Chapter 28
The City Green Landscapes: Environmental Benefits and Typologies of Green Landscapes in Delhi

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Abstract Green landscapes help and provide many environmental benefits that will improve the air quality, water quality, biodiversity and habitat protection. The negative impact and pressure of an increase in population affect the environment locally, regionally and globally. Major environmental challenges which the cities are facing nowadays are the episodes of urban floods, urban heat, pollution, earthquakes, pandemics, etc. It is agreed through different literature that green landscapes are essential for the wellbeing of the people. Environmental strategies for an urban area need to be supported by several factors that are biotic and abiotic. The ecosystem services in the cities and the chain of the ecosystem's sustainability help to overcome the issues of environmental stresses in urban areas. Vegetation is considered one of the important biotic factors that immensely protects the environment and its surroundings in several ways. The density and spatial configuration of urban green landscapes like the canopy covers, buffers along the roads and patches of greens in between the built-up areas affect immediate environments and help in regulating the land surface temperatures and improve both local and city-wide urban air quality. This chapter will focus on the different typologies and environmental services of urban green landscapes in Delhi. The green landscapes in Delhi are maintained by various organisations and that is mainstream at the levels of spatial plans. The Planning Norms have tried to mainstream green landscapes but still, the green landscapes are in process of incorporating the different current environmental challenges like Climate Change, Urban Heat Islands effects and Air Pollution Management. Well-planned and designed green landscapes along different land uses have positive impacts on the environment.

Keywords Urban green landscapes · Environmental benefits · Typologies urban green landscapes

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Introduction

Urbanisation also refers to the expansion of the urban population scale and the corresponding series of economic and social changes (Wang et al. 2015). Urbanisation features are one of the important events in the development history that also produces environmental challenges, but development also creates opportunities for the cities to grow that can contribute to border visions of improving the quality of life of the people and its surroundings. Activities in urban areas have negative and positive impacts at different scales of spatial development and on green spaces.

India has the tenth-largest forest area in the world. In 2020, India ranked third globally in increasing its forest area from 2010 to 2020. The forests covered 24% of India's total geographical area, accounting for two percent of the world's total forest area in 2020.

Green landscapes in urban areas are manicured, cleaned and designed and have not much native vegetation. Landscapes depend on the different spatial scales in the city elucidated to many typologies: parks, gardens, cemeteries, tot lots, green buffers, etc. (Doherty 2017). Green infrastructure is the term coined that has soft as well as hard landscapes in their nature of designing. Green landscapes categorically viewed by the human eye are the different shades of greens, different patterns, shapes and sizes.

Urban green spaces provide various ecological, social and cultural services such as air and water purification, groundwater recharge, noise reduction, recreational purposes, social gatherings and many cultural activities. Increasing the green spaces in urban areas has a significant reduction in air temperatures and air quality purification (Ashraf et al. 2015).

Developmental plans are more focused on the economic development of the city and do give strict compliances or guidelines on how to integrate or protect green spaces in urban planning. The Government prioritised large-scale infrastructure projects to increase the local GDP and propel a world-class urban city. The integration of green infrastructure with the development plans interchangeably gives a way towards sustainable development spatially.

In the Indian context, there is a need to work on multiple spatial scales to adapt to changing precipitation dynamics focusing both on the installation of local solutions and developing zoning regulations for the integration of green landscapes for multi-functional urban systems. A strong interrelation between population growth, urbanisation and decreasing urban greens has been established by various literature; consequently, urban dwellers suffer from various kinds of pollutants-induced diseases. As the urban population has grown at a rapid pace during the past few years, the landman ratio in the cities is also shrinking which is impacting the urban green spaces (Ashraf et al. 2015).

Environmental Benefits of Urban Green Landscapes

Ecological Benefits

(a) Biodiversity and Nature Conservation: Urban landscapes host large amounts of biodiversity. 13 biodiversity indicators for both habitat and species diversity are taken into account for the monitoring study of urban parks in Flanders, North Belgium, the study concluded that Urban and suburban parks may be considered important 'hotspots' of biodiversity in cities (Cornelis and Hermy 2004). Green landscapes surrounding the urban build forms have less biodiversity as compared to the natural habitats or nondisturbed landscapes. Urban green spaces often contain simplified habitats with midstory vegetation with native grounds (Hatcher and Yu 2018) that prevent damage to the natural landscape, biodiversity and natural habitat. Such green spaces improve the quality of air, and canopy covers reduce the noise levels.

