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(Ecosystem Services and Disservices of Urban Forest and people's perception towards it)

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Contents

ACRONYMS

ANOVA: Analysis of Variance

CBS: Central Bureau of Statistics

DFRS: Department of Research and Survey

EDS: Ecosystem Disservices

ES: Ecosystem Services

FAO: Food and Agriculture Organization

FRTC: Forest Research and Training Center

GIS: Geographical Information System

LM: Lalitpur Municipality

LSMC: Lalitpur Sub Metropolitan City

LULC: Land Use and Land Cover

MA: Millennium Ecosystem Assessment

MOF: Ministry of Forestry

NDVI: Normalized Difference Vegetation Index

NGOs: Non-Governmental Organizations

NTNC: National Trust for Nature Conservation

OSM: Open Street Map

SD: Standard Deviation

SPSS: Statistical Package for the Social Sciences

TEEB: The Economics of Ecosystems and Biodiversity

UF: Urban Forest

UN: United Nations

VDC: Village Development Committee

1. Abstract

Urban forestry has significant importance in human life and has provided multiple ecosystem services for city dwellers such as food production, water storage, raw materials, habitat provision, temperature regulation, recreation, tourism, and educational importance Besides that urban forestry also has some disservices such as allergic potential, damage to infrastructure, aesthetic damage, and failure of tree growth. Despite growing scholarly attention to urban forests, few studies to date have conducted comprehensive assessments of their ecosystem services and disservices. This study conducts an interdisciplinary and wide-ranging assessment of ecosystem services and disservices of Lalitpur Metropolitan City (LMC). 7 ecosystem services and 4 disservices were identified from the literature review. Taking into consideration these ecosystem services and disservices from the literature review a questionnaire survey was conducted among the local inhabitants of Lalitpur Metropolitan City. Most of the respondents perceive the defined ecosystem services and disservices in LMC whereas most of the respondents perceive aesthetic damage in small concentrations as urban ecosystem disservice. A correlation test among ecosystem services and disservices was done by using Spearman's correlation analysis. Water storage strongly correlates with all the ecosystem services perceived except food production. Besides that, habitat provision also has a strong correlation with temperature regulation and education opportunities. Along with that damage to infrastructure and aesthetic damage have a strong correlation, allergic potential and aesthetic damage have a moderate correlation while all the disservices have a weak correlation. One-way ANOVA was performed to test the statistical significance between demographic factors, multiple ecosystem services, and disservices of urban forest with the significance value (i.e., $p<0.05$). Education level has no significant difference in perceived ecosystem services and disservices. Cronbach's Alpha was used to test the reliability of the eight items of protection of the urban forest in LMC. I would pay more municipal tax to protect urban forests, which was insignificant so was removed from the analysis. The KMO test and Bartlett test were done to assess the validity of the null hypothesis. Mean, standard deviation, and variance for all the items were calculated and overall, all the respondents agreed with the items of urban forest protection. One-way ANOVA was performed to test the statistical significance between demographic factors and items of protection of urban forest with the significance value (i.e., $p<0.05$).

Keywords: Urban forest, Ecosystem services, Ecosystem disservices, Perception.

Ecosystem Services and Disservices of Urban Forest and people's perception towards it.

(A Case Study of Lalitpur Metropolitan City, Nepal)

2. Background

More than 75% of the population lived in cities in many of the more industrialized nations in 2000 (Francis and Chadwick 2013), and by 2050, it is predicted that two-thirds of the world's population will do so (Gómez-Baggethun and Barton 2012). Population rises, primarily in urban areas (Dye 2008). The process of urbanization is aided by the phenomenon of urban sprawl, which is expanding faster than population growth in developed nations (Pickett et al., 1997). (Cadenasso et al., 2007). Urban forests (UF) are essential for a growing urban population's quality of life and overall well-being (Bonaiuto et al. 2003; Chiesura 2004).

Urban forests, which include all trees, shrubs, lawns, and other vegetation in cities, offer residents of those cities a range of ecosystem services, including food and raw materials production, global climate regulation, urban temperature regulation, runoff mitigation, and recreational opportunities, as well as ecosystem disservices, including issues with tree damage, allergies, and infrastructure damage (Escobedo et al., 2011; Gómez-Baggethun and Barton, 2013). Under the conditions of upcoming environmental change and population growth, promoting sustainable cities is essential. Cities today and in the future may make sure that their urban residents have access to ecosystem services. The urban forest is one of the primary providers of ecosystem services in cities and can serve as the foundation for information to measure ecosystem services and negative effects, identifying places with insufficient supply that do exist.

Cities are characterized by a variety of players with various objectives and viewpoints on trees (Agbenyega et al., 2009; Lyytimäki and Sipilä, 2009; Popoola and Ajewole, 2001). According to literature, all trees generally provide ecosystem services like reducing pollution and are thus desired. A more complex evaluation indicates that urban forest areas simultaneously provide various diverse ecosystem products. It is crucial to distinguish between ecosystem functions, services (benefits), and disservices (costs). These ideas are being applied more frequently to explain how ecosystem function and structure relate to urban residents' quality of life Lyytimäki and Sipilä, 2009; Tratalos et al., 2007; Young, 2010). These outputs can be categorized as ecosystem services or environmental quality depending on the urban context (i.e., diversity of natural processes, individual and social views, demography, and economic realities) disservices. Different ecosystem services are important to people depending on the specific urban forest structure and pollution in that city's difficulties (Young, 2010).

Ecosystem services (ES) have been described in a variety of ways by different authors (Boyd and Banzhaf, 2007, Fisher et al., 2009), but they have always been done so concerning people (Chan et al., 2006; Tallis and Polasky, 2009). They can be distinguished from ecological functions on account of this characteristic. No matter whether humans or other animals are present, ecosystem activities still take place (Tallis and Polasky, 2009). An ecological function might be a tree that traps pollutants in the air or water. If that function raises the local area's standard of air and water, that is an ecosystem service that enhances human health. Ecosystem services are defined by Brown et al. (2007) as "the specific outcomes of ecosystem functions that either directly sustain or enhance human life" because of this distinction between functions and services. Ecosystem services are features of ecosystems that are actively or passively, directly, or indirectly, used to promote human well-being, Kroeger and Casey (2007) argue that to count as ultimate ecosystem services, those elements of nature that are directly used, consumed, or enjoyed by humans should be considered.

According to Zhang et al. (2007), ecosystem disservices (EDS) have a detrimental effect on wellbeing. Ecosystem disservices also fall within the definition of ecosystem services as finished products. Moreover, like ecosystem services, urban forests provide a variety of functions, often at varying levels. According to different people or communities (Agbenyega et al., 2009; Zhang et al. (2007). For instance, one side's aesthetic is another source of an attractive, comfort-improving shade tree allergies, trash, and obstructing the view. These divergent Perceptions will be influenced by more than just the design of urban forests. but also, on personal tastes as well as specific pollution a difficulty (Agbenyega et al., 2009). Disservices to ecosystems are not only pecuniary, but they might also take the shape of social annoyances as well as pollution.

Perception refers broadly to how people mentally process information derived from the environment around them (Rossi. et.al, 2015). The cognition of perception can be influenced by biological (e.g., individual differences in eyesight or taste) and socio-cultural factors (e.g., interpreting inputs that we sense), as well as the physical attributes of what is being perceived. Perception responses refer specifically to the cognitive construct of how something is being perceived. The term diversity captures the range of contextual, methodological, demographic, and cognitive considerations behind the study of people's experiences with the environment around them, and how people generate their perceptions and responses from these experiences. Finally, experience refers to the range of cognitive, emotional, and behavioral processes that shape how people relate to their environment. Measuring individual attitudes towards urban green spaces has received sparse coverage in the environment and planning. One reason may be due to the greater importance that natural forests have occupied in global environmental concerns with the result that local land use types such as urban green spaces have not been comprehensively studied. Another reason is that local environments have complex social characteristics, and it has been technically easier and more cost-effective to generalize research results using coarser scales of analysis. However, this approach risks incurring ecological and exceptional fallacy problems (Trochim, 1999). Efforts to assess and understand people's perceptions of urban forests are necessary to enable planners and urban managers to better incorporate diverse community needs into urban forestry. Understanding the range of human encounters and responses concerning urban nature is key to activating pathways that promote biodiverse urban landscapes nature-based human well-being and healthy communities (Shanahan et al., 2015).

2.1.A Brief History of Urbanization and Urban Green Space Today

The earliest human settlements in regions with an abundance of resources and chances for building shelter can be linked to the beginning of the urbanization process (Francis and Chadwick 2013). A more impermeable built environment developed around these regions because of the natural population growth that followed. The size of the settlement is determined by how far you can travel while carrying a bucket of water. Field access was necessary, and the home was regarded as the center of existence (Larson, 2012). The process of urbanization advanced as new building methods were created and resources from nearby areas were utilized. The development process changed because of the Industrial Revolution, and population density increased. (Francis and Chadwick 2013). Cities were made up of a compact center with industry and basic dwellings. (Davis et al. 2011). Urban society was formed because of the growth of housing facilities, infrastructure, and an affluent population, resulting in distinct urban gradients of people working in the center and residing in the periphery (Davis et al. 2011; Francis and Chadwick 2013). A significant change that resulted in the growth of the road and train network was the centralization of things like education in schools or healthcare in hospitals. Urban regions expanded because of increased industrialization (Francis and Chadwick 2013). The 1950s saw the introduction of an increasing number of suburban projects along with a rise in automobile use, which furthered suburbanization. Deindustrialization and the expansion of the service industry defined the post-World War II era. In the 1980s, suburbanization gradually came to an end, and the emphasis shifted to the growth of already-built environments (Davis et al. 2011).

2.2.Urban forestry in Nepal's context:

A strong custom concerning the preservation of roadside trees emerged during the rule of Chandra and Juddha Shamsher from the period of 1885. But there has been a difference in this. In the 1960s and 1970s, contemporary urban-environmental planning was introduced, and as a result, the Nepali government renovated all the city's roads and streets. To preserve already mature trees and establish new ones where none previously existed, many of Kathmandu's older streets were widened. Urban environmental planners began focusing on three-line green belts in the 1980s rather than a single-line tree-planting idea. Urban forestry growth today is primarily observed in a few cities. Urban forestry has been practiced in the shape of park development. In the country's urban regions, some examples of well-known parks include Ratna Park in Kathmandu, Balaju Park in Lalitpur, Tribhuwan Park in Tulsipur, Sankha Park in Butwal, and Mitra Park in Kathmandu. The municipalities in consideration are primarily responsible for carrying out these urban forestry-related actions in the cities. Additionally, though not consistent enough, plantation operations have been carried out on occasion. Roadside plantations have emerged as the most interesting urban forestry practice in recent years. Pokhara, Hetauda, Damauli, Narayangadh, and other towns offer some outstanding examples. Urban forestry has not yet been considered as a possible sector for growth in the Act and Bylaws related to forestry. However, there are some laws and regulations, such as the Forest Act of 1992, the Forest Regulation of 1994, the Environment Conservation Act of 1996, the Environment Conservation Regulation of 1997, and other acts related to plant conservation, that have a direct bearing on both the naturally occurring or planted forest and the living things that live in urban areas. Additionally, there is no specific section in any official organizations for urban forestry. Regarding the responsive agency for the administration of urban forestry, there is still some confusion.

Any industry must be improved through scientific study. The same applies to urban forests. Urban forestry has not been the subject of a lot of study. The Department of Forest Research and Survey (DFRS) has only conducted a very small number of studies in a select number of towns, including Pokhara, Kathmandu, and Chitwan.

2.3. Rationale of the study

Although urban forestry has gained widespread support around the globe, its promise for cities and towns in underdeveloped nations has not yet been fully realized (Konijnendijk et al., 2006). Food and Agriculture Organization (FAO) has been attempting to promote UF in developing nations since 1990, there are still barriers to its implementation in these nations due to a lack of information and strategically coordinated action (FAO, 2002; El Lakany, 1999) Though urbanization in and of itself is not necessarily a problem, haphazard and unplanned urban growth has brought about several environmental issues, including the invasion of public space and riverbanks, air and water pollution, and the generation of solid waste. Nearly half of the world's population lives in urban areas, despite municipalities taking up a very small percentage of the planet's overall land area (United Nations, 2001).

One such exciting idea that has recently gained the ability to address a variety of urban requirements and realities is urban forestry. It might be claimed that urban forestry needs to be included in the fundamental infrastructure of populated urban cities and towns due to the numerous advantages they offer. Urban forestry, however, does not currently receive the attention it deserves. Evaluation of services and disservices, involvement level, attitude, and perception can help to identify any barriers to urban forestry activities, which will allow for the analysis of issues and potential solutions relating to the growth and sustainability of urban greenery.

Additionally, the entire area has seen a rise in industrialization and commercialization. The entire city environment is significantly deteriorating day by day because of rapid and unplanned urbanization, commercial expansion, and population pressure. Also, during the past 50 years, the number of trees has been quickly dwindling due to industrialization in the urban fringe areas and changes in land use both within the city and in the nearby urban fringes (Ansari, 2008). Urban forestry is still frequently viewed as a desired but not necessarily environmentally oriented endeavor. This indicates that the public is less engaged in urban forestry development because they are not sufficiently aware of the value of having tree coverings in and around their living spaces. To implement the necessary programs in time for the growth of urban greenery in the valley, it is necessary to examine the level of knowledge among the public regarding urban forestry services and disservices.

3. Literature review

Although there is a lack of this kind of research in Nepal, this part tries to review the relevant and currently available literature to the current study. Urban forestry should be the subject of several studies and investigations, according to a few global studies on large cities, to advance human civilization, enhance the environment, and protect biodiversity.

3.1.Conceptual overview of urban forestry

The idea of urban forestry originated in North America in the 1960s. The maintenance of trees in urban environments is known as urban forestry. The word "urban forestry" was first used in writing in 1894 (Cook referenced in Konijendijk, et al., 2006), even if a true definition of what it is has been difficult to establish and is historically contextual. The art, science, and technology of managing trees and forest resources in and around urban community ecosystems for the psychological, sociological, economic, and aesthetic benefits trees give is how it is commonly characterized (cited in Kjell, 2005). The idea of "urban forestry," which includes the design, planning, creation, and management of trees and forest stands with amenity qualities located in or close to urban areas, has gained wider acceptance (Nilsson and Randrup, 1997).

The cultivation and management of trees for their current and potential contributions to the physiological, sociological, and economic well-being of urban life is the focus of urban forestry, a specialist area of forestry. It embraces a multimanager system that includes urban watersheds, wildlife habitats, possibilities for outdoor enjoyment, landscape design, recycling of municipal garbage, general tree care, and the production of wood and fiber as raw materials. Urban forestry encompasses the management of all trees in the region influenced by and used by the urban population, not just city trees or individual trees (Randrup et al., 2005). Arboriculture, arbor-ecology, arbor economics, arbor planning, and arbor sociology are the five main elements of urban forestry (Costello, 1993).

