Urban Forest Resources: A Strategy for Achieving Land Degradation Neutrality

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Abstract

Urban forest plays a vital role in conserving diversity and maintaining the forest cover outside the forest. In modern times, development challenges urban planning, economy, ecosystem, environment, and human health. Conservation of biodiversity and forest resources in an urban area is a major challenge and has become the global need to overcome the problem faced by cities due to urbanization. Urban greenery affects the surrounding landscape in direct and indirect ways. Cities with green forest cover help in mitigating the climate change impact and it also offers various ecological, environmental, and ecosystem services. Rapid urbanization leads to an increase in deforestation rate, which harms the biosphere and human-built environment. Minimizing deforestation is a great topic of concern to adapt and minimize the climate change impacts on the ecosystem and environment. The development of urban forestry and greenery in these areas improve the microclimate, aesthetic value of the landscape as well enhance the floral and faunal diversity in an urban area. Climate change and destruction of habitat due to deforestation lead to threatening biodiversity. Urban forest plays a crucial role in a sustainable agroecosystem and provides many products and services. The management strategies and effective policy are needed

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to be properly implemented to enhance the green cover and lead toward sustainable cities and development.

Keywords

Biodiversity · Urban green space · Land degradation · Climate change

19.1 Introduction

Urban forestry and urban green space are one of the most important resources for sustainable urban infrastructure and cities. This has a potentially positive impact on the urban environment with wider dimensions. The urban forest creates a relationship between society and the environment and leads to harmony between natural processes and human civilization (Khan et al. 2020a, b). Urban forest resources include trees in urban space, parks, garden areas, green space, etc., in cities. These urban forest resources facilitate various ecological services and conserve and improve the biodiversity of the region (Khan et al. 2022; Nowak 2018).

Rapid urbanization is a major challenge for sustainable cities and development along with urban forest cover and resources (Banerjee et al. 2020). Building and construction work in an urban area is rapidly decreasing the vegetation cover in cities and causing various eco-environmental impacts. The importance of urban forestry toward the sustainable and eco-cities by environmentalists and urban designers made them work and applied implementation of urban forestry concept across the world. In cities, urban vegetation controls various forms of pollution (Escobedo et al. 2011). Trees and vegetation in cities also help in providing shelter and habitat to different faunas, which in turn conserve the biodiversity. Urban tree resources offer various ecosystem services including air purification, noise control, microclimate regulation, groundwater recharge, carbon (C) capture, carbon sequestration ($C_{seq.}$), etc. (Ascari et al. 2015; Khan et al. 2022). In this perspective, many evergreen and broad leaf species show good results in reducing noise and air pollution and also providing shade and shelter to biota and human beings. Urban forest resources include a cluster of park trees, gardens with trees, and any green spaces including rooftops, riparian corridors, city parks, and urban forests >0.5 ha (Endreny 2018).

Urban forest helps in mitigating climate change and its negative impact. Urban cities are prone to various environmental problems and land-use changes caused by climatic and anthropogenic perturbations. In this context, urban forest resources help in mitigating change and social consequences of urban sprawl to make cities more resilient to these changes. Urban forest resources improve the quality of cities life, providing food, supporting pollination, regulating temperature, improving health, providing recreational and spiritual benefits, and human well-being (Cheisura 2004).

The urban greenery/forest resources are considered as a lung of city that help in the construction of the high-quality human settlement, eco-design of cities, and human-built environment. Therefore, urban forestry besides its functions and services enhances the forest cover of the nation. The forest resources in developing

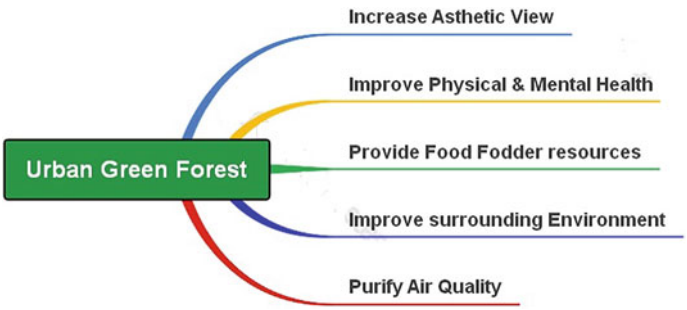

Fig. 19.1 Urban green forest and their roles in human civilization (Compiled: Khan et al. 2022; Nowak 2000, Nowak 2018)

countries are depleting, which is creating pressure on the natural ecosystems and their processes and functions (Raj and Jhariya 2021a, b). Thus, plantation schemes in degraded land, wasteland, and urban areas and their proximities can meet the objective of the nation's goal of increasing the forest cover (Khan et al. 2021a, b). In this context, government of India has launched various schemes and programs to enhance the vegetation cover as forest and tree outside forest (TOF). Recently, Indian government has launched the Nagar Van Project intending to create urban green space in 200 Indian cities in the coming 5 years. Sustainable cities can be designed by opting for eco-friendly technologies in various spheres of human habitation and the surrounding landscape. This only can lead toward the overall prosperity of human civilization and sustainable development (Fig. 19.1). In this context, this chapter deals with the urban forest resources and forest cover and their role in overall eco-environmental services and development.

19.2 Urban Forest Resources

Forests and other tree components including woodland and plantations are an integral part of urban areas. Urban forest resources comprise all diverse types of plant life forms that entirely intermingle and ensure many ecosystem services. These resources provide various tangible and intangible services for a better urban environment and people's health. Therefore, urban forest resources ensure environmental sustainability and ecological stability through promising food-soil-climate security. However, forest resource assessment is quite important for understanding tree covers and related services in urban areas. Ground inventory and geographic information system-based assessment are good strategies that require better planning and management for urban forest and green space assessments (Hoang and Tran 2021). However, analyzing dendrometric parameters in forest resource assessments is also influenced by water quality and soil types under prevailing climatic conditions (Sanesi et al. 2006).