(b) Climate Improvement: Climate change will have far-reaching consequences for urban areas. Green landscapes affect weather and climate, and they influence both the albedo of the area and the amount of water vapor and carbon dioxide in the air.

(c) Temperature Reduction: Due to anthropogenic activities, the urban heat island (UHI) effect is primarily increased in the surroundings of densely built environments. But green landscapes surrounding the built forms help to regulate the local climate and heat sources in the area (Jin et al. 2018). Urban temperatures can be strategically handled through a network of planned urban green spaces. Urban landscapes have a cooling effect of between 2° and 8° due to increases in evapotranspiration (Fam et al. 2008).

(d) Water Efficiency: Green landscapes recharge the groundwater and improve the quality of surface water. Urban-built forms can be designed with green roofs and rain gardens, and bioswales that improve groundwater recharge reduce local flooding and improve the quality of water. These remedies are small-scale interventions that have little impact on the large-scale environmental disasters that pose the greatest danger to urban infrastructure and communities (Davis and Naumann 2017). Urban green landscapes have a positive impact on the hydrological characteristics of the highly modified urban catchments. Ground covers help in water recharge and infiltrations with effective removal of significant amounts of pollutants such as phosphorus, lead and nitrogen and fine sediments (Fam et al. 2008).

Pollution Abatement

(a) Air Pollution: Trees, Plants and the groundcovers have a variable capacity to capture or filter the air pollutants and absorb the gasses, which improves the air circulation and decreases the ambient temperatures (Impact of green space on Heat and Air pollution in urban communities: A meta-narrative Systematic Review, 2015). Air pollution has a severe impact on roadside trees, but many trees have a high air pollution tolerance index (APTI), trees such as people, neem and Sheesham are found to be the highest APTI along the roads (Erum and Satish 2020).
(b) Noise Pollution: Thick buffers of vegetation can reduce the noise limits, and it is expected to design large green landscapes from the beginning of the planning of the area (Gonzalez-oreja et al. 2010). In the urban residential environment to strive for lower sound levels and to ensure 'noise-free' places, it is mandated to protect, preserve and even increase the supply of urban green landscapes (Gidlof-Gunnarsson and Ohrstrom 2007). To design the cities and green areas like green belts/buffers/shelter belts/avenues to be created as noise barriers, it is essential to consider the bed of native species with high canopy volume and considerable foliage (Maleki et al. 2011).

Psychological Benefits:

(a) Recreational: Different typologies of green landscapes have different varieties of recreational facilities, for example, Tot lots, Neighbourhood parks are simply close to residential areas people and children can easily access everyday recreational activity. Recreational activities will include playing, walking, meditation, yoga, exercise, etc.
(b) Mental Health: People can attain physical, mental and spiritual healing by simply spending time out of doors in the parks, forest areas, near the mountains, or in, isolated spaces, where they can spend time with nature (Gesler 2003).

Economic Benefits

Mostly, the urban green landscapes are under local urban bodies that facilitate commercial, income income-generating from the fest, fairs and sports events. Economic efficiency results in net social welfare, typically in the form of reduced costs to society, such as reduced healthcare costs. Vegetations are the free source that improves the air, water and land pollution and provides oxygen to the people. Private property value on natural open space is higher as compared to the without an open space amenity. Implementation of green roofs and other urban green infrastructures has the potential cost-saving in building energy consumption.

Energy–Saving Benefits

(a) Efficient transport management: Green landscapes along the roads increase the opportunities for non-motorised movement, bicycling and pedestrian-friendly networks.
(b) Energy efficiency: Vegetation on the roofs or Roof gardens. Vertical gardens are the potential to reduce the load on-grid power supply. Many studies conducted show that healthy urban green spaces, in the conditions of drought shown to be a positive potential for energy consumption and cost-saving (Cornelis and Hermy 2004).

