Revitalizing Urban Landscapes: A Case Study of Urban Green Spaces and Urban Greenways in Pune, India

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Revitalizing Urban Landscapes: A Case Study of Urban Green Spaces and Urban Greenways in Pune, India

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Abstract: Rapid urbanization raises concerns about the availability of urban green infrastructure. This study looks at Pune, India, to see how Urban green spaces (UGS) and urban greenways (UGWs) might help revitalize urban environments. Urban Greenways are linear open space networks that enhance ecological and socioeconomic advantages. Using Geographic Information Systems (GIS), the study assesses Pune's Urban green space distribution, size, and identifies limitations through survey of carefully selected case studies in the study area. The study recognizes ward wise shortcoming of urban green space with respect to the norms provided by Urban and Regional Development Plans Formulation and Implementation (URDPFI) and World health Organization (WHO). It proposes framework to plan Urban greenways s to connect Urban green spaces to form a comprehensive green network for improving inhabitants' quality of life.

Keywords: Urban Green Space (UGS); Urban Greenway (UGW); Green Infrastructure; GIS Analysis; Pune.

1. Introduction

Urban Green Spaces (UGS) and Urban Greenways (UGW) play a pivotal role in urban ecosystems, contributing to both ecological dynamics and human well-being. These green spaces are essential components of urban environments, improving environmental quality, enhancing human well-being, and promoting sustainable urban development. Their significance lies in their ability to mitigate pollutants and toxins produced by cities, increase resilience to climate change impacts such as deforestation, landslides, and flooding, and reduce disparities in greenery distribution, thus addressing social inequalities. Research indicates that green spaces positively impact mental health, with higher tree density per kilometer of street associated with fewer antidepressant prescriptions. In terms of physical health, managing green cover has the potential to prevent a significant portion of global diseases.

The intention of this research is to establish a qualitative analysis of UGS through Surveys and quantitative analysis of the UGS through overall area distribution within the study area. The research also intends to further delve in the integration of UGS through UGW by adapting proper planning methods. A framework is established towards a comprehensive development of UGS and UGW for the benefit of planners, authorities and stakeholders.

2. Objectives of the research.

This research aims to study the role of Urban Green Spaces and Urban Greenways. Further to evaluate the current state of urban green spaces and its linkages if any, in Pune city, India, and propose potential alternatives to meet the growing demand for such spaces. The study employs Geographic Information System (GIS) tools to analyze the urban green spaces, facilitating the development of a comprehensive planning proposal. By analyzing the data, this study seeks to enhance the planning and management of urban green spaces in Pune, and further establish ground work for integration with urban greenways, ultimately improving the quality of life for its residents.

The evaluation study encompasses several key objectives. Firstly, it aims to understand the significance of urban green spaces and their role in the urban context. Secondly, the study investigates the various challenges faced by urban green spaces in Pune city. Furthermore, it assesses the benchmarks, policies, and provisions for urban green spaces in accordance with the Urban and Regional Development Plans Formulation and Implementation (URDPFI) guidelines. Lastly, the study identifies deficiencies in urban green spaces and provides recommendations to bridge the vegetation gap in the study area. It further elaborates on the necessity of linking these urban green spaces through urban greenways for network

and ecological benefits.

3. Urban Green Spaces (UGS)

Urban green spaces in India are sections of the city dedicated to vegetation, recreation, and environmental sustainability. These areas include parks, gardens, greenbelts, and urban forests. According to the Ministry of Urban Development and the Indian Council of Forestry Research and Education (ICFRE), urban green spaces improve air quality, provide recreational opportunities, and help to preserve biodiversity. Norms call for a minimum of 15-20% green cover in urban development to prevent pollution, heat islands, and promote citizens' health and well-being. Initiatives such as the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) seek to create and preserve green spaces throughout Indian cities.

3.1 Importance of Urban Green Spaces (UGS)

Urban Green Spaces (UGS) are regarded as critical and sustainable components of urban growth. They offer numerous benefits at the national, local, and individual levels, as well as opportunities for various stakeholders[1]. UGS contribute to the identity and attractiveness of a city, making it more desirable for residents, businesses, investors, and tourists. Consequently, they enhance the overall competitiveness of cities[2]. Moreover, UGS have a profound impact on social and economic life, ecological systems, urban planning, and the overall quality of life in cities. They have influential effect on reducing the air pollution in the surrounding atmosphere[3]. Spatial equity for variable green spaces within urban area provides for more optimized planning of the green network[4]. This study focuses on specific parts of Pune city, rather than the entire urban area. The analysis utilizes data from the years 2001 to 2020, with the study's scope limited to that period. It is important to note that this research is conducted within the framework of a particular study area and acknowledges its inherent limitations. UGS play a critical role in urban ecosystems, benefiting both ecological dynamics and human well-being. They play an important role in mitigating the urban heat created in the urban area[5] . The Urban green spaces are also an effective source to augment the carbon sink[6]. They are also very effective in mitigating the urban heat island effect due to the presence of vegetation[7]. However, the destruction and degradation of vegetation due to rapid urbanization pose significant challenges. The changing economic factors within the urban space also modulate the Urban green spaces over a certain period of time[8]. Monitoring and protecting urban green spaces become increasingly crucial for urban planners in making informed decisions and preserving green spaces in cities. Global disparities were observed in the use of Urban green spaces post the covid pandemic[9]. Industries such as Hospitality are also considering the green initiatives to reduce its adverse effects on environment[10]. Similarly Green manufacturing process reduce impacts on environment contributing to better ecological habitat[11] . The evaluation of urban green spaces in Pune city aims to address the demand for green spaces and enhance the quality of life for residents. By understanding the importance, challenges, and policy benchmarks associated with urban green spaces, this study contributes to the sustainable and long-term growth of cities, promoting social, economic, and ecological well-being.

3.2 Urban Green Spaces in URDPFI norms

Urban green spaces, as described by the Urban and Regional Development Plans Formulation and Implementation (URDPFI) guidelines, are critical components of urban planning that aim to improve environmental quality and livability in Indian cities. URDPFI guidelines recommend allocating at least 10-12 square meters of green space per person. These places include parks, playgrounds, gardens, and urban woods, which help to maintain ecological balance, provide leisure activities, and enhance aesthetic value. The guidelines underline the importance of systematic design, construction, and preservation of green spaces in combating urban heat islands, improving air quality, supporting biodiversity, and promoting urban dwellers' physical and emotional well-being. URDPFI recognizes UGS as natural habitat in their clause 9.5.1. In the clause 9.5 on Urban planning approach, URDPFI suggests the use of green spaces for cooling effects, social interactions, and psychological support in reducing human stress levels.