These resources provide various services that can ensure urban sustainability at ecological, social, and economic dimensions. Urban forest resources can provide a variety of plants and ample green space that regulate other natural resources like soil, water, and air, which maintains ecological stability (Nowak et al. 2006). Thus, the function of forest resources would be critical due to population variations in urban areas. Moreover, forest-based resources ensure biomass and energy productions along with shading provision to buildings and paved surfaces in urban cities (Yu and Hien 2006). However, several biotic disturbances and climate change-mediated insect pests and disease outbreaks affect these forest resources in urban cities (Zhang and Brack 2021). For example, fungal-endophyte-mediated complex disease syndromes have declined plant vigor losses in various tree species, for example, *Quercus rubra*, *Acer pseudoplatanus*, *Quercus robur*, and *Alnus cordata* in urban cities of Parco Nord regions. Declining tree vigor due to several diseases like chlorosis, necrosis, tree dieback, leaf-wilt, and bark cracks was observed in tree species under urban setup. Thus, adopting scientific management practices would be a viable tool to protect the forest species from various biotic and climatic disturbances (Turco et al. 2006). In this context, smart urban forest and its management can effectively manage all forest resources for the welfare of humans and the environment (Prebble et al. 2021). A management-oriented effective policy along with good governance is required to protect forest resources that enhance biodiversity and intensify ecosystem services for a better sustainable urban world.

19.3 Multifunction of Urban Forestry

Urban forests in cities perform various functions for the environment and human beings. The urban forest in the cities connects the people with the environment as ecology and the natural balance of the planet are influenced by anthropogenic activities. Urban forest cover provides shelter, maintains ecological functions, and provides many opportunities to enhance ecosystem services. Urban forest-based ecosystem services across the globe are shown in Table 19.1 (Koricho et al. 2020).

Rapid urbanization and expansion create many challenges in urban areas such as environmental problems, soil health, and habitat destruction of many flora and fauna, which lead to biodiversity loss (Jhariya and Singh 2021a, b, c; Raj et al. 2018). Green infrastructure in urban areas plays a vital role in coping with climate change and its negative impact on the ecosystem. Urban forest resources are very important to safeguard the environment in cities for maintaining a healthy and pure environment. Urban green resources (e.g., trees and vegetation) help in cooling the air temperature, reduce the wind speed, provide shade and shelter, reduce soil loss, control pollution, improve biodiversity, moderate climate change, and play a significant role through providing multifunctional services to urban ecosystem, human and other living organisms that leads to sustainable development and urban sustainability (Fig. 19.2).

Urban forest facilitates various direct and indirect benefits to human society. These forests are capable to produce diversified goods and services for human civilization. In developing countries, urban forests are an important source of

Table 19.1 Urban forest-based ecosystem services across the globe

Regions	TD	CS	CS	PR
Adama city in Ethiopia	96.0	21.3	1.5	0.02
Perth city in Australia	83.0	15.0	0.3	0.2
Barcelona city in Spain	141.0	11.2	0.5	0.10
Urban region of London	35.0	15.0	0.5	0.12
Beijing city in China	79.0	7.4	0.4	0.3
Toronto city in Canada	160.0	19.3	0.8	0.07
Urban region of Atlanta	275.0	39.3	1.3	0.11
Los Angeles	48.0	10.4	0.4	0.04
Washington city in U.S.	121.0	32.9	1.01	0.06
Oakville city in Canada	192.0	14.8	0.66	0.03
Syracuse city in New York	167.0	25.4	0.84	0.04
Woodbridge town New Jersey	164.0	26.7	0.93	0.08
San Francisco city	55.0	16.3	0.42	0.03

TD tree density (ha^{-1}), *CS* carbon sink (t ha^{-1}), *CS* carbon sequestration (t ha^{-1} year^{-1}), *PR* pollution removal (t ha^{-1} year^{-1})
Modified from Koricho et al. (2020)

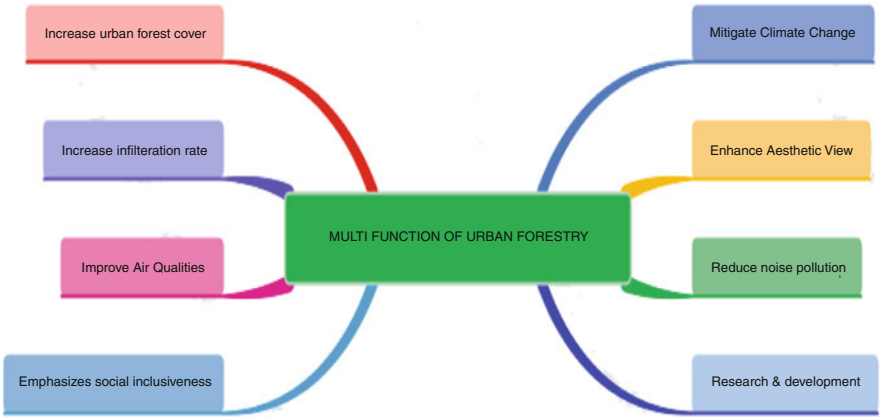

Fig. 19.2 Multifunction of urban forest resources (Khan et al. 2022; Koricho et al. 2020)

wood for construction work and fuelwood. Fruit trees and some medicinal plants in gardens, streets, and residential areas help urban dwellers to make use of the product. Planting and growing trees in urban areas strengthen the economy and multifunctional nature of urban agriculture. Species like *Syzygium cumini*, *Mangifera indica*, and other fruit tree species in urban areas facilitated nutrition and economic gains. Urban agriculture improves the availability of food for local people and shortens thesupply chain that supports food security (Raj et al. 2020). Urban agriculture helps to contribute as C sink in an urban area; along with the productive function, they also play a protective role by reducing environmental pollution and managing the urban ecosystem.

