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Green Infrastructure in Urban Settings: Bringing Together the Forest and Concrete Jungle

* [1] Assistant. Prof. Ar. **Arun Kumar Koottharasan Nadar**
[1] *Department of Architecture, Aditya College of Architecture, Mumbai, India*
E-mail [1]: nadararunkumar3@gmail.com

Abstract
Landscape is a crucial part of any breathing space an urban area has. In this research paper, we go through a new way of looking at landscapes integrating landscape at various levels in the urban fabric integrating vegetation on upper levels which are accessible by escalators and lifts just like a metro station. Since most of the ground space has already been utilized the higher levels of urban space will be used for landscaping. these structures will be created of RCC and modern precast units. where nature will take over and vegetation will be planted. They can be worked out to imitate forests and agriculture. So there will be no bias between the prehistoric world and the modern concrete jungle. This will act as an overlap between the natural and manmade world. i.e. it will fall between the living and nonliving. The importance of research is to guide the traditional practices in a new way of looking at providing landscaping in urban areas. It will no longer be a monotonous horizon. In some places sky will be visible and in some places it won't be. there will be levels to it. Most visibility will be at the higher levels. Once this is done there is also the possibility of bringing Fauna as well into the city the wildlife both carnivorous and herbivorous living within the city. It was never in the beginning articulated that man has to live away from the forest to be safe and live a life away from nature.. these wild and domestic animals will be habituating these places in a controlled manner. we. With increasing pollution, it is necessary to bring back nature to urban areas. Once this becomes possible there is no hesitation in bringing aquatic life within the city this will also eradicate the use of water elements in urban areas without the presence of aquatic life. the research will be carried out through case studies and literature reviews. Combined with in-depth analysis of pure conceptual framework with sketches and in-depth discussion with inferences.
Keywords: Urban; Forest; Landscape; Sustainable; Aquatic.

1. Introduction

Green Infrastructure can help maintain and enhance ecosystems by connecting different natural areas, which is important for the health of the environment and people. GI contributes to the economy by increasing land values, creating jobs, and making cities more attractive to live and work in. The Cascade Model classifies GI functions and benefits, which can help in understanding and managing GI more effectively.GI is seen as a cost-effective and environmentally friendly alternative to traditional 'grey' infrastructure, providing multiple benefits due to its multifunctionality.(Baró et al. 2015). Green Infrastructure can help with climate change by providing benefits like better health, a cleaner environment, and social and economic advantages. Most GI studies come from cooler places like the United States, Australia, and the United Kingdom, and there's a need for more research in warmer areas and places like Asia and South America. GI research focuses mainly on planning, the environment, and social issues, as well as some work on health, and economics.(Parker and Baro 2019).

Urban green spaces help conserve natural ecosystems and offer benefits like more food for animals, leading to more birds and mammals in cities. These green areas connect different habitats, helping animals like small mammals and birds to move around and find resources. Some animals have adapted to city life and can be more common in urban areas than in the wild. Planting a variety of native trees can prevent the loss of animal diversity in cities. Urban areas can manage storm water by mimicking natural water patterns and using plants and soil to clean and reduce runoff. Trees can be especially useful in very urban areas for managing stormwater and supporting wildlife.(Singh, Singh, and Singh 2020).

The green infrastructure includes areas like parks and rivers to help the city deal with natural disasters and climate change. The aim is to protect nature and improve the quality of life for people by providing services like clean air and water. the green areas, considering things like nature, society, and laws. Have to be mapped using special methods. By using pictures from locals it helps in better understanding how people use and feel about these green spaces. There arise issues like not having enough data and needing more local knowledge and skills. (Amado et al. 2020). Definition and Components of Green Infrastructure. The eight key principles for planning green spaces in cities are important for nature and people (Afara et al., 2024). These principles are connectivity, multifunctionality, multiscale, integration, diversity, applicability, governance, and continuity. It is found that these principles can help make cities more sustainable and better places to live. It is done by guiding how to use and manage green areas.(Monteiro, Ferreira, and Antunes 2020).The Seattle Green Factor (SGF) is a tool that helps designers in Seattle create landscapes that manage water drainage and enhance the environment, with a minimum requirement for green landscaping in new developments. In Ireland, local area plans provide detailed guidance on integrating environmental considerations into land use, such as managing water drainage and protecting

