International Journal of Environmental Sciences
Vol. 10 No. 3 (October-December, 2024)

https://www.theaspd.com/ijes.php

Integrating Urban Forests into Sustainable Urban Planning: Strategies, Challenges and Future Directions

Shweta Suhane[1], Utpal Sharma[2], Ritu Agrawal[3], Surya Pratap Singh[4]

[1,2]*Institute of Architecture and Planning, Nirma University, Ahmedabad,Gujarat, India, 382481*
[3]*Department of Architecture and Planning, BIT Mesra, Ranchi, Jharkhand, India, 835215*
[4]*Department of Civil Engineering, Srinath University, Jamshedpur, Jharkhand, India, 831013*

Corresponding author: shwetasuhane@gmail.com / *shweta.suhane@nirmauni.ac.in*

Received: 15th August 2024
Revised: 16th October 2024
Accepted: 10th November 2024

Abstract: Urban forestry and green spaces are crucial to making agglomeration sustainable froman environmental, social, and health perspective. In doing so, this paper considers how urban forests (UFs) could be included in land use planning in cities, and the kind of challenges encountered by UFs in relation to this, including details about the standard programme of work containing issues of UHI, Pollution etc. Information is also provided in relation to where improvements might be possible in this case instead. The paper concludes with a review how the urban forests can control microclimate and air quality, stressing its potential to reduce heat islands and overall health. It also explains about carbon sequestration with the emphasis on afforestation as the effective form in the reduction of the emissions of greenhouse gases. The paper discusses the ideal intersection of policies-people-participation as well as policy-technology interfaces. Issues like spatial limitations, operational policies, and the use of multi–professional perspectives are considered. Another interesting discussion in the paper is the role of technology in UGS management and in engaging the community through Artificial Intelligence (AI) as well as Geographic Information Systems (GIS). Some of the future developments are to enhance the awareness of the general public on the effects of environmental conservation as well as adopting sophisticated technologies to enhance the decision making on the same subject. Lastly, the review stresses the recommendations for integrated management and a better coherence of planning approaches in order to deal with and prevent constraints on urban ecosystems.

Keywords: Urban forests, Sustainable urban planning, Climate change, Ecosystem services, Urban greening

1. INTRODUCTION

Urbanization has reshaped the modern civilization beyond imagining and rightly so, comes with several development opportunities. However, it also poses some intimidating challenges most of which are on the social aspect of human life such as air pollution. Various emissions that are a sure menace to the wellbeing of people include a compound of pollutants as a consequence of hastened industrialization, enhanced vehicle usage and growing energy demands triggered by urban growth[1]. Thus, the issue of how to assess the sources of pollution in the urban environment and their impact on the state of health of the people living in cities is explored in this review. It also considers various measures for improving mitigation of urban air quality and developing a better sustainable and healthy urban environment. Cities are turning into centers of cultural and economic association generating interest to those looking for

better opportunities[2]. However, there are other consequences that cannot be predicted when there is an increase in population in urban centers for instance pollution. The main factors believed to have led to this rise in pollution levels include, pollution from home energy use, automobile exhaust, and industry pollutants.

These include particulate matter, nitrogen oxides and volatile organic compounds which are directly responsible for respiratory and cardiovascular diseases, resulting in immense pressure on the health sector[3]. Various industries let out a large number of emissions into the environment because of the many processes that are involved when manufacturing. Moreover, the problem of an over reliance on cars and the utilization of fossil fuel, which results in the atmospheric emission of toxic materials[4].

There are a range of activities which need to be undertaken aiming at reducing the problem of urban air pollution. Among these actions are:

(a) Introduction of standards that define emission quantities so that the transportation technologies that we rely immensely on, can be maintained and kept in check. A particular example lies in the fact that legal standards which are set and consistently applied to cars and industries significantly decrease the amount of hazardous emissions which get released into the environment. The policies that set allowable limits and aim at controlling specific pollutants may have a positive effect on business and manufacturers to adopt cleaner technologies. This way sustainable city design can help reduce pollution levels we have in the country. Some examples of this are: expanding the green areas, investing in public transport and promoting pedestrian and cycling paths instead of cars' use. Another characteristic of sustainable urban development is zoning laws that separate single-family neighborhood's from highly dense urban industrial zones.

(b) Monitoring the effectiveness of measures being taken for reducing pollution as well as assessing areas with high pollution incidencts may be made easier by incorporating advanced technologies in air quality monitoring. The above technologies can actually help decision-makers to get good information so that they make proper decisions. Therefore, it is necessary for the local people to be engaged in activities for the improvement of air standards. Awareness creation projects, tree planting exercises, and clean up drives in the neighborhood are examples of community-based projects that can potentially mobilize citizens to take a collective action and they can also be encouraged to feel more responsible.

(c) Individual trees, parks and forests are essential for enhancing the environmental quality of urban areas,while amenity improvement and conservation of biodiversity have been the traditional objectives of urban greening[5]. However, there is an increasing acceptance of the views on carbon management and other Environmental and Social Standards (ESS), provided by urban trees[6]. Understanding the problem areas in terms of pollution results in better planning of UG. The benefits that people obtain from ecosystem functions or the roles by which ecosystems in their direct and indirect ways positively influence the wellbeing of human beings are referred to as Ecosystem services (ES)[7]. As per (Maes et al., 2016), these services belong to provisioning, regulatory, cultural and supporting types of services. It also includes regulating functions such as air purification, climate regulation and carbon sequestration that are assisted by the urban forests[8].

In addition, adverse situations with air pollution can be exacerbated by the heightened or urban heat island (UHI) intensity referring to situations wherein built up areas of cities or towns are relatively warmer as compared to the surrounding rural areas. The formation of ozone depends on meteorological factors such as the UHI effect and therefore calls for enhanced effort for reduction of ozone in urban regions[9]. This process has been driven by a range of environmental problems, including worsening air pollution, biodiversity loss, the urban heat island effect, and rising greenhouse gas emissions, as shown in figure 1.

Figure-1 Role of urban forests in mitigating environmental degradation caused by urban development.

Air quality control is a difficult task, ripple effect shows that ozone concentrations in urban areas are very reactive to changes in precursor emissions[10]. Preparedness in terms of extensive research studies and policy measures is needed in order to adequately respond to the two-pronged effects of the Greens in the urban areas on the climatic comfort and air quality of the region. Accurate numerical simulations which have high-resolution values can be applied to quantify these effects and to guide the development of proper environmental legislation. According to (Haase et al., 2014), the study had suggested that while increasing the level of urban greening increases comfort through temperature reduction, it at the same time decreases the air quality in some areas due to unsuitable conditions for pollen dispersion[10]. As we all know that there are a lot of benefits of urbanization, at the same time, there are large issues, especially for the air pollution. The increasing energy consumption, frequency in usage of cars, as well as industrialization have greatly complicated the pollution front which is highly destructive to public health. To deal with these issues, a number of measures are necessary, such as stringent limits for emissions, ecological approach to urban development, advanced control technologies,bottom-up initiatives, etc. Consequently, this calls for the increased investment in area of urban forests and greening initiatives which enables the enhancement of the overall environmental quality of cities through carbon sequestration, air purification, and climate control.