19.4 Ecosystem Service of Urban Forest

Urban trees and green space improve the urban environment and community health. The health of an urban ecosystem can be measured by tree cover and the status of vegetation in that area. An ecological system such as soil, air, and water is supported by vegetation and their intricate relationship in an urban landscape. High tree cover provides more and healthy ecosystem services to an urban area in the form of reducing water runoff, $C_{seq.}$, heat reduction, soil and water conservation, biodiversity improvement, climate change mitigation (Parsa et al. 2020; Yan et al. 2018). Trees found near residence/building provide shade and help in cooling air and reduce solar exposure. Estimating ecosystem services and their annual value (in money) makes a clear understanding of urban forest resources and related services for managing biodiversity and environmental health. In this context, the annual value (million $) of various ecosystem services from Gainesville's urban forest resources is depicted in Fig.19.3 (Andreu et al. 2019). The total annual monetary benefits from forest ecosystem services are 24.5 million US dollar. Ecosystem services as carbon sequestration contributed second rank (5.9 million US $) after energy-saving services as 7.7 million US dollar. These creates awareness among the people about the importance of urban forest resources and thus helps to strengthen ecosystem services for a better urban environment.

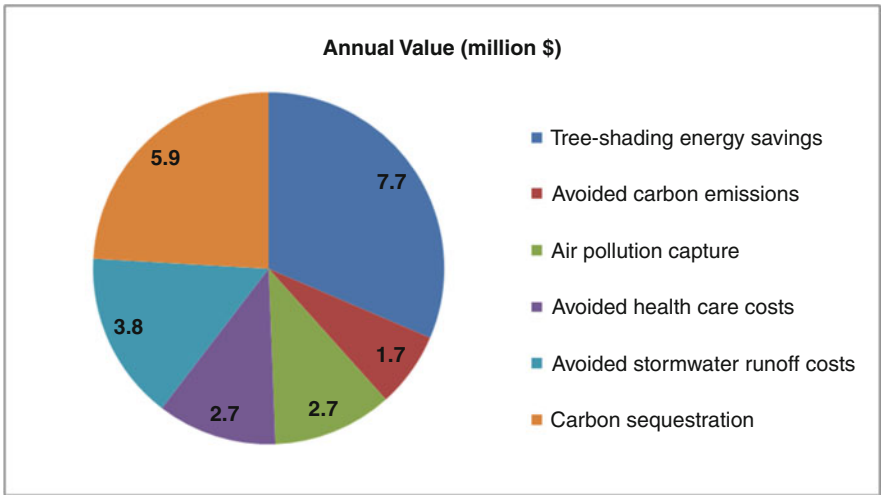

Fig. 19.3 Annual value of ecosystem services provided by urban forest resources in Gainesville's, Florida (Andreu et al. 2019)

19.4.1 Water Conservation and Runoff Reduction

Water scarcity in urban areas is the major problem due to population pressure, utilization, and lowering of groundwater table day by day followed by global warming and climate change phenomenon. In most of the regions of the world, especially in a developing country, the availability of fresh water is becoming a scarce resource at present time. This will worsen in the coming future if proper steps toward judicious conservation and management of water resources are not given due consideration. The urban forest cover helps in reducing runoff intensity and increases the water-holding capacity of soil, which helps in increasing groundwater recharge. The different component of a tree helps in reducing the storm-water flow by rainwater interception through various tree components such as leaves, stems, branches, etc. Moreover, applying organic mulch helps in soil-water conservation (Mechergui et al. 2021) along with run-off reduction in urban forest areas. For example, in an arid urban region, a mulch application with a range of 0.25–0.50 kg/m^2 enhanced soil water content along with runoff amount reductions by 28–83%, respectively (Wang et al. 2021). Tree roots help in absorbing water and also help to hold the soil particle and prevent runoff, which manages the runoff amount in urban areas. Trees in urban space also reduce the cost of constructing storm water control infrastructure and are cost-effective techniques to manage the trinity of soil-water-environment (Jhariya et al. 2019a, b).

19.4.2 Air Quality in Urban Area

With increased urbanization and pollution rate due to many anthropogenic activities, air quality in the urban area gets polluted. Urban forest helps in controlling pollution levels in urban cities. Different tree species have different absorbing/removal tendencies of pollutants and other contaminants from the atmosphere. In this context, tree species for removing pollutant for improving air quality is depicted in Table 19.2 (Nowak 2000). Urban forest cover is the sink to store C from the atmosphere. Urban forest trees produce oxygen for 18 people per tree on daily basis. Cities are moving toward green cities to reduce the impact of pollution in urban areas. Urban forest cover can work as efficient air cleaning machines. Broad leaf species help in intercepting particulate matters and pollutants from the air. Trees in urban areas help in improving the health issues caused by poor air quality. Trees are a very important component in urban cities and the loss of trees in the urban area increases the heating effect due to loss of shade and evaporation. Trees help in reducing temperature levels in an urban atmosphere.

19.4.3 Carbon Reduction by Urban Trees

Urban forest plays a key role in C management by enhancing C sink and reducing GHGs emissions that minimize C footprints and climate change issues globally

Table 19.2 Tree species for removing pollutant for improving air quality

Scientific name	Common name	O_3	CO	SO_2/NO_2	PM
Ulmus procera	Common elm	√	√	√	√
Ulmus rubra	Indian elm		√		
Tilia europaea	British isles	√		√	√
Tilia euchlora	Caucasian linden		√		
Tilia tomentosa	Silver linden		√		
Fagus grandifolia	American beech	√	√	√	
Betula alleghaniensis	Yellow birch	√	√	√	
Liriodendron tulipifera	American tulip tree	√	√	√	
Tilia americana	American linden	√	√		
Fagus sylvatica	Common beech	√	√		
Tilia platyphyllos	Large-leaf lime	√			
Betula papyrifera	Paper birch	√			
Ginkgo biloba	Ginkgo		√		
Platanus x acerifolia	London plane tree			√	√
Cupresso cyparis x leylandii	Leyland cypress				√
Juglans nigra	Black walnut			√	√
Abies alba	Silver fir				√
Larix decidua	Common larch				√
Picea rubens	Red spruce				√
Populus deltoides	Poplar			√	