Typologies of Urban Green Landscapes in the Hierarchy of Spatial Plans in Urban Areas

Urban green landscapes are an important contributor and significant part of sustainable development. Developments of green spaces need to consider interdisciplinary and integrative approaches such as economic, political, social, cultural, management and planning aspects to improve existing landscapes and optimise landscapes' policies (Hartswick 2013).

Green spaces in urban landscapes are one of the important land uses that provide several ecological services. As the availability of green spaces is scarce in cities, this planner are usually faced with conflicting challenges. Green city modules such as street orientation concerning sun direction, prevailing wind direction, and albedo effects help in reducing the negative impacts of the built spaces.

Existing Hierarchy of Spatial Plans in Delhi NCR

The size and hierarchy of the maps used to depend on the size of the planning area and the coverage of the information to be shown. The spatial scales and typology of urban green landscapes are shown in the Table 28.1. The hierarchy of urban green landscape in Delhi NCR is related to different scales of spatial planning through different guidelines, master plans and zonal plans.

The existing status of the organised green landscapes by different urban local bodies in the cities makes a sincere effort to analyse the proportion of an area under the categorisation of parks.

As per the guidelines of Urban and Regional Development Plans Formulation and Implementation (URDPFI), the open spaces/green spaces are categorised into recreational spaces, organised green and other common open spaces (such as vacant lands/open spaces including floodplains and forest cover). Considering open spaces/green spaces including the above-mentioned categories, provision of

Table 28.1 Spatial scales and typology of urban landscapes

S. No	Spatial scales	Urban green landscapes
1.	Regional scale 1:250,000–1:100,000 (for larger regions) 1:100,000–1:50,000 (for smaller regions)	1. Forest • Dense green • Open scrub • Non-agricultural plantation 2. Wasteland • Gullied land • Waterlogged area • Barren land • River sand 3. Agriculture • Cultivated land • Open scrub • Non-agricultural
2.	City 1:50,000–1:25,000 (District development plan) 1:25,000–1:10,000 (Metropolitan region plan)	1. Regional park/biodiversity parks 2. City park 3. City multi-purpose grounds 4. Heritage areas 5. Greens along MRTS, highways, expressways 6. Airports 7. Flood plains 8. Forests 9. Buffers along railway lines 10. Institutional greens 11. Green belt
3.	Zonal 1:10,000–1:8000 (as per state provision)	1. District park 2. Community park 3. District multi-purpose ground 4. Greens along arterial and subarterial roads 5. Graveyards/cemeteries and burning Ghats 6. Sports facilities 7. Horticulture areas/nurseries 8. Vegetable farms/orchards
4.	Local 1:5000–1:1000 (as per the requirement of the project)	1. Neighbourhood park 2. Housing area park 3. Community multi-purpose ground 4. Tot lot at housing cluster level 5. Local road side plantation 6. Traffic islands

Source Urban and Regional Development Plans Formulation and Implementation (URDPFI) Guidelines, 2015, Master Plan of Delhi, 2021

10–12 m^2 per person is desirable. The number of organised green spaces is depend on the planning units. Different scales of planning units have different typologies of organised greens, for example botanical greens, zoological parks, local parks, playgrounds, sports complex etc. shown in Table 28.2.

As per the guidelines mentioned in National Building Code (NBC), 2005.

1. Open spaces/maidans should be spatially distributed and multiple functions in time to be promoted.
2. In any layout or subdivision of land measuring 0.3 ha or more in residential and commercial zones, the community open space shall be reserved for recreational purposes which shall as far as possible be provided in one place.
   (a) The minimum recreational space provided shall be 450 m^2.
   (b) The minimum average dimension of the recreational space shall not be less than 7.5 m, and the length shall not exceed 2.5 times the average width.
3. Each recreational area and the structure on it shall have an independent means of access.
4. Any building line is to be at least 3 m away from the boundary of recreational open space.
5. Zoological garden is to be as per central zoo authority provisions.

As per the Master Plan Delhi (MPD), 2021.

The green spaces/open spaces are categorised under the green belt along the border of NCT Delhi (Table 28.3).