3.2.Trend of urbanization

If the 20th century can be considered the urbanization century for Europe and North America, the 21st century is the urbanization century for Asia (Kjell, 2005). In developing nations, urban areas will make up approximately 90% of the predicted global population growth between 1995 and 2030. Soon, more than half of the people in Asia and Africa will reside in urban regions, compared to between 75% and 85% in Central and South America (FAO, 2002). One of the biggest difficulties in the coming decades will be managing changes in the urban population (Kjell, 2005). Urban regions require more land to supply inputs and outputs of resources and energy, which harms forests and other green spaces. In Asia, it was predicted in the early 1990s that continuous urbanization and suburbanization would result in the loss of more than a quarter of the continent's green area within two decades (Kuchelmeister and Braatr, 1993). The need for food, fuel, and shelter will expand in tandem with the significant urban population expansion, necessitating the development of methods in which forestry will play a larger role in supplying these necessities and in enhancing the urban living environment (FAO, 1989; Kuchelmeister, 1991; Olembo and de Rham, 1987). The valley began to become urbanized in the late 1950s, but urbanization began to accelerate and become uncontrolled in the 1970s. Greater Kathmandu's land use, particularly in the Kathmandu Metropolis and Lalitpur Sub metropolis, has altered significantly over the past three decades.

3.3. Services of urban forestry

Many scholars (Dwyer, et al., 1991; Ulrich, 1990; Keller 1979;) have noted the significance of urban forests in enhancing aesthetic quality, ecological maintenance, cleaning the air, and regulating temperature extremes. People simply feel better living near trees; they have a significant societal function in reducing tensions and enhancing psychological wellness. According to one study, hospital patients who are placed in rooms with windows that face trees recover more quickly and stay in the hospital for fewer days (Ulrich, 1990). When it comes to enhancing the environment and quality of life for the contemporary urban population, the creation of multifunctional urban green structures can be a significant contributor to sustainable urban development (Konijnendijk et al., 2004).

3.4. Disservices of Urban Forestry

Urban ecosystem disservices have received relatively little attention from studies. This shortage of research does not, however, indicate a complete lack of information. Contrarily, several fields have a long history of characterizing various forms of harm brought on by natural factors without ever using the term "ecosystem disservice." Recently, several authors have made the case that it is crucial to consider both the "good" and "bad" that ecosystems produce to develop a more balanced starting point for management action (Delshammar, Stberg, & xell, 2015; Lyytimäki, Petersen, Normander, & Bezák, 2008; Shapiro & Báldi, 2014). The financial costs of preserving urban trees, allergens, pest outbreaks, air pollution, concerns for personal safety, and physical damage are a few examples of disservices in the context of urban forests (Escobedo, Kroeger, & Wagner, 2011). To sustain community support for management initiatives and given the numerous stakeholders engaged in managing urban ecosystems, ecosystem disservices should be addressed alongside ecosystem services (Sandbrook & Burgess, 2015). To fully comprehend residents' tree management choices, develop strategies to support management goals, and/or modify management to better reflect residents' responses to disservices, exploration of disservices in urban forests should also include residents' negative experiences with urban trees (Kirkpatrick, Davison, & Daniels, 2013).

3.5. Constraints in Urban Forestry Development

Although urban forestry is beneficial in many ways, we do not directly profit from it. Thus, people in urban areas are disregarding plantations. Every little piece of land in the city is being taken over for habitation. The home is not the only significant issue; our health must also be taken into consideration. The amount of greenery is being reduced by the encroachment of new settlements and the removal of trees for numerous reasons. Urban people's ignorance, lack of awareness, and lack of education about the benefits have become a major barrier to the success of urban forestry (Pokharel, 2000). Trees in the built environment encounter many difficulties. The availability of water and nutrients, soil quality, and space restrictions are all variables that restrict the growth of trees in developed environments. In these circumstances, trees will only be able to support themselves if they are cared for by communities of people. Urban public tree maintenance is frequently quite disorganized and lacking in correct arrangements. As a result, many areas with trees suffer from poor upkeep, especially in areas with tight resources. Regrettably, due to the financial demands of more urgent political and social challenges affecting cities, such as crime and education, urban forestry projects sometimes receive little funding from municipal budgets or little attention from the decision-makers (Parker, 1995; Tate, 2000). As a result, there are no longer any opportunities for establishing green spaces and trees. The high cost of land in urban settings is another barrier to the development of urban forestry. This causes pressure on green spaces in urban centers and the conversion of forest lands in suburban and peri-urban areas (FAO, 1995).

3.6. Possible Opportunity for Urban Forestry Development

The protection of existing green spaces, such as parks, gardens, playgrounds, etc., increased avenue and roadside planting, rooftop gardening, the introduction of forestry and nursery activities in newly developing areas between built-up and peri-urban areas, and the promotion of homestead gardening and social or community forestry in peri-urban areas are all potential opportunities (Ansari, 2008). Future urban forestry programs in underdeveloped nations should, to the greatest extent possible, use a participatory approach. Urban residents should ideally be able to participate in decision-making and implementation from the selection of tree species to the actual planting, care, and (where applicable) harvesting of tree products (Carter, 1993). The success rate of the planting program is raised by this participation. Yet, if locals aren't involved in the planning and planting of the trees, the community might not appreciate the efforts (Miller, 1988). A preliminary analysis of management potential and needs must be conducted before beginning urban forestry. People back initiatives they deem worthwhile, particularly if they stand to gain directly from them (IADB, 1997). For instance, urban trees are more likely to survive when people beg for them (Kuchelmeister, 1991), and trees that are worshipped have a survival rate of almost 100%. Working with neighborhood associations and other local NGOs is frequent; to involve the public, one must look beyond the typical city park boundaries to the neighborhoods that are around urban open spaces (Jaenike, 1997).

3.7. Challenges of urban forestry

The main difficulty facing urban forestry is raising public knowledge of the importance and advantages of urban forests, their proper maintenance, and the necessity to regard urban forests as critical infrastructure when developing community plans. Without this knowledge and comprehension, money, and support for the execution of urban forestry programs won't be available (NKUCFC, 2008). Maintaining tree and planting site inventories, calculating, and optimizing the benefits of trees, limiting expenses, securing, and sustaining public support and funding, and creating laws and rules for trees on both public and private land are some of the management problems. Inadequate planting sites for trees are another issue brought on by rising densities and increasingly impermeable surfaces. Insufficient root and canopy space, poor soil, inadequate or excessive water and light, heat, pollution, mechanical and chemical damage to trees, and mitigation of tree-related dangers are additional arboricultural issues that urban forestry brings (NKUCFC, 2008).

4. Objectives

- To assess the ecosystem services, disservices, and existing tradeoffs and synergies in Lalitpur Metropolitan City.
- To understand how demographic factors affect the ecosystem services and disservices in Lalitpur Metropolitan City.
- To assess perceptions of people towards urban forest protection in Lalitpur Metropolitan City.

5. Methodology

Based on secondary data, first, the ecosystem services and disservices offered by Lalitpur Metropolitan City were assessed.

5.1. Classification and Categorization of Ecosystem Services

Ecosystem services were categorized according to The Economics of Ecosystems and Biodiversity (TEEB) program into four basic groups: provisioning, regulating, cultural, and habitat services (TEEB, 2010). First, a study of the literature was done on the positive effects provided by urban forests globally and specifically for Nepal. A literature analysis of scientific articles, policy and commercial documents, books, webpages of Nepali governmental institutions and organizations connected to LMC, master theses, and media documents to determine the ecosystem services specifically offered by Lalitpur was done. Based on the data from the sources listed above, Lalitpur's ecosystem services were chosen, classified, and coded by the TEEB's categories for ecosystem services. Ecosystem service assessments frequently make minor adjustments to the categories of ecosystem services to better reflect the local circumstances or specific ecosystem types (Camps-Calvet et al. 2016).

5.1.1. Definition of Assessment Indicator

Indicators were established for measuring each ecosystem service category (for example, provisioning services) and subcategory (for example, raw materials and water), selecting those that offered the best level of precision within the available data. 3 provisioning services, 1 supporting service, 2 cultural services, and one regulating service were included. The ability of humans to receive goods from ecosystems, such as food, water, and resources, including wood, oil, genetic resources, and medicines, is known as provisioning services. Any advantage derived from ecosystem functioning and natural processes is categorized as providing regulatory services. Examples include controlling the climate, preventing floods and other environmental disasters, pollinating plants, purifying water, and more. Non-material benefits that humans can get from ecosystems are included in cultural services. These include academic growth, spiritual enrichment, leisure, and aesthetic ideals. Supporting services are those that relate to how the habitat functions and so affect survival.

5.2. Classification and Categorization of Ecosystem Disservices

Lyytimäki (2014) tried to categorize dozens of ecosystem disservices (EDS) recorded in newspapers into six groups, including weather-related events, worries and risks, aesthetic issues, activity inhibition, and harmful ecosystem functions. In addition, Shackleton et al. (2016) classified ecosystem damage into six groups depending on the ecosystems from which they originated and the aspects of human well-being that were impacted. Vas et al. (2017) additionally proposed that there are five different forms of EDS, including health, material, security, and safety, cultural and aesthetic, and leisure and recreation EDS. Although these EDS classifications have benefits of their own, it is difficult to compare them to the findings of other ES studies. A literature analysis of scientific articles, policy and commercial documents, books, webpages of Nepali governmental institutions and organizations connected to Lalitpur metropolitan city, master theses, and media documents to determine the ecosystem disservices specifically offered by Lalitpur was done. Based on the data from the sources listed above, Lalitpur's ecosystem disservices were chosen, classified, and coded by the categories for ecosystem disservices according to Lyytimäki (2014). Classification of EDS based on related functions can allow ES and EDS research to be combined more effectively.

5.2.1. Definition of Assessment Indicator for Ecosystem Disservices

As a result, a functional categorization scheme for EDS is comparable to the popular ES classification scheme for MA. When individuals require things but can't get them because of ecosystem processes or functions, provisioning EDS applies. The harm or costs those individuals incurred because of the management of environmental processes are referred to as regulating EDS. Finally, cultural EDS describes non-material costs or harm that people incur because of ecosystems. Since supporting EDS is similarly the foundation for the delivery of ES and is challenging to identify on their own, they were left out of the analysis.

5.3. Structuring the questionnaire

The dimensions of attitude towards the ecosystem services and disservices offered by urban forests were investigated by the questionnaire survey instrument. These parameters were established through literature analysis. The affinity analysis approach divided the problems into groups with increasing levels of clarity and specificity. Demographics data were measured in categorical variables whereas seven ecosystem services and 4 ecosystem disservices provided by urban forests were measured in binomial scale i.e., Yes /No. Each topic has questions that were created to address it. A 5-point Likert scale with answers ranging from 1 (Strongly agree) to 5 (Strongly disagree) and a 3 (neutral) option was used to present eight attitude issues towards the different items of protection urban forest.

Variables and their measurement scale

Variables	Description	Measurement Scale
Sex	Stated gender of respondents	Categorical
Age	Number of years since birth	Descriptive
Education	Highest academic achievement	Categorical
Occupation	Profession involved in	Categorical
Urban forest protection	Attitudes towards urban forestry protection	1-5 Likert
Ecosystem services from urban forest	The positive impact of urban forest	Binomial
Ecosystem Disservices from urban forest	The negative impact of urban forest	Binominal
Income	Total salary after tax	Descriptive

Table 1: Components included in the questionnaire.

5.4.Quantitative Online Questionnaire

Data regarding names, address coordinates, phone numbers, and emails about local inhabitants of different backgrounds were collected from the Lalitpur Metropolitan City office to conduct the survey. A total of 851 people's data was collected from the LMC office and then the survey was conducted using the Google form. A quantitative online questionnaire was conducted between May 10th and July 29th, 2023. Participants were asked to answer questions about their demographic status, their perception towards the items of the urban forest, ecosystem services, and disservices they are deriving from the urban forest.

5.5. Data Analysis

5.5.1. Quantitative Phase

For quantitative data analysis, Statistical Package for the Social Sciences (SPSS) and QGIS were used. First, all the data obtained were filtered, and coded into numeric form and the frequency of all the demographic factors, ecosystem services, and disservices were analyzed using descriptive statistics. Then the normality of the dataset was tested using the Kolmogorov-Smirnov test ($p>0.05$), but it was found that the dataset was not normally distributed because the p values were <0.05 and the histogram didn't show the normally distributed curve (i.e., bell shape). A correlation analysis between all ecosystem services and disservices indicators was performed using Spearman's correlation coefficient r (significance level $p=0.01$, $p=0.05$). Spearman's correlation coefficient is widely used in ecosystem services and disservices assessment to measure the linear relationship between 2 ecosystem services and disservices (Lee and Lautenbach, 2016). Disservices were classified as weak ($r<-0.03$), moderate ($-0.05<r<-0.03$), or strong ($r<-0.05$)

following Fagerholt et al. 2012. Likewise, services were classified as weak (r<0.03), moderate (0.03<r<0.05), or strong (r>0.05). Tradeoffs and synergies between ecosystem services and disservices were mapped using the correlation coefficient. To test the relation between demographic variables, ecosystem services, and disservices from urban forests One Way ANOVA was performed in SPSS with significance values(p<0.05). All the charts, tables, and graphs were prepared from SPSS and Microsoft Excel.

The questionnaire items about the protection of urban forestry were analyzed for accuracy by Churchill's item purification method (Churchill, 1979). Items with a 'corrected-item-total' correlation of less than or equal to 0.3 are insignificant and removed from the items set. Exploratory factor analysis was applied to the items to examine the attitude structure. KMO and Bartlett's test of sphericity was done to assess the validity of a null hypothesis. Mean, standard deviation, and variance were calculated for significant items to know the perception towards the protection of urban forestry. Means values for the items of urban forest protection ranging from (1-1.80 Strongly disagree, 1.81-2.6 Disagree, 2.61-3.40 Neutral, 3.41-4.20 Agree, and 4.21-5 Strongly Agree). One Way ANOVA was performed to test the significant difference between attitudes components and demographic factors with significant value (P<0.05).

5.6.Study Area

5.6.1. Description of study area

Nepal is a small landlocked country with a total area of 147,181 km2, in which more than 80% of people live on subsistence agriculture in rural areas (Gautam et al. 2009). Nepal's economy is mainly structured by the agriculture sector which accounts for more than 85% of human resource involvement and in 2009–2010 contributed 33% of gross domestic product (Gautam et al. 2009; MOF 2010). Along with agriculture, forestry is the dominant land-use system of the country, with 24.7% (3.64 M ha) of land covered by forest and 12.9% (1.90 M ha) by shrub (FAO 2006). Most of the population relies entirely on agriculture and forests for deriving their basic needs (Acharya 2002).