However, taking advantage of greens, there is a need to apply design and horticulture principles, take the right design and species in consideration to enhance the positive impacts, and reduce the negative impact of urban greening[11]. It only becomes more evident that decision makers require new ideas and cooperation to improve the quality of air with congestion of cities. For the creation of safe, prosperous, cultural and healthy places for everyone in the growing cities, it requires collective efforts of the policy makers, academics and communities[12].

This paper considers documenting through literature's; various challenges encountered in the inclusion of urban forests (UFs) in land use planning (LUP) in cities, including details about the standard programme of work containing issues like zoning etc. and certain specific improvements / mitigation measures that might be possible. The care and sustenance of urban green spaces (UGS) are discussed as well as the importance of correct policies-people-participation and policy-technology interfaces. Another interesting discussion in the paper is the role of technology in UGS management and in engaging the community through Artificial Intelligence (AI) as well as Geographic Information Systems (GIS)[13]. Some of the future developments are to enhance the awareness of the general public on the effects of environmental conservation as well as adopting sophisticated technologies to enhance decision making on the same subject.

2. LITERATURE REVIEW

This literature review is done with an aim to establish the importance of urban greens with respect to the environment and more specifically, air quality. Trees particularly in the urban landscape help in diminishing the effects of the UHI, mitigating the Greenhouse effect through absorption of CO_2 while also offering local purifying of the air. Nonetheless, it is crucial to understand that a number of factors affect the performance of urban forests; these include tree species, management and urban planning. Several studies indicate that near-surface temperature and people's thermal comfort temperature can be enhanced by green spaces – for instance, green roofs and walls. Still, it is worth pointing out that the cooling effects may be negated through increased biogenic emission from some tree species that in effect reduce air quality through reduction of pollutants' diffusion and aggregation of particulate matter. This is why the choice of tree genotypes that will be used in efforts to increase woodland within cities should be of low emission[14].

The reviewed literature presents the interactions between urban forests, climate variation, air condition, and ecosystems services. Monteiro et al. (2022) identify that there is still a lack of attention to urban risks in the IPCC reports[15], the work of Esperón-Rodríguez et al. (2021) informs that vulnerability of urban plant species is increasing because of climate change and is higher in low latitude regions[16]. All other benefits as evidenced by Yu et al. (2022) include temperature reduction despite the possibility of enhanced air pollution due to biogenic emissions[14]. Studies on city afforestation by Ogunbode & Asifat, (2021) and tree death rate by Esperón-Rodríguez et al., (2022) point to the importance of the principles of restoration and a perspective view[17][18]. A sample of plantation forestry is considered in the Indian context by Swetha et al., (2023)[19], and effects of forest management on CO_2 emission in China byMighri et al., (2022)[20]. In more densely-populated parts of the world, they note that trees within urban areas are sometimes overlooked by mapping services and call for more citizen involvement in tree-plant coverage surveys. Urban forests notably re-emerge as a component of climate change adjustment, according to Pataki et al. (2021), particularly regarding local adjustment though with research restrictions to mitigation [21]. Overall, existing studies on urban forestry in regions suggest the call for better management of the science, sufficient monitoring of its programme, and integrated trans-disciplinary approach to fully exploit the full potential of addressing current environmental issues in urban areas.

Further the current studies show that, in fact, urban forests do more harm than good, but this depends on factors such as vegetation layout, species variety, and mitigation measures. Raihan (2024) points out that effects of urban greenery cannot be listed in blacks and whites, and hence needs further study[22]. These benefits need to be placed in a spectrum, rather than being categorized as positive or negative. Yu et al (2022) pointed that, although urban greening helps to cool down the temperatures[14], it poses the risk of fine particulate matter air pollution and biogenic emission, thus recommending species selection[23]. Miao also elaborates more on how urban forests affect air pollutant concentration by noting that the effects can either be positive or negative based on such aspects as time of the day and weather by (Miao et al., 2022)[24]. This serves to emphasize the interdependence between vegetation and air quality in that factors like dispersion and deposition are very vital. Introducing the overall research area of air pollution, climate change and urban forests, De Marco et al., (2022) highlights the following research gaps and directions: (a) improvement of the monitoring networks; (b) synergy between ground and satellite systems[25]. This is in view of enhancing knowledge on the health of urban forests subjected to air pollution and climate change impacts, and most importantly, formulation of appropriate mitigation measures.

Another important field where the role of urban forests can be seen is public health. Several researchers have identified that urban Blue and Green Infrastructure may mitigate the human health impact of climate change [26]. The review of the matter indicates that while the urban forests are potential barriers to climate change and pollution, their usefulness highly depends on the context. Thus, there is a need to continue studying problems related to green urbanization, including the choice of plant species and the relationships between vegetation and air environment.

If benefits from urban forests are to be fully realized for sustainable development of urban centers, long term assessments, and targeted risk management practices must be sustained.

2.1 Identified Research Gap

a) Insufficient coverage on inadequate air conditioning and its effects on urban climate policies as presented by IPCC.
b) In addition, there have not been any global evaluations of vulnerability of urban forests or climate change studies on species mortality in urban environments.
c) Lack of knowledge regarding the influence of urban green provision and its spatial configuration in climate change solutions.
d) There is a lack of field data quantifying the vertical effect of urban forests on air-borne pollutants and wind borne dispersion.
e) Long term monitoring is very low, inadequate integration of ground and satellite observations.

3. APPROACHES

Different morphometric descriptors are used by several researchers to describe the composition and configuration of green areas and the dynamics of their impact on Land Surface Temperature (LST) spatial heterogeneity. There are various approaches for mapping and estimating effectiveness of urban forests on climate change and air quality. Key approaches include the measures of Proportion of Landscape (PLAND); a method used to evaluate the regional distribution of various land cover types, such as forests, urban areas, and water bodies. The Normalized Difference Vegetation Index (NDVI), which is a metric used to assess vegetation health and density, derived from satellite sensor measurements. A higher NDVI indicates healthier or denser vegetation. NDVI is widely applied in fields such as agriculture, forestry, and other environmental studies. Connors et al. (2013) and Chen et al. (2014) have demonstrated that LST may be affected by land-use configurations as well as specified indexes[27][28]. Zhibin et al. (2015) observed that complete satellite green vegetation reduces UHI, but relative fragments increase it[29]. Cooling thereby expressed by obtained parameters such as the 'Park Cool Island (PCI)' or 'Green Space Cool Island(GCI)' stands at a range of 1–7°C in comparison to the adjacent area depending on the size, shape and degree of urban green planning. There are also the local issues of measuring in-situ temperatures for which there are very few meteorological stations and hence the tendency is shifting towards remote sensing. The analysis of edge characteristics and internal park temperatures also supports the argument for the use of landscape metrics in planning urban environments. Implicitly, the optimization of these insights is necessary to improve the cooling impacts of green spaces and make the built environment resilient to climate change dynamics.

