herzog et al. (1982) and Kaplan (1982), preference is one of the finest indicators

of human perception. This is because it is a by-product of perception and people regularly make preference judgements. Furthermore, information, natural reaction, cognitive process, motivation, emotion, and perception have a greater influence on preference assessment than anything else.

Considering this, it can be said that preference is the gathering of data regarding how individuals perceive their surroundings. Therefore, the preference survey method is used in this study to identify the underlying variables influencing perceptions, such as attitude, user characteristics, usage patterns, and spatial configurations in Nairobi's urban forests.

To analyze the data, this study used factor analysis to condense the larger number of qualities into a more manageable collection of variables that were then used to infer conclusions. To understand the underlying reason these factors (also known as latent or component factors) capture a significant amount of information about a group of variables in the dataset, factor analysis is performed. Some of the features in data with many predictors may share a common pattern when analysed. The elements that share a common meaning at their core might be affecting the target variable via sharing this causation, hence these features are joined to form a factor. As a result, a factor (or latent) is a fundamental component that unifies or underlies all the other variables. Additionally, because these latent variables (or latent constructs) cannot be measured independently using a single variable, they cannot be directly observed.

Therefore, a factor (or latent) is a core element that unifies or underlying all other variables. Moreover, these latent variables (or latent constructs) cannot be directly seen because they are incapable of being independently quantified by a single variable. For this study, a total of forty (40) attitude statements were looked at, with their analysis being condensed into six (6) components.

3. Sampling

In sampling, a heterogeneous cluster-based frame was adopted for this study, necessitating that all five urban forests be selected from which six visitor clusters could be selected and simple random sampling adopted. Additionally, the demographic makeup of the respondents was checked to ensure a good representation of variables such as gender, ethnicity, and educational background.

Non-willingness of every respondent from the sampling units to respond made the study use non-probability voluntary sampling to identify sample units which were visitors in forests from the study areas. According to (Kothari et al., 2009), results obtained from the analysis of such a deliberately selected sample are still tolerably reliable as the investigator was impartial, worked without bias, and had the necessary experience to make sound judgments.

Stratified probability sampling was used to create strata in each study area. The number of strata in each urban forest was determined based on the sizes of these study areas. City Park, Karura, and Ngong Road forests were divided into four strata, while Nairobi Arboretum and Michuki Park were divided into two strata.

Equal samples were then collected from each of the strata. This sampling method helps increase precision where a bigger population requires a smaller sample size.

The sampling unit was the visitors in the selected urban forests of City Park, Nairobi Arboretum, Karura, Ngong Road, and Michuki Park in Nairobi at the time of the study interviewed on their perception of the urban forests and preference attitudes of their urban forest environment. This unit was achieved by selecting all the willing participants that were present in the forest at the date and time of the data collection.

4. Data Analysis

SPSS and Excel were used in data processing and analysis of variables. Data entry, coding, and graphs projection were made using Excel spreadsheets, while SPSS was used in the descriptive analysis to calculate frequencies, mean, mode, medians, and Analysis of Variance (ANOVA).

Principal Component Analysis (PCA) was used in SPSS version 21 along with Kaiser Normalization and Varimax Rotation. To achieve a relatively strong coefficient and effective loading of variables, the loading factor was adjusted at a maximum of 0.5. Statements from these variables were loaded into component groupings known as preference dimensions. The mean, mode, and median of each dimension were determined to rank the dimensions and further analyse the level of preference and likeability.

4.1. Principal Component Analysis

Principal Component Analysis describes the data reduction method needed to determine the participant preference dimensions. As a result of this procedure, participants' attitude statements are divided into several useful categories that reflect their regular responses to attitude statement questionnaires.

The equation below illustrates Principal component analysis as.

$$Y = W1*PC1 + W2*PC2 + \dots + W10*PC10 + C$$

where, PCs are the components and Ws are the weights for each of the components.

4.2. Factor Analysis

A factor (or latent) is a common or underlying element with which several other variables are correlated as shown below.

$$X1 = W1*F + e1 \quad X2 = W2*F + e2 \quad X3 = W3*F + e3$$

where, F is the factor, W is the weights and e are the error terms.