Table 28.2 Hierarchy of organised green

S. No	Planning unit	Number of organised green spaces
1.	Housing cluster	3–4 local parks and playgrounds
2.	Neighbourhood	3–4 local parks and playgrounds
3.	Community	2–3 local parks and playgrounds
4.	District/zone	1 district-level park and sports centre, maidan
5.	Subcity centre	1 city-level park, sports complex, botanical/zoological garden, maidan

Source Urban and Regional Development Plans Formulation and Implementation (URDPFI) Guidelines, 2015, Ministry of Housing and urban affairs

Table 28.3 Hierarchy of urban landscape

S. No	Use zone	Activities permitted
1.	Green belt	Forest, agriculture use, vegetation belt, wildlife sanctuary, bird sanctuary, biodiversity park, plant nursery, orchard, floriculture, open playground, agroforestry
2.	Regional park	Biodiversity parks, ridge (Aravalli forest), shooting range, botanical garden, zoological garden
3.	City park	Aqua park, arboretum, open playground, botanical garden
4.	District park	The theme park, children's park, orchard, specialised park, children's traffic park, area for water harvesting, archaeological park, national memorial

Source Master Plan Delhi, 2021

Mainstreaming the Urban Green Landscapes in Urban Areas

Environmental planning is the planning of the natural resources, planning initiated through the base plan for better living environments and improvement of natural resources. Climate change and other environmental concerns cannot be mitigated only by providing green landscapes. This will have to be coupled with sustainable land management strategies. Planning the urban areas with the integration of green landscapes is a comprehensive task. All the different spatial plans at different levels from perspective plans to master plans, zonal plans and district plans are developed based on the size and character of the city.

Green spaces are rigorously decreased in many cities of India and are further decreasing with growing urbanisation and population increase. With the rising urban population, the per capita availability in many urban areas has reduced drastically and can be expected to decrease further (Govindarajulu 2014).

Mainstreaming of green spaces with urban areas and with spatial plans is studied by several countries that are having a positive impact on the environment but there are many hurdles to incorporating the techniques on the ground. In addition, in some countries there is a need for collaborative action on many fronts—social, economic, political and regulatory (Campbell et al. 2016). Integration of green spaces/green landscapes in the developmental plans is the need of the hour; in a few countries, it is adapted but still integration concerning climate change is pending. However, park size, shape, or location in the urban area have generally been determined by forces of urban planning and design; because of this, the capacity of urban parks and open green spaces improves the local environment (Gonzalez-oreja et al. 2010).

To moderate and eventually curb the environmental impacts of urbanisation, sustainable ways of planning are required planning and design of landscape around the urban built forms with high APTI trees support in reducing the environmental stress levels. In 2014, after severe flooding events affected 137 cities in China, the Chinese government decided to invest heavily into green infrastructure and create ‘sponge cities’ through a pilot construction program (Jin et al. 2018).

International and National Initiatives for Creating Blue-Green Infrastructures

Through different literature studies, the initiative is taken by different government departments to boost the green–blue infrastructure (Table 28.4).

Table 28.4 Initiative at international and national levels

S. No	Scale	Location	Initiative
At international level			
1.	City	Wuhan, China	Sponge city program
2.	City	Vancouver, Canada	Rain city
3.	City	Singapore	Active beautiful, clean (ABC) water program
4.	Regional	Hoeksche, Netherlands	Agro-land improvement through blue-green networking
5.	Regional	30 locations, Netherlands	Room for the river
6.	City	Portland, US	Gray to green
At national level			
7.	City	Delhi	Blue green policy, master plan 2041
8.	City	Bhopal	Blue green master plan, 2025
9.	City	Hubbali-Dharwad	Green mobility corridor
10.	City	Surat	Creating "wild valley bio-diversity park" as city lungs by rejuvenation of existing wasteland along the creek
11.	City	Bhubaneswar	B-active—parks, open spaces and public spaces up-gradation leads to creating gender-neutral open spaces

Source Observer Research Foundation, Occasional paper, 2021

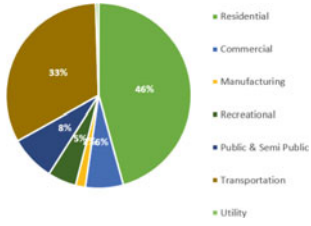
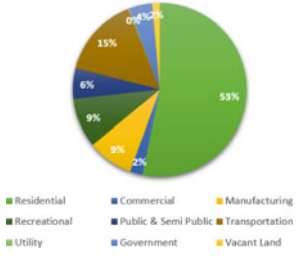
Urban Green Landscapes of Delhi