3.1 Mitigation Strategies

Few measures taken in India in response to UHI are highlighted further, which showcases the linkages of environmental interventions for managing thermal stress in Indian cities. Interrelated policies and missions include the National Mission on Green India, National Conservation Strategy, which indirectly address extant objectives of enhancing greenery, preserving forests to combat UHI (Ministry of

Environment, Forest and Climate Change, MoEF&CC). Other crude claims of UHI impacts are expressed in programs such as the 'Environment Impact Assessment (EIA) where vegetation cover and minimal exposed surfaces are required in any development project (State Environment Impact Assessment Authority). The National Mission on Sustainable Habitat (NMSH) is the direct approach towards UHI by following remarkable undertakings, for example, increasing cool greenery, using cool rooftops, and promoting lifestyle changes for decreasing greenhouse gas emissions (Ministry of Housing and Urban Affairs, MoHUA).

Along these lines we have the Energy Conservation Building Code (ECBC) and the Indian Green Building Council (IGBC) which prioritizes sustainable building practices, including cool roofs and green infrastructure, to combat UHI effects[30][31].

Other related programs like the National Urban Transport Policy (NUTP), whereas it does not expressly target UHI but offers guidelines such as eco-street designs that will help in minimizing the heat generated by streets for urban future, the Jawaharlal Nehru National Solar Mission (JNNSM) address UHI problem indirectly by advocating appropriate implementation of renewable energy that reduces heat from human activities for urban future (Ministry of Urban Development, MoUD and Ministry of New and Renewable Energy). Finally, Smart City Mission, aims at green Infrastructure development in the framework of overall urban sustainability goals (MoHUA, 2015). These actions themselves tell us that India has not singled out a singular method in combating UHI but draws from policy, infrastructure and green technologies for building resilience in its cities.

In order to evaluate the role of urban forests in fighting climate change and improving quality of fresh air, the following considerations are to be taken: The efficiency is the main criteria andthe focus is made on reducing the concentration of the UHI effect and improving the environmental conditions. For instance, green roofs and walls minimize the heat island effect of buildings and enhance air quality around structures while cool pavements and roads attempt to reduce temperatures of paving surface and resultant discharge. Kucera (2024)[32] discusses addressing the implementation challenges, wherein he describes briefly of the challenges involved in investing in renewable energy. Firstly, there are high initial expenses, frequent maintenance is required, and people are not that receptive. Specific examples include; Green roofs need extensive support for structures and constant attention in order to maintain vegetation health[33]. Contextual adaptation cannot be overlooked either since the applicability and effects of these solutions are determined by climate, urban form and infrastructure. Thus, high albedo materials may be most useful in warm areas whereas although green roofs are amenable, they require an understanding of the native plant species to perform the best. Future models need to adopt regulatory and policy support to enhance the implementation process. In well-developed urban forestry cities, these measures are implemented within the overlying environmental planning context with the policies and laws in place that give effect to the strategies[34].

3.2 Carbon Sequestration

Carbon capture methods plan to decrease emissions of greenhouse gas (GHG) and lower the concentration of carbon dioxide in the atmosphere. Recent studies show that establishment of 900 billion hectare of land could sequester about 200 MT of carbon which makes afforestation option relevant [35]. This strategy is in tandem with the global approach towards climate change mitigation which utilizes natural absorbtion for CO_2 such as forests [36]. Carbon capture and storage can therefore be measured with the help of several models and tools. For estimating today's biomass, species classification and tree coverage, researchers and practitioners make use of remote sensing and aerial imagery. By means of these technologies, companies can acquire forested land to remove its carbon through carbon trading markets that demand peculiar scrutiny and accreditation [37]. Such instruments are of great importance in

accurately determining carbon stocks in diverse ecosystems and regions. For instance, Beijing has been one of the cities that have undergone rapid urbanization and this has impacted on natural spaces and ecosystem services. Research also points to the ability of urban green space – by means of NPP – to store carbon. Studies employing land use change models in addition to landscape pattern indices make predictions concerning the future impacts on NPP to allow for carbon neutrality strategies and principles of sustainable city planning. According to X. Xiang et al., (2023) the command and control of S&T/research institutions have been restructured[38].

3.3 Biomass and Carbon Pools

Based on the Terrestrial Carbon Model, the Intergovernmental Panel on Climate Change (IPCC) divided the terrestrially stored carbon biomass into several pools which are illustrated in the following figure 2.

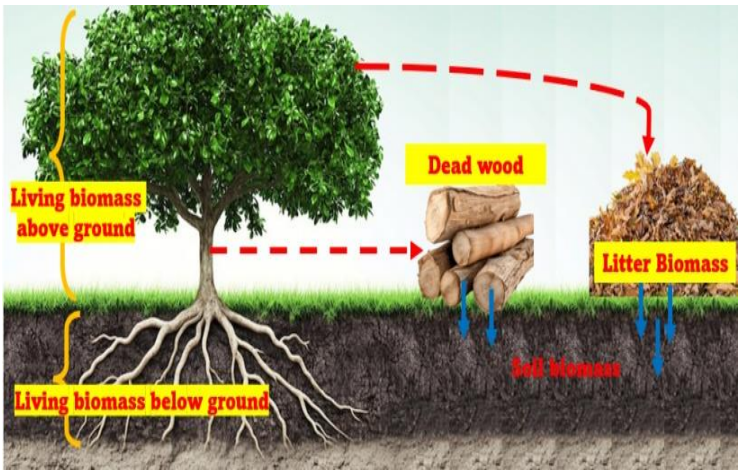

Figure 2: Various pools of Carbon Biomass

The "Good Practice Guidance" (GPG) developed by the IPCC (IPCC, 2003) has universally identified six land use classes (LULUCF): forest land, cultivated land, pasture land, Swamp land, built up area and other land for measuring the carbon stock [39][40]. These findings also emphasize the necessity of engaging natural carbon sinks into the urban planning and global climate frameworks to address carbon effusion problem efficiently.