PM particulate matter
Modified from Nowak (2000)

(Banerjee et al. 2021a, b, c, d; Buzási et al. 2021; Zhang and Brack 2021).Trees have a great ability to store C from the atmosphere, reduce greenhouse gases (GHGs), and contribute to minimizing the negative consequence of global warming. Trees components (above/below) help in storing C into biomass and sequester CO_2 from the environment. An older tree can conserve more C than the young trees depending upon the site quality and inherent characteristics of the species. Climate change in the addition of destruction and degradation of forest resources leads to a problem through increasing C levels in the environment (Meena et al. 2022; Roy et al. 2022; Yadav et al. 2022). Thus, the urban forest plays a vital role in improving and mitigating the climate change impact on the biosphere.

19.4.4 Trees and Energy Conservation

The tree tends to conserve energy and thus benefits urban cities from direct shading. Trees improve the microclimate of the region and save money on energy costs and also reduce various forms of GHGs and air pollution (Hwang et al. 2017). During summer seasons, urban cities experience more heat as urban areas absorb more heat waves due to less vegetation resulting in warmer air temperature as compared to an area having good vegetation and trees. Trees increase the albedo effect by reflecting

the short waves and providing shade to urban infrastructure, thus lowering the temperature level in an urban environment.

19.4.5 Maintaining and Enhancing Wildlife Habitats and Corridors

Urban forest resources maintain biodiversity and provide shelter to many wild animals, which ensure balance in the urban ecosystem. Biodiversity conservation is very important for a balanced ecosystem. In urban regions, environment gets harsh due to faulty practices; thus, greenery in this landscape often is the symbol of nature and life. The urban tree helps in providing food for the fauna and bird species; in turn, they play the role of pollinator in urban area and its proximity. Anthropogenic activities affect the resources of the earth and beautiful landscapes; thus, trees and vegetation in an urban area help in minimizing the negative outcomes caused by anthropogenic activities. Biodiversity and wildlife conservation in an urban area also included with sensory stimulation and help in connecting the human with the natural landscapes and help in improving the ecosystems and human health that leads to the overall prosperity of the biosphere (Honda et al. 2018; Silva-Rodríguez et al. 2021).

19.4.6 Urban Forest Cover and Climate Change

Trees in the urban area act as C sink for carbon dioxide (CO_2) fixation and mitigation during photosynthesis and store C into vegetation biomass. Urban forest resources help to store C in above and below biomass and sequester CO_2. Thus, increasing green cover in urban area helps in the accumulation of C that leads to mitigating climate change. Anthropogenic activities such as deforestation, burning of coal, and management activities such as crown thinning also resulted in increment of CO_2 in the atmosphere. Urban forest cover is a key to improving C storage and sequestration in the cities. C sequestration and storage is key ecosystem services delivered by urban forest resources. Thus, the greater the urban forest cover greater will be the C sequestration and mitigation potential of CO_2. As per Zhao et al. (2010), C storage values were reported as 11.74 Tg and 30.25 t ha^{-1} as compared to 166.5 ton $year^{-1}$ and 1.66 ton ha^{-1} $year^{-1}$, respectively, in Hangzhou's urban forests. Moreover, better management of urban forests offsets 18.6% of C emitted by anthropogenic industrial activities in the city. For sustainably managing the urban environment, the integrated management approach is needed and can be a good solution under changing climatic perspective. Integrated management of resources tackled in urban ecosystem practices aims to address the linkage between ecosystem components and urban cities. Changing land use into eco-friendly approaches may help in improving water, air, soil quality, and reducing the overexploitation of these precious resources, and building the ecosystem resilience. Urban green space reduces GHGs. C in a tree is measured in two ways: storage in tree biomass and sequestration per year. Trees' ages also affect the rate of absorption rate; different aged trees have different capacities of storage intensity. Urban vegetations are very

helpful in maintaining environmental attributes viz., temperature, relative humidity, evapotranspiration, etc., and have a substantial impact on weather and climate change.

The health of community ecology can be measured by tree health. Trees are a good indicator of urban ecosystem health; cities with good forest cover may face fewer ecosystem problems than the cities with the less forested area. Good urban forest cover with less impervious surface helps in reducing the storm water runoff, storing and sequestering the atmospheric C, and reducing the energy consumption of urban infrastructure. The urban tree also helps in maintaining the water conservation and management in the watershed region and helps in resource conservation across the world. Community forestry and social forestry by private and public sectors also helps in mitigating climate change in urban cities. Trees in urban areas have the potential to work as C sink, good pollution controllers. The TOF plays a vital role in cycling global C, TOF includes roadside planting, gardens, residential areas various institutional or academic landscapes. Urban vegetation has a high potential in mitigating environmental degradation due to rapid urbanization through ecosystem services.

19.4.7 Tree and Sustainable Cities

Trees are an important component in an urban ecosystem as they play a vital role in maintaining the diversity and services in the ecosystem. Trees in the urban area provide nonpriced benefits like controlling pollution, mitigating climate change, C sequestration, improving aesthetic view, and many functions for improving urban life. The relationship between society and the environment is very much altered by urbanization and activities and process during urbanization that affects the ecosystem services, environment, sustainability, and resilience. Urban forest resources are the most important contributor and play a significant role in the sustainable development of cities. Sustainable development includes the interdisciplinary and integrative approaches for the management and improvement of existing facilities and services provided by urban forest resources (Khalaim et al. 2021). Trees around the urban centers provide goods and services to people. Many environmental services such as green infrastructures in cities benefit to climate, the people living in the cities, and contribute to sustainable development goals. Urban forest and vegetation help in the management of water by improving groundwater recharge. Sustainable supply of water is a major task as the increasing population and demand for water in urban cities are getting high. Thus, these urban forest resources help in recharging the groundwater under the urban setup. The presence of urban green space and urban resources are an asset to urban cities for sustainable growth and development of healthy life.