The error is the variance in each X that is not explained by the factor.

Rankings of relevance and contribution to the urban forest ecosystem were supplied by the scale on characteristics of urban forests. Using the content identification method (CIM), similarities among attitudinal groups—whether in the most or least preferred groups—were examined. Finally, this method established the

identification of attitude traits as the determinant of enduring attitude patterns. As a result, in this procedure, attitude statements with similar features were grouped, and the preference dimensions were given names based on the theoretical framework from the literature review.

The study sought first to establish the demographic data of the respondents. Secondly, a field survey was conducted through attitude statement schedules to determine urban forest characteristics and user values associated with Nairobi's forests, with 400 being the target sample size. To rank the assessed attitudinal statements and determine which set of statements are the most and least preferred based on item magnitude, the descriptive analysis needed to uncover the important urban forest characteristics and overall mean preference score.

5. Study Area

The study area of this research was in Nairobi County, which has many urban forests of public and private nature. The study's complexity required the selection of public urban forests of significant acreage. Hence through non-probability purposive sampling, five gazetted urban forests of City Park, Nairobi Arboretum, Karura and Ngong Road, were sampled to represent urban forests with similar urban forest characteristics Nairobi County Kenya (Figure 1).

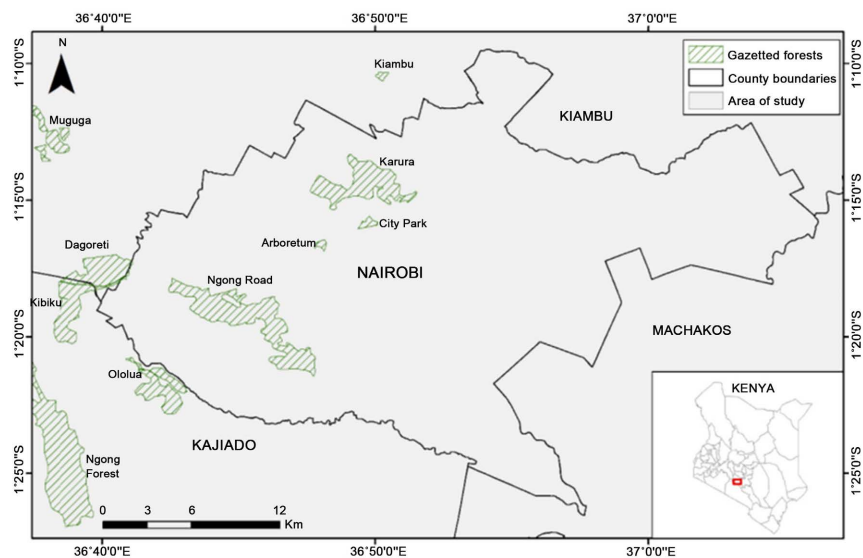


Figure 1. The study area. Nairobi Urban forests Map. Source: Oloo, Murithi, & Jepkosgei 2020.

6. Results

6.1. Factor Analysis for Attitudes towards Nairobi's Urban Forests

In this study, users' perceptions of Nairobi's urban forest ecosystems were the observed variables, and factor analysis was done to determine the underlying elements that explain the correlation pattern within that set of variables. The reliability of the items taken out of the surveys was evaluated using the Cronbach alpha

value. The alpha statistic for the items was discovered to be 0.788, exceeding the cut-off of 0.65 established by numerous academics and demonstrating the internal consistency of the factors.

Bartlett's test for sphericity and the Kaiser-Meyer-Olkin (KMO) test for sample adequacy were carried out to distinguish the correlation between the variables to enlighten the study on the applicability of components analysis. The KMO index value was 0.653, which is higher than the threshold (0.5), and Bartlett's test of sphericity was significant ($\chi^2(780) = 2197.538, p 0.05$). As a result, the data could be analysed using factors, as shown in **Table 1** and **Table 2** below.