3.4. Microclimate Regulation

Due to urbanization, the number of people owning cities has risen from 30% in 1950 to 54%, in 2014 most likely it is to become 66%, in 2050 [41]. As noted earlier, there are some problems arising from this fast urban growth especially in the urban environment where green elements like trees are helpful in solving these problems. Apart from the view and attraction they offer the metropolitan areas, the trees are important for so many ecological purposes. They reduce air temperatures, generate oxygen, increase humidity, remove pollutants, save energy, minimize impact of wind and reduce noise [42]. Research shows the functions that trees have on climate control in urban areas and especially on the issue of thermal comfort across different climatic conditions. Studies by Shashua-Bar et al., (2011), show that trees are capable of affording some advantage for light reflection, evaporation, heat absorption, for giving shelter from the sun and considerably reducing wind velocity[43]. Apart from reflecting sunlight and absorbing moisture from the air, trees also have the uses of offering shade thus reducing the ground temperature. Kong et al., (2017) explains that the trees also have different effects on wind by strategically placing it, they can actually slow wind speed which is useful in hotter climates. But a dense tree cover in

densely populated areas can also result in heat entrapment[44]. Research also builds on specific characteristics which include size, shape, and density of the leaves in connection to microclimate and tree physiology or native and invasive species affecting the climate of a particular region. With the help of the data collected by airborne thermal infrared cameras and meteorological instruments, Yilmaz et al., (2021) focuses on the effects of trees on the temperature distribution and urban heat islands[45]. Thus integrating trees into urban planning not only raises standards of living but is the only solution to reduce pollution and heat in areas and make cities safer and habitable for the generations to come.

3.5 Urban Forests and Air Quality

There are several environmental challenges that affect urban areas, some of which if not well managed pose great threats to the health of the people where air pollution is one of them. The World Health Organisation (WHO) records that 9 out of 10 people in the world live in areas with poor quality air in cities due to the density of emission activities and specially motor vehicles[46]. This increase in air pollution combined with the impacts of climate change results in a double-dose problem that urgently requires remedial action [47].

Green spaces in the city, and especially trees are increasingly important for good air quality (and health), as well as urban sustainability. Leaves to plants are like the lungs of humans, and have a good absorption effect on these kinds of air pollutants like, CO_2, O_3, NO_2 and SO_2[48], through leaf stomata or right surface deposition. They improve air quality as well, reduce noise and save energy while promoting thermal comfort [42]. Some of the common pollutants in urban areas are particulate matter (PM), nitrogen dioxide (NO_2) and sulfur dioxide (SO_2). Most of these pollutants are a product of industrialization and car exhaustion systems[49]. These pollutants are very harmful to health particularly on those that are sensitive such as children and the elderly. They worsen conditions of the respiratory and cardiovascular systems [46].

Air quality issues are addressed through policy and scientific collaboration through international initiatives such as the United Nations Framework Convention on Climate Change (UNFCCC) and regional programs such as the European Monitoring and Evaluation Programme (EMEP) and SAFAR in India [50][51].Opportunity to reduce air pollution through urban green spaces (UGS), depends on certain parameters, which includes the kind and density of the plant present. A study being conducted indicates that increased and closely knit plant hedges that pull in and consume pollutant aerosols are more effective than others. In addition, with regards to particulate matter, a higher surface area of conifers means that they are much more capable of filtering out small particles whereas mature deciduous trees, particularly those in urban areas are noted for their abilities to absorb gases [48]. To sum up, the idea of expanding green areas into the framework of urban planning can be considered as one of the key strategies aimed at decreasing air pollution rates and thus enhancing people's health. Thus, public health and living quality may be improved in many ways due to clean air and well-maintained urban trees that planters can select for all city inhabitants.

4. CHALLENGES, LIMITATIONS AND MITIGATION MEASURES

4.1. Urbanization and Space Constraints

Urban green spaces (UGS) are beneficial in many social, health and environmental aspects that are of great importance in enhancing quality of life in the urban region. However, issues such as poor planning, decline in the quality of the workmanship, and unideal policies often make it hard to

implement them properly and ensure they are fairly shared amongst metropolitan areas. This is because UGS is poorly distributed and made available in inadequate quantities because green spaces have not been given the necessary attention during the planning processes for the urban land which sees green spaces competing with other land uses for residential, commercial, and industrial purposes. This disregard not only worsens the overall quality of life of people living in urban areas but also results in decreased recreational activities [48]. The study found that quality is a critical determinant of green spaces in cities to residents' value. The better quality greens make positive self images, less stress levels, and a higher level of life satisfaction. However, a lot of cities are faced with issues such as decrease of open space and poor quality areas which are associated with air pollution and adverse health effects [52].

Needless to say, while guiding decision-makers towards the strategies for the efficient management and development of UGS, policy measures often fail to measure the mark. For instance, WHO recommends that each person should get at least 9m^2 of green space; nevertheless, these standards are often ignored because of differences in urban densities and failure to implement policies[46].

The norms that these cities may find hard to meet are the aforementioned ones; the cities are Mumbai, Ahmedabad, and Chennai. This goes a long way in pointing out the reason for necessitating policy approaches that pay attention to the local environment. Specifically print media was used along with the guidelines by Ministry of Urban Development, Government of India for this study. This is why it is inevitable to resort to strategic actions in the quest to improve the UGS scenarios. More enhanced planning means that it has to integrate multidisciplinary approaches and thus there has to be development of standards that can adapt to local conditions. This ensures that the UGS are of quality, get adequate access by all residents and are enough in number [53]. Therefore, GIS and spatial data are crucial for better planning of UGS. They enhance the involvement of the people and accountability of the plan by allowing the decision-maker to make rational decisions concerning the distribution of the green areas and the feasibility of implementing new plans and projects [54]. Such targets and concepts include greenways and green belts, which, in addition to proper selection of plants, can be introduced and improve the modern green spaces' quality. By optimizing UGS geometry, these guidelines preserve urban biodiversity while increasing diversity and accessibility. Gill et al., (2007) propagates that Green walls and rooftops, for example, which are new methods of 'greening,' are possible in densely populated urban areas. It is possible to cultivate vegetation in vertical surfaces and enhance the surface aesthetic beautifying green spaces while on the other hand green roofs provide other environmental benefits like moderation of temperature[55]. Planned and management of UGS should involve and be successful with the public involvement. Applying locals during workshops and consultations ensures that the UGS meet the community demand and supply necessities while at the same time creating awareness and a sense of ownership among people [49].

There is concern in addressing the challenges that are associated with the planning and management of UGS hence the need for the legislators, planners and the community stakeholders need to be in harmony in the planning and addressing of the challenges facing the UGSs: On the quality and availability of green spaces in urban areas, it's possible to strategize the provision and improve the livability, resilience to issues affecting the environment, and the welfare of the people living in cities.

4.2 Integration of UrbanForests in densely populated areas

Urban green spaces (UGS) are crucial in enhancing the status of life in urban centers and the quality of the air we breathe. Urban trees also perform the function of the biological air filters whereby the trees directly remove particles from the air in the form of particulate matter as noted by (Zhang & Qian, 2024)[56]. In this manner, these trees not only remove particulate matter through their leaves and therefore enhance air quality but also provide ecosystem services. The study draws attention to the cross-

cutting approaches needed for effective UGS management and AI's role in transforming UGS data analysis through design and management techniques. Indeed, the Artificial intelligence (AI) solutions are capable of encouraging the development of UGS through availability of easier solutions on the upkeep requirements as well as improvements needed for UGS. Cities can guarantee inclusivity and sustainability in UGS management by incorporating stakeholders and communities in governance processes, which will enhance the general quality of the urban environment [57].