4. Urban Greenways (UGW)

Urban greenways are linear open spaces that connect natural, cultural, and recreational areas within cities, allowing for walking, cycling, and other non-motorized activities while also encouraging environmental sustainability and improving the overall quality of life for urban people. Urban greenways are important for boosting urban biodiversity, lowering the urban heat island effect, and encouraging citizens to engage in physical exercise[12]. Hunter additionally demonstrated the social benefits of urban greenways, such as enhanced social connections, community cohesiveness, and mental health[13]. Many city plans are influenced by the pattern of greenways[14]. These green areas not only have ecological and recreational value, but they also contribute to cities' overall resilience and liveability by providing a respite from the urban hustle and bustle while encouraging sustainable urban development practices[15]. In the face of rising urbanization and climate change challenges, urban greenways must be developed and maintained in order to create more sustainable and liveable urban environments.

4.1 Importance of Urban Greenways

Urban greenways are essential components of urban landscapes, providing numerous planning and

environmental benefits that contribute to well-being and city sustainability. Research emphasizes the value of urban greenways in improving urban liveability and environmental quality. Greenways, according to studies, serve an important role in urban design because they provide multifunctional places for activities such as walking, cycling, and picnicking, increasing physical exercise and social interaction among urban people[16]. Urban greenways increase citizens' overall quality of life by providing accessible and safe green spaces within cities, while also encouraging community cohesion and a feeling of place[17]. Cultural significance is established with land water interface and the urban green spaces[18].

From an environmental standpoint, urban greenways provide a variety of ecosystem services that improve the ecological health of urban regions. These green spaces serve as green infrastructure, providing shade, lowering surface temperatures, and improving natural ventilation. Greenways also play an important role in improving air quality by absorbing pollutants like nitrogen dioxide and particulate matter through vegetation and encouraging carbon sequestration, which helps to mitigate climate change[19]. Greenways provide more gratifying social connections than environmental advantages [20]. Studies have also been conducted to provide links between users' perceptions of urban greenways and the aesthetic value of the neighbourhood [21]. One study reveals encouraging information about enhanced physical activity levels in the home near Greenways [22]. It was found that 'The 606' Chicago's Bloomingdale Greenaway had a favourable influence on crime reduction[23]. Another study examined the phenomenon of rising property values near Greenways[24]. The employment density analysis was done, and it revealed a positive relationship with urban Greenway[25]

Furthermore, urban greenways provide as vital corridors for wildlife mobility and biodiversity conservation in urban areas. Greenways play an important role in integrating fragmented habitats, allowing species to travel freely and facilitating gene flow, which is necessary for preserving genetic diversity and population resilience[26]. Urban greenways sustain a diverse range of plant and animal species, contributing to urban biodiversity and ecosystem health. Native tree plantations along greenways have ecological benefits for the city[27].

In addition to their ecological and social benefits, urban greenways contribute significantly to public health and well-being. Access to green areas has been linked to better mental health outcomes, lower stress levels, and greater general well-being among urban inhabitants[28]. Greenways offer possibilities for physical activity, relaxation, and enjoyment, all of which are necessary for maintaining a healthy lifestyle and lowering the risk of chronic diseases including obesity and cardiovascular disease[29].

4.2 The Indian Context of Urban Greenways

In India, urban greenways have evolved as critical components of urban planning and development, providing a variety of benefits that address the concerns of growing urbanization and environmental deterioration. Research has underlined the value of urban greenways in Indian cities in encouraging sustainable urban growth, enhancing environmental quality, and improving the general well-being of urban populations. An increasing trend is observed in Indian business sector to disclose the green initiatives taken on annual basis[30]. The National Urban Transport Policy (NUTP) promotes use of Non-Motorized Transport (NMT) modes for environmental benefits in the city[31]. According to research, urban greenways in India have an important role in providing green places for recreation, encouraging biodiversity conservation, and limiting the effects of urban heat islands[32]. These green spaces act as vital lungs for cities, reducing air pollution and improving overall air quality[33].

Indian urban greenways have been acknowledged for their ability to reduce social and health inequities by providing equitable access to green areas for all people, regardless of socioeconomic background[34].

Greenways provide chances for physical activity, social connection, and mental refreshment, all of which improve urban people' overall well-being and quality of life. By incorporating greenways into urban planning methods, Indian cities can create more sustainable and habitable landscapes that promote biodiversity protection, public health, and community resilience in the face of urbanization.

5. Interrelationship of Urban Green Spaces (UGS) and Urban Greenways (UGW)

Urban green spaces and urban greenways are both important in improving the quality of life in cities, but their design, usefulness, and impact on urban surroundings vary substantially. Urban green spaces, such as parks and nature reserves, provide huge amounts of natural landscapes inside urban areas, allowing for recreation, relaxation, and biodiversity conservation[35]. These areas frequently have different ecosystems, such as grasslands, woods, marshes, and water bodies, which sustain a variety of plant and animal species. Furthermore, open green areas help to reduce urban heat island effects by providing shade and cooling via evapotranspiration[36]. Urban greenways, on the other hand, are linear corridors that usually follow natural or man-made features such as rivers, railroads, or old industrial corridors and are intended to enable non-motorized transit and enjoyment. While urban greenways may lack the biodiversity and broad vistas of urban green spaces, they enable connectivity between different parts of the city, supporting active commuting and providing possibilities for walking, jogging, and cycling[37]. Also, urban greenways can act as green infrastructure, helping to regulate stormwater runoff

and reduce flooding risks in urban areas[38].

Urban green spaces and urban greenways differ significantly in terms of spatial distribution and accessibility within cities. Urban green spaces are typically centralized and greater in size, often placed on the outskirts or in the heart of urban districts, making them accessible to a diverse spectrum of residents[39]. These venues act as hubs for community gatherings and cultural events, promoting social cohesiveness and a feeling of place[40]. In contrast, urban greenways are scattered linearly across the city, following traffic routes and varying in width and accessibility[41]. While urban greenways provide recreational options for close inhabitants, their linear nature may limit access for those living further away from the corridors, especially in neighbourhoods with limited access to the greenway network[42].

Additionally, the ecological functions and biodiversity value of Urban green areas and urban greenways differ as a result of habitat diversity and management strategies. Urban green spaces can support a vast range of plant and animal species, including local flora and fauna[43]. Proper management strategies, such as habitat restoration and invasive species control, are critical to sustaining biodiversity in these places[44]. In contrast, urban greenways, which are frequently characterized by linear constructions and fragmented habitats, may support fewer species and be more vulnerable to disruptions from surrounding land uses and human activities[45]. However, smart design and management interventions, such as native plant landscaping and wildlife corridors, can improve the ecological value of urban greenways while also promoting habitat connectivity within urban landscapes.

6. Methodology of the research.

The methodology of the study entails the use of numerous methods to achieve the objectives. The study is analysed using two fundamental methods: qualitative and quantitative analysis. Primary surveys of theme gardens in Pune were conducted for the qualitative analysis. In the quantitative analysis method, however, the per capita availability of all wards in Pune was calculated using the 2011 population. The data used in the present study are primary and secondary data. Primary data has been used in the qualitative method analysis. Literature review, deducing and ranking of parameters, questionnaire formation are the steps followed for the primary survey.