Table 1. Data reliability. Source: Author 2022.

| Reliability Statistics | |
|------------------------|------------|
| Cronbach's Alpha | N of Items |
| 0.788 | 40 |

Table 2. KMO and Bartlett's Test. Source: Author 2022.

| KMO and Bartlett's Test | | |
|--|--------------------|----------|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | 0.653 |
| | Approx. Chi-Square | 2197.538 |
| Bartlett's Test of Sphericity | df | 780 |
| | Sig. | 0.000 |

6.2. Communalities of the Items

The extraction communality values show the variance estimate in each variable accounted for by the factors in the factor solution. From the table, most of the variance estimates are above 50%, which is recommended in this study as shown in **Table 3** below.

Table 3. Data communalities. Source: Author 2022.

| Communalities | | |
|--|---------|------------|
| | Initial | Extraction |
| Willingness to plant a tree as a conservation initiative | 1.000 | 0.713 |
| Birds should be part of the city | 1.000 | 0.703 |
| It is comfortable walking in the forest | 1.000 | 0.686 |
| High-rise buildings are a threat to urban forests | 1.000 | 0.682 |
| Advertisement billboards are a threat to street trees | 1.000 | 0.662 |
| Provide space for animals in the city | 1.000 | 0.640 |
| Feel secure in the forest | 1.000 | 0.615 |
| Management of urban forests in Nairobi is adequate | 1.000 | 0.613 |
| All parts of the forest are easily accessible | 1.000 | 0.603 |

Continued

| | | |
|--|-------|-------|
| Urban forests protect the city against climate change effects | 1.000 | 0.603 |
| Enjoy watching animals and birds in the forest | 1.000 | 0.592 |
| I prefer walking in the forest to city streets | 1.000 | 0.583 |
| Animals should be part of the city | 1.000 | 0.582 |
| We do enough to protect urban forests | 1.000 | 0.576 |
| Trees make the city beautiful | 1.000 | 0.568 |
| More access points should be provided | 1.000 | 0.554 |
| The importance attached to urban forests is adequate | 1.000 | 0.550 |
| More animals should be introduced into the forest | 1.000 | 0.529 |
| Forest access should be free for the public | 1.000 | 0.525 |
| The Nairobi city county should manage Nairobi's forests | 1.000 | 0.524 |
| The forest staff are adequate in managing the forest | 1.000 | 0.517 |
| More trees should be planted in the forest | 1.000 | 0.516 |
| Recreation facilities in the forest are sufficient | 1.000 | 0.514 |
| People cause pollution in the forest | 1.000 | 0.484 |
| New road developments in Nairobi are a threat to Nairobi's urban forests | 1.000 | 0.482 |
| Walking in the forest is beneficial | 1.000 | 0.473 |
| Willingness to volunteer in activities to improve the forest | 1.000 | 0.458 |
| Entrance fees are affordable | 1.000 | 0.456 |
| Forests in the city should be cleared to provide more land for housing | 1.000 | 0.453 |
| Saddened by the rate of development around forests in Nairobi | 1.000 | 0.444 |
| Willingness to be trained in ways to conserve the forest | 1.000 | 0.438 |
| Natural forests are better than artificial landscapes | 1.000 | 0.436 |
| We value real estate development more than urban forests | 1.000 | 0.434 |
| Ablution facilities in the forest are adequate | 1.000 | 0.418 |
| Forests in the city pose a security risk | 1.000 | 0.385 |
| Waste management in the forest is adequate | 1.000 | 0.370 |
| Commercial activities in the forest are a threat to the forest | 1.000 | 0.351 |
| We attach little value to the protection of urban forests | 1.000 | 0.326 |
| Entry fees should be increased | 1.000 | 0.285 |
| Ease of access | 1.000 | 0.105 |

Extraction Method: Principal Component Analysis.

6.3. The Components Explain Variance

In this study, six components were retained, and the variance explained by each component was reported. From the analysis, component 1 reported the highest

percentage variance explained (13.686%) as shown in **Table 4** below. In essence, the percentage variance is explained by each component, while the cumulative percentage shows the total percentage variance explained by all the components. It is depicted that; the total variance explained by the six components is 51.121%, slightly above 50%.