4.3. Maintenance, Monitoring, Evaluation and Management

Many strategies are proposed as to how these issues and concerns should be addressed in a bid to ensure the provision of adequate urban green space in the future. Such measures include ensuring that newly developed zones include an area of not less than 20% green area, carrying out periodic census of trees, and extending priority on the conservation of other existing green cover. Higher tree survival rates are recommended to be achieved with professional tree management practices such as selecting tall seedlings before planting them and providing 24 hours protection. If trees are to grow and mature healthily within the urban environment, hard surfacing and concreting have to be kept as far as possible away from the trees [58]. There is also the need to regulate the issuance of permits for tree cutting together with the need to enforce compensating planting clauses.

In order to enhance understanding and participation of the general public towards urban forestry, practices such as; earmarking an area in every district as biodiversity park, tree tourism and ceremonial plantations among others are being encouraged. There are various ways of enhancing green areas in cities that have to be adopted sustainably, these include: (a) Incorporation of national tree planting programme, (b) Adherence to citizens participation in tree planting and (c) Exploring CSR programme for greening projects [58]. These initiatives highlight how crucial it is to incorporate environmental factors into urban planning and encourage community involvement in order to create communities that are healthier and more resilient.

Further speaking of the local governing system's in Ahmedabad; senior authorities confirmed adding some 1,500 air sensors across the city in the face of severe air pollution. This initiative ranged from putting water mist machines in affected areas where pollution is rife. To this effect, the project that costs Rs 150 million will place these sensors in the municipality's control room so that timely action can be taken when pollution surges. Adding to other occupational measures such as tree plantation, promotion of electric vehicles etc the initiative can be seen as a positive strategy to control air quality. According to low-cost sensor networks of the EPIC/Yale/NYU research team, they can enhance pollution prediction and crusade[59]. Further under the National Clean Air Programme, funds have been allocated to 131 cities to combat air pollution[60].Real-time monitoring; these cutting-edge air sensors will be seamlessly connected to the municipality's control room, ensuring round the clock monitoring of air quality. The real-time data will enable the authorities to take swift and targeted action. Thorough investigations are also planned to be conducted, to identify the root causes and take action. Water mist machines are planned to be deployed if pollution levels spike in any area to mitigate the problem. A network of low-cost air sensors can improve pollution forecasting[61].

4.4 Integrating Urban Forests into Urban Planning Frameworks

This section elaborates the essential urban forestry research and on how UFs and the issue of urban planning has achieved a milestone of breaking barriers into mainstream issues touching on the environment as well as climates. The term mainstreaming has been borrowed from the development assistance, to incorporate themes into policies and programs, and is also applicable in environmental and climate adaptation difficulties. They envisage changing the policy process by promoting multi-actor

decision-making and structural reforms within governance so that it minimizes policy fragmentation [62]. Critics in turn have indicated that mainstreaming can sometimes be too top heavy and dismissive of other paradigms[63]. Most of the UF related literature focuses on the problems and concerns that revolve around trees and the benefits of trees.

The principles of mainstreaming UFs that have been proposed include the treatment of trees in planned urban environment in terms of maintenance into the long-term, interdisciplinary compatibility, stakeholder cooperation, monitoring of change, and adopting adaptive management concepts, as outlined above, There have been attempts to put economic values for UFs at par with planned urban environment, as also explained above[64]. have been made with these attempts, however, UF and urban planning often fail to align at times[65]. Municipal priorities believe that the well-being of people and public services are more important than the technical approaches[66]. Due to budget constraints and divergent agendas of urban planning in UF, its cooperation is limited significantly[66]. This paper argues that for UF to work effectively, there is the need to understand governance and decision-making systems in municipalities [67].

A conceptual analysis shows that the following barriers hinder mainstreaming of UF in the management of urban systems such as funding gaps, lack of information and inter-sectoral coordination. These are potential problems on the status of mainstreaming initiatives [68]. The mainstreaming initiatives may become a mere formality or ignore other objectives of making the cities if the problems of the marginalized sections are not addressed [63].Due to the implementation and governance problems, the introduction of UF into urban planning requires further attention.

It is revealed that municipalities need to apply the adaptive management strategies for enhancing the resilience and sustainability of urban ecosystems through integrated urban forestry with other urban issues [48][69].As a result of increasing focus on the part of urban sustainability and resilience, this overview highlights the interlinkage between urban forestry, urban planning and governance. It also emphasizes the necessity of integrated approaches.

4.5 Public Engagement and Education

In the idea of sustainable development and probably enhancing community participation towards environmental issues, environmental education is crucial. It aims to equip the students with the awareness of ecological problems and skills required in addressing the same [70]. There are studies that prove that consciousness about the environment through education decreases the process of deforestation and increases indices of human development[71].Besides environmental literacy, children who receive environmental ideas at their tender age enjoy and respect conservation of environment all their lifetime [72]. This educational strategy helps to rebuild the relationship between the communities and the environment; to fight against the indifference to the matters concerning the ecology; to promote the green way of living [70]. Functional frameworks of environmental education exist and consist of forming attitudes, awareness raising, and practical participation constructing ability and personal effectiveness of individuals to make enhanced substantial contributions to the stewardship of the environment [73].

While the Supreme Court of India directs the states to teach environmental education it is implemented by the NCERT in the National Curriculum Framework. Nonetheless, challenges persist: They include a shortage of public awareness, and while the school curriculum reflects several issues of environmental degradation, they are not up to date [62]. Filling these gaps is very important in nurturing a generation of people who will be in a position to address today's environmental issues. Education reform must emphasize practical knowledge and experience education, which will allow receiving practice in locality and global environmental education in addition to receiving knowledge[74]. Apart from increasing environmental consciousness, this strategy also instills the sense of responsibility to create an

environmentally sustainable urban environment. It is the argument of this paper that enhancing environmental education through engaging creative approaches and community participation can bridge the chasm between knowledge and practice. Global educational systems may contribute to the building of stronger and sustainable cities all over the world by raising an awareness of the occurring environmental problems and engaging people.

5. FUTURISTIC APPROACHES / TECHNOLOGICAL INNOVATIONS

Introducing artificial intelligence (AI) in urban green spaces (UGS) is a rapidly progressing field seeking to enhance city inhabitants' quality of lives with new technologies. In this paper, the author examines many case studies that demonstrate AI's revolutionary effect in controlling UGS and promoting community involvement. First, based on the comments of citizens on cities tourism sites like Trip Advisor, AI technologies of Natural Language Processing (NLP) and text categorization are being employed to obtain rather impressive data on the quality of UGSs from the side of residents themselves. This information may be valuable for urban planners and municipal governments in the improvement of green space management. Second, establishment of a web based Geographic Information System (webGIS) incorporated a systematic UGS database. This interactive application enables the towns to plan and construct the UGS in a participatory manner. Last, the use of the VR and digital technology also led to enhancement of community involvement specifically in redesign of parks so as to encourage social support and create a sense of belonging to the inhabitants. It is noteworthy that these innovations have evoked the time, which denotes AI's capabilities of revolutionizing the essence of urban planning by enhancing the UGS administration and the engagement of citizens for responsible city development for a sustainable future.