Lalitpur is in eastern Nepal and is the largest metropolitan city in the Lalitpur District. It has a land area of 15.46 km2 and is divided into 22 wards. It has a population of 162,991 constituting a total of 68,922 households with an average family size of 4.66 persons, and a male-to-female ratio of 1.08 (CBS, 2020). Lalitpur offers a unique opportunity for studying the real-time urban forestry response to continuing development during a period of rapid economic change in the country. The city is relatively flat, with an elevation range of 1,280–1,330 masl. It lies within the warm temperate climatic zone of Kathmandu Valley, with a typical monsoonal two-season per year climate. The average annual temperature in the valley is 15–20C, reaching a maximum of 32C during summer and a minimum of 2C in winter. The annual average precipitation is typically in the range of 2,000–2,400 mm, with most rain falling during June to September17.

5.6.2. Map of the study area

The map of the study area was prepared with the help of QGIS software version 3.16.16.

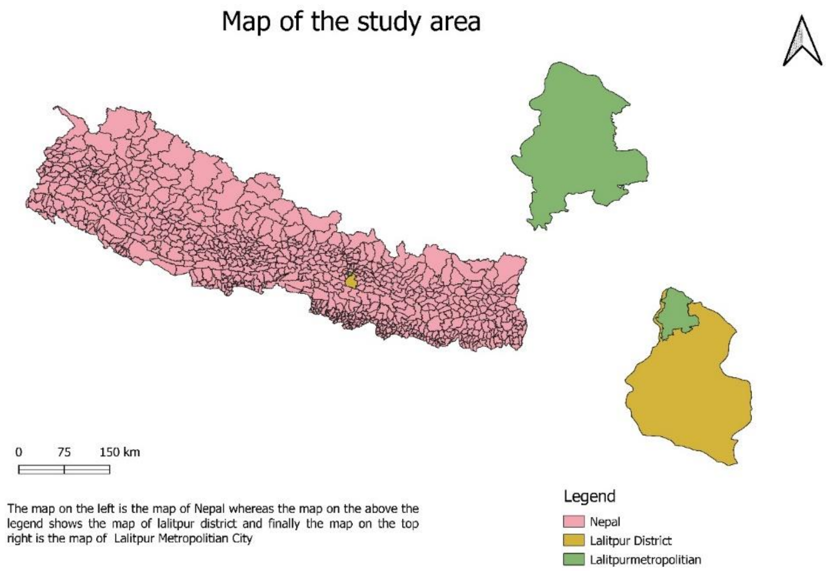

Figure 1: Map of the study location

5.6.3. Brief History of Urban development and land use in Lalitpur Metropolitan City

The urban history of the city of Lalitpur is as old as the urbanization of the valley itself, which was rich and self-sustained, with its strong agricultural and economic base. The city seems to have started about a little over two thousand years ago, during the Kirat rule Various rulers of different dynasties Kirat, Licchavis, Mallas to Shahs contributed to its development and prosperity. Agriculture use has been the predominant land use in Lalitpur, followed by forests and grasslands. Over the past decades, urbanization has encroached upon agricultural land and more recently on more fertile land along the river flood plains closer to the developed areas of the city. It has spilled over into adjoining VDCs converting agricultural land to urban use.

Landuse	**Area Covered (km2)**
Cultivated	7.33
Residential	5.78
Occupational	0.047
Industrial Area	0.046
Educational Institutions	1.66
Roads	0.34
Forest	0.03
Total	15.46

Table 2: Land use of LMC

Source: LMC office Brochure (2022)

5.6.4. Normalized Difference Vegetation Index (NDVI)

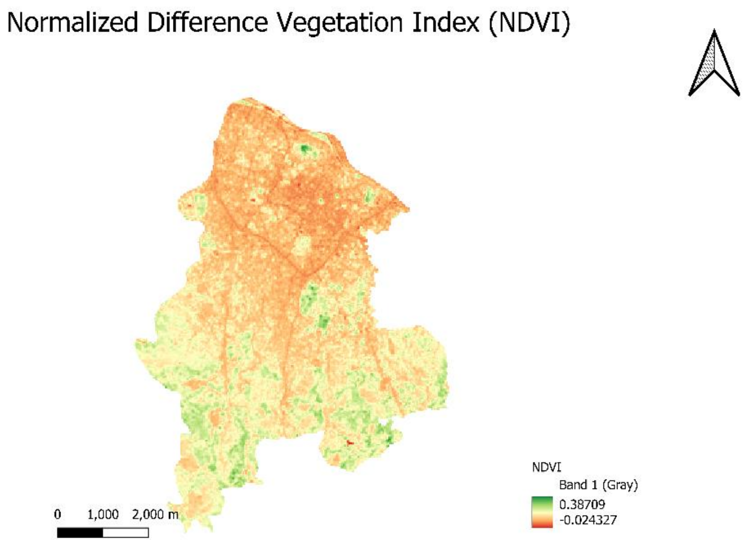

Figure 2: NDVI map of LMC

An image exhibiting greenness, or relative biomass, can be created by using the Normalized Difference Vegetation Index (NDVI), a standardized index. The NDVI measures the qualities of red and near-infrared (NIR) light, which can be used to categorize high and low vegetation and identify dryness. The NDVI map shown in Figure 2 was prepared with the help of QGIS software version 3.16.16. The red part in the NDVI map indicates the non-vegetated area (buildings, roads, construction, etc.) while the green part shows the vegetated area (natural forest, roadside plantation, artificial parks, etc.).

NDVI= NIR-RED/NIR+RED

6. Result

6.1. Ecosystem Services and Disservices

From the literature review and case studies of published papers about urban forestry in Lalitpur metropolitan city & ecosystem services, 4 ecosystem disservices were identified and discussed below.

6.1.1. Food Production

By balancing urban zones and agricultural belts, Howard proposed the perfect layout for cities with a comfortable settlement (Howard, 1965). Food provision was chosen as an important ES of urban forests in the study area not only because our ancestors used to eat food from forests (such as chestnut, corn, and pine nuts), but also because the agriculture experience program in urban parks is expanding in Nepal right now and because 80% of our citizens are willing to participate in agriculture in urban parks (Jeong et al. Citation2013). Both the studies by Clark and Nicholas (Citation2013) and Bulut et al. (Citation2010) were taken into consideration while defining the attribute of food provisioning. The proportion of fruit trees in urban forests is positively connected with people's preference for urban forests, claim Bulut et al. (Citation2010). Different parks, roadside trees, and home gardens. has mainly supported food production through the production of fruits, berries, etc. in LMC. An indicator of the flow and trend in agricultural output using data on actively managed agricultural land (land utilized for pasture, food, and fodder production) and land managed by urban forest in Lalitpur Metropolitan City was used. Over the past three decades, there has been a striking change in land use/land cover (LULC) in LMC, since most of the previously vegetated and agricultural land has been transformed into impermeable urban land (Sarif et al. 2020). Statistics depict that the agricultural land is getting shrinkage while the food production from urban forests in LMC has increased in the past decades.

6.1.2. Water storage

Urban forests serve as vegetated regions that permit water penetration while minimizing surface run-off, which could otherwise raise peak flood outputs. As a result, water can seep through and be absorbed by the vegetation, which then transpires it into the atmosphere (Bolund and Hunhammar Citation1999). Also, Urban forests are important ecosystems that have a big impact on how well rainfall drains. Throughout the hydrological cycle, tree crowns and the urban forest play important functions. Raindrops are deflected by tree crowns, which decreases the amount of water that reaches the permeable or impermeable surfaces below. Surface water storage capacity is one characteristic of tree crowns that affects interception, according to comparative research by Xiao and McPherson (2016). Here, the amount of water drawn from the rivers of Lalitpur for commercial, domestic, and public usage is referred to as the ecosystem service flow of water. The Bagmati River and its tributaries drain the valley and provide most of the water used for agriculture and residential purposes (Shakya et al. 2019; Chaudhary et al.2021). Surface water and groundwater in Lalitpur have deteriorated due to uncontrolled growth, including rapid urbanization, excessive industrialization, waste management inaccuracies, and inadequate sanitation. (Ghimire et.al.2023) concluded that urban trees avoid 331745 m^3 of stormwater runoff.

6.1.3. Raw Materials Production

Urban forestry has provided another major importance to the ecosystem with the production of raw materials by positively influencing human life daily. The wood wastes produced from urban forestry can be used to make bioenergy, which emits no net greenhouse gases and gives the material a better suitable destination and higher added value. De Meira et.al. (2021) researched bioenergy production from urban forestry species and the species such as Nectandra megapotamica, Terminalia catappa, Handroanthus sp., and Cenostigma pluviosum produced charcoal with a satisfactory yield and quality. Besides that, raw materials available in the research area were timber, firewood, and fodder. A variety of sources offering information for specific years show a general increase in the amount of timber, firewood, and fodder collected in Lalitpur during the research period. Firewood (44% of the total volume harvested), bedding (40%), and fodder (15%) were the three most significant products Khanal, K. P. (2002).

6.1.4. Opportunities for recreation and tourism

Urban forestry can be used as a recreational and tourism site which includes open spaces, parks, ponds, scenic parkways, trails, and walkways that can be utilized. Lalitpur also offers a wide range of recreational and tourism opportunities, including excursions, running, hiking, and camping as well as the opportunity to collect wild edible plants in urban forestry. An assessment of the flow and trend of recreation and tourism was the percentage of the Lalitpur population that visited urban areas. Different monuments and buildings from ancient also served as recreational and tourism sites in Lalitpur metropolitan city. Patan Durbar Square and the Newar culture offered by Lalitpur have become a major source of income from tourism in Lalitpur metropolitan city. According to the report published by Tourism Board Nepal (2021) and Patan Newar Culture Conservation Society, 10051 people visited the Patan Darbar Square (Nepal Tourism Statistics, 2021). Central Zoo in Juwalakhel also serves as the best urban park for recreation and tourism. Over one million tourists come to enjoy the beauty of urban zoos annually (NTNC, 2022).

6.1.5. Educational opportunity

There is a lot of educational use of Lalitpur. According to NTNC (Nepal), LSMC actively supports the use of urban forests as a venue for environmental and cultural history education in kindergartens, schools, and universities. There are public visit farms in Manmohan Park, Bp Park, and Shahid Smarak Park by Patan Multiple Campus and Tri Chandra Multiple Campus that provide guided tours and teach visitors about plant varieties. The outdoor recreational council of Lalitpur and the neighboring areas provides nature-based camps for kids, nature-based recreation introduction courses for migrants, and teaching courses in nature-based education for teachers (Lalitpur Municipality, 2020). The number of publications each year was chosen as a proxy to evaluate trends in the educational qualities of Lalitpur because statistics on the total number of educational programs, excursions, visits, or the number of people who took use of these educational opportunities could not be discovered. The Forest Research and Training Center Library's database search produced 1051 publications total for the analyzed period in the categories related to urban forest and recreation books (1045), thesis (6), and articles (31). natural-based enjoyment (including guides to Lalitpur), natural and cultural history, and nature protection are common themes in these works. Our data, which is sorted by publications per decade, reveals a distinct peak in the 1990s, which was followed by an upward trend in the following decades (FRTC,2021).

6.1.6. Temperature regulation

Evapotranspiration is the mechanism through which heat is used to fuel the evaporation process, which entails turning liquid water in plants into vapor and so cooling the air. According to research by Bolund and Hunhammar (1999), the presence of trees in cities greatly lowers summer temperatures. Due to their ability to provide shade and humidity, urban trees also help to moderate local temperatures. Urban forests have the potential to both slow down climate change and assist urban society to adapt to its effects. Urban forests are a crucial component of humanity's adaptation to climate change because they store carbon in their biomass while growing trees removes carbon dioxide from the air. Climate regulation can be evaluated from the amount of carbon stored and sequestered by the urban forest in Lalitpur Sub Metropolitan City. On a city scale, the LMC urban tree canopy sequesters 35,170 tons of carbon annually and stores 1.1 million tons of carbon. According to another study, there was a decline in forest cover between 1989 and 2011. The percentage of land covered by forests was 80% in 1989, 53.9% in 1999, and 50.7% in 2011. This demonstrates that the amount of forest cover has rapidly decreased between 1989 and 2011, with rates of change from 1989 to 1999 and 1999 to 2011 being 16.48% and 9.6%, respectively. This offsets the expansion of the agricultural region, whose coverage was 11.5% of the entire study area in 1989 but climbed to 27.9% in 1999 and 36.66% in 2011(Mishra. P., 2018). However, the amount of carbon that is being stored in urban trees is frequently increased due to the increased plantation in the city area.

6.1.7. Habitat provision

Urban areas are growing and providing new wildlife habitats. The diversity, number, and species of birds and animals that use these habitats are influenced by the layout and planning of these metropolitan regions (Aronson et al., 2014). While some species are uncommon in cities, generalist species frequently thrive there (Gatesire et al., 2014). For instance, urbanization has a deleterious impact on birds with specialized eating habits (such as insectivores) (Callaghan et al., 2020). Even while urbanization affects birds by altering the environment, urban areas frequently preserve and provide some avian habitat, such as tiny forest portions that are mixed in with constructed areas. Despite their tiny size, numerous boundaries, and potential isolation from bigger forest patches, these urban forest remnants are still used by birds all year long (Archer et al., 2019). Urban residential zones can offer usable habitat for birds in addition to forest fragments (Ikin et al., 2014). Many residential areas still have huge trees for canopy cover, and there may be shrubs, tiny trees, and native ground cover for the understory. (Belaire et al. 2014) discovered that residential yards with more diverse and thick vegetation and fewer groomed lawns have higher bird diversity. The National Trust for Nature Conservation has developed the Central Zoo as a center for ex-situ wildlife conservation areas. Central Zoo provides shelter to a total of 942 individual mammals, birds, fish, and reptiles of 127 species (NTNC,2022).

6.1.8. Damage to infrastructure

Urban trees may interact with neighboring infrastructure (i.e., engineered constructions) even though they are now generally viewed as green infrastructure (Escobedo et al. 2019). For example, structures and systems for energy, water, and sewage, communication, and transportation. During storms, trees can harm industrial infrastructure, and resolving disputes between trees and infrastructure is a top priority. Among arboriculture experts (Vogt et al., 2015). Urban forestry frequently faces issues such as property damage and utility service interruptions, and there is an increasing corpus of literature on managing tree risks to evaluate and reduce these harms (Klein et al. 2019). Storm-related tree issues highlight a contradiction that exists in urban forest management because of the spatial relationships that produce damage from ice storms, snowstorms, and hurricanes grey infrastructure and tall trees are arranged in this way. (Magarik et al. 2020). On highways and sidewalks, trees can occasionally block traffic and people walking, and tree roots may block sewer pipes. Infrastructure issues, such as trees hiding traffic signs and roots lifting pavements, are frequently the subject of complaints to tree police in Sweden. Tree-infrastructure conflicts have been recognized in urban tree management for more than a century (Dean 2005). Kantipur Post report published during the spring of 2019 roadside plantation due to a heavy storm affecting the Ring Road area which affected the vehicles and buildings of that area.