Table 4. Total variance explained. Source: Author 2022.

| Component | Total Variance Explained | | | | | | | | |
|-----------|--------------------------|---------------|--------------|-------------------------------------|---------------|--------------|-----------------------------------|---------------|--------------|
| | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 5.474 | 13.686 | 13.686 | 5.474 | 13.686 | 13.686 | 4.616 | 11.539 | 11.539 |
| 2 | 4.387 | 10.968 | 24.654 | 4.387 | 10.968 | 24.654 | 4.082 | 10.204 | 21.743 |
| 3 | 3.978 | 9.944 | 34.598 | 3.978 | 9.944 | 34.598 | 3.142 | 7.855 | 29.598 |
| 4 | 2.797 | 6.993 | 41.591 | 2.797 | 6.993 | 41.591 | 3.070 | 7.675 | 37.273 |
| 5 | 1.937 | 4.842 | 46.433 | 1.937 | 4.842 | 46.433 | 2.789 | 6.973 | 44.245 |
| 6 | 1.875 | 4.688 | 51.121 | 1.875 | 4.688 | 51.121 | 2.750 | 6.875 | 51.121 |

Extraction method: Principal Component Analysis

6.4. Scree Plot

A scree plot was used to graph eigenvalues against the component number as shown in **Figure 2** below. From the graph, it is deduced that the first six values are clearly above the eigenvalue of 1.8 set in this research. From the seventh component, the line tends to flatten, meaning each successive component accounts for smaller and smaller amounts of the total variance.

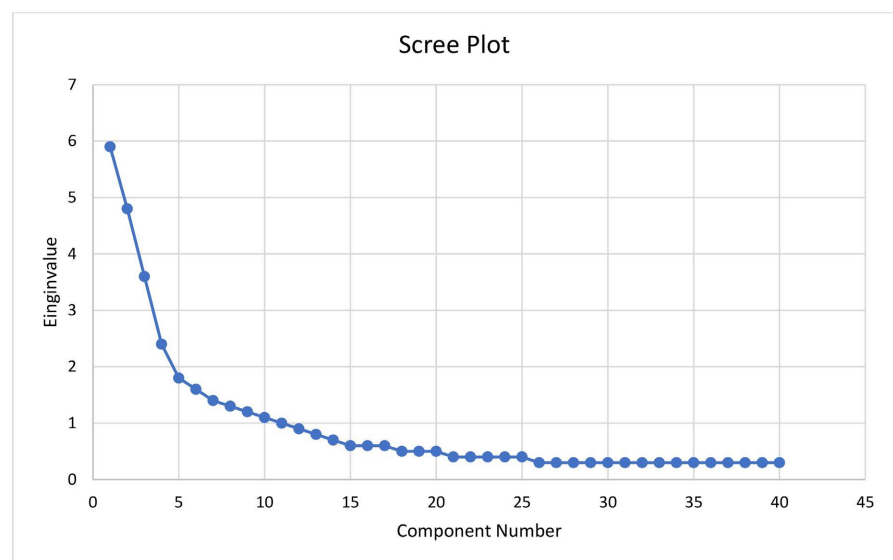


Figure 2. Scree plot. Source: Author 2022.

6.5. Component Transformation Matrix

The component transformation matrix shows the correlation between the components before and after rotation. Positive values show a positive correlation between the variables before and after rotation, while negative values show a negative correlation between the components before and after correlation. For instance, the correlation between component 1 before and after rotation is $r = 0.786$, showing a strong positive correlation as shown in **Table 5** below.

Table 5. Component transformation matrix. Source: Author 2022.

| Component Transformation Matrix | | | | | | |
|---------------------------------|--------|--------|--------|--------|--------|--------|
| Component | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 0.786 | 0.284 | 0.241 | 0.247 | 0.078 | 0.419 |
| 2 | -0.308 | -0.443 | 0.341 | 0.561 | 0.455 | 0.267 |
| 3 | -0.339 | 0.812 | -0.105 | 0.221 | 0.402 | -0.059 |
| 4 | -0.168 | 0.194 | 0.897 | -0.299 | -0.153 | -0.129 |
| 5 | 0.375 | -0.123 | 0.087 | 0.110 | 0.409 | -0.811 |
| 6 | -0.055 | 0.102 | 0.046 | 0.689 | -0.659 | -0.275 |

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

6.6. Rotated Component Matrix

Component extraction and component rotation were conducted. The component extraction method employed was a principal component (PCA), while component rotation was conducted using varimax rotation. From the 40 items, six components were extracted that can provide meaningful correlation amongst users' attitudes towards Nairobi's urban forest ecosystems and were reliable for factor analysis. The factor loadings of each component are tabulated in **Table 6** below.