While in the quantitative analysis, the ward-wise population data has been obtained from the District Census Handbook, 2011 and the old ward boundary has been obtained. The per capita availability was calculated with help of the secondary data like population of the wards and the total area of gardens. The existing garden locations are marked on the map of the Pune with the help of ArcGIS 10.2.2. As the ward map is modified during each election, the names of some wards have been changed or some new wards have been created from older ones.

Figure 1 provides a brief explanation of survey methodology. In order to examine the current situation prior to the on-site survey, literature, research articles, and data from the Pune Municipal Corporation (PMC) were used. Survey questionnaires were constructed using parameters that were determined to be appropriate for the study. A public opinion survey was carried out to interpret the gardens' current situation. This was carried out as part of the analysis of the qualitative survey. In order to analyze the quantitative survey, secondary data were used. During this time, several literatures were studied. The Pune Garden Department, the PMC's official website, was used to collect all data relating to gardens, including their areas, locations, and the wards to which they belong. The survey methods that were employed in this study are briefly depicted in Fig. 2.

7. The Study area

Pune, nicknamed the "Oxford of the East," is a thriving metropolis in Maharashtra, India. It is located on the Deccan Plateau, 560 meters above sea level, between the Western Ghats and the Sahyadri range, near the confluence of the Mula and Mutha rivers. This geographic location contributes to Pune's lush environment and mild climate, with temperatures ranging from 15°C to 35°C with an average annual rainfall of 722 mm, primarily during the monsoon season. The surrounding cities, such as Mumbai, Nashik, Solapur, and Kolhapur, improve Pune's connection and regional relevance. With a population of more than 7 million, Pune is India's ninth most populous city, with a diversified demography that includes many young professionals, students, and expats. The primary language is Marathi, but Hindi and English are also widely used. Pune has a literacy rate of over 87%, highlighting its status as an educational hub with multiple notable institutions. Economically, Pune is strong and diverse. It has long been a manufacturing and automotive hub, with major companies such as Tata Motors and Bajaj Auto headquartered there. In recent decades, it has evolved as a leading IT and software services hub, attracting industry giants such as Infosys, Wipro, and TCS, as well as a thriving start-up community. This economic variety is further bolstered by a robust educational system and a lively cultural landscape. Pune's rise has been defined by fast urbanization, stretching from its historical heart to suburban regions like Hinjewadi, Baner, and Kharadi, which have become significant IT. The city's infrastructure has been improved, with initiatives like as the Pune Metro improving urban mobility. Looking ahead, Pune is poised for continuing expansion, aided by programs such as the Smart City Mission, which seeks to improve urban living standards through sustainable development. Economic estimates expect continuous investment growth in information technology, education, and manufacturing, as well as required increases in

housing, healthcare, and transportation. Efforts to balance urbanization and environmental conservation will be critical. Pune's rich legacy, educational brilliance, and economic vibrancy promise its bright future prospects. With the passage of time, the city's physical development