6.1.9. Allergic potential

Urban forestry has some environmentally harmful effects, such as air allergic potential to humans and other living species due to the invasion of alien species in the urban forested area (Petri et al. 2016), even though the advantages of urban trees for the environment and energy conservation have been extensively researched and promoted (Roy et al. 2012). According to the few life cycle studies done on urban trees, activities like nursery production, planting, pruning, removal, and disposal result in emissions of carbon dioxide and other greenhouse gases, including those from vehicles and tree care equipment. As a result, newly planted urban trees start as net carbon emitters and only become carbon neutral after about three decades, when sequestration outweighs emissions, according to Petri et al. (2016). Swami (Ficus benjamina) and Kapoor (Cinnamomum camphora) have caused allergies to humans due to the dispersal of pollen and seeds (Pandey, H. P., & Luitel, D. R., 2020).

6.1.10. Aesthetic Damage

However, there are also negative aspects of aesthetics (Dronova 2019). Public irritation with tree-related inconveniences has developed into a well-documented problem in recent years. Research on irritation has concentrated on aesthetic effects and the production of fruit, branch, and leaf litter (Kirkpatrick et al. 2013) by trees in urban areas. They spend most of their time handling annoyance complaints. For instance, in Nepal, complaints regarding nuisance-based services are what tree officers spend most of their time dealing with (Davies et al. 2017). The annoyance levels of residents and pedestrians point to inherent differences in human attitudes and preferences related to urban trees, even though irritation levels may be decreased by suitable species selection and maintenance (Kirkpatrick et al. 2013). In addition, whereas rising property and rental costs linked to urban greenery are frequently seen as financial expressions of indirect aesthetic advantages (Irwin et al. 2017), such outcomes can also lead to "green gentrification" that drives away vulnerable populations. Researchers are becoming more aware that urbanization could be a social disadvantage of urban greening. Expectations for social advantages, such as improving social contact, clash with the likelihood that urban tree planting may promote resident displacement in underprivileged communities (Maas et al. 2009). Leaves and branches of the urban trees have blocked the view in Lalitpur which has caused aesthetic damage.

6.1.11. Failure of Tree Growth

Cities offer a wide variety of differing growing environments for trees, which influences the diversity of urban tree species. The latitude and elevation of cities, as well as their size, naturally affect this. The usage of city land varies, from plazas and parking lots to residential districts and parks to industrial zones and high-traffic areas with street canyons. In certain locations, trees have an interaction with microclimate conditions, both subjecting themselves to them and modifying them. Structures like buildings and pavements can create arid conditions with higher temperatures and lower air humidity (Kjelgren and Clark 1993). Properties and scarcity of space, light and air conditions with gaseous and particulate pollution, coarseness, and compaction of soil with low availability of nutrient minerals and mineral pollution, and limited water availability are stress factors that predominate at different intensities due to location in the land-use mosaic of cities. In the several papers published in Trees, most of these difficulties with trees are discussed. Only 800 plants are growing well among 5000 different species planted which was done by Rotary Club Lalitpur in Ring Road Area by roadside (Kathmandu Post, 2022). This was due to the lack of nutrients and damage by vehicles running on the road. Thapa et.al (2021) reported that canker disease has affected the different pine and poplar species of Lalitpur and disrupted tree growth.

6.2. Demographic profile of the respondents

Demographic variables	Number	Percentage
Sex		
Male	267	50.1
Female	260	48.8
Prefer not to say	6	1.1
Education level		
Primary school	62	11.6
High school	130	24.4
Bachelors	210	39.4
Masters	131	24.6
Occupation		
Agriculture	101	18.9
Business	78	14.6
Service	109	20.5
Wage Labor	43	8.1
Student	88	16.5
Others	97	18.2
Prefer not to say	17	8.1
Income		
<10000	56	10.5
10000-50000	40	7.5
50000-100000	412	77.3
>100000	22	4.1
Missing Observation	3	0.6
Age		
15-30	145	27.3
31-46	199	37.5
46-60	122	23.0
>60	65	12.2
Missing observation	2	0.4

Table 3: Demographics profile of the respondents

Descriptive statistics were calculated for all the demographic factors with SPSS. Gender diversity with 50.1% male and 48.1% female. Educational backgrounds include 11.6% of primary school, 24.4% of high school, a greater percentage i.e., 39.4% in bachelor's and 24.6% of masters. Regarding professional background, 18.9% were involved in agriculture, 14.6% in business, 20.5% in service, 8.1% worked as wage laborers, 16.5% were students, 18.2% others and 8.1% didn't want to say their occupation. Age and income were categorized into 4 different categories to simplify the result analysis and interpretation. 27.3% of the 15-30 age group, 37.5% of the 31-45, 23% of 46-60 and finally 12.2% above 60. 10.5% have income less than NRs.10000 per month, 7.5% have income between NRs (10000-50000), and 77.3% have income between NRs. (50000-100000) and 4.1% have income greater than NRs. 100000.

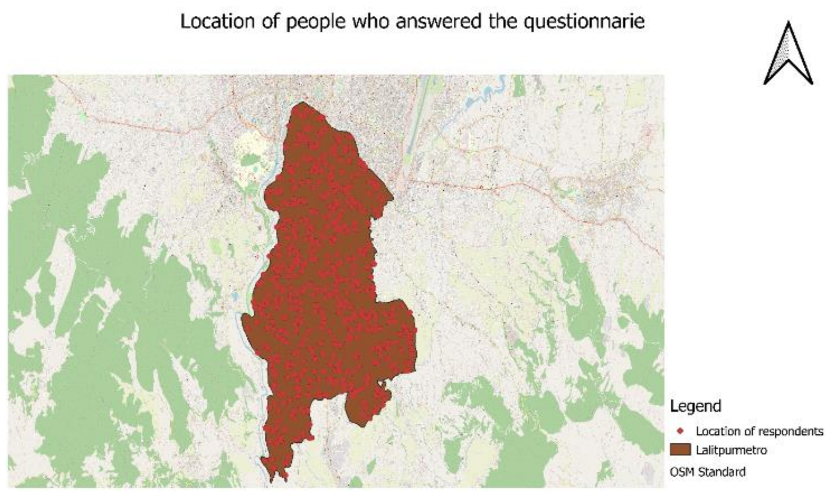

Figure 3: Address location of the respondents

The latitude and longitude points were collected from the LMC office while taking the basic information about the respondents. The latitude and longitude data were inserted into the LMC shapefile in QGIS to find out the exact location of the respondents within LMC.

6.3. Ecosystem Services from Urban Forest

Services	Responses(N)	Percent
Education opportunity	350	14.70%
Food production	338	14.20%
Water storage	320	13.40%
Raw Materials Production	339	14.20%
Habitat provision	345	14.50%
Temperature Regulation	350	14.70%
Recreation and Tourism	340	14.30%
Total	2382	100%

Table 4: Perceived Ecosystem Services from Urban Forest in LMC

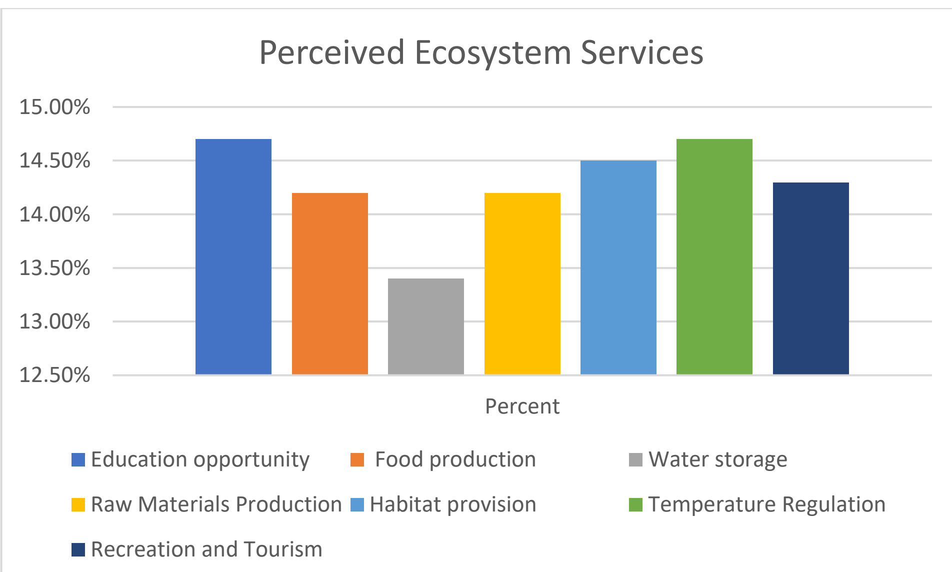

Figure 4: Perceived Ecosystem Services in LMC

The ranking of the ecosystem services based on respondents' perception of having the greatest positive influence on people's lives as follows: Education opportunity, temperature regulation in the same position, followed by habitat provision, recreation, and tourism, food production, and raw materials production have the same rank and finally water storage has the lowest rank.

Ecosystem services		Food production	Water storage	Temperature Regulation	Raw materials production	Habitat provision	Recreation and Tourism	Education opportunities
Food production	Correlation Coefficient	1	-.143**	-.098*	-0.038	-0.072	0.003	-.098*
	Sig. (2-tailed)		0.001	0.024	0.377	0.099	0.942	0.024
Water storage	Correlation Coefficient	-.143**	1	.136**	0.05	0.071	0.071	.136**
	Sig. (2-tailed)	0.001		0.002	0.247	0.101	0.103	0.002
Temperature Regulation	Correlation Coefficient	-.098*	.136**	1	-0.014	0.062	0.006	1.000**
	Sig. (2-tailed)	0.024	0.002		0.744	0.155	0.889	
Raw materials Production	Correlation Coefficient	-0.038	0.05	-0.014	1	0.012	0.037	-0.014
	Sig. (2-tailed)	0.377	0.247	0.744		0.787	0.389	0.744
Habitat Provision	Correlation Coefficient	-0.072	0.071	0.062	0.012	1	0.024	0.062
	Sig. (2-tailed)	0.099	0.101	0.155	0.787		0.582	0.155
Recreation and Tourism	Correlation Coefficient	0.003	0.071	0.006	0.037	0.024	1	0.006
	Sig. (2-tailed)	0.942	0.103	0.889	0.389	0.582		0.889
Education Opportunities	Correlation Coefficient	-.098*	.136**	1.000**	-0.014	0.062	0.006	1
	Sig. (2-tailed)	0.024	0.002		0.744	0.155	0.889	1

Table 5: Correlation between ecosystem services

While testing the correlation among the ecosystem services with a significance level (p=0.05, 0.01) with Spearman's correlation the result was, that food production has a negative correlation with all other ecosystem services except recreation and tourism and educational opportunity while recreation and tourism has a positive correlation with all other ecosystem services. Education opportunity was negatively correlated with raw materials only and has a positive relationship with all other ecosystem services besides that water storage also has a positive relationship with all other ecosystem services listed except food provision. It was found that temperature control and education have a strong correlation (i.e., r=1). Along with that water has a strong correlation with temperature regulation, habitat provision, recreation and tourism, and education with a correlation coefficient (i.e., r=0.136, r=0.071, r=0.071, r=0.136). Besides that, temperature regulation and habitat provision have a strong positive correlation with each other with a correlation coefficient (i.e., r=0.062). Finally, habitat provision has a strong correlation with education with a correlation coefficient (i.e., r=0.062). And all the other ecosystem services have a weak correlation with each other.

6.4. Ecosystem Disservices of Urban Forest

Ecosystem Disservices	**Responses(N)**	**Percent**
Allergy	338	27.40%
Damage to infrastructure	377	30.50%
Aesthetic damage	162	13.10%
Failure of tree growth	358	29.00%
Total		100%

Table 6: Ecosystem Disservices in LMC

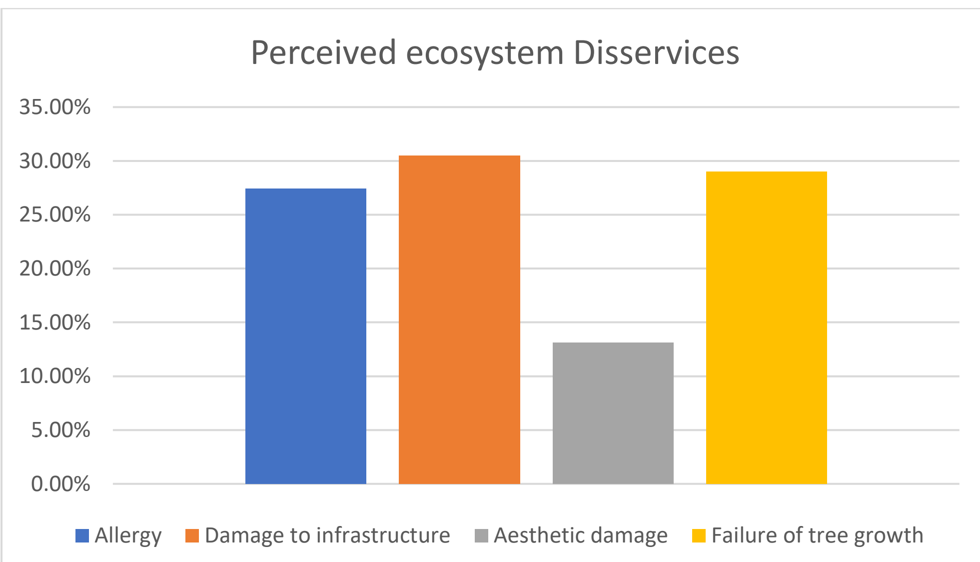

Figure 5: Perceived Ecosystem Disservices in LMC

The ranking of ecosystem disservices based on respondents' preferences that are negatively influencing their lives is as follows: Damage to infrastructure, Failure of tree growth, Allergic potential, and finally aesthetic damage. Respondents don't perceive aesthetic damage as an ecosystem disservice from urban forest.

6.4.1. Correlation between Ecosystem Disservices

Ecosystem Disservices		Allergic potential	Damage to infrastructure	Aesthetic damage	Failure of tree growth
Allergic potential	Correlation Coefficient	1	0.075	-0.034	-0.008
	Sig. (2-tailed)	.	0.082	0.438	0.859
Damage to infrastructure	Correlation Coefficient	0.075	1	-0.041	-0.012
	Sig. (2-tailed)	0.082	.	0.344	0.791
Aesthetic damage	Correlation Coefficient	-0.034	-0.041	1	0.011
	Sig. (2-tailed)	0.438	0.344	.	0.797
Failure of tree growth	Correlation Coefficient	-0.008	-0.012	0.011	1
	Sig. (2-tailed)	0.859	0.791	0.797	.