Factor Loadings

The higher the factor loadings, the higher the item's contribution to the component. The presence of a negative factor loading is an indication that the item is related in the opposite direction from the component. Essentially, factor loadings greater than 0.5 show that the factor can significantly interpret the component. On the other hand, factors loadings less than five are considered not to significantly explain the corresponding component as shown in **Table 6** below.

Table 6. Factors loadings. Source: Author 2022.

| Component | Name | Items | Factor loadings | Mean |
|-------------|---|---|-----------------|------|
| Component 1 | Benefits and functions of urban forests | Willingness to plant a tree as a conservation initiative | 0.824 | 6.07 |
| | | Urban forests protect the city against climate change effects | 0.748 | 6.04 |
| | | Enjoy watching animals and birds in the forest | 0.708 | 6.02 |

Continued

| | | | | |
|--------------------|--|--|--------|------|
| Component 1 | Benefits and functions of urban forests | More trees should be planted in the forest | 0.644 | 6.09 |
| | | Trees make the city beautiful | 0.584 | 6.08 |
| | | Willingness to be trained in ways to conserve the forest | 0.581 | 6.08 |
| | | Willingness to volunteer in activities to improve the forest | 0.550 | 5.43 |
| | | Natural forests are better than artificial landscapes | 0.529 | 6.05 |
| | | We attach little value to the protection of urban forests | 0.472 | 5.04 |
| | | Forests in the city should be cleared to provide more land for housing | -0.383 | 2.40 |
| | | Ease of access | 0.212 | 4.19 |
| Component 2 | Management of urban forests | Management of urban forests in Nairobi is adequate | 0.739 | 3.85 |
| | | The forest staff are adequate in managing the forest | 0.695 | 4.02 |
| | | The importance attached to urban forests is adequate | 0.690 | 3.64 |
| | | Recreation facilities in the forest are sufficient | 0.647 | 3.58 |
| | | We do enough to protect urban forests | 0.627 | 4.11 |
| | | The Nairobi city county should manage Nairobi's forests | 0.566 | 4.04 |
| Component 3 | Urbanization and Land Use | Entry fees should be increased | 0.496 | 3.47 |
| | | Highrise buildings are a threat to urban forests | 0.798 | 4.78 |
| | | Advertisement billboards are a threat to street trees | 0.780 | 4.56 |
| | | New road developments in Nairobi are a threat to Nairobi's urban forests | 0.667 | 4.86 |
| | | Saddened by the rate of development around forests in Nairobi | 0.519 | 4.82 |
| | | Forest access should be free for the public | 0.481 | 4.16 |
| | | Forests in the city pose a security risk | 0.358 | 4.36 |
| Component 4 | Accessibility | All parts of the forest are easily accessible | 0.764 | 3.89 |
| | | It is comfortable walking in the forest | 0.754 | 4.88 |
| | | Feel secure in the forest | 0.667 | 4.68 |
| | | More access points should be provided | 0.480 | 4.67 |
| | | Ablution facilities in the forest are adequate | 0.459 | 3.41 |

Continued

| | | | | |
|--------------------|---------------------------------|--|--------|------|
| Component 5 | Biodiversity | Birds should be part of the city | 0.742 | 5.04 |
| | | Provide space for animals in the city | 0.704 | 4.81 |
| | | Animals should be part of the city | 0.684 | 4.79 |
| | | We value real estate development more than urban forests | -0.484 | 4.80 |
| Component 6 | Threats to urban forests | People cause pollution in the forest | 0.643 | 4.75 |
| | | I prefer walking in the forest to city streets | 0.600 | 5.11 |
| | | More animals should be introduced into the forest | 0.495 | 5.58 |
| | | Entrance fees are affordable | 0.455 | 4.78 |
| | | Commercial activities in the forest are a threat to the forest | 0.435 | 4.59 |
| | | Waste management in the forest is adequate | 0.406 | 4.24 |
| | | Walking in the forest is beneficial | 0.398 | 5.29 |