Various current studies have employed AI techniques to predict trees' conditions and ES supply in urban trees. Research has focused on other factors like Diameter at Breast Height (DBH) and the tree with the largest amount of leaf area to arrive at the ES values needed in planning sustainable urban forests and planning of landscapes[75].Such techniques employ massive data to predict the ES benefits and support decision makings for urban greening interventions[57].These milestones underscore the importance of AI in enhancing the capacity of cities to adapt and be sustainable as well as consultative public participation especially in the management of green spaces.

6. CONCLUSION

Therefore, the consideration of the urban forests in urban development constitutes important practice in establishing resilient cities. Urban forests are a valuable asset to cities due to their contribution to carbon storage, modification of climate, and reduction of pollution, features that prepare cities to effectively support residents' health and well-being. A plethora of researches on these issue and its analysis reveals that there are key challenges limiting effective integration and these include; space issues, weak policies in the context of urban development, and a misalignment of municipal agendas with the objectives of urban forestry. In essence, solving these issues needs policy measures as well as awareness creation involving a combination of concrete policies and creative ideas. Implemented with success in the case of the UGS management and participation, AI and GIS can prove really useful to future urban planning projects. Moreover, enhancing the knowledge of people and raising the awareness of the citizens would likely enhance the prospects and increase the responsibility towards the environment, which in its turn would contribute to sustainable development. To enhance the implementation of urban forests into the general urban development strategies and frameworks, feasibility studies should apply the principles

of adaptive management, and there should be co-ordination of the green spaces planning together with other urban planning frameworks. Such aspects should be addressed so that the various aspects of human and natural environment within municipalities of the urban areas can be improved and support increasing durability and sustainability of ecosystems, thus the standard quality of life for people in towns can be improved.

REFERENCES

O. Opeoluwa et al., 2024,"AIR QUALITY AND PUBLIC HEALTH: A REVIEW OF URBAN POLLUTION SOURCES AND MITIGATION MEASURES," Eng. Sci. Technol. J., vol. 5, (2), pp. 259–271. doi: 10.51594/estj.v5i2.751.

F. Marson, P. Eagly, and O. M. Russell, 2023, "Impact of Social Assistance Programs on Family Economic Welfare in Urban Environments: An Analysis of Equity and Community Engagement," Law Econ., vol. 17, (3), pp. 186–202. doi: 10.35335/laweco.v17i3.44.

M. Pastor, J. M. Cha, M. Méndez, and R. Morello-Frosch, 2024, "California dreaming: Why environmental justice is integral to the success of climate change policy," Proc. Natl. Acad. Sci., vol. 121, (32).doi: 10.1073/pnas.2310073121.

K. Escandón et al., 2021, "COVID-19 false dichotomies and a comprehensive review of the evidence regarding public health, COVID-19 symptomatology, SARS-CoV-2 transmission, mask wearing, and reinfection," BMC Infect. Dis., vol. 21 (1), p. 710. doi: 10.1186/s12879-021-06357-4.

R. Pandit, M. Polyakov, S. Tapsuwan, and T. Moran, 2013,"The effect of street trees on property value in Perth, Western Australia," Landsc. Urban Plan., vol. 110, pp. 134–142 .doi: 10.1016/j.landurbplan.2012.11.001.

Roy, S., Byrne, J., & Pickering, C. (2012). A systematic quantitative review of urban tree benefits, costs, and assessment methods across cities in different climatic zones. Urban Forestry & Urban Greening, 11(4), 351–363. https://doi.org/10.1016/j.ufug.2012.06.006.

R. S. de Groot, M. A. Wilson, and R. M. . Boumans, 2002, "A typology for the classification, description and valuation of ecosystem functions, goods and services," Ecol. Econ., vol. 41 (3), pp. 393–408. doi: 10.1016/S0921-8009(02)00089-7.

J. Maes et al.,2016, "An indicator framework for assessing ecosystem services in support of the EU Biodiversity Strategy to 2020," Ecosyst. Serv., vol. 17, pp. 14–23, . doi: 10.1016/j.ecoser.2015.10.023.

R. Lafortezza and J. Chen, 2016, "The provision of ecosystem services in response to global change: Evidences and applications," Environ. Res., vol. 147, pp. 576–579. doi: 10.1016/j.envres.2016.02.018.

D. Haase et al., 2014, "A Quantitative Review of Urban Ecosystem Service Assessments: Concepts, Models, and Implementation," Ambio, vol. 43(4), pp. 413–433. doi: 10.1007/s13280-014-0504-0.

J. Yuan and C. S. Kim, 2024, "The Ecological Design of Marine Urban Green Space Plant Landscaping Based on the Concept of Sustainability," Plants, vol. 13(7), p. 923. doi: 10.3390/plants13070923.

H. Xiang, X. Heng, B. Zhai, and L. Yang, 2024, "Digital and Culture: Towards More Resilient Urban Community Governance," Land, vol. 13(6), p. 758, . doi: 10.3390/land13060758.

K. Zhou and R. Tan, 2024,"Understanding the structure of public perceptions towards urban green spaces: A

mixed-method investigation," Urban For. Urban Green., vol. 101, p. 128496. doi: 10.1016/j.ufug.2024.128496.

M. Yu, W. Zhou, X. Zhao, X. Liang, Y. Wang, and G. Tang, 2022,"Is Urban Greening an Effective Solution to Enhance Environmental Comfort and Improve Air Quality?," Environ. Sci. Technol., vol. 56, no. 9, pp. 5390–5397. doi: 10.1021/acs.est.1c07814.

A. Monteiro, J. Ankrah, H. Madureira, and M. O. Pacheco, 2022,"Climate Risk Mitigation and Adaptation Concerns in Urban Areas: A Systematic Review of the Impact of IPCC Assessment Reports," Climate, vol. 10(8), p. 115. doi: 10.3390/cli10080115.

M. Esperon-Rodriguez et al.,2021,"Climate-change risk analysis for global urban forests," bioRxiv,p..443030.https://www.biorxiv.org/content/10.1101/2021.05.09.443030v1%0A

T. O. Ogunbode and J. T. Asifat, 2021 "Sustainability and Challenges of Climate Change Mitigation through Urban Reforestation-A Review," J. For. Environ. Sci., vol. 37(1), . https://doi.org/10.7747/JFES.2021.37.1.1

M. Esperon-Rodriguez et al., 2022 "Assessing climate risk to support urban forests in a changing climate," PLANTS, PEOPLE, PLANET, vol. 4(3), pp. 201–213, doi: 10.1002/ppp3.10240.