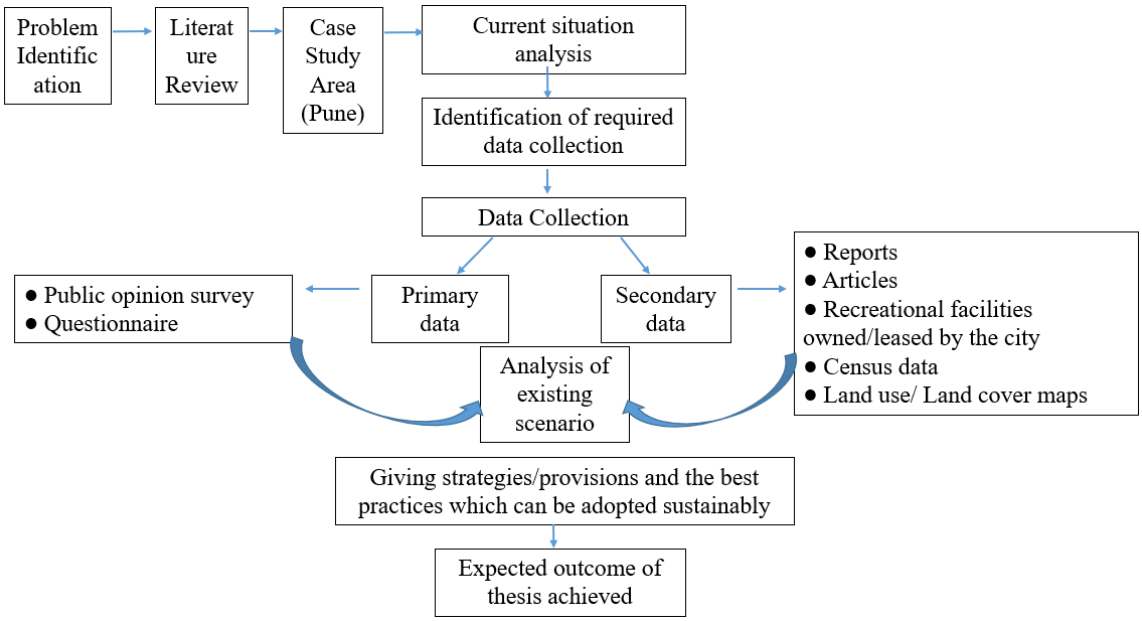

Fig. 1: Methodology Flow Chart

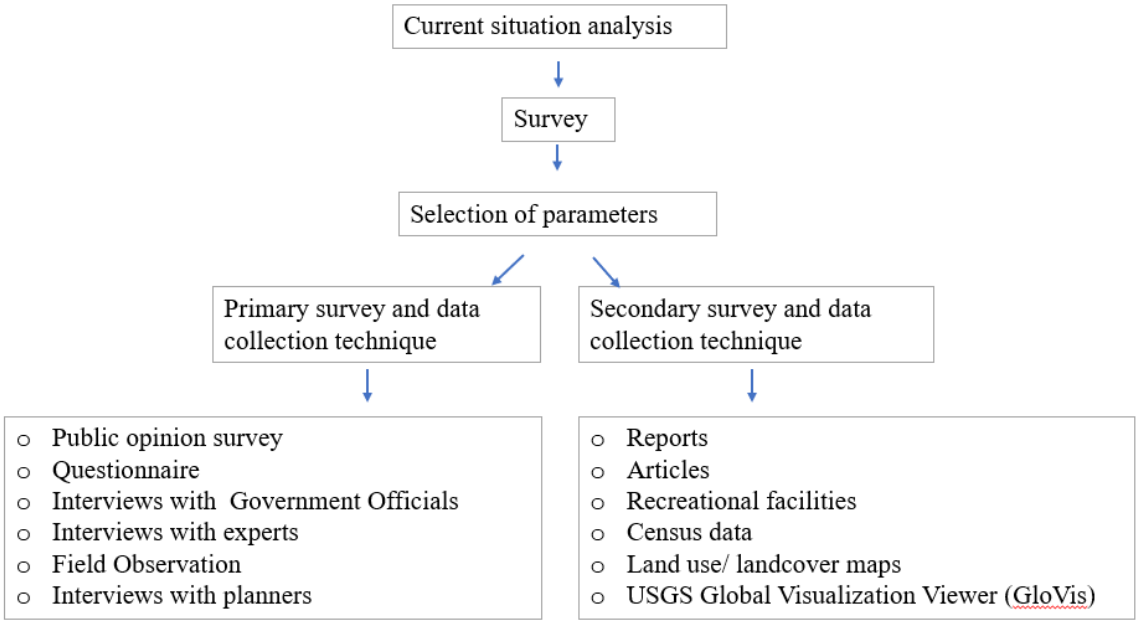

Fig. 2: Survey Methodology

and physical growth were surpassed by the city's rapid natural growth, the influx of migrants, and activity. Pune also has a riverfront, unfortunately being polluted for variable issues[46]. Urbanization poses a significant threat to urban open spaces in cities. People's social and cultural behavior necessitates the development of open spaces with adequate facilities and infrastructure, and meeting recreational needs necessitates the creation of an open space system that can cater to the needs of various population groups. Open space planning is required to provide opportunities for both active and passive recreation. Construction materials for providing such spaces should also be carefully selected for environmental sensitivity, such as alternative to river sand[47] . It is, therefore, necessary to conduct a careful study of the existing open spaces in terms of their types, development or degradation over time, and effectiveness in contributing to the social, environmental, and economic needs of the city. The methodology used to maintain per capita green space availability in the city vicinity was a comparative analysis of cities whose per capita green space is compared to the Indian Urban and Regional Development

Plans Formulation and Implementation (URDPFI) standards. Ward wise per capita availability of green space has been calculated to know the availability of the green space in the city and then it has been compared to the URDPFI Guidelines and to the World Health Organization (WHO) Norms.

Table 1. The types of Survey

Sr. No.	Survey Types	Methods Used
1.	Qualitative Survey	1. Observation of the study area by the author 2. Public-opinion Survey
2.	Quantitative Survey	Comparison of the existing vegetation situation with the standards in terms of Per capita standards for the Urban Green Open Space.

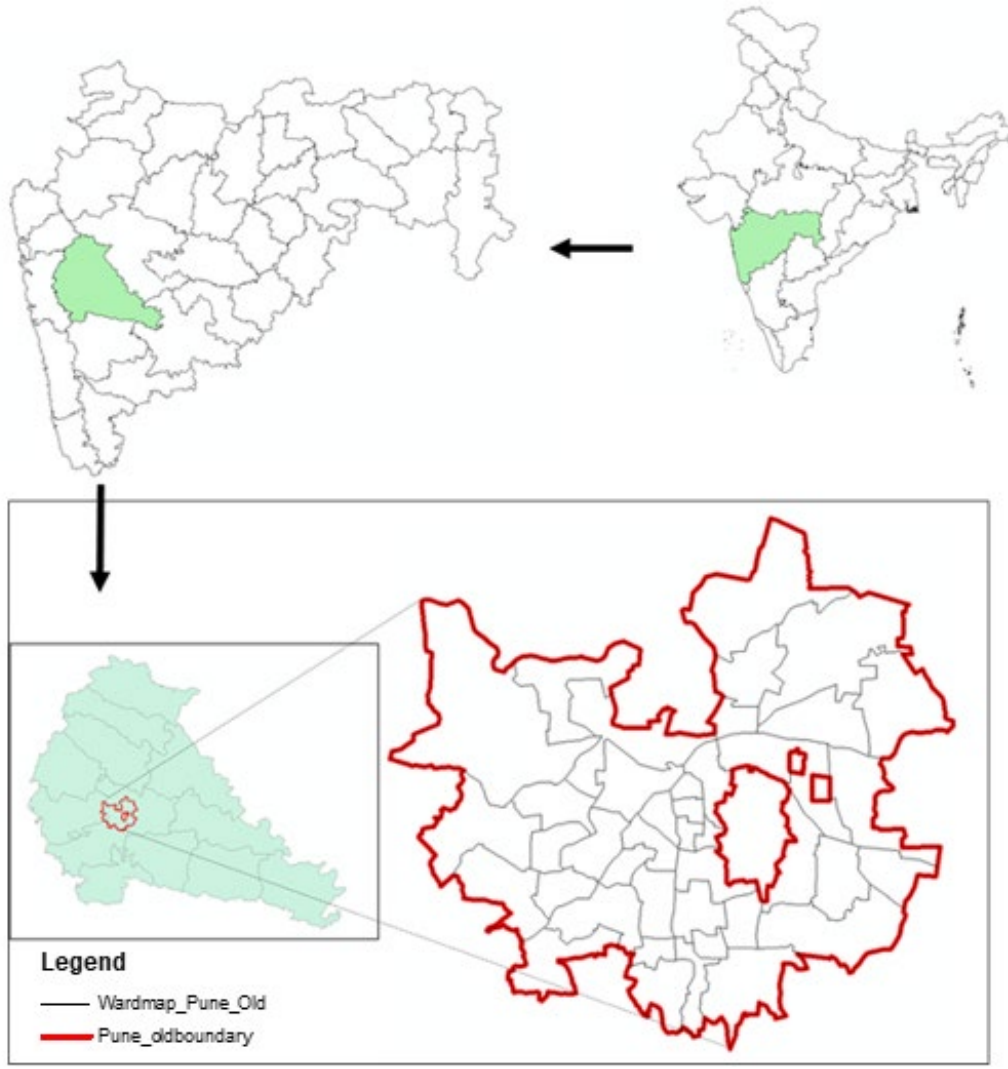

Fig. 3: The Study Area, Pune, India. (data generated by authors)

Table 2: Parameters of the survey

Sr. No.	Categories	Parameters	Referenced Literature
1.	Amenities	a. Parking	Exploring Park Quality in Urban Setting with Environmental Justice, Alternative Measurements, and Social Interaction[48)]
		b. Restrooms	--
		c. Pathways	The Allure of Garden Paths & Walkways Blog: https://www.surroundslandscaping.com/the-allure-

			of-garden-paths-walkways/
		d. Benches	Effects of outdoor seating spaces on sociability in public retail environments[49]
		e. Drinking water booth/fountains	Promoting Water Access and Intake in Parks and Public Spaces https://researchinchildhealth.org/drink-tap
2.	Aesthetic features	a. Planting b. Turf lawns	Exploring Park Quality in Urban Setting with Environmental Justice, Alternative Measurements, and Social Interaction[48]
		c. Water features	The effects of water elements in urban space perception: A case study in Üsküdar Municipality Square[50]
3.	Maintenance and cleanliness	a. Maintenance condition	1. Manageable Predictors of Park Visitor Satisfaction: Maintenance and Personnel[51] 2. Maintenance, improvement, and supervision of parks and playgrounds in Davao City: An evaluative study[52]
4.	Play area (for children)	a. Swings b. Sea saw c. General play set d. Slide down e. Trampoline f. Gym climbing	1. Green Spaces and Parks- Kanpur Kanpur municipal Corporation[53] 2. The importance of outdoor play for young children's healthy development[54]
5.	Sitting and Resting features	a. Benches	Effects of outdoor seating spaces on sociability in public retail environments (Oram et. al., 2018)[49]
		b. Gazebos/Huts c. Seat walls/bleachers.	Comparative Analysis of Five Observational Audit Tools to Assess the Physical Environment of Parks for Physical Activity, 2016[55]
6.	Landscaping	a. Flowers, shrubs/ bushes b. Play Squares/ Circle integrated with fountains c. Sculptors of personalities d. Paving e. Fences f. Lighting	1.Evaluation of urban green spaces in Bratislava Tamara R and Eva P[56] 2. Lighting urban parks – reviewing the basics Dr. Amardeep M. Dugar[57]