Component Means

The means for the six key components identified were ranked as shown in **Table 7** below. This ranking shows that the component of Urban forests benefits is the most important attitude component with a mean of 5.41 while the component of Management of urban forests is the least key component with a mean of 3.82 as shown in **Table 7** below.

Table 7. Key component means. Source: Author 2022.

| Component | Mean |
|----------------------------|------|
| Urban Forest Benefits | 5.41 |
| Threats to urban forests | 4.91 |
| Biodiversity | 4.86 |
| Urbanization and Land Use | 4.59 |
| Accessibility | 4.31 |
| Management of Urban Forest | 3.82 |

7. Attitude Dimensions to Urban Forests in Nairobi

Measurement scales normally include equal numbers of positively and negatively stated items to avoid agreement bias. In this study, a 40-item standard questionnaire for rating attitude statements on a 7-point Likert scale comprised both positive statements in favour of urban forest resources and negative statements opposed to urban forest resources.

To identify the underlying issues affecting user attitudes, six components were extracted from the 40 attitude items that can provide a meaningful correlation amongst users' attitudes towards Nairobi's urban forest ecosystems. In this study,

the user attitudes with a factor loading greater than 0.5 show that the factor can significantly interpret the component. The six components constitute the concepts that can provide a framework for conserving urban forests.

7.1. Factor 1: Benefits and Functions of Urban Forests

According to the ranking, urban forests' component benefits and functions were the most significant attributes of user attitudes toward urban forests in Nairobi. This finding is supported by the highest mean score of 5.41. This is preferable in the 7-degree Likert scale, as shown in **Table 8** below.

Table 8. Factor 1: Benefits and functions of urban forests (Source: author, 2023).

| Factor 1: Benefits and functions of urban forests | Factor loadings | Mean |
|---|-----------------|------|
| Willingness to plant a tree as a conservation initiative | 0.824 | 6.07 |
| Urban forests protect the city against climate change effects | 0.748 | 6.04 |
| Enjoy watching animals and birds in the forest | 0.708 | 6.02 |
| More trees should be planted in the forest | 0.644 | 6.09 |
| Trees make the city beautiful | 0.584 | 6.08 |
| Willingness to be trained in ways to conserve the forest | 0.581 | 6.08 |
| Willingness to volunteer in activities to improve the forest | 0.550 | 5.43 |
| Natural forests are better than artificial landscapes | 0.529 | 6.05 |

The attitude of willingness to plant a tree as a conservation initiative scored the highest mean of 0.824 in this factor. This finding is supported by the general need to protect the urban forest revealed by the study. This can also be attributed to the concept of biophilia and the connection to nature inherent in humans. This factor is also constituted by attitudes on key benefits of urban forests in the form of climate change effects mitigation, animal and bird watching, and beauty with means of 0.748, 0.708, 0.644, and 0.584, respectively. This finding is supported by the attraction of people to the urban forest environment and the biophilia concept outlined above. Furthermore, the benefits accrued from urban forests justify conserving urban forests.

7.2. Factor 2: Management of Urban Forests

According to the ranking, the component management of urban forests was the second most significant attributer to user attitudes towards urban forests in Nairobi. This finding is supported by the mean score of 3.82. This is preferable in the 7-degree Likert scale, as shown in **Table 9** below. This confirms that managing urban forests is key to sustainable utilization and protection.

The urban forest benefits and functions outlined in Factor 1 above can be considered a resource that must be utilised and managed sustainably. Therefore, this

calls for a management strategy and framework supported by this factor of urban forest management.