Table 7: Correlation between Ecosystem Disservices

Correlation analysis with Spearman's correlation of ecosystem disservices showed damage to infrastructure and aesthetic damage has a strong negative correlation with correlation coefficient (r=-0.041), allergic potential and aesthetic damage have moderate negative correlation (i.e., r=-0.034) while all the disservices have a weak correlation with each other.

6.5. Correlation between Ecosystem Services and Disservices

Ecosystem services and Disservices		Food production	Temperature regulation	Water storage	Raw materials production	Habitat provision	Recreation and Tourism	Education opportunity
Allergic potential	Correlation Coefficient	0.031	-0.017	-0.061	-0.039	-0.053	0.07	-0.017
	Sig. (2-tailed)	0.47	0.695	0.159	0.365	0.22	0.108	0.695
Damage to infrastructure	Correlation Coefficient	.085*	-0.074	-0.011	-0.008	-.121**	0.022	-0.074
	Sig. (2-tailed)	0.05	0.086	0.795	0.861	0.005	0.62	0.086
Aesthetic damage	Correlation Coefficient	0.07	-0.029	-0.044	-0.042	0.01	-0.02	-0.029
	Sig. (2-tailed)	0.106	0.504	0.313	0.337	0.823	0.647	0.504
Failure of tree growth	Correlation Coefficient	-0.023	-0.027	0.04	.817**	0.001	0.054	-0.027
	Sig. (2-tailed)	0.591	0.536	0.355	0	0.976	0.213	0.536

Table 8: Correlation between Ecosystem Services and Disservices

Correlation analysis between the perceived ecosystem services and disservices by the respondents of LMC was analyzed using Spearman's bivariate test. Table 7 shows the correlation between ecosystem services and disservices. Failure of tree growth has a positive correlation with 4 ecosystem services i.e., water storage (strong correlation), raw materials production (strong correlation), and habitat provision weak correlation) and recreation and tourism (strong correlation) with correlation coefficient (r=0.040, 0.877, 0.001, 0.054) while it has a negative correlation with the remaining 3 ecosystem services. Aesthetic damage has a positive correlation with 3 ecosystem services food production (strong correlation), and habitat provision (weak correlation) with a correlation coefficient (r=0.070, 0.010) beside that it has a negative correlation with 5 ecosystem services. Damage to infrastructure and allergic potential has a positive correlation with food production (strong correlation, medium correlation) and recreation and tourism (weak correlation, strong correlation) with correlation coefficient (r=0.085, 0.022, and r=0.031,0.070) and has a negative correlation with 5 ecosystem services.

6.5.1. Existed synergies and tradeoffs between ecosystem services and disservices.

Correlation analysis is used in this part to support the interaction between the different indicators. To determine the correlations of trade-off connections and a synergistic link between the indicators, Spearman's correlation analysis was conducted. Every correlation in this investigation was statistically significant with (p=0.01, p=0.05). In general, a strong correlation is one where the coefficient value is between ±0.050 and ±1, a medium correlation is one where the value is between ±0.030 and ±0.049, and a low correlation is one where the value is below ±0.029. When there is a positive relationship between two ecosystem services and disservices it shows the synergies between and when there is a negative relationship between two variables it shows the tradeoffs which are explained in Figure 6.

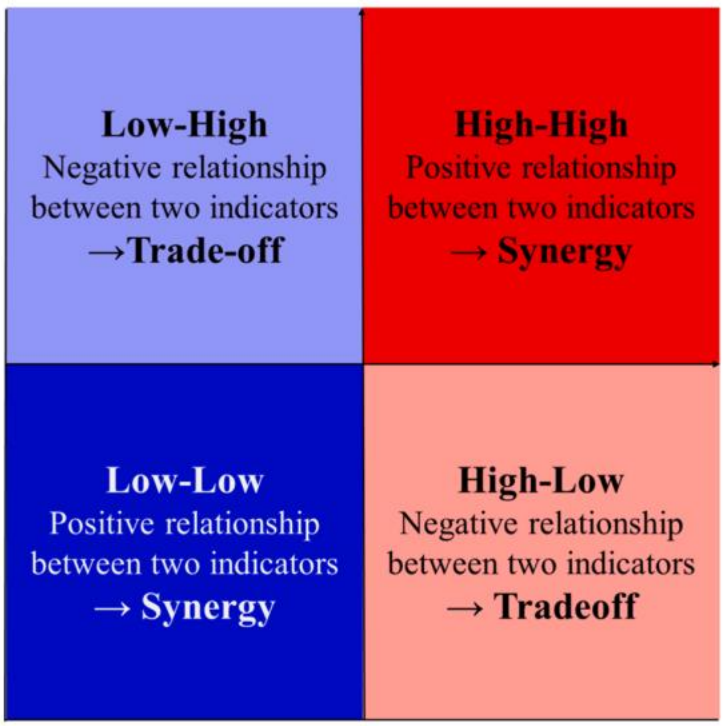

Figure 6: Tradeoffs and Synergies

Ecosystem Services and Disservices	**Synergies**	**Tradeoffs**
Food production	Recreation and Tourism, Allergic potential, Damage to infrastructure, Aesthetic damage, Failure of tree growth	Water storage, Temperature regulation, Raw materials production, Habitat provision, education opportunity
Water storage	Temperature regulation, raw materials production, habitat provision, recreation and tourism, and education opportunities.	Allergy and damage to infrastructure, aesthetic damage, and failure of tree growth
Raw materials production	Habitat provision, Recreation and Tourism.	Temperature regulation, education opportunity, allergic potential, damage to infrastructure, aesthetic damage, and failure of tree growth.
Temperature regulation	Habitat provision, Recreation and Tourism, education opportunity	Allergic potential, aesthetic damage, failure of tree growth, Damage to infrastructure
Habitat provision	Recreation and tourism, education opportunities, aesthetic damage, and failure of tree growth	Allergic potential and damage to infrastructure.
Recreation and Tourism	Education opportunity, Damage to infrastructure, allergic potential, and failure of tree growth	Aesthetic damage
Education opportunity		Allergic potential, damage to infrastructure, aesthetic damage, and failure of tree growth
Allergic potential	Damage to infrastructure	Aesthetic and Failure of Tree Growth
Damage to infrastructure	Allergic potential	Aesthetic damage and Failure of tree growth
Aesthetic Damage	Failure of tree growth	
Failure of tree growth		

Table 9: Existed Synergies and Tradeoffs between ecosystem services and disservices.

Different ES and EDSs frequently have nonlinear relationships with one another and complicated human usage patterns, which leads to many ways in which they can interact and trade-off synergies against one another. Trade-offs, often known as negative associations, occur when the supply of one ES increases while the supply of another ES decreases similarly with EDSs. Synergies, or favorable interactions, on the other hand, signify simultaneous increases or decreases in the supply of numerous ES and EDSs. Such linkages make it typical for ecosystem management practices to have unanticipated results. For instance, the expansion of services for provisioning (food, water, raw materials, etc.) may result in the decline of services for regulation (temperature, climate, nutrient cycling, soil conservation, etc.). The above table reveals that food production has a positive synergistic relationship between recreation and Tourism, allergic potential, damage to infrastructure, aesthetic damage, and failure of tree growth which means food production increases with the increase of the ecosystem services and disservices, as Water storage, Temperature regulation, Raw materials production, Habitat provision, education opportunity has negative tradeoffs relationship with food production i.e., food production decreases with increase in these ecosystem services and disservices. Water storage has a positive synergistic relationship with Temperature regulation, raw materials production, habitat provision, recreation and tourism, education opportunity, and negative tradeoffs relationship with Allergy and damage to infrastructure, aesthetic damage, and failure of tree growth. Raw materials production has a positive synergistic relationship with Habitat provision, Recreation, and Tourism and a negative tradeoff relationship with Temperature regulation, education opportunity, allergic potential, damage to infrastructure, aesthetic damage, and failure of tree growth. Temperature regulation has a positive relationship with Habitat provision, Recreation and Tourism, education opportunities and a negative relationship with Allergic potential, aesthetic damage, and failure of tree growth, Damage to infrastructure. Habitat provision has a positive relationship with Recreation and tourism, education opportunities, aesthetic damage, and failure of tree growth and a negative with Allergic potential and damage to infrastructure. Recreation and Tourism have a positive relationship with Education opportunities, Damage to infrastructure, allergic potential, and failure of tree growth, and a negative relationship with aesthetic damage. Education opportunity has a negative relation with Allergic potential, damage to infrastructure, aesthetic damage, and failure of tree growth, allergic potential has a positive relation with damage to infrastructure and a negative relation with aesthetic damage and failure of tree growth. Damage to infrastructure has positive synergy with allergic potential and negative tradeoffs with aesthetic damage and failure of tree growth. Aesthetic damage has a positive synergy with the failure of tree growth.

6.6.Relation between Perceived Ecosystem Services, disservices and Demographics factors

P values from One Way ANOVA					
	Sex	Age Group	Income Group	Education level	Occupation
Food production	0.33	0.81	0.06	0.36	0.82
Water storage	0.10	0.16	0.82	0.38	0.96
Raw materials production	0.00	0.04	0.00	0.36	0.03
Temperature regulation	0.79	0.40	0.06	0.93	0.74
Habitat provision	0.25	0.08	0.01	0.22	0.00
Recreation and Tourism	0.76	0.04	0.82	0.81	0.04
Educational opportunities	0.79	0.04	0.68	0.93	0.74
Allergic potential	0.24	0.01	0.02	0.10	0.03
Damage to infrastructure	0.02	0.13	0.03	0.64	0.02
Aesthetic Damage	0.51	0.49	0.34	0.52	0.93
Failure of tree growth	0.00	0.04	0.42	0.27	0.03

Table 10: Relation between demographic factors, ecosystem services, and disservices

To understand the relation between different demographic factors and perceived ecosystem services and disservices, One-way ANOVA($p<0.05$) for the significance test was performed. It was found that age group has a significant difference in the perception of people for raw materials production and recreation and tourism with p values (p=0.04, p=0.04) while for all the other ecosystem services age group has no significant difference which means age group does not affect the perception of people about ecosystem services and for ecosystem disservices, it was found that age group has significant difference on the failure of tree growth with significant value(p=0.04) while age group has no significance difference on other three remaining ecosystem disservices.

It was found that the income group has a significant difference in habitat provision and raw materials production with significant values (p=0.01, p=0.00) while none of the remaining ecosystem services are affected by the income group, and for the ecosystem disservices, it was found that income group has significant difference on allergic potential and damage to infrastructure with significant values (p=0.02, p=0.03) whereas aesthetic damage and failure of tree growth weren’t affected by income group.

The significance test revealed that sex has a significant difference on the perception of people for raw materials production with p values (p=0.00) while for all the other ecosystem services sex has no significant difference which means sex does not affect the perception of people about ecosystem services and for the ecosystem disservices it was found that sex has significant difference on damage to infrastructure and failure of tree growth with significance value (p=0.02, p=0.01) while other two ecosystem services weren't affected by the sex of the respondents.

A significant test with education level, different ecosystem services, and disservices revealed that education level has no significant difference on the ecosystem services because all the respondents were educated and have some level of knowledge about ecosystem services and disservices from urban forestry.

It was found that occupation has a significant difference in raw materials production, habitat provision recreation, and tourism with p values (p=0.03, p=0.00, p=0.04) while all the other ecosystem services weren't affected by the profession, they are involved in and for the ecosystem disservices it was found that profession respondents involved in has significant difference on all ecosystem disservices i.e., damage to infrastructure, allergic potential, aesthetic damage, and failure of tree growth with significance value (p=0.03, p=0.02, p=0.04, p=0.03).

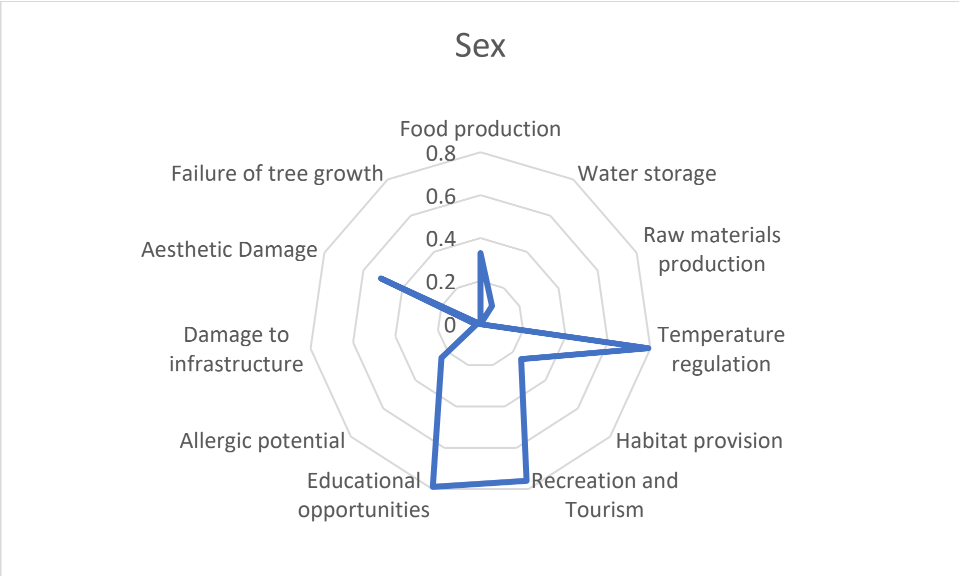

Figure 7: Significance between ecosystem services, disservices, and sex.

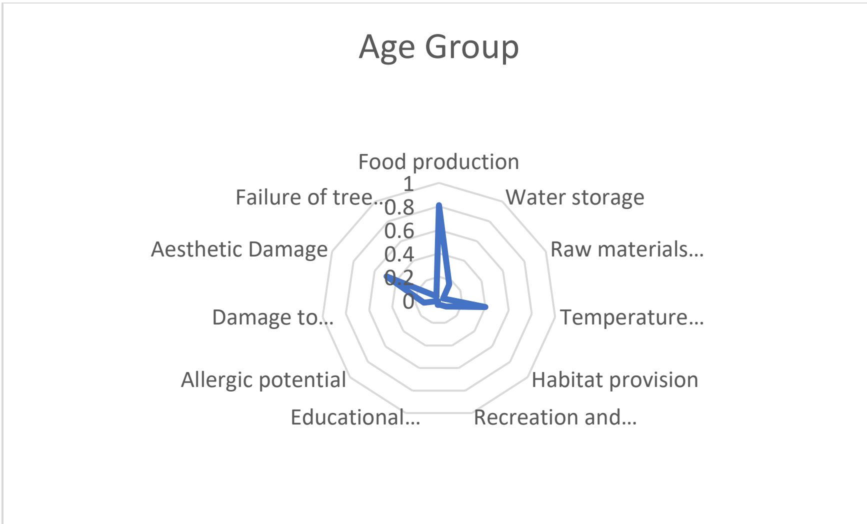

Figure 8: Significance between ecosystem services, disservices, and age group.