19.5 Impact of Deforestation on Urban Forest Cover

The global forest faces various problems leading to the degradation of these valuable resources to a great extent. Among all the deforestation is more devastating and degrading the resources directly beside their indirect huge losses in various spheres related to the environment and ecology (Fig. 19.4) (Zipperer et al. 2012).

Urban green space includes diverse life forms of flora facilitating various ecosystem balance, which hampers due to anthropogenic influence. Deforestation activities alter the vegetation dynamics and associated ecological functions and processes and associated ecosystem. The developmental process and land-use changes have negative impacts on urban green space and vegetation cover in an urban setup.

19.5.1 Factors Affecting Urban Vegetation Development

- Lesser availability of the area for urban greening.
- Deprived soil health and quality due to biotic interference to affect the overall health and development of the urban vegetation and plantation affords.
- Hostile environmental conditions for invasive, alien species, which affect the indigenous biota.
- Frequent expansion of infrastructure setup in the urban area alters the tree cover and population dynamics.
- More stress and drought due to pollution and other factors affecting the ecological amplitude of the species.
- Lack of proper planning, developmental activities as well as governmental initiatives with the people participation toward the awareness of urban forestry programs.

The deforestation activities in the urban landscape can be minimized through campaigning regarding environmental justice, promotion of urban forestry, and protection measure to check the negative consequences of climate change and global warming (Hwang et al. 2017). The vision-related to urban forestry and its development must be addressed in the working and development plan of the city. Further, community transformation and participation toward conservation of nature instead

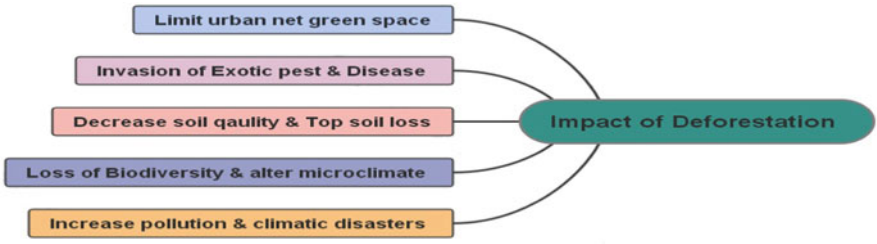

Fig. 19.4 Deforestation impacts on environmental segments. (Modified: Zipperer et al. 2012)

of destruction of vegetation need to be promoted followed by plantation, community stewardship, and technological intervention.

19.6 Prospects of Urban Forestry and Development

Urban forestry practices are rapidly increasing in the present time due to global and regional efforts toward sustainable cities and improving the green cover in the urban setup. The prospect of urban forestry is wider to link the human being with nature and get more ecological benefits from forest resources on a sustainable basis (Khan et al. 2021a, b, 2022). This is a growing concept with the urban science and its scientific design, management, and socio-ecological context to move forward for sustainability. This not only fulfills and satisfies the needs of human society but also advances the ecosystem conservation affords as well as an adaptive mechanism to natural alterations. The urban forestry opportunities integrate the urban free space areas for restoration, utilization, eco-socio-environmental development, green infrastructure, and design perspectives, climatic adaptive and mitigation strategy, eco-environmental resilience, and many more. The success of urban forestry depends upon the people's participation, awareness regarding eco-environmental functions of urban forestry resources, the establishment of various green spaces, green infrastructure and designing, proper policies instruments, and planning for sustainable urban development (Fig. 19.5).

Moreover, integrated urban forestry development and planning must be implemented through joint participation of people along with the government/cities authorities for successful execution of the schemes. In addition to this, proper monitoring and mapping of urban forest resource need to be explored on a

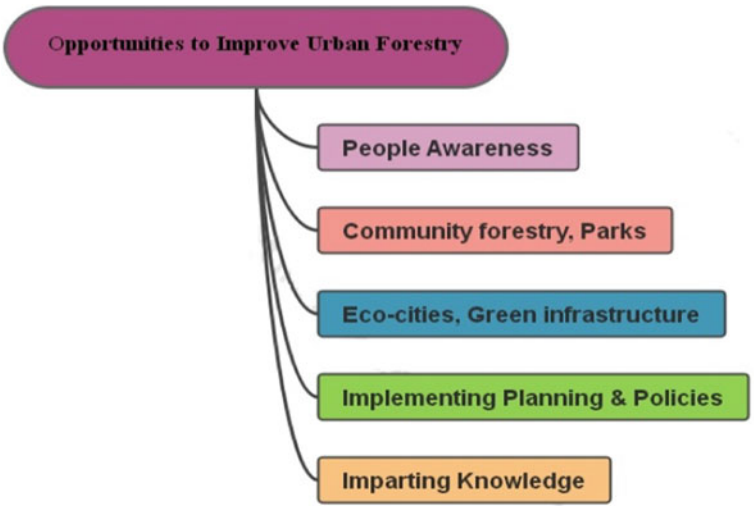

Fig. 19.5 Prospects and opportunities of urban forestry

time-to-time basis toward risk assessment, environmental perception, and analysis of other related aspects. Urban forestry schemes and programs link the people with nature and natural resources. This leads to social progress through the environment stewardship integrating the ecology, environment, economics, and social dimensions. This often attracts and influences people's perception, participation, and behaviour regarding their natural resource conservation concerns.