Table 9. Factor 2: Management of urban forests (Source: author, 2023).

| Factor 2: Management of urban forests | Factor loadings | Mean |
|---|-----------------|------|
| Management of urban forests in Nairobi is adequate | 0.739 | 3.85 |
| The forest staff are adequate in managing the forest | 0.695 | 4.02 |
| Importance attached to urban forests is adequate | 0.690 | 3.64 |
| Recreation facilities in the forest are sufficient | 0.647 | 3.58 |
| We do enough to protect urban forests | 0.627 | 4.11 |
| The Nairobi city county should manage Nairobi's forests | 0.566 | 4.04 |
| Entry fees should be increased | 0.496 | 3.47 |

7.3. Factor 3: Urbanization and Land Use

According to the ranking, Urbanization and Land use were the third significant attributer to user attitudes towards urban forests in Nairobi. This finding is supported by the mean score of 4.59, which is essentially preferable on the 7-degree Likert scale, as shown in **Table 10** below. This finding confirms the rapidly urbanising environment's role and importance in conserving urban forests. This relationship is antagonistic but mutually beneficial if it occurs in a sustainable environment. Urbanization reduces land for urban forests but brings more people to the city who crave the urban forest environment. This relationship justifies the conservation of the existing urban forests in the rapidly urbanizing world.

Table 10. Factor 3: Urbanization and land use (Source: author, 2023).

| Factor 3: Urbanization and Land use | Factor loadings | Mean |
|--|-----------------|------|
| High-rise buildings are a threat to urban forests | 0.798 | 4.78 |
| Advertisement billboards are a threat to street trees | 0.780 | 4.56 |
| New road developments in Nairobi are a threat to Nairobi's urban forests | 0.667 | 4.86 |
| Saddened by the rate of development around forests in Nairobi | 0.519 | 4.82 |
| Forest access should be free for the public | 0.481 | 4.16 |
| Forests in the city pose a security risk | 0.358 | 4.36 |

7.4. Factor 4: Accessibility

According to the ranking, Accessibility was the fourth most significant attributer to user attitudes towards urban forests in Nairobi. This finding is supported by the mean score of 4.31, which is essentially preferable on the 7-degree Likert scale, as shown in **Table 11** below. This finding connects the user with the urban forest

resources. Without access to urban forests, their utility is meaningless and therefore not useful in the city.

Table 11. Factor 4: Accessibility (Source: author, 2023).

| Factor 4: Accessibility | Factor loadings | Mean |
|--|-----------------|------|
| All parts of the forest are easily accessible | 0.764 | 3.89 |
| It is comfortable walking in the forest | 0.754 | 4.88 |
| Feel secure in the forest | 0.667 | 4.68 |
| More access points should be provided | 0.480 | 4.67 |
| Ablution facilities in the forest are adequate | 0.459 | 3.41 |

This component provides a case for enhancing access to urban forests and sufficient amenities to ensure ample utilization of urban forests. The respondents in this study, who were derived from visitors in the urban forests surveyed, accessed these forests through different means from residential neighbourhoods across Nairobi.

7.5. Factor 5: Biodiversity

According to the ranking, Biodiversity was the fifth most significant attributer to user attitudes towards urban forests in Nairobi. This finding is supported by the mean score of 4.86, preferable on the 7-degree Likert scale, as shown in **Table 12** below. This finding confirms the main attraction to urban forests and the biophilia concept in Component 1. The flora and fauna in the urban forests of a city contribute to the ecological balance and provide ecosystem services that form part of the benefits and functions outlined in Factor 1 above. This further confirms that the city needs plants, animals, and birds in its fabric for a balanced ecosystem.

Table 12. Factor 5: Biodiversity (Source: author, 2023).

| Factor 5: Biodiversity | Factor loadings | Mean |
|--|-----------------|------|
| Birds should be part of the city | 0.742 | 5.04 |
| Provide space for animals in the city | 0.704 | 4.81 |
| Animals should be part of the city | 0.684 | 4.79 |
| We value real estate development more than urban forests | -0.484 | 4.80 |

7.6. Factor 6: Problems and Threats to Urban Forests

According to the ranking, the component Problems and Threats to urban forests was the sixth most significant attributer to user attitudes towards urban forests in Nairobi. This finding is supported by the mean score of 4.91, preferable on the 7-degree Likert scale, as shown in **Table 13** below. This finding summarises the main challenges facing urban forests, which can be attributed to pollution, urbanization,

waste management, and deforestation. These challenges need solutions for the urban forests to remain a key component of the urban fabric.