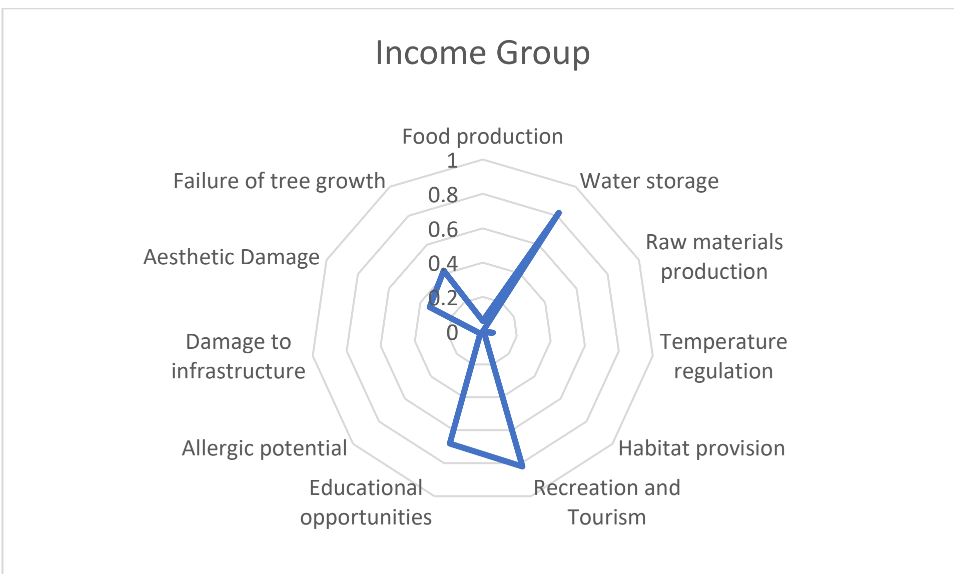

Figure 9: Significance between ecosystem services, disservices, and income group.

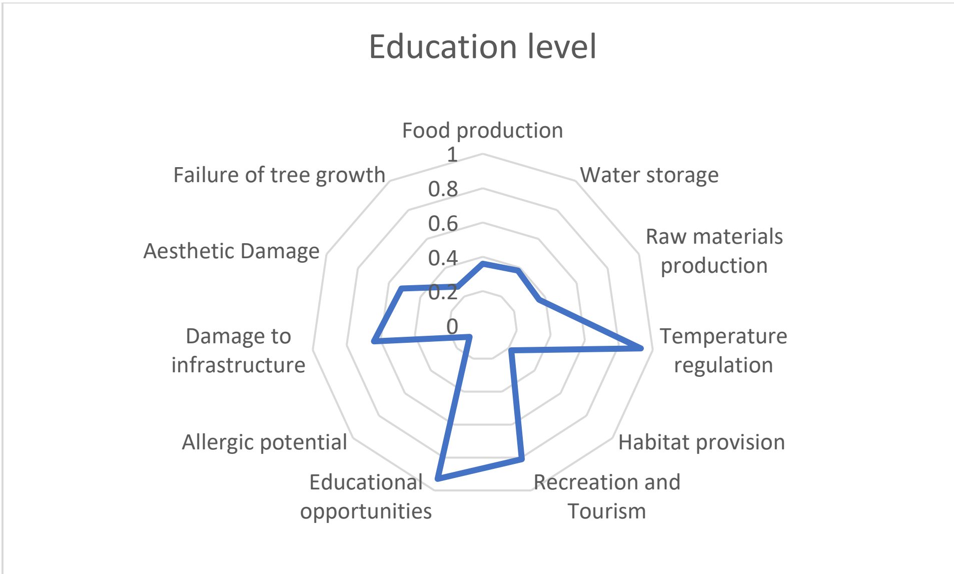

Figure 10: Significance between ecosystem services, disservices, and education level.

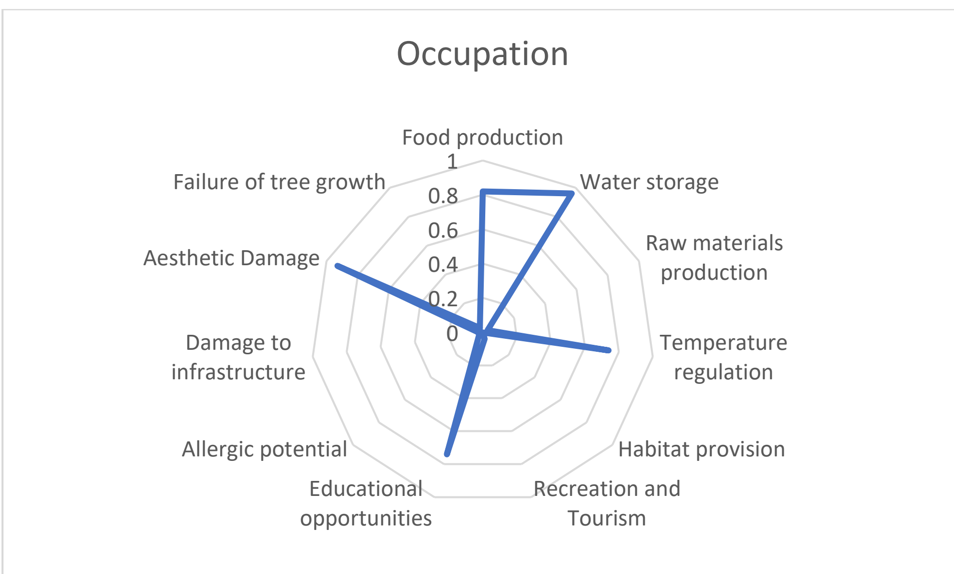

Figure 11: Significance between ecosystem services, disservices, and occupation.

6.7. Relation between Perceived Ecosystem Services, Disservices and Demographic factors

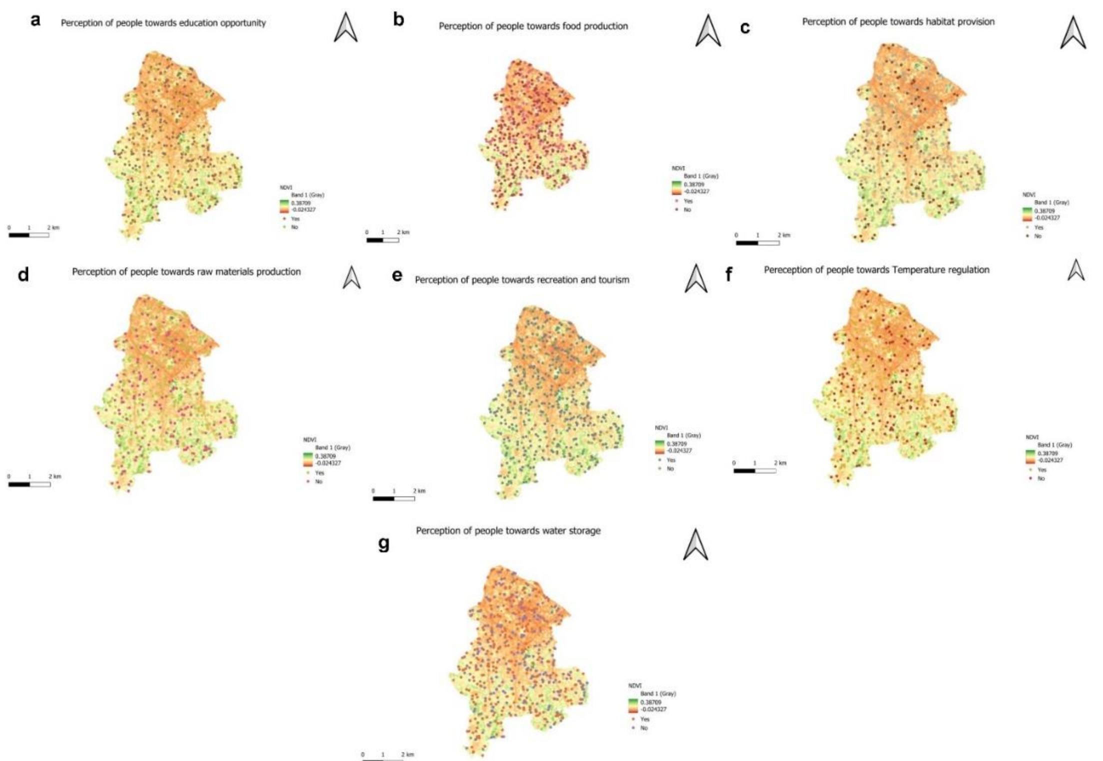

Figure 12: Perception of people towards ecosystem services based on location.

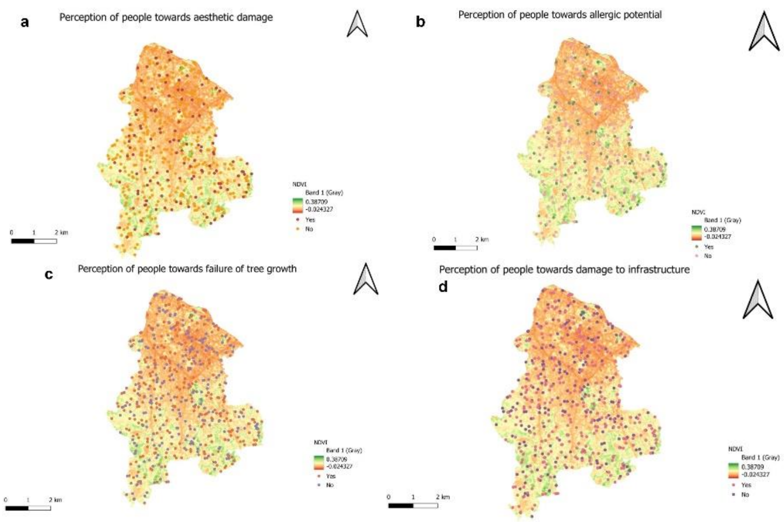

Figure 13: Perception of people towards ecosystem disservices based on location.

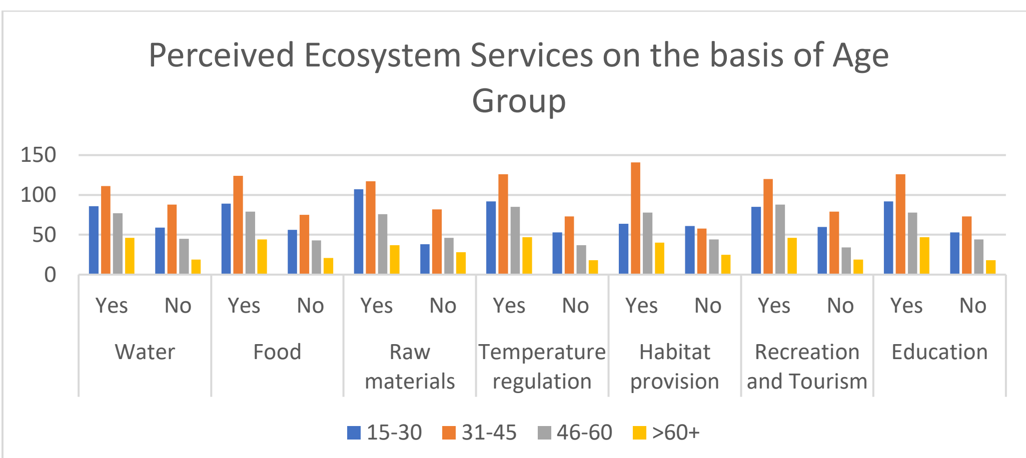

Figure 14: Perceived Ecosystem Services based on Age Group

Most of the people of the age group 31-45 perceive the greater importance of all the ecosystem services.

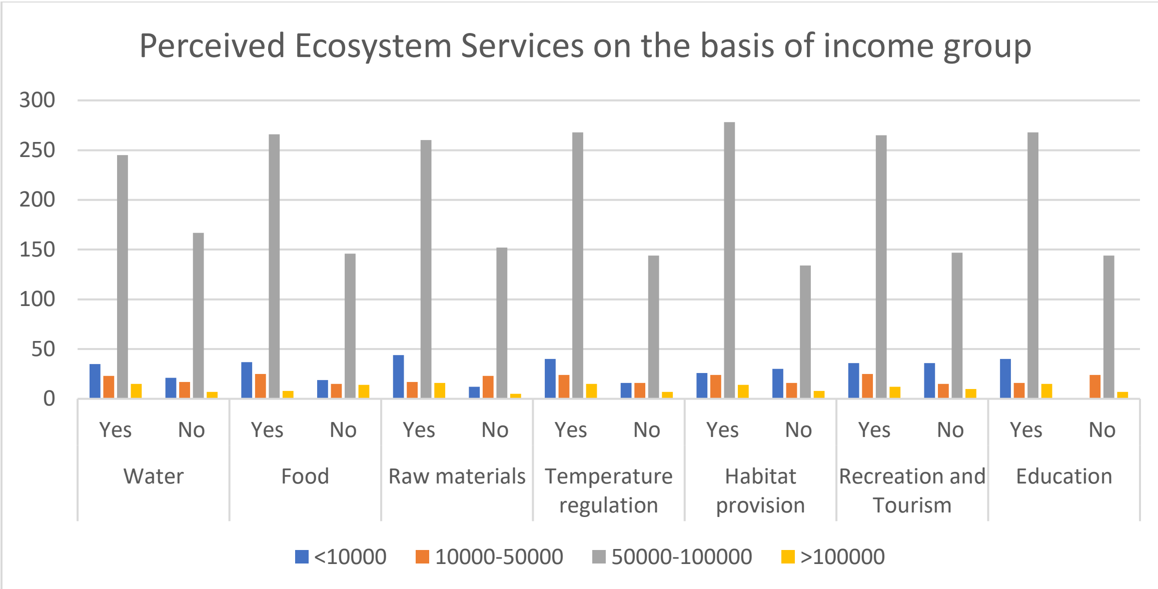

Figure 15: Perceived Ecosystem Services based on Income Group

The graph shows that most of the respondents having a salary of 50,000-100,000 have perceived greater importance of ecosystem services.