19.7 Management Aspects

Management aspects are an important consideration for the success of any schemes and programs. Developing a proper management plan for urban forestry includes the goal of management, changes on urban and periurban green cover, urban forest resource management plan toward optimizing green covers in precise duration (Jhariya et al. 2019a). Further, monitoring the changes and alterations in an urban area and its proximity due to biotic pressure must be well defined in the management action plan to meet the desired goal of management. This requires accurate data base by the forest managers to tackle the urban forest resources and the services it offers to human beings (Khan 2018). Further, the ecological services provided to the ecosystem by the urban forest resources can be improved through decision-making tools, which are essential roadmap to guide regarding the management and policies context. Well-planned and well-managed urban forest resources are more effective toward climate change adaptation and mitigation, resilient and sustainable in the various spheres. Therefore, planting trees is precious followed by their proper care, maintenance, and management for increasing the forest cover and achieving the sustainable goal.

19.8 Research and Development of Urban Forest Resources

The urban forest resource assessment, monitoring, evaluation through research and development activities are the building blocks of ecosystem management. Research and development help for proper and efficient planning, execution, and management toward urban forest resource development (Khan et al. 2019a, b, 2020a, b). The research and development must be aligned with the climate change scenario and other disturbance regimes, because urban landscapes have more biotic alteration of systems as well as harsh growing environment to the plants. Thus, the screenings of potential species with diversified environmental, ecological, and socio-economic outputs having wider ecological amplitude must be done through careful and applied research and development plans. Urban vegetation and landscape database quantification should be taken for strengthening the improvement of urban green space and sorting out the constraints and hurdles faced during the past. Moreover, inclusive, logical, and scientific databases and information are obtained from quality research and developmental activities related to urban forest resources.

19.9 Policies and Legal Framework

Non-judicious use of resources, human greed, population explosion, and lacunae in the policies and legal framework leads to an unsustainable and unhealthy urban environment. In this context, human civilization and development need to redefine and rethink to balance harmony with nature. Sustainable urban development depends upon the proper planning, policies, and strategic roadmap to conserve and enhance the urban forest cover. In this perspective, collaboration and execution of sustainability aspects of the urban landscape need to align with local, national, and international levels. The conservative approach of urban vegetation improves the life of the city, enhances the ecology and sustainability of the urban landscape (Khan 2018). The technological intervention and upgradation of science have few pessimistic consequences as environmental quality degradation and pollution loads, which are threatening the human being. Thus, new initiatives need to be implemented for increasing urban forest cover toward sustainable cities through offsetting the carbon emission and reduction through vegetation and soil carbon pools (Lal and Stewart 2017).

19.10 Future Thrust

The urban planning and development under changing climate context need to be linked and well-aligned with the compatible policies framework as well as future directions to manage the urban landscape in sustainable ways (Khan et al. 2019a, b). The climate-related policies for the urban area need to be given due consideration for C management strategies (Jhariya et al. 2021a, b, 2022). Under this perspective proper assessment of forest structure (physical attributes of vegetation), vegetation modelling for urban area and its proximity for deriving optimum output, framing appropriate management plan followed by proper evaluation and monitoring of these landscapes are essential toward overall prosperity and well-being of human civilization and ecosystem (Fig. 19.6) (Nowak 2018).

For the effective management plan of the urban forest resources, the databank of emission and reduction followed by strategies to combat these issues in the current climatic context will surely move toward a sustainable world (Raj et al. 2021, 2022). Further, time-to-time monitoring along with technological and methodological validation is essential for the prediction of future changes. The greenery programs in the urban setup can be enhanced to generate awareness and motivation toward conservation of nature through urban forestry, afforestation; reforestation, social forestry, aesthetic forestry, home garden, Oxygen Park, botanical parks, and garden, as well as plantation activities improve the resilience of human-built environment (Khan et al. 2022).

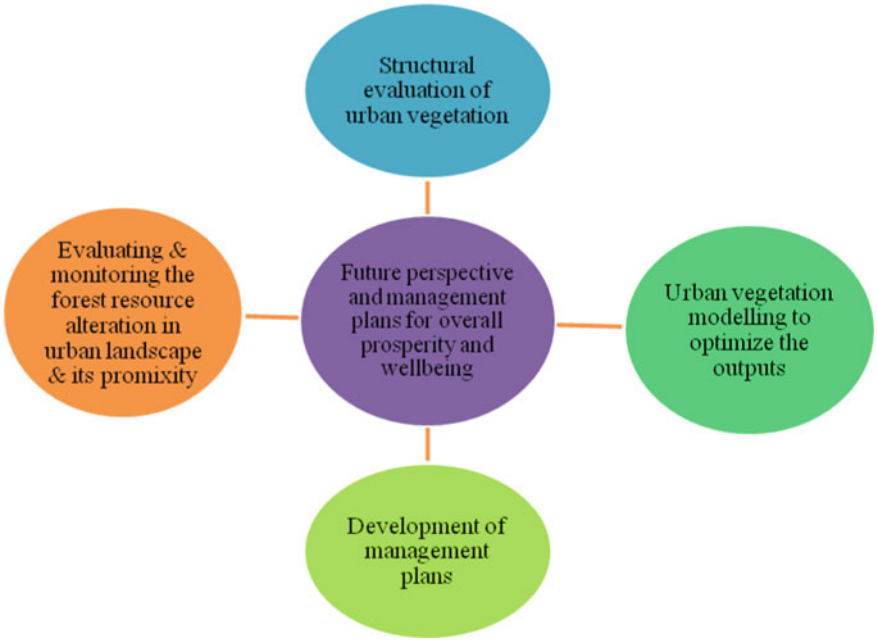

Fig. 19.6 The future perspective for management and implication for future wellbeing. (Modified: Nowak 2018)

19.11 Conclusion

Urban development is critical for changing climate worldwide, because the urban landscape has a substantial part of the world's C cycle. After all, it possesses significant C flux and C alteration as compared to other land-use or ecosystems. This landscape was mainly altered by the human-built environment and became a source of biotic climate change. The information related to urban vegetation, characterization of source and sink of C is essential toward management, conservation of these floras for sustainable planning and development of urban ecosystems. The idea and database on the urban region are important for C monitoring, fluxes, and for adapting pollution and climate mitigation framework and policy development and formulation. Screening of site-specific species having higher ecological adaptation and amplitude is needed for moving forward to emission reduction strategy.