7.1 The Survey of Study area

As previously discussed in the methodology, surveys of the study area were conducted using two distinct methods: qualitative and quantitative surveys. The authors made observations in the first qualitative surveying method based on a set of selected parameters. Public opinion surveys were done as part of the second qualitative surveying technique to have a better understanding of the park's quality and upkeep. Data was gathered from the Pune Municipal Corporation's Garden Department for the quantitative survey in order to compare it to standards and detect vegetation gaps. URDPFI Guidelines and WHO Norms were taken into consideration for the quantitative survey analysis.

7.2 Outline of Surveys conducted in the Study area

For the survey, parameters considered are parking, restrooms, pathways, benches, and drinking water fountain or booths under the category of amenities. Under the category of aesthetic features, parameters selected were Planting, Turf lawns and Water features. To check the maintenance condition specific gardens have been surveyed. Swings, Sea saw, General play set, slide down, Trampoline, and Gym climbing are the parameters categorized under Play area for children. The parameters chosen for the seating and resting features category were Benches, Gazebos/Huts and Seat walls/bleachers. Flowers, shrubs/ bushes, play squares/circle integrated with fountains, Sculptors of personalities, Paving, Fences and Lighting are among the Landscaping that were considered for the survey. Before surveying the study area, survey questionnaires were designed through expert opinions. A specific number of parameters were considered when creating the survey questionnaire. The questionnaires covered all aspects of all the parameters as indicated in table 2. For the qualitative analysis, this detailed parameter categorization helped to understand the condition and maintenance of the gardens in Pune city. In the qualitative analysis, only surveyed garden data has

been analyzed. The questionnaire included a range of responses from Excellent, Good, Moderate, Porr and Very Poor. At the end, there was a small open-ended section for comments, which helped to better understand some of the earlier open-ended responses.

8. Case Studies and their Selection

To achieve a thorough examination, case studies for the study of Urban Green Spaces have been selected strategically. Four case studies are picked from various sites within the city, each representing a different zone such as residential, commercial, industrial, and peri-urban sectors. This geographical diversity guarantees that a variety of environmental and socioeconomic factors are represented. Each green area is chosen based on its unique functions, such as recreational parks, ecological reserves, community gardens, and urban forests, in order to better comprehend the diverse roles, they play in urban life. Expert advice from urban planners, ecologists, and landscape architects is sought to identify areas that support a varied range of plants and wildlife, assuring ecological richness and biodiversity. These specialists also help to highlight the particular qualities of each case study, such as historical significance, innovative design, or community involvement, which add depth to the analysis. The selection includes a wide range of survey-relevant aspects, such as accessibility, usage patterns, maintenance practices, and environmental advantages. The case study selection method strives to give a comprehensive view of urban green spaces, allowing for a clear understanding of their contributions to urban sustainability and quality of life.

8.1 Lakaki Lake Garden, Model Colony

Model Colony Lake, also known as Lakaki Lake, is a six-acre abandoned quarry site in Pune that dates back nearly a century. The lake gets its name from the "Lakaki" residence of famous industrialist Kirloskars in the area. The lake has long been a peaceful haven for migratory birds, buffalos, anglers, and nature lovers. A narrow peripheral walkway was introduced around the lake without displacing the existing vegetation and large trees on the site because the lake was surrounded by high structures for viewing the birds from afar. The lake's periphery was gradually filled with boulders to support the walkway. The walkway was formed by covering the top of the boulders with concrete. A built-in concrete trough for planting water plants and tall reed grass to screen people from birds in the lake area can be found on the sloping edge of the pathway. The walkway has artificial lighting. The lake area is only open in the morning and evening, and visiting hours are limited.

8.2 Osho Garden, Koregaon Park.

Pune has a plethora of beautiful gardens with diverse flora and fauna that are both visually and spiritually soothing. Osho Teerth Garden in Koregaon Park is one of the most popular parks among these lovely gardens. This magnificent Japanese-style garden behind the Osho Ashram is one of the city's most beautiful green spaces. The place is surrounded by well-kept gardens and trees imported from Bangalore, Vadodara, and Kolkata. The Park even has a bamboo tree patch that attracts a large number of birds from the surrounding areas. Over 1,000 people visit the site each week, and to ensure that they can relax and meditate in the idyllic surroundings, marble slabs have been placed beneath the emerald canopies of trees, along with statues of Buddhas in meditative postures.

8.3 Tilak Rose Garden, Sahakarnagar.

In 1962, Jayantrao Shridhar Tilak, a politician and the editor of the newspaper Kesari, as well as the grandson of Indian nationalist and independence activist Bal Gangadhar Tilak, gathered a group of rose enthusiasts to form the Rose Society of Pune, which was dedicated to popularizing rose cultivation. The Pune Municipal Corporation (PMC) decided to create a rose garden in 1999 at his request. As a result, the Jayantrao Tilak Rose Garden was established in Sahakar Nagar, Pune. Over 400 varieties of hybrid tea, floribunda, miniature, climbing, shrub, and standard roses can be found in the garden.

Fig. 4: Lakaki Lake Garden, Model Colony, Pune.
(Photographs by authors)

Fig. 5: Osho garden, Koregaon Park, Pune
(Photographs by authors)

Fig. 6: Tilak Rose Garden, Pune (Photos by Authors)

Fig. 7: The P. L. Deshpande Garden, Sinhgad road. (Photographs by authors)

8.4 The P. L. Deshpande Garden, Sinhagad road.

The Pune Okayama Friendship Garden, on Sinhgad Road, is modelled after one of Japan's most famous gardens, "The Korakuen Garden," in Okayama City, Japan. The Korakuen Garden has a proud 300-year history. The 10-acre Pune Okayama Friendship Garden represents the culture and intricate ideologies of an authentic Japanese garden. The garden serves as a perfect link between the cities of Okayama and Pune, encouraging cultural, traditional, economic, industrial, and friendship ties. A composition of fire, harmony, line spirit world, and water define the garden's characteristics. As a result, the garden expresses the various elements in order to speak about light and darkness, soft and hard, stillness and motion, warmth and cold. It is based on the Chinese philosophy of Yin and Yang.