Swetha B. S., I. Prabhakar, and Veeresh, 2023, "The Role of Forests in Combating Climate Change and Promoting Sustainable Development: An Integrative Review," Int. J. Environ. Clim. Chang., vol. 13(11), pp. 3755–3761. doi: 10.9734/ijecc/2023/v13i113555.

Z. Mighri, S. Sarwar, and S. A. Sarkodie, 2022, "Impact of Urbanization and Expansion of Forest Investment to Mitigate CO2 Emissions in China," Weather. Clim. Soc., vol. 14(3), pp. 681–696. doi: 10.1175/WCAS-D-21-0101.1.

Pataki, D. E., Alberti, M., Cadenasso, M. L., Felson, A. J., McDonnell, M. J., Pincetl, S., Pouyat, R. V., Setälä, H., & Whitlow, T. H. (2021). The Benefits and Limits of Urban Tree Planting for Environmental and Human Health. Frontiers in Ecology and Evolution, 9(3), 1684. https://doi.org/10.3389/fevo.2021.603757

A. Raihan, 2024, "A review on the role of green vegetation in improving urban environmental quality," Eco Cities, vol. 4(2), p. 2387. doi: 10.54517/ec.v4i2.2387.

S. P. Singh and M. K. Sharma,2017, "Impact of Air Pollution on Global Environment," Res. Rev. J. Ecol., vol. 7(1), pp. 23–32. doi: https://doi.org/10.37591/rrjoe.v7i1.816.

C. Miao, A. Cui, Z. Xiong, Y. Hu, W. Chen, and X. He, 2022, "Vertical evaluation of air quality improvement by urban forest using unmanned aerial vehicles," Front. Ecol. Evol., vol. 10. doi: 10.3389/fevo.2022.1045937.

A. De Marco et al., 2022, "Strategic roadmap to assess forest vulnerability under air pollution and climate change," Glob. Chang. Biol., vol. 28(17), pp. 5062–5085. doi: 10.1111/gcb.16278.

L. Capari, H. Wilfing, A. Exner, T. Höflehner, and D. Haluza , 2022, "Cooling the City? A Scientometric Study on Urban Green and Blue Infrastructure and Climate Change-Induced Public Health Effects," Sustainability, vol. 14(9), p. 4929. doi: 10.3390/su14094929.

J. P. Connors, C. S. Galletti, and W. T. L. Chow, 2013, "Landscape configuration and urban heat island effects:

assessing the relationship between landscape characteristics and land surface temperature in Phoenix, Arizona," Landsc. Ecol., vol. 28(2), pp. 271–283. doi: 10.1007/s10980-012-9833-1.

A. Chen, X. A. Yao, R. Sun, and L. Chen, 2014, "Effect of urban green patterns on surface urban cool islands and its seasonal variations," Urban For. Urban Green., vol. 13(4), pp. 646–654. doi: 10.1016/j.ufug.2014.07.006.

R. Zhibin, Z. Haifeng, H. Xingyuan, Z. Dan, and Y. Xingyang,2015, "Estimation of the Relationship Between Urban Vegetation Configuration and Land Surface Temperature with Remote Sensing," J. Indian Soc. Remote Sens., vol. 43(1), pp. 89–100. doi: 10.1007/s12524-014-0373-9.

K. Abbass, M. Z. Qasim, H. Song, M. Murshed, H. Mahmood, and I. Younis, 2022, "A review of the global climate change impacts, adaptation, and sustainable mitigation measures," Environ. Sci. Pollut. Res., vol. 29(28), pp. 42539–42559. doi: 10.1007/s11356-022-19718-6.

FSI, 2017, "India State of Forest (ISF) Report 2017." pp. 1–36.

D. C. Kucera, 2024, "Multi-Scale Analysis of Factors Influencing Urban Greenness, Temperature, and Vegetative Cooling," University of California. https://www.proquest.com/openview/32ffe089ee041b5c18192891aaa3f106/1?pq-origsite=gscholar&cbl=18750&diss=y

H. Liu et al., 2021, "Impacts of green roofs on water, temperature, and air quality: A bibliometric review," Build. Environ., vol. 196, p. 107794 . doi: 10.1016/j.buildenv.2021.107794.

M. Hartigan, J. Fitzsimons, M. Grenfell, and T. Kent, 2021, "Developing a Metropolitan-Wide Urban Forest Strategy for a Large, Expanding and Densifying Capital City: Lessons from Melbourne, Australia," Land, vol. 10(8), p. 809. doi: 10.3390/land10080809.

J.-F. Bastin et al.,2019, "The global tree restoration potential," Science (80-.)., vol. 365(6448), pp. 76–79. doi: 10.1126/science.aax0848.

H. Lütjen, C. Schultz, F. Tietze, and F. Urmetzer, 2019, "Managing ecosystems for service innovation: A dynamic capability view," J. Bus. Res., vol. 104, pp. 506–519. doi: 10.1016/j.jbusres.2019.06.001.

G. W. Sileshi, 2014, "A critical review of forest biomass estimation models, common mistakes and corrective measures," For. Ecol. Manage., vol. 329, pp. 237–254. doi: 10.1016/j.foreco.2014.06.026.

X. Xiang, N. Zhou, M. Ma, W. Feng, and R. Yan, 2023, "Global transition of operational carbon in residential buildings since the millennium," Adv. Appl. Energy, vol. 11, p. 100145. doi: 10.1016/j.adapen.2023.100145.

IPCC, 2003, Good practice guidance for land use, land-use change and forestry. IPCC National Greenhouse Gas Inventories Programme. doi: 10.5555/20083162304.

ISFR,2017, "India State of Forest Report. Dehradun: Ministry of Environment and Forests, Forest Survey of India (FSI).

United Nations,2014, "World Urbanization Prospects: 2014 Revision, Department of Economic and Social Affairs, Population Division, New York.

S. . Gill, J. . Handley, A. . Ennos, and S. Pauleit, 2007, "Adapting Cities for Climate Change: The Role of the Green Infrastructure," Built Environ., vol. 33(1), pp. 115–133. doi: 10.2148/benv.33.1.115.

L. Shashua-Bar, D. Pearlmutter, and E. Erell, 2011, "The influence of trees and grass on outdoor thermal comfort in a hot-arid environment," Int. J. Climatol., vol. 31(10), pp. 1498–1506. doi: 10.1002/joc.2177.

L. Kong et al.,2014, "Regulation of outdoor thermal comfort by trees in Hong Kong," Sustain. Cities Soc., vol. 31(1), pp. 12–25. doi: 10.1016/j.scs.2017.01.018.

S. Yilmaz, I. Sezen, and E. N. Sari, 2021, "The relationships between ecological urbanization, green areas, and air pollution in Erzurum/Turkey," Environ. Ecol. Stat., vol. 28(4), pp. 733–759, . doi: 10.1007/s10651-021-00484-6.