References

Andreu MG, Hament CA, Fox DA, Northrop RJ (2019) Values and ecosystem Services of Gainesville's urban Forest in 2016. School of Forest Resources and Conservation, UF/IFAS Extension, EDIS, FR345, pp. 3

Ascari E, Licitra G, Teti L, Cerchiai M (2015) Low frequency noise impact from road traffic according to different noise prediction methods. Sci Total Environ 505:658–669

Banerjee A, Jhariya MK, Yadav DK, Raj A (2020) Environmental and sustainable development through forestry and other resources. Apple Academic Press Inc., CRC Press- a Taylor and Francis Group, US & Canada, p 400

Banerjee A, Meena RS, Jhariya MK, Yadav DK (2021a) Agroecological footprints management for sustainable food system. Springer Nature, Singapore

Banerjee A, Jhariya MK, Meena RS, Yadav DK (2021b) Ecological footprints in agroecosystem- an overview. In: Banerjee A, Meena RS, Jhariya MK, Yadav DK (eds) Agroecological footprints management for sustainable food system. Springer Nature, Singapore, pp 1–23

Banerjee A, Jhariya MK, Raj A, Yadav DK, Khan N, Meena RS (2021c) Land footprint management and policies. In: Banerjee A, Meena RS, Jhariya MK, Yadav DK (eds) Agroecological footprints management for sustainable food system. Springer Nature, Singapore, pp 221–246

Banerjee A, Jhariya MK, Raj A, Yadav DK, Khan N, Meena RS (2021d) Energy and climate footprint towards the environmental sustainability. In: Banerjee A, Meena RS, Jhariya MK, Yadav DK (eds) Agroecological footprints management for sustainable food system. Springer Nature, Singapore, pp 415–443

Buzási A, Pálvölgyi T, Szalmáné Csete M (2021) Assessment of climate change performance of urban development projects- case of Budapest. Hungary Cities 114:103215

Cheisura A (2004) The role of urban parks for the sustainable city. Landsc Urban Plan 68(1): 129–138

Endreny TA (2018) Strategically growing the urban forest will improve our world. Nat Commun 9: 1160

Escobedo FJ, Kroeger T, Wagner JE (2011) Urban forests and pollution mitigation: 16 analyzing ecosystem services and disservices. Environ Pollut 159:2078–2087

Hoang ND, Tran XL (2021) Remote sensing–based urban green space detection using marine predators algorithm optimized machine learning approach. Math Probl Eng 2021:5586913

Honda T, Iijima H, Tsuboi J, Uchida K (2018) A review of urban wildlife management from the animal personality perspective: the case of urban deer. Sci Total Environ 644:576–582

Hwang WH, Wiseman PE, Thomas VA (2017) Enhancing the energy conservation benefits of 636 shade trees in dense residential developments using an alternative tree placement strategy. Landsc Urban Plan 158:62–74

Jhariya MK, Singh L (2021a) Herbaceous diversity and biomass under different fire regimes in a seasonally dry forest ecosystem. Environ Dev Sustain 23(5):6800–6818

Jhariya MK, Singh L (2021b) Effect of fire severity on soil properties in a seasonally dry forest ecosystem of Central India. Int J Environ Sci Technol 18(3):1–12

Jhariya MK, Singh L (2021c) Productivity and carbon accumulation in tropical dry deciduous forest ecosystem. In: Chaturvedi RK, Singh R, Bhadouria R (eds) Tropical dry forests: emerging features and ecological perspectives. Nova Science, pp 269–287

Jhariya MK, Banerjee A, Meena RS, Yadav DK (2019a) Sustainable agriculture, forest and environmental management. Springer Nature, Singapore, p 606

Jhariya MK, Yadav DK, Banerjee A (2019b) Agroforestry and climate change: issues and challenges. Apple Academic Press Inc., CRC Press- a Taylor and Francis Group, US & Canada, p 335p

Jhariya MK, Meena RS, Banerjee A (2021a) Ecological intensification of natural resources for sustainable agriculture. Springer Nature, Singapore, p 655

Jhariya MK, Banerjee A, Meena RS, Kumar S, Raj A (2021b) Sustainable intensification for agroecosystem services and management. Springer Nature, Singapore

Jhariya MK, Meena RS, Banerjee A, Meena SN (2022) Natural resources conservation and advances for sustainability. Elsevier, Academic Press, Amsterdam

Khalaim O, Zabarna O, Kazantsev T, Panas I, Polishchuk O (2021) Urban green infrastructure inventory as a key prerequisite to sustainable cities in Ukraine under extreme heat events. Sustainability 13:2470