9. The Analysis of the Survey

Primary survey, photo documentation, observation, and secondary data gathering techniques are employed for qualitative analysis. Additionally, the scaling analysis method was being used. Following features contributed to the analysis:

Availability and connectivity;
Attractive, active health and wellness support;
Maintenance and management level;
The functions of urban green space;

Table 3 specifies the area of the surveyed gardens.

Figure 9 shows the locations of the existing gardens in the Pune city and Figure 8 shows the locations of the surveyed gardens.

As previously stated, the survey was based on both the questionnaire and public opinion. The survey was conducted using the methodology proposed by the experts. Parameters were determined through scholarly literature. After determining the parameters, expert opinion was sought to rank those parameters. Following that, questionnaires were created based on the parameters. Finally, some of the theme-based gardens were surveyed using a structured questionnaire. Based on the results of the study of 204 gardens, it can be said that 67% of the gardens have parking facilities, whereas 33% of the gardens do not. Additionally, the state of the restrooms varied, with 20% being considered fair, 30% in bad condition, and 10% being in very good shape. Furthermore, 71% of the gardens in the survey contain drinking water booths, compared to 29% who do not. The Aesthetical features were of secondary considerations to most of the users, while some users expressed them to be of more artistic in nature with respect to local art and craft. The children play equipment's were found faulty in most of the cases due to lack of regular maintenance. The resting and seating areas were regularly placed in most cases, and many users expressed satisfactory use of the benches and gazebos. They also provided increased interactive opportunities at social level. The landscape was very soothing and well maintained in the case studies, and most of the user's expressed happiness about the variety and design of all such soft landscape features.

There are numerous issues concerning urban green spaces that are contributing to their sudden decline in urban areas. At the national level, there are a number of policies and notification acts that serve as benchmarks for forest and green cover protection. There is also a decline in quality of life and well-being at the city level as a result of the loss of green spaces[58]. These Green spaces also need monitoring for proper maintenance[59]. In this study, some of the standards are used for comparing the per capita availability of green space which are as per table 4.

The Urban Regional Development Plans Formulation and Implementation (URDPFI) guidelines, 2014 recommend 10 to 12 sq.m of open space per person. The international minimum standard suggested by the World Health Organization (WHO) and adopted by the publications of the United Nations Food and Agriculture Organization (FAO) is a minimum availability of 9 sq.m of green open space per city dweller.

Table 5 gives the detailed scenario of availability of green space in each ward.

Per Capita Availability of the green space in the study area is given by:

Total area of green space / Population
= 249472600 / 3124458
= 7.90 square meters

Table 6 gives a detailed scenario of the availability of green space in Pune city.

The per capita availability is calculated by using the total area of gardens and the total population of the city. The per capita Green Space in Pune is below the set standards. The analysis of per capita green space in Pune revealed

that all wards, with the exception of those under the Kondhawa - Yewalewadi Ward office, fail to meet even the WHO's recommended criteria of 9 square meters 'per capita green space,' and only one ward office meets the WHO's criteria. When the per capita green space was compared to the URDPFI Guidelines, none of the wards met the URDPFI Guidelines' criteria of 10-12 square meters per capita green space.

Table 3: Surveyed Gardens with their areas

Sr. No.	Garden Name	Area (in sq.m)
1	Late. P.L. Deshpande Garden Phase-1 (Pune Okayama Maitri Garden)	40,000
2	Lakaki Lake	22,000
3	Late. Jayantrao Tilak Rose Flower Garden	8,000
4	Osho garden	9,836

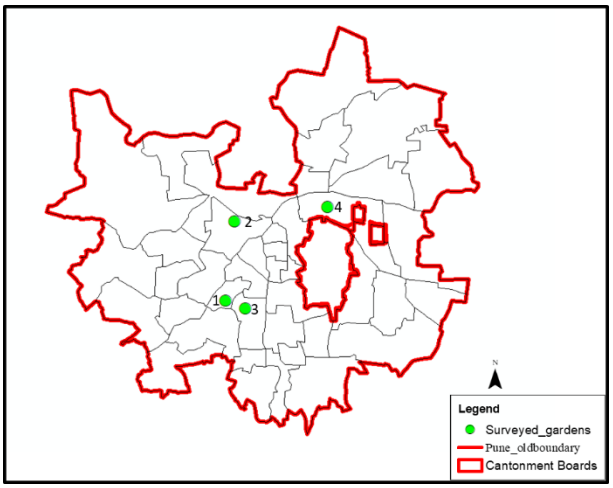

Fig. 8: Location of Gardens Surveyed in the study area (data generated by authors)

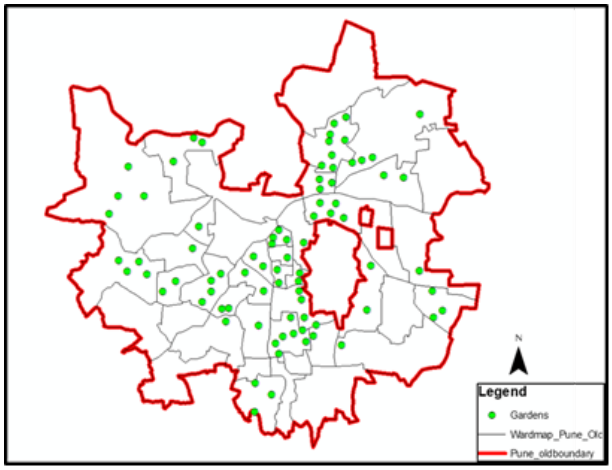

Fig. 9: Existing Gardens in the study area (data generated by authors)