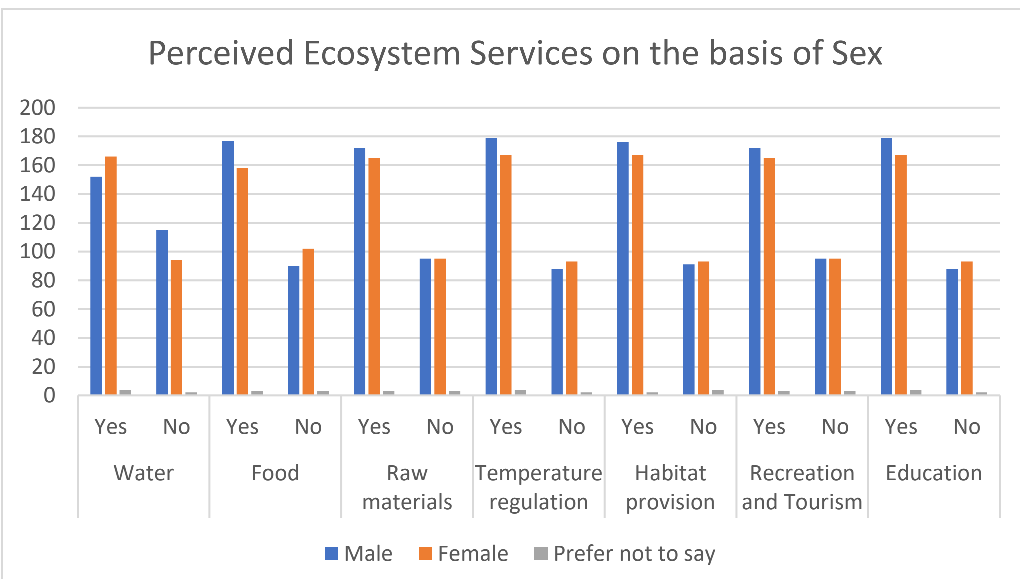

Figure 16: Perceived Ecosystem Services based on sex.

It was found that more female thinks that urban forest provides water storage benefits than male while all the other ecosystem services are perceived more by male. Both males and females have perceived ecosystem services almost in the same ratio.

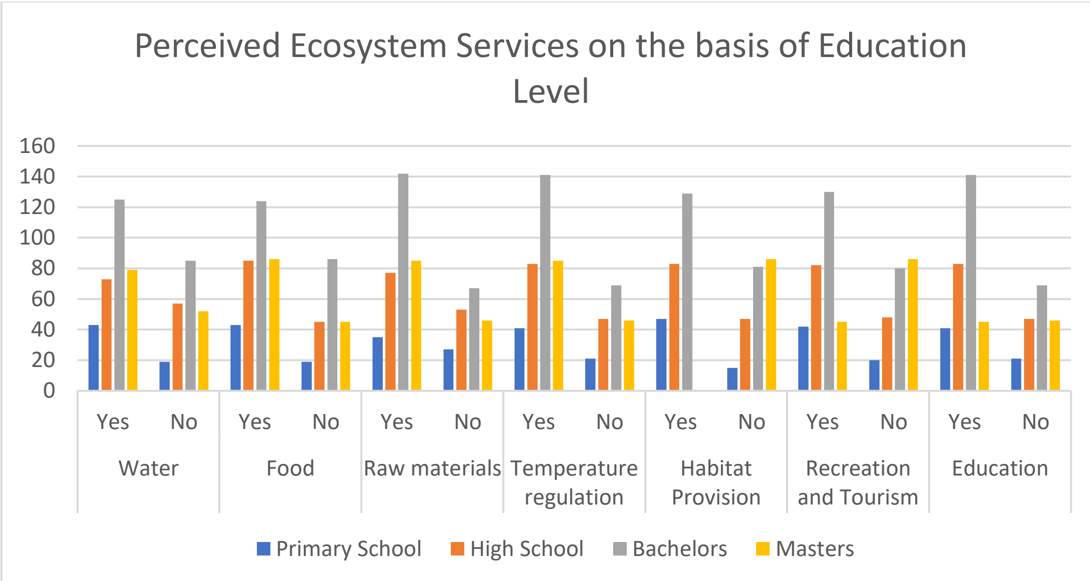

Figure 17: Perceived Ecosystem Services based on education level.

Most of the respondents with bachelor's level education have significantly perceived the positive greater importance of ecosystem services which is then followed with the education level master's and students having primary have significantly perceived the less importance of ecosystem service this may be because of the lack of good knowledge about the ecosystem services and urban forest.

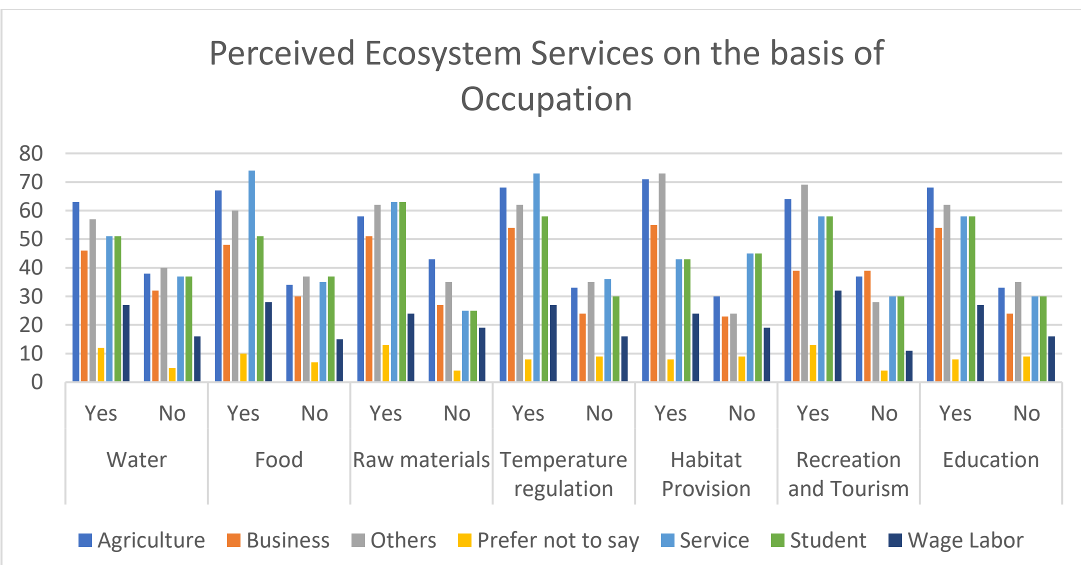

Figure 18: Perceived Ecosystem Services based on occupation level.

Most of the respondents who were involved in agriculture have perceived the greater importance of water storage service and education opportunities as benefits from urban forestry. Besides that people involved in service and students have perceived the benefits of urban forest.

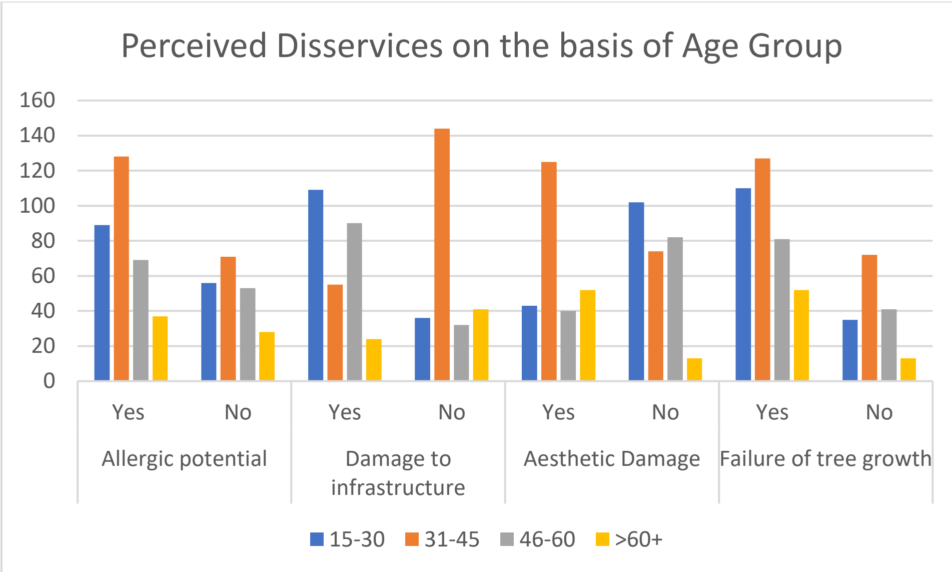

Figure 19: Perceived Ecosystem Disservices based on age group.

Respondents of age group 31-45 have perceived allergic potential, failure of tree growth, and aesthetic damage while age group 15-30 has perceived damage to infrastructure in greater concentration as ecosystem disservice.

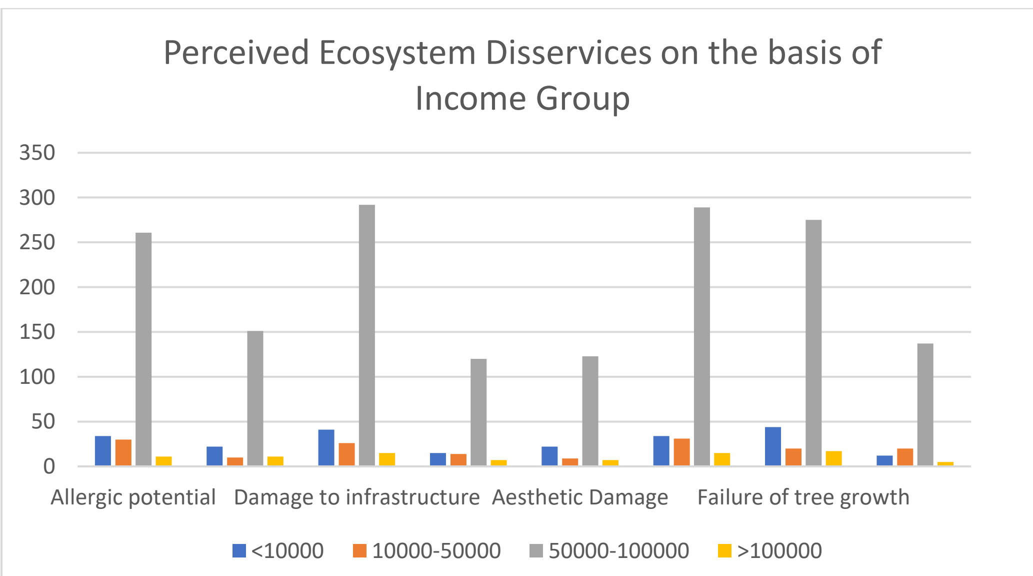

Figure 20: Perceived Ecosystem Disservices based on income group.

Respondents having a salary between 50000-100000 significantly have perceived all the ecosystem disservices in greater concentration.

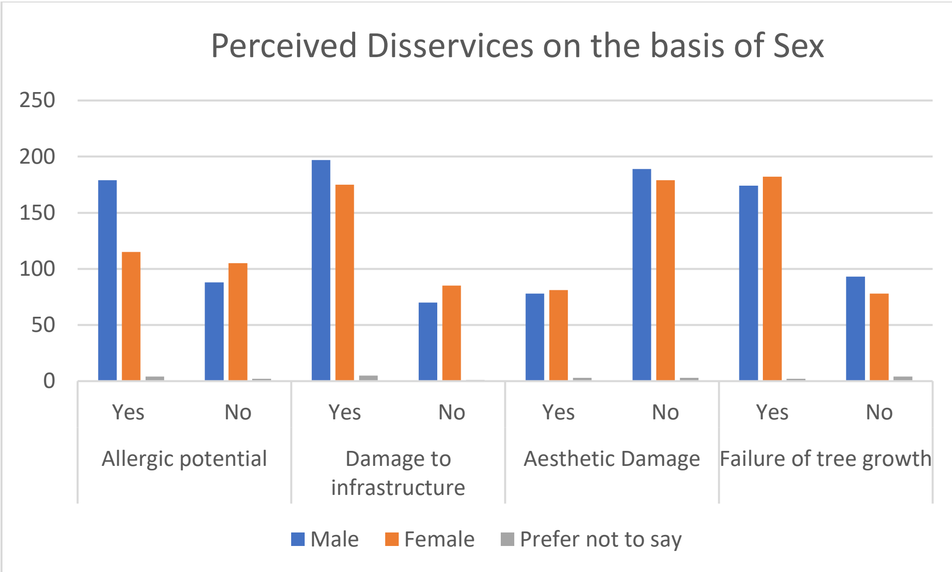

Figure 21: Perceived Ecosystem Disservices based on sex.

Female respondents think that failure of tree growth and aesthetic damage while male respondents think allergic potential and damage to infrastructure have a greater concentration of ecosystem disservices in LMC from urban forestry.

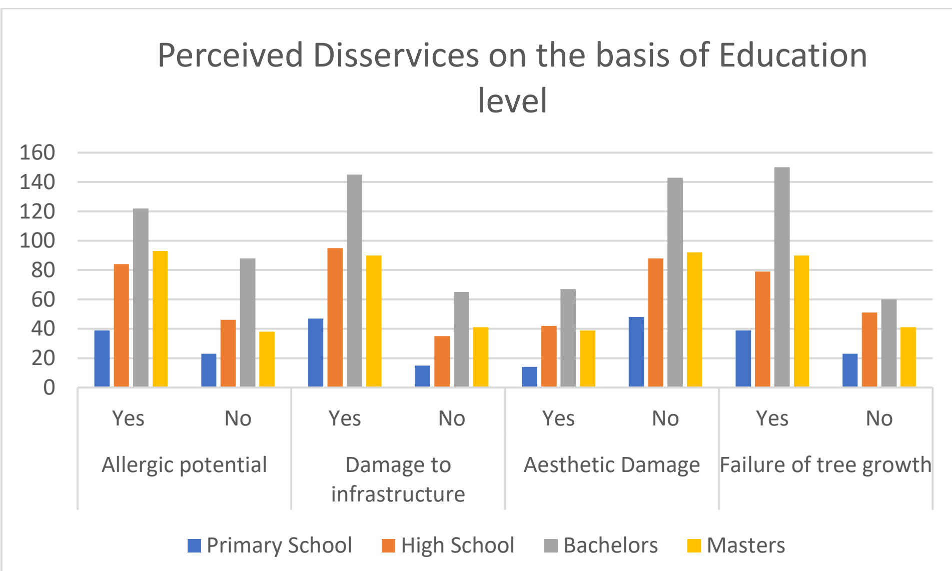

Figure 22: Perceived Ecosystem Disservices based on education level.

Respondents who have an education level of bachelor's have perceived all four ecosystem disservices followed by master's level student. Indicates that people who have higher levels of education have greater knowledge about ecosystem disservices.