WHO, 2018, "9 out of 10 people worldwide breathe polluted air, but more countries are taking action. https://www.who.int/news/item/02-05-2018-9-out-of-10-people-worldwide-breathe-polluted-air-but-more-countries-are-taking-action#:~:text=Air pollution levels remain dangerously,outdoor) and household air pollution.

CAP,2024, "Climate Action Plan (CAP24)," From Dep. Environ. Clim. Commun., https://www.gov.ie/en/publication/67104-climate-action-plan/

S. Suhane, R. Polara, A. Gajjar, R. Agrawal, and U. Sharma, 2023, "The Effect of Urban Green Spaces on Air Pollution Reduction: A Case of Ahmedabad," E3S Web Conf., vol. 436, p. 10009. doi: 10.1051/e3sconf/202343610009.

USEPA, 2024, "Progress Cleaning the Air and Improving People's Health,". Online Available: Progress Cleaning the Air and Improving People's Health.

UNFCCC,2020, "United nations climate change annual report 2020,".

EMEP, 2020, "Transboundary particulate matter, photo-oxidants, acidifying and eutrophying components" Joint MSC-W & CCC & CEIP Report.

UNEP, 2015,"Guidance on Organizational Life Cycle Assessment. LifeCycle Initiative, United Nations Environment Programme and Society for Environmental Toxicology and Chemistry, Paris, France,". Available: http://www.lifecycleinitiative.org/wp-content/uploads/ 2015/04/o-lca_24.4.15-web.pdf

David Suzuki Foundation, 2015, "THE IMPACT OF GREEN SPACE ON HEAT AND AIR POLLUTION IN URBAN COMMUNITIES: A META-NARRATIVE SYSTEMATIC REVIEW," .https://davidsuzuki.org/wp-content/uploads/2017/09/impact-green-space-heat-air-pollution-urban-communities.pdf

C. Armeni, 2016, "Participation in Environmental Decision-making: Reflecting on Planning and Community Benefits for Major Wind Farms," J. Environ. Law, p. eqw021 . doi: 10.1093/jel/eqw021.

D. J. Nowak, S. Hirabayashi, A. Bodine, and E. Greenfield, 2014, "Tree and forest effects on air quality and human health in the United States," Environ. Pollut., vol. 193, pp. 119–129. doi: 10.1016/j.envpol.2014.05.028.

F. Zhang and H. Qian, 2024,"A comprehensive review of the environmental benefits of urban green spaces," Environ. Res., vol. 252, p. 118837. doi: 10.1016/j.envres.2024.118837.

A. A. R. Pratiwi, S. Risnanto, A. Chalid, Kusmadi, K. A. Munastha, and D. R. Witarsa, 2022, "Employing AI to Develop Green Space in Urban Area," in 2022 16th International Conference on Telecommunication Systems, Services, and Applications (TSSA),pp. 1–5. doi: 10.1109/TSSA56819.2022.10063869.

MoEF&CC, 2022,"Annual-report-2021-22-Final MOEFCC," MoEF CC Annu. Rep.

EPIC/NYU/Yale, 2022,"Low-Cost Air Sensors Can Improve Pollution Forecast: Study," https://epic.uchicago.edu/news/low-cost-air-sensors-can-improve-pollution-forecast-study/

MoEF&CC, 2023, "Allocation of funds to 131 cities under National Clean Air Programme to combat air pollution,.https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1989207

Ahmedabad Mirror,2024, "AMC has new post for gardens dept: The civic body will soon come up with a new policy for disposal of green waste," Jul. 11, 2024. https://www.ahmedabadmirror.com/amc-has-new-post-for-gardens-dept/81871266.html#goog_rewarded

Onlyias, "Globalisation: Impact on Indian Society, Benefits, and Challenges." [Online]. Available: https://pwonlyias.com/upsc-notes/impact-of-globalization-on-indian-society/

Karlsson-Vinkhuyzen et al,2014, "Mainstreaming biodiversity where it matters most". Wageningen University, 2014.

M. Antonenko, D. Dushkova, and T. Krasovskaya, 2023,"Urban Forests in Megacities from the Perspective of Ecosystem Services Using the Timiryazevsky Forest Park, Moscow, as a Case Study," pp. 197–214. doi: 10.1007/978-3-030-73089-5_13.

V. Schwab, 2022, "Assessing the potential impacts of tall buildings on a predominantly low-rise built urban environment A case study from Västerås, Sweden,".

S. Barron and E. J. Rugel, 2023, "Tolerant greenspaces: Designing urban nature-based solutions that foster social ties and support mental health among young adults," Environ. Sci. Policy, vol. 139, pp. 1–10. doi: 10.1016/j.envsci.2022.10.005.

C. Ordóñez et al.,2020, "Decision-making of municipal urban forest managers through the lens of governance," Environ. Sci. Policy, vol. 104, pp. 136–147 . doi: 10.1016/j.envsci.2019.11.008.

K. Mogelgaard, A. Dinshaw, N. Ginoua, M. Gutierrez, P. Preethan, and J. Waslander, 2018, "From Planning To Action: Mainstreaming Climate Change Adaptation Into Development," World Resour. Inst., no. September, pp. 1–24 . https://www.wri.org/%0Ahttps://files.wri.org/d8/s3fs-public/from-planning-action-mainstreaming-climate-change-addaptation-into-development.pdf

V. Muñoz Sanz, S. Romero Muñoz, T. Sánchez Chaparro, L. Bello Gómez, and T. Herdt, 2022, "Making Green Work: Implementation Strategies in a New Generation of Urban Forests," Urban Plan., vol. 7(2) . doi: 10.17645/up.v7i2.5039.

I. P. Fitri,2021, "Challenges of urban forest park restoration on post-closure landfill : Perception and future engagement from the local communities," Chulalongkorn University, Bangkok, Thailand. doi: 10.58837/CHULA.THE.2021.157.

R. Godoy, M. Jacobson, J. De Castro, V. Aliaga, J. Romero, and A. Davis,1998, "The Role of Tenure Security and Private Time Preference in Neotropical Deforestation," Land Econ., vol. 74(2), p. 162. doi: 10.2307/3147048.

UNESCO,2021, "Education policy review report: Education for sustainable development,".

W.Leal Filho, E. Pallant, A. Enete, B. Richter, and L. L. Brandli, 2018, "Planning and implementing sustainability in higher education institutions: an overview of the difficulties and potentials," Int. J. Sustain. Dev. World Ecol., vol. 25(8), pp. 713–721. doi: 10.1080/13504509.2018.1461707.

S. A. Bhat, A. T. Zahid, B. A. Sheikh, and S. H. Parrey, 2017, "Environmental Education in India: An Approach to Sustainable Development," FIIB Bus. Rev., vol. 6(1), pp. 14–21., doi: 10.1177/2455265820170102.

S. Wei and S.-T. Cheng, "Estimating Pruning-Caused Loss on Ecosystem Services of Air Pollution Removal and Runoff Avoidance," Sustainability, vol. 14(11), p. 6637, May 2022, doi: 10.3390/su14116637.