Khan N (2018) Assessment of vegetational diversity in urban environment of Ambikapur. MSc farm forestry dissertation, Sarguja University Ambikapur (CG), India
Khan N, Jhariya MK, Yadav DK (2019a) Population structure of vegetation in urban environment of Sarguja, Chhattisgarh, India. J Plant Dev Sci 11(3):133–142
Khan N, Jhariya MK, Yadav DK (2019b) Invasion and impact of non-native species on indigenous flora in an urban ecosystem of India: a case study. Int J Ecol Dev 34(4):103–118
Khan N, Jhariya MK, Yadav DK, Banerjee A (2020a) Herbaceous dynamics and CO_2 mitigation in an urban setup- a case study from Chhattisgarh, India. Environ Sci Poll Res 27(3):2881–2897
Khan N, Jhariya MK, Yadav DK, Banerjee A (2020b) Structure, diversity and ecological function of shrub species in an urban setup of Sarguja, Chhattisgarh, India. Environ Sci Poll Res 27(5): 5418–5432
Khan N, Jhariya MK, Raj A, Banerjee A, Meena RS (2021a) Soil carbon stock and sequestration: implications for climate change adaptation and mitigation. In: Jhariya MK, Meena RS, Banerjee A (eds) Ecological intensification of natural resources for sustainable agriculture. Springer, Singapore, pp 461–489
Khan N, Jhariya MK, Raj A, Banerjee A, Meena RS (2021b) Eco-designing for sustainability. In: Jhariya MK, Meena RS, Banerjee A (eds) Ecological intensification of natural resources for sustainable agriculture. Springer, Singapore, pp 565–595
Khan N, Jhariya MK, Raj A (2022) Urban greening toward sustainable development and sustainability. In: Ozturk M, Khan SM, Altay V, Efe R, Egamberdieva D, Khassanov FO (eds) Biodiversity, conservation and sustainability in Asia, south and middle Asia. Springer, Switzerland, pp 345–373
Koricho HH, Seboka AD, Song S (2020) Assessment of the structure, diversity, and composition of woody species of urban forests of Adama city, Central Ethiopia. Arboric J
Lal R, Stewart BA (2017) Urban soils. CRC Press, Boca Raton
Mechergui T, Pardos M, Jhariya MK, Banerjee A (2021) Mulching and weed management towards sustainability. In: Ecological intensification of natural resources for sustainable agriculture. Springer, Singapore
Meena RS, Yadav A, Kumar S, Jhariya MK, Jatav SS (2022) Agriculture ecosystem models for CO_2 sequestration, improving soil physicochemical properties, and restoring degraded land. Ecol Eng 176:106546
Nowak DJ (2000) Tree species selection, design, and management to improve air quality. Construction technology: annual meeting proceedings of the American society of landscape architects
Nowak DJ (2018) Improving city forests through assessment, modelling and monitoring. Unasylva 250(69):30–36
Nowak DJ, Crane DE, Stevens JC (2006) Air pollution removal by urban trees and shrubs in the United States. Urban For Urban Green 4(3–4):115–123
Parsa VA, Salehi E, Yavari A (2020) Improving the provision of ecosystem services from urban forest by integrating the species' potential environmental functions in tree selecting process. Landscape Ecol Eng 16:23–37
Prebble S, McLean J, Houston D (2021) Smart urban forests: an overview of more-than-human and more-than-real urban forest management in Australian cities. Digital Geography Soc 2:100013
Raj A, Jhariya MK (2021a) Site quality and vegetation biomass in the tropical Sal mixed deciduous forest of Central India. Landsc Ecol Eng 17(3):1–3
Raj A, Jhariya MK (2021b) Carbon storage, fluxes and mitigation potential of tropical Sal mixed deciduous forest ecosystem in Chhattisgarh. India J Environ Manage 293(1):112829
Raj A, Jhariya MK, Harne SS (2018) Threats to biodiversity and conservation strategies. In: Sood KK, Mahajan V (eds) Forests, climate change and biodiversity. Kalyani Publisher, New Delhi, p 381
Raj A, Jhariya MK, Yadav DK, Banerjee A (2020) Climate change and agroforestry systems: adaptation and mitigation strategies. Apple Academic Press Inc., CRC Press-A Taylor and Francis Group, US and Canada, p 383

Raj A, Jhariya MK, Khan N, Banerjee A, Meena RS (2021) Ecological intensification for sustainable development. In: Ecological intensification of natural resources for sustainable agriculture. Springer, Singapore, pp 137–170

Raj A, Jhariya MK, Khan N (2022) The importance of forest for soil, food and climate security in Asia. In: Ozturk M, Khan SM, Altay V, Efe R, Egamberdieva D, Khassanov FO (eds) Biodiversity, conservation and sustainability in Asia, south and middle Asia. Springer, Switzerland, pp 33–52

Roy O, Meena RS, Kumar S, Jhariya MK, Pradhan G (2022) Assessment of land use systems for CO_2 sequestration, carbon credit potential and income security in Vindhyan region. India Land Degrad Dev 33(4):670–682

Sanesi G, Lafortezza R, Bonnes M, Carrus G (2006) Comparison of two different approaches for assessing the psychological and social dimension of green spaces. Urban For Urban Green 5: 121–129

Silva-Rodríguez EA, Gálvez N, Swan GJF, Cusack JJ, Moreira-Arce D (2021) Urban wildlife in times of COVID-19: what can we infer from novel carnivore records in urban areas? Sci Total Environ 765:142713

Turco E, Marianelli L, Vizzuso C, Ragazzi A, Gini R, Selleri B, Tucci R (2006) First report of *Botryosphaeria dothidea* on sycamore, red oak and English oak in North-Western Italy. Plant Dis Rep 90(8):1106

Wang B, Niu J, Berndtsson R, Zhang L, Chen X, Li X, Zhu Z (2021) Efficient organic mulch thickness for soil and water conservation in urban areas. Sci Rep 11:6259

Yadav VS, Gupta SR, Yadav SS, Meena RS, Lal R, Sheoran NS, Jhariya MK (2022) Carbon sequestration potential and CO_2fluxes in a tropical forest ecosystem. Ecol Eng 176:106541

Yan H, Wu F, Dong L (2018) Influence of a large urban park on the local urban thermal environment. Sci Total Environ 1(622–623):882–891

Yu C, Hien WN (2006) Thermal benefits of city parks. Energ Buildings 38:105–120

Zhang B, Brack CL (2021) Urban forest responses to climate change: a case study in Canberra. Urban For Urban Greening 57:126910

Zhao M, Kong Z, Escobedo F, Gao J (2010) Impacts of urban forests on offsetting carbon emissions from industrial energy consumption for Hangzhou. China J Environ Manage 91(4):807–813

Zipperer WC, Foresman TW, Walker SP, Daniel CT (2012) Ecological consequences of fragmentation and deforestation in an urban landscape: a case study. Urban Ecosyst 15:533–544