Table 13. Factor 6: Threats to urban forests (Source: author, 2023).

| Factor 6: Problems and Threats to urban forests | Factor loadings | Mean |
|--|------------------------|-------------|
| People cause pollution in the forest | 0.643 | 4.75 |
| Prefer walking in the forest to city streets | 0.600 | 5.11 |
| More animals should be introduced in the forest | 0.495 | 5.58 |
| Entrance fees are affordable | 0.455 | 4.78 |
| Commercial activities in the forest are a threat to the forest | 0.435 | 4.59 |
| Waste management in the forest is adequate | 0.406 | 4.24 |
| Walking in the forest is beneficial | 0.398 | 5.29 |

8. Discussion

The study findings established that if the benefits and functions of urban forests are recognised and promoted, the attitudes of the city residents and urban forest users will be changed positively. Secondly, the study also established that proper management of urban forests is key in predicting the quality and state of urban forests. Thirdly, urbanization and land use strategies, policies, and patterns affect and threaten urban forests through competing needs in a capitalistic environment. Fourthly, accessibility is key in promoting the utilization and enjoyment of urban forest resources. The fifth finding is biodiversity and its role and place in the urban environment. This is the key attraction to urban forests which directly affects the meaning and value attached to the urban forest by the users and city residents. An increase in biodiversity will positively affect the user's attitudes. Lastly, in the sixth finding, if problems and threats to urban forests are reduced, the attitudes of the city residents and urban forest users will be changed positively too.

9. Conclusion

The first finding of the study was that the sentiments people had about urban woods were most strongly influenced by their benefits. An average score of 5.41 confirms this. The respondents' general appreciation and like of nature in the city can be credited for this. Additionally, it demonstrates how much Nairobi's citizens value urban trees' advantages.

Thirdly, biodiversity was the third attributer of attitudes associated with urban forests. This is supported by a mean score of 4.86. This confirms the role of flora and fauna in urban forest ecosystems. The first objective's findings on urban forest components further support this finding. Biodiversity is the source of ecosystem services and the main attraction to urban forests.

Fourthly, urbanization and land use were the fourth attributer of attitudes associated with urban forests. This is supported by a mean score of 4.59. This confirms

the challenges and threats of urbanization to the urban forests in Nairobi. Urbanization causes put pressure on urban forests through competing land use demands.

Fifthly, accessibility to urban forests was the fifth attributer of attitudes associated with urban forests. This is supported by a mean score of 4.31. This finding provides a case for enhancing access to urban forests and sufficient amenities to ensure ample utilization of urban forests. The respondents in this study, who were derived from visitors in the urban forests surveyed, accessed these forests through different means from residential neighbourhoods across Nairobi.

Sixth, managing urban forests was the sixth characteristic of attitudes related to urban forests. A 3.82 mean score corroborates this. The perceived poor management of Nairobi's urban woodlands is evidence in favour of this conclusion. A thorough resource inventory and monitoring should serve as the foundation for managing urban forests, much like policies and planning should.

In summary, participants generally had favourable attitudes towards urban forests in Nairobi, with most residents believing that urban forests are beneficial and need protection. Interestingly, the residents are willing to participate in the protection of these urban forests as they recognise them as a beneficial shared resource. People protect what they deem valuable, and this can be reported to be true in this study.

In conclusion, the summarised interpretation of the users' attitudes is that there is a universal appreciation of the role and benefits of urban forests. There is also a great appetite for these benefits as illustrated by the quest for universal access and general improvement of the forest's environment. In addition, available scientific literature, evidence, and numerous policy instruments have emphasized the importance of urban green spaces in urban social-ecological systems to mitigate several problems of urban dwellers in the last two decades. This study has further brought out the attitudes that users of Nairobi have towards its environment. These attitudes summarise the values attached to the natural environment and its presence in the city. These values provide a basis for protection since it is generally accepted that a society cannot protect what it does not value.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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