Delhi has a much larger green cover as compared to other metropolitan cities in the country and is called a green city. The percentage of green areas in Delhi as per the Master Plan Delhi 2021 constitutes 8722 ha, which is around 19% of the total urban land area of 44,777 ha. This includes the greens under the forest area (Delhi ridge), and the balance area under green land use is about 7145 ha, in the form of district parks, city parks, community parks, etc., comprising around 15% of the total urban land area. In addition to this, other green land uses include neighbourhood parks, tot lots in the residential areas, institutional areas like Jawaharlal Nehru University (JNU), Indian Institute of Technology (IIT), Delhi Technical University (DTU) and Delhi University, and plantation along drains and roadside plantations. In the urban extension of Delhi, the green cover is to be provided at the rate of 15% of the total land.

The distribution of green spaces given in the different zonal plans of Delhi indicates different green land uses in Delhi (Table 28.5).

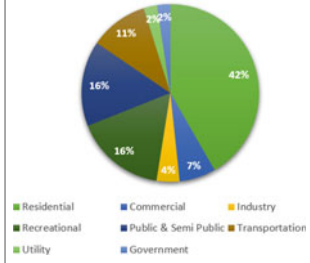
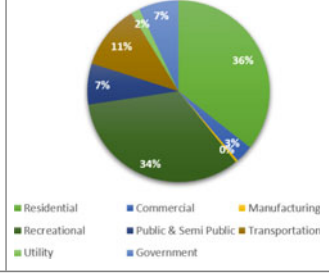
The different zonal plans of Delhi show the percentages of the green spaces and the typologies of urban green land uses (Fig. 28.1), and these green spaces are spatially shown in Fig. 28.2. The green land uses categories as mentioned in

Table 28.5 Distribution of green spaces in green land uses in different zones of Delhi

Zones/zonal plan		Land uses	Green land uses
Zone-A			Parks and open spaces • Netaji Subhash Park • Gandhi Ground, open area around Red Fort • Sports complex, Railways station stadium • Neighbourhood parks and play areas
Zone-B			Neighbourhood parks and playgrounds

(continued)

Table 28.5 (continued)

Zones/zonal plan		Land uses	Green land uses
Zone-C			• Northern ridge • Greens surrounding historical monuments • District parks • Bungalow areas with large backyards • Sports complexes
Zone-D			• Greens in government offices • Central vista • Central ridge • Bungalow zone

(continued)

Table 28.5 (continued)

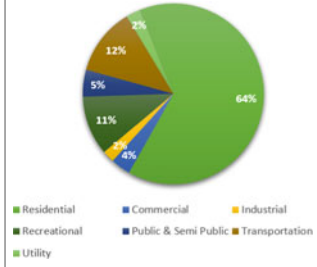
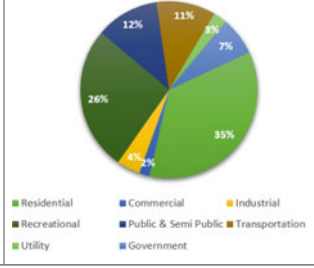
Zones/zonal plan		Land uses	Green land uses
Zone-E			• Greens in Yamuna Sports Complex • Green along Sanjay Lake • Greens along the water bodies • Greens along historical monuments
Zone-F			• Southern ridge • Biodiversity parks • City forests • Greens along historical monuments • Institutional greens • Neighbourhood greens

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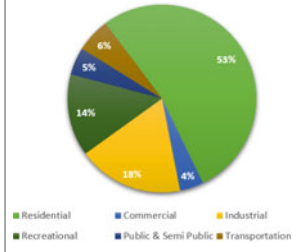
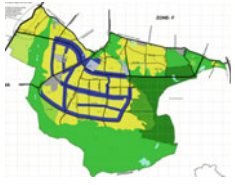
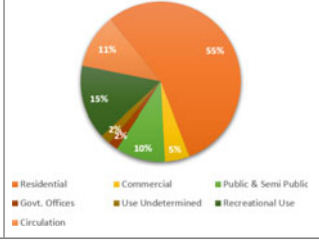
Table 28.5 (continued)