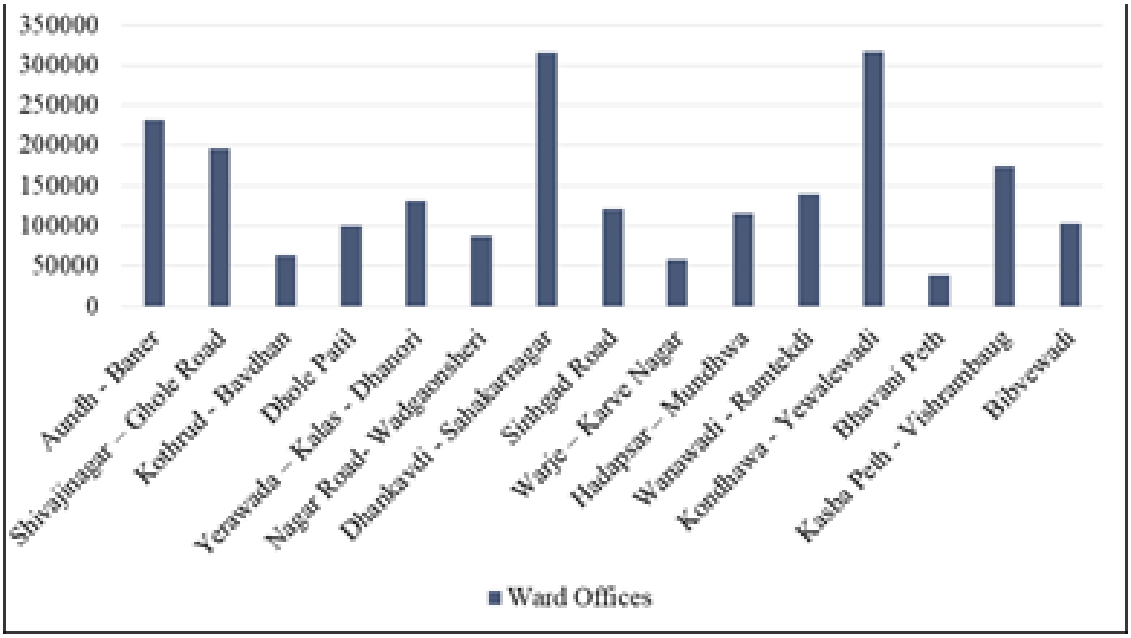

Fig. 10: Ward wise total area of gardens (data generated by authors)

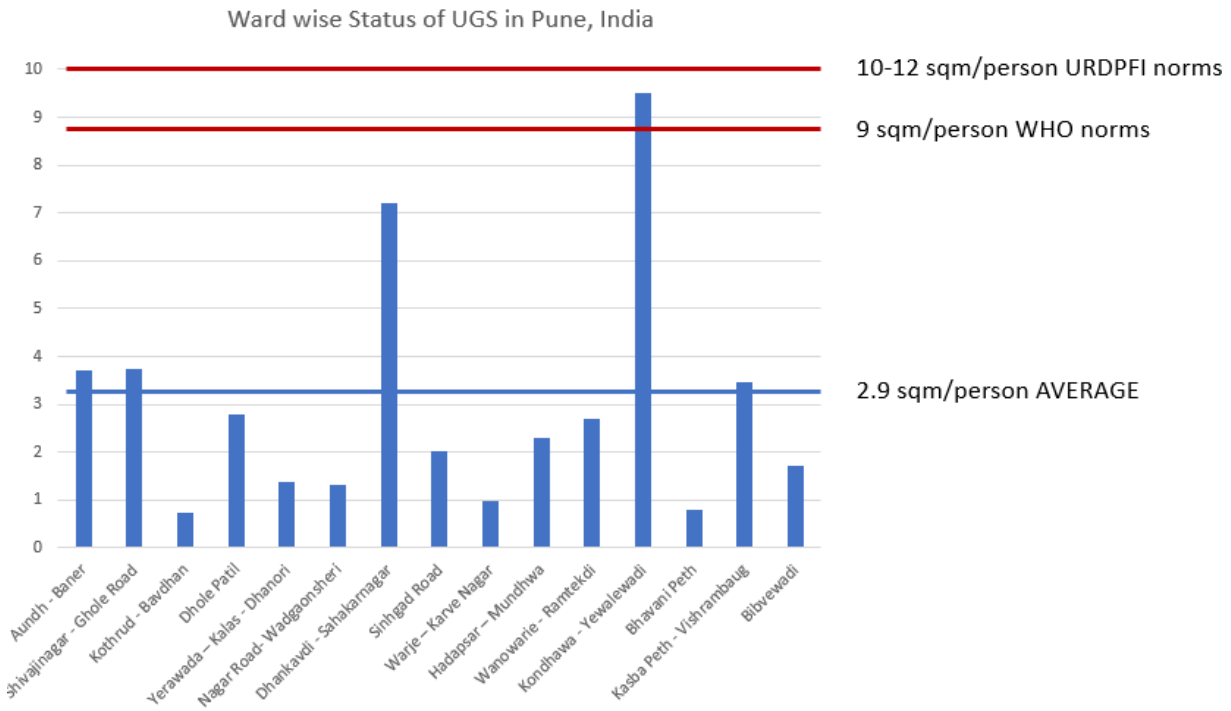

Fig. 11: Ward wise Shortfall of UGS (data generated by authors)

Table 5: Comparison the Ward wise Per Capita Availability of Green Space with the standards

Sr. No	Ward Name	Ward No.	Population (2011)	No. of Gardens	Total Garden Area (in sq.m.)	Per Capita availability of Green Space (sq.m)	Comparing with URDPFI Guideline	Comparing with WHO Norms	Comparing with overall Pune Per capita space
1	Aundh - Baner	8, 9	62,279	13	2,31,904	**3.72**	10-12 sq.m. per person	9 sq.m per person	7.9 sq.m per person
2	Shivajinagar - Ghole Road	7, 14	52,293	17	1,96,200	**3.75**			
3	Kothrud - Bavdhan	10, 11, 12	83,029	13	62,659.60	**0.75**			
4	Dhole Patil	20, 21	36,197	12	1,00,812	**2.79**			
5	Yerawada – Kalas - Dhanori	1, 2, 6	95,624	20	1,32,035	**1.38**			
6	Nagar Road- Wadgaonsheri	3, 4, 5	65,760	12	87,100	**1.32**			
7	Dhankavdi - Sahakarnagar	35, 39, 40	43,801	19	3,15,302.05	**7.20**			
8	Sinhgad Road	30, 33, 34	59,604	11	1,20,600	**2.02**			
9	Warje – Karve Nagar	13, 31, 32	58,140	14	57,689	**0.99**			
10	Hadapsar – Mundhwa	22, 23, 26	50,055	12	1,15,030.96	**2.30**			
11	Wanowarie - Ramtekdi	24, 25, 27	51,476	10	1,39,686	**2.71**			
12	Kondhawa - Yewalewadi	38, 41	33,249	10	3,15986	**9.50**			
13	Bhavani Peth	17, 18, 19	48,652	6	39,000	**0.80**			
14	Kasba Peth - Vishrambaug	15, 16, 29	50,117	19	1,74,000	**3.47**			
15	Bibvewadi	28, 36, 37	59,955	16	1,03,500	**1.73**			

Total 850231	**204 Gardens**	**21,91,504.61 sq.m**				

Table 6: Comparison of Pune City's per capita green space status with the standards

Name of the city	Population (census 2011)	Total area of green space (sq.m)	Per capita green	Comparing with URDPFI Guidelines	Comparing with WHO Norms	Remarks
Pune (PMC)	3,124,458	2,49,472,600	**7.9 sq.m**	10-12 sq.m per person (-2.1 to -4.1)	9 sq.m per person (-1.1)	Pune city's per capita Green Space is below standards