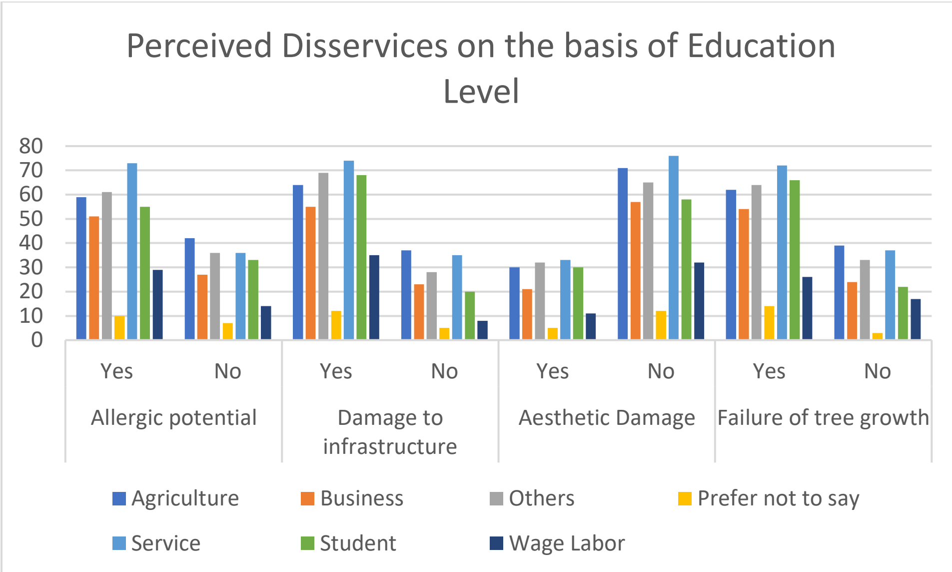

Figure 23: Perceived Ecosystem Disservices based on occupation.

Respondents engaged in service and students think that urban forestry has negative impacts on people's lives. People engaged in agriculture also perceived ecosystem disservices in higher concentration which means that people who were engaged in agriculture are also getting affected by the urban forest disservices.

6.8.Perception of respondents about the protection of Urban Forest

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
I would like to participate in the protection of urban forests in my neighborhood.	21.50	27.811	.487	.699
Having easy access to information about green spaces in my neighborhood will encourage me to be more involved in its planning and management	21.67	30.443	.548	.728
I use the urban forest in my neighborhood to relax and use the urban forest in my neighborhood for recreation	21.25	26.522	.448	.657

The urban forest in my neighborhood contributes to my quality of life.	21.56	25.066	.478	.647
I would support keeping the existing urban forest in my neighborhood as it would increase my property value	21.59	25.911	.471	.651
I want more trees along the roadside.	21.61	24.811	.536	.632
I think the local history of my neighborhood should be included in the management of its green spaces	21.55	25.274	.521	.637

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.739
Bartlett's Test of Sphericity	Approx. Chi-Square	664.453
	df	21
	Sig.	.000

Table 11: Items retained about the protection of urban forest.

The set of questionnaire items about the perception of urban forest protection was analyzed for accuracy in SPSS by the Churchills item purification method (Churchill, 1979). Items with a 'corrected-item-total' correlation of less than or equal to 0.3 are insignificant and removed from the items set. So, the item I would pay more municipal taxes so that urban forest gets protected was removed. This means that respondents living in LMC want urban forestry without paying for the urban forestry. The Cronbach Alpha values range from 0.6 to 0.7 which means there is acceptable internal consistency among the items. A strong KMO statistic (73%) and significant Bartlett test (P = 0.00) indicate sufficient aggregate variance to use factor analysis. Factor analysis improved validity by removing one item that loaded on multiple factors with a value of 0.3 or greater. The KMO indicates the power of the variables to represent the concept, and the Bartlett chi-squared test assesses the validity of the null hypothesis—there is no difference in the variance of the correlation of the variables.

Perception about the protection of urban forest	**Mean ±SD**	**Variance**	**Level**
I would like to participate in the protection of urban forests in my neighborhood.	3.62±1.47	2.161	Agree
I think having easy access to information about urban forests in my neighborhood will encourage me to be more involved in its planning and management	3.45±1.39	1.793	Agree
I use the urban forest in my neighborhood to relax and use the urban forest in my neighborhood for recreation	3.87±1.32	1.762	Agree
The urban forest in my neighborhood contributes to my quality of life.	3.55±1.48	2.217	Agree
I would support keeping the existing urban forest in my neighborhood as it would increase my property value	3.53±1.37	1.900	Agree
I want more trees along the roadside.	3.51±1.42	2.021	Agree
I think the local history of my neighborhood should be included in the management of its green spaces	3.57±1.38	1.907	Agree

Table 12: Perception about the protection of urban forest

The mean, standard deviation, and variance for each of the items were calculated to analyze the result and to know the perception of the respondents about the items of the protection of the urban forest. Overall, the respondent's perception aligns with agreeing with all the elements of protection of urban forests with the mean values ranging from 3.45 to 3.62.

P values from one-way ANOVA					
Attitudes	Age Group	Income group	Sex	Education Level	Occupation level
Q1	0.00	0.27	0.89	0.00	0.81
Q2	0.35	0.04	0.16	0.33	0.18
Q3	0.11	0.87	0.03	0.10	0.00
Q4	0.00	0.20	0.37	0.00	0.00
Q5	0.66	0.54	0.46	0.69	0.00
Q6	0.12	0.00	0.18	0.10	0.00
Q7	0.00	0.01	0.05	0.00	0.00

Table 13: Significance Relation between demographic factors and urban forest protection items

One-way ANOVA was performed to examine the significant difference between demographic factors and attitudes toward the protection of urban forests. I would like to participate in the protection of urban forests in my neighborhood is significantly affected by 2 demographic factors i.e., age group and education level while income group, sex, and occupation don't have any significant difference in this item. I think having easy access to information about urban forests in my neighborhood will encourage me to be more involved in its planning and management is significantly affected by income group only. I use the urban forest in my neighborhood to relax and use the urban forest in my neighborhood for recreation is significantly affected by occupation level and sex of the respondents. The urban forest in my neighborhood contributes to my quality of life and is significantly affected by age group, education level, and occupation status. I would support keeping the existing urban forest in my neighborhood as it would increase my property value and is significantly affected by occupation level only. I want more trees along the roadside to be significantly affected by income group and occupation status. Finally, I think the local history of my neighborhood should be included in the management of its green spaces is significantly affected by all the demographic factors.

7. Discussion

Given the significance of urban forests in supplying ecosystem services to societies that are becoming more urbanized, it is also important to conduct integrated ecosystem services assessments in addition to the existing assessments of environmental damages. Even so, there hasn't been enough research done on how different demographic factors may perceive and use ecosystem services and disservices. This study uses Lalitpur Metropolitan City as a case study site to examine how people perceive ecosystem services and disservices from urban forestry. The findings were described in the following section concerning the literature, along with the study's limitations and potential future research directions. There are three theoretical contributions made in this paper. First off, this study attempted to classify the ecosystem services and disservices provided by urban forests in Lalitpur by considering various types of urban forests that influence people's preferences for Ess and EDSs in contrast to previous studies that only presented the status of classifications of ESs in nature (MEA Citation2005; TEEB Citation2010) and cities (TEEB Citation2010; Buchel and Frantzeskaki Citation2015). Second, while researchers (Kwon et al. Citation2004; Koo et al. Citation2013) also showed the status of preferences of consumers of Ess and EDSs of urban forests, this study also investigated consumer preferences for ESs of the various types of urban forests. Finally, it measures the people's preferences for the protection of urban forests (Bernath and Roschewitz Citation 2008). Based on evaluations of domestic data, this study recommended a detailed working strategy to satisfy people's preferences for urban forest ESs and EDSs. By doing this, we were able to make this research more applicable and useful. This study has various real-world applications.

7.1. Perceived Ecosystem Services and Disservices

The overall result revealed that the most perceived ecosystem services were education opportunities and temperature regulation with 14.7% which was followed by habitat provision with 14.5%, which is as significant as the result of (Thapa et. al 2022) with 16.3% education opportunity, 13.2% as habitat provision. Water storage was the least perceived ecosystem service in this study but Thapa et. 2022 showed water storage as the more perceived ecosystem service.

Besides that, most people perceived damage to infrastructure with 30.5% ecosystem disservice followed by failure of tree growth and allergic potential with 29% and 27.4%. Finally, a low number of respondents perceived aesthetic damage as an ecosystem disservice with only 13.1%. Thapa et. al. 2022 concluded that 21% of the respondents think that urban forestry practice in the LMC has damaged the aesthetic value of the environment but this study found that only 13.1% of the respondents perceive aesthetic damage as an ecosystem disservice. This means that the respondents don't perceive aesthetic damage as an ecosystem disservice.

7.2.Impact of Demographic Factors on Ecosystem Services and Disservices

According to research by Eriksson et al. (2012), and Hegetschweiler et al. 2020, sociodemographic background variables rarely influence opinions of urban forest services and disservices. However, some previous research has found that factors such as age, gender, and educational level were significant (Tyrväinen et al. 2003; Meyer et al. 2019). But in this study education level has no significant difference in ecosystem services and disservices. Regarding gender both males and females perceive in a similar ratio only aesthetic damage was the ecosystem service which the gender doesn't perceive as ecosystem disservice. People of young age (31-45) have mapped the greater ecosystem services and disservices which is consistent with (Ode Sang et al. 2016) Differences in methodological techniques, as well as variations in cultural and geographic contexts, may be used to explain differences in sociodemographic variables. Tradeoffs and synergistic effects were observed to occur in the interactions of ESs and EDSs in several earlier studies (Rodrguez et al. Citation2006; Chisholm Citation2010; Raudsepp-Hearne et al. Citation2010). The level of other ESs and EDSs may rise or fall because of raising the level of demographic factors qualities to raise the level of a particular ES and EDS. As a result, it might not be possible to maximize and minimize the delivery of all ESs and EDSs simultaneously. When planning and managing urban forests, officials must use an integrative strategy that considers the desires of the public. In addition to increasing and extending the use of urban forests, managing ESs and EDSs by public opinion will also enhance public satisfaction with urban forest management. Finally, the respondents mapped services and disservices more frequently the more familiar they were with the urban forest.

7.3.Perception about the protection of urban forest

The outcome of the attitude test towards urban forestry protection is multi-dimensional. This study has provided a thorough framework for measuring attitudes toward urban green spaces. In earlier studies, the attitude toward urban green spaces was not effectively operationalized. According to this study, the perception of respondents leans towards the agreement, which is significant as Balram, S., & Dragićević, S. (2005). I would pay more municipal taxes to protect the urban forest was removed from both studies. A strong KMO of 77% existed (Balram, S., & Dragićević, S. 2005) which was a bit more than this study. This study reveals that most of the respondents of young age i.e., 31-45 years have positive perceptions about the protection, which is like Balram, S., & Dragićević, S. (2005). Also, this study showed that most people who were students and involved in services have a positive attitude towards the protection of the urban, which is different from the study done by Balram, S., & Dragićević, S. (2005) which shows that people who were involved in business have more positive perception towards urban forest protection. This study reveals that almost the same ratio of males and females has a positive attitude toward urban forest protection, which is different from the study done by Balram, S., & Dragićević, S. (2005) which states that more female respondents have shown positive.

8. Conclusion

The study began with the hypothesis that urban residents of Lalitpur metropolitan city preferences towards ecosystem services and disservices. This study measures the positive sides and negative sides of urban forestry by confirming this theory, we may offer quantifiable data that will inform and supplement policy on the management of urban forest ESs by reducing the negative impacts while taking urban residents' preferences into account.

The created attitude instrument offers opportunities for several further social integration research inquiries, which are crucial for community cohesion and overall quality of life. The association’s location of green areas, demographics, and user sentiments can be combined to create evidence of there’s potential for social integration areas. When conducting theoretical and applied research, scale and the consequences have long generated debate, unresolved. Additionally, information on the degree to which when comparing data, aggregate measurements can be investigated as a true depiction of individual metrics, home surveys combined with aggregate ecological results of census surveys.

9. Limitation

Random sampling among the respondents of LMC was done and data collection was done online so it wasn’t possible to collect the perception of the people who don’t have access to the internet. Besides that, all the educated people were surveyed so the perception of illiterate people about the ecosystem services provided by urban forest cannot be made through this study. Regarding how the results should be interpreted, there are several restrictions. First off, because this study's geographic concentration is on Lalitpur, it might not be able to adequately capture national desires for urban forests. Various implications for the preferences for ecosystem services and disservices given by urban forests in Nepal can be further described if the patterns of people's choices in other cities in Nepal can be compared and evaluated in future studies. Second, it was first believed that all marshes and rivers may benefit from the use of ESs and EDSs (MEA Citation 2005; TEEB Citation 2011). The reclassification of urban forest ESs and EDSs based on the common ESs, and EDSs was not considered in this study. The fact that much recent research has examined ESs based on MA's or TEEB's ESs categories (Wallace Citation 2007; Costanza Citation 2008; Fisher and Kerry Turner Citation 2008) makes it unnecessary to take these elements into account. We can therefore concentrate on the specialized ESs, and EDSs offered by urban forests, reduce the number of ecosystem attributes, and produce more elaborate and accurate results by considering the functions, services, and uses of urban forests and developing an ESs and EDSs classification system that can be applied specifically to urban forests (Costanza Citation2008; Fisher et al.

Citation2009; Ahn Citation2013). To benefit a larger audience, it is concluded by recommending that these characteristics be considered in future studies.

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11. ANNEX

11.1. Questions included.

1. Sex
- Male
- Female
- Others
- Prefer not to say.

2. Age
3. Education level
- Primary education
- High school
- Bachelors
- Masters

4. Occupation
- Agriculture
- Business
- Service
- Wage Labor
- Student

- Others
- Prefer not to say.

5. Income (NRS) per month
6. I would like to participate in the protection of urban forests in my neighborhood.
7. I would pay more municipal taxes so that the existing urban forest gets protected.
8. I use the urban forest in my neighborhood to relax and use the urban forest in my neighborhood for recreation.
9. The urban forest in my neighborhood contributes to my quality of life.
10. I would support keeping the existing urban forest in my neighborhood as it would increase my property value now the perception.
11. I want more trees along the roadside.
12. I think the local history of my neighborhood should be included in the management of its green spaces
13. I think having easy access to information about green spaces in my neighborhood will encourage me to be more involved in its planning and management.
14. Do you think urban forests provide food?
15. Do you think urban forests provide water?
16. Do you think urban forests provide raw materials?
17. Do you think urban forests help with temperature regulation?
18. Do you think urban forests provide habitat provision?
19. Do you think urban forests provide opportunities for recreation and tourism?
20. Do you think urban forests provide educational opportunities?
21. Do you think urban forests have damaged infrastructure development?
22. Do you think urban forest trees have allergic potential to the people?
23. Do you think urban forests have decreased the aesthetic value of the environment?
24. Do you think trees growing in urban forests are at risk of failure?

Questions 6 to 12 will be measured on a 1 to 5 Likert scale.

Questions 13 to 23 will be measured on a binomial scale (Yes /No).

Note 1 strongly disagree.

2- Disagree

3- Neutral

4. Agre

5. Strongly Agree

11.2. Photos of urban forestry in Lalitpur

Figure 24: Urban plantation in Lalitpur Metropolitan City