Zones/zonal plan		Land uses	Green land uses
Zone-H			• Protected forest • Orchards • District park • Playground • Neighbourhood park
Zone-J			• Regional park • Green belt • Asola Bird Sanctuary

(continued)

Table 28.5 (continued)

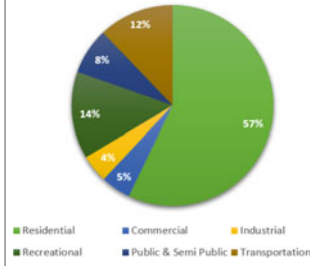
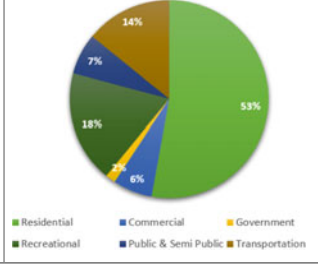
Zones/zonal plan		Land uses	Green land uses
Zone-K-I			• City park • District park • Community park • Theme parks • Multi-purpose grounds • Facility corridors for greenways
Zone-K-II			• District park

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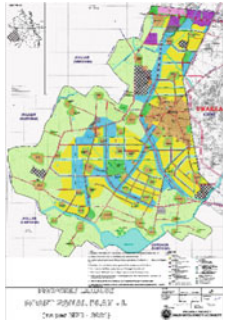
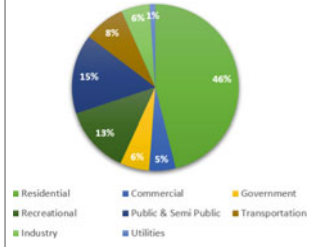
Table 28.5 (continued)

Zones/zonal plan		Land uses	Green land uses
Zone-L			• City park • Community park • District park • Neighbourhood park • Multi-purpose ground • Theme park

Source Zonal Plans Delhi, 2021
Source Master Plan Delhi 2021, Zonal Plans Delhi

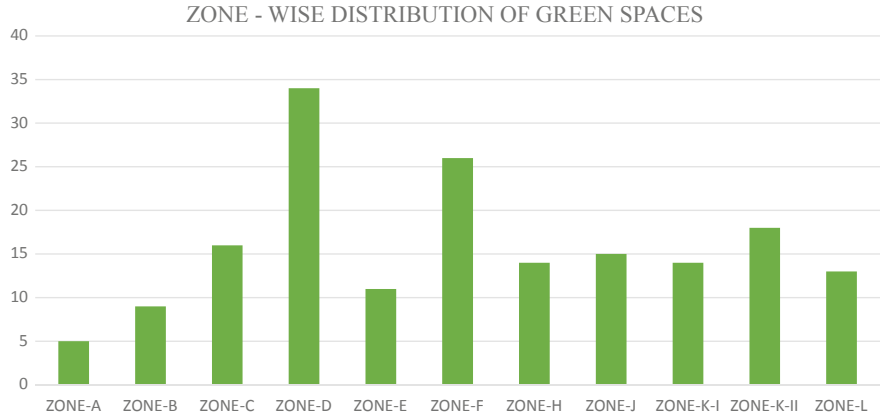


Fig. 28.1 Percentages of green spaces in each zone in Delhi. *Source* Master Plan Delhi 2021, Zonal plans Delhi

Master Plan Delhi 2021 include parks, playgrounds, city parks, district parks, neighbourhood parks, multi-purpose grounds with open spaces, forest areas, theme parks, biodiversity parks, etc.

The percentages in each zone vary as the sizes of the zones vary according to the Master Plan Delhi, 2021. The highest percentage of green spaces exists in Zone-D, which is approx. 34% but the variations of green land uses are less as compared to Zone-F. In Zone-F, the percentage of green spaces is approx. 26% and having variations in green land use. The green land uses here indicate the different typologies and variety of green spaces that exist in this zone which includes the southcentral ridge, biodiversity parks, city forests, greens around historical monuments, neighbourhood greens and institutional greens.

In Fig. 28.2, Zone-N, Zone-P–I and Zone-P–II are underdeveloped areas of Delhi and their green spaces are not considered for this chapter.