10. Results for Urban Green Spaces study in the context of Pune.

Due to the expanding population, parks and gardens play a greater and greater significance in metropolitan areas, especially in developing nations like Pune. 204 public gardens are managed by the Pune Municipal Corporation (PMC), which serves the needs of the community and fosters environmental sustainability. While the majority of parks include similar amenities including sitting places, walking paths, wide open spaces, and shaded platforms, there are differences in size and maintenance. While some parks don't have open gyms or playgrounds for kids, others include other amenities like water features, sculptures, and gazebos. Except for a few parks that have a nominal entry fee, most parks are free to access. They are maintained by Pune Municipal Corporation (PMC) and open for a certain period of time throughout the day, with an afternoon closure for maintenance and cleaning. Scope needs to be established to regulate traffic movement for easy access to such green open spaces[53)]

The study results revealed information about the placement and hierarchy of open spaces in wards of Pune. The amount of urban green open space that is available per person was also calculated. Although a significant majority of respondents (97%) acknowledged the value of open spaces and their development, just 39% indicated a willingness to contribute to their maintenance. Both men and women reported a preference for accessing neighborhood- and regional-scale open spaces for varied activities. The existence of stray animals, overgrowth, garbage, vandalism, encroachments, and other problems made gardening in highly populated regions difficult.

This study focused on per capita green space and compared Pune's existing gardens to the URDPFI recommendations. The existence of urban green zones was determined to have an impact on the city's "green performance". Urban open spaces are critical for improving the cityscape, providing natural diversity, and raising the quality of life in cities. They promote societal improvement, economic growth, and the spread of ecologically responsible ideas. The study emphasizes the importance of keeping Pune's parks and gardens' unique traits, ambiance, and use while also ensuring their sustainability.

11. Discussion

11.1 Proposals and Recommendation for Urban Green spaces

The surveys carried out in the four Urban green Spaces, indicate the overall shortcomings in the infrastructural issues such as rest rooms quantity and quality, along with the equipment's in the UGS. The play equipment's in the UGS were of special concern for safety and maintenance. Some of the UGS also lacked in proper parking facilities. As such, special attention is required to address these issues in the current and planned UGS for the city. Although landscape and aesthetical features show satisfaction from the user point of view, an ecological consideration should also be kept in mind such that the UGS performs the function of environmental revival.

At policy level, following considerations are proposed herewith for the benefit of planners and Authorities. To combat the degradation caused by excessive use, it is recommended to create local green spaces near residential areas, adopt proportionate design functions, and guarantee that these areas are maintained and cleaned on a regular basis. To address community unhappiness with green space features and services, community involvement in the planning and building phases is recommended, providing adequate time for the advantages of green space interventions to manifest. In addition, the uncertainty surrounding maintenance expenditures can be efficiently addressed by implementing low-maintenance design principles, exploring creative funding mechanisms, and working collaboratively with community groups and organizations to gain local political support. These policy initiatives aim to address difficulties and ensure the sustainability of urban green spaces. Interaction within local population needs to be enhanced for creating such urban green spaces[60)]. The suggested solution strategies include specific methods to the sustainable management of urban green areas. These tactics include forming partnerships and programs, making design and inventory management recommendations, and taking into account financial sustainability. It is also of importance that the

green spaces are managed and maintained by proper personal with conservation approach towards environment[61]. In addition to maintenance issues, provision of well-designed play equipment's with scientific approach needs to be taken up in green spaces. The equipment's to be designed such that they can function with least maintenance requirement. Additional numbers of rest room facilities to be provided along with provision for regular maintenance of the same. Mere scientific methods do not augment for the precautionary practices in case of environmental protection. Collaboration with varied stakeholders, such as local community organizations, tourism departments, and art organizations, is emphasized as an important way to improve the utilization and diversity of urban green areas. Additionally, producing revenue through events, sponsorships, and collaborations can help to ensure the financial viability of green space management. The combination of these solution solutions will increase the long-term sustainability of urban green spaces, alleviate environmental dangers, address encroachment difficulties, and promote the overall development and well-being of cities.

11.2 Further research scope development and Integration of UGS and UGW

Research may be taken up to develop a framework for providing UGS and UGW that are not only in line with the requirement of the stake holders but also requiring limited interventions for maintaining the same. Research may also be taken up for development of various equipment's, as a fun and learning experience which are safe to use across age groups and require limited maintenance.

Using Geographic Information Systems (GIS) to design the integrated approach for UGS and UGW would enhance the planning process. GIS is an effective tool for urban planners and designers to assess existing conditions, identify possible greenway routes, and evaluate the socio-environmental implications of proposed designs[62].

After identifying possible greenway corridors, GIS is utilized in the design phase to help planners and designers create conceptual plans and layouts for the greenway network. GIS-based design tools, such as landscape modelling and visualization software, enable stakeholders to investigate various design scenarios and evaluate their possible effects on the environment and communities[63].

Once a preliminary design is completed, GIS-based evaluation tools will be used to examine the possible advantages and trade-offs of the proposed UGS and UGW integration[64]. This could include conducting spatial analyses to quantify the ecological value of greenway corridors, estimating their influence on stormwater management and flood risk reduction, and assessing their potential to promote physical activity and public health. Additionally, GIS-based visualization tools can be utilized to engage stakeholders and get input on suggested designs[63].

11.3 Framework for UGS and UGW integration for Implementation

The model is derived based on the understanding developed from the detailed analysis of the study area, deriving parameters, survey through the case studies and analysis of the survey. General understanding was developed with respect to the interrelationship between UGS and UGW, and the possible integration of UGS and UGW for the benefit of the Urban setup. A stepwise framework is derived as detailed below, for phased implementation.

a. Collection of the Data sets through satellite imagery, GIS layers, city plans, zoning plans, development plans.
b. Identification of potential corridors through river banks, canal side paths, large road medians, irrigation canals.
c. Physical inspection through field surveys, environmental impact studies, connectivity through road network, parks, green hillocks, residential areas and public amenities.
d. Engagement of all the stakeholders through community participation, and collaboration with various authorities.
e. Feasibility analysis through technical aspects, infrastructural planning, flood risks, legal implications, costing and funding.
f. Integration in the Urban planning, insertion in the development plans, inclusion of clauses in control rules, phasing plan for prioritizing high implication UGS and UGW.

12. Conclusion

The study establishes the shortcoming of required UGS in Pune city in comparison with the norms set by URDPFI and WHO. It proposes mitigation methods to overcome the shortcomings, and also suggests certain improvements based on the survey carried out in the selected UGS of Pune. The research emphasizes the critical necessity for urban green infrastructure in the face of rising urbanization, particularly in cities such as Pune, India. The study emphasizes the significance of interconnected green networks in regenerating urban landscapes by examining the possibilities of both Urban green spaces (UGS) and urban greenways (UGWs). Using Geographic Information Systems (GIS), the study conducts a partial review of existing UGS in Pune, identifying locations with insufficient green space provision. Furthermore, the concept of UGWs emerges as a promising approach for increasing the ecological and social benefits of UGS by establishing linear networks that connect these areas. The study contributes by creating a framework for establishing integration of UGS and UGW in a given study area.

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