Delhi's every zone has not well-distributed green spaces as per the need to capture the air pollutants that result in the generation of dust from passing vehicular traffic and other polluting sources. Most of the built forms are devoid of the green spaces that are required to preserve the natural environments of the surrounding areas. The urban built forms should have integration with the 'Model Building Byelaws', and the associated green spaces along them, which strongly recommends purification, and enhancement of the surrounding areas and ultimately help in increasing rainwater harvesting, ameliorating air pollution, etc.

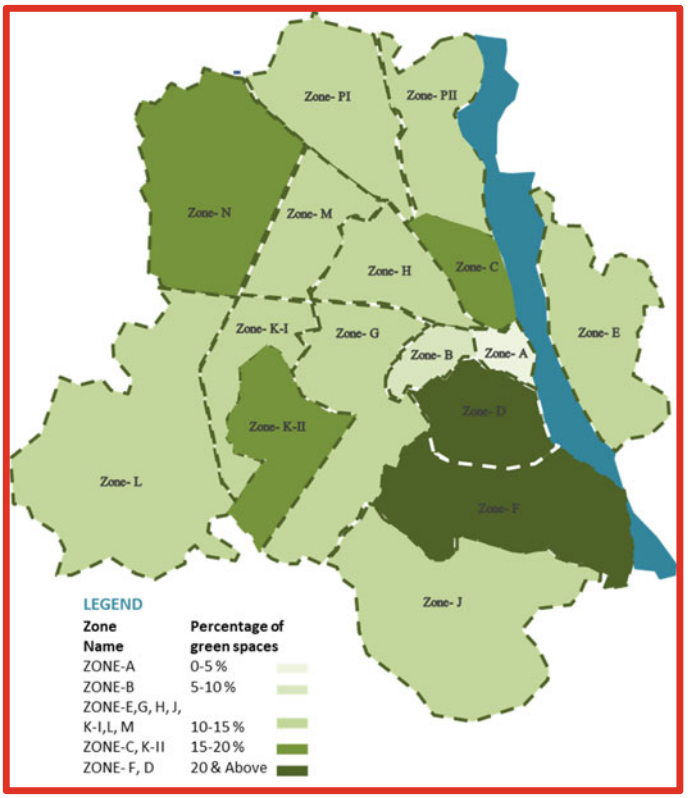


Fig. 28.2 Spatial distribution of green spaces in each zone in Delhi. *Source* Master Plan Delhi 2021, Zonal plans Delhi

Conclusion

The integration of green landscapes with spatial plans is not a new concept and many global cities have already integrated within their spatial plans and transition, driven by exacerbating climate impacts and events. It is crucial to consider urban green landscapes alongside the ecological while planning for adaptation and resilience.

In Delhi, there is a need to work on typologies of vegetation that has to be integrated with the different built forms and areas, for example near the industrial land uses need to plant the vegetation species that have the highest air pollution tolerance index, along the water bodies and River Yamuna, vegetation that helps in purification of polluted water.

This chapter revealed that green landscapes have many environmental potentials that cater to environmental issues and need to encompass spatial plans that acknowledge green landscapes with the development plans of the city. The integration of environmental planners in plan making process and implementation of the different

development plans on the grounds is the need of the hour, and green resources will need to be planned mindfully for a sustainable future. According to the World Health Organization (WHO), the per capita green space should be 9.5 m^2. However, the percentages of greens in Delhi as compared to the other cities are higher but lower or negligible in zones A, B, E and H of Delhi whereas in zones M, G and N green spaces are available but partially accessible or not accessible by the people. It required the integration of green–blue infrastructure, as possible areas are along the different water bodies, along the River Yamuna, areas under depressions and green parks as the project examples of Neela Hauz and Tughlakabad biodiversity reveal that polluted water bodies can be rejuvenated and converted into blue-green infrastructure within the city.

Spatial planning and mapping of its natural resources are important steps towards providing precise locations of urban green and blue landscapes in Delhi. The proposed green land uses and activities are required to be adopted on spatial maps and their implementation on the grounds, such as urban farming, Biodiversity Parks, Nature conservation Zones, Forest areas, green buffers, shelterbelts and green mobility corridors. The planning techniques of mapping help to sustain green land uses and do their preservation and conservation by providing equal and associated green land uses along different built forms.

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