nocturnal animals. Fingal County Council (FCC) in Ireland uses GI planning to balance environmental protection with urban growth, aiming to improve the quality of life and conserve ecosystems. The SGF score sheet in Seattle assigns weighted scores to landscape features based on their size, function, and ecological benefits, promoting multifunctional landscaping. In Denmark, the Finger Plan restricts certain developments in green wedges to maintain landscape quality and encourages multifunctional land use that supports ecosystem services. Seattle's score sheet for GI planning combines drainage management, aesthetics, and ecological enhancement, serving as a flexible tool for designers. FCC's local area plans for Baldoyle-Stapolin and Portmarnock South integrate sustainable drainage, heritage, recreation, and biodiversity into a cohesive environmental strategy. Seattle's planning tool is the first in the USA to require a minimum score for multifunctional landscaping in development projects, encouraging innovative design solutions. The Finger Plan in Denmark uses green wedges to separate urban and rural areas, promoting compact city development and access to rural landscapes. FCC's GI network planning uses spatial data to identify and connect key conservation and amenity sites, enhancing ecosystem connectivity. The Finger Plan has evolved to include a wider range of ecosystem services, such as climate adaptation and biodiversity conservation, in its development initiatives. (Lennon 2019)

Urban green spaces can help cities like Catania adapt to climate change by improving air quality and reducing heat in the city. Three strategies for enhancing green spaces including areas with social functions, resilient areas for climate adaptation, and maintaining current green spaces; the inclusive approach was most favored. Focus groups with local people helped me understand what they think about urban green spaces and how they can be improved. A special method is used called NAIADE to look at different ideas for green spaces and see which ones people liked best.(Sturiale and Scuderi 2019). It is been found that parks and gardens are good for the city and can make it cooler and nicer to live in. People liked the idea of having parks that everyone can use and that bring the community together the most. Talking with people in the city helped them figure out what they wanted from their parks and green areas. A special way of looking at people's ideas helps in choosing the best plans for the city's green spaces.(Sturiale and Scuderi 2019) Green infrastructure (GI) can help cities adapt to climate change and provide many benefits, but it is not yet widely used in urban planning. It is identified that the five main challenges to using GI: are design standards, regulatory pathways, socio-economic issues, funding, and innovation. The study suggests that political support and involving people in the community are important for successfully adding GI to cities. Examples from different cities around the world show that GI can be used in many ways, like making parks that also clean water or streets that reduce flooding. The study points out that GI is usually cheaper than traditional ways of building city infrastructure and can save money in the long run.(Zuniga-Teran et al. 2019)

It is found that in Gangnam-gu, a district in Seoul, about 65% of the land is used for urban areas like homes and businesses, while about 35% is greenspace, which includes parks and natural areas. Six main types of natural areas are identified: forests, planted areas, grasslands, streams and wetlands, cultivated lands, and urbanized areas, which can further be divided into 22 smaller groups based on the types of plants and how natural they are. A bird count in the area showed that there are 61 different species of birds, with a total of 10,919 individual birds found during the winter season. It is suggested to protect and fix up areas with important plants and wildlife, and create paths for birds to move between green spaces.(Lee et al. 2005). Urban ecosystem services are valuable for improving city life by providing benefits like recreation, health, and resilience against environmental changes. It is important for maintaining local ecological knowledge and the role of urban ecosystems in reducing cities' ecological footprints. Economic valuation of ecosystem services is emphasized to reveal the hidden costs of biodiversity loss and infrastructure development. Strategies for enhancing urban ecosystem services are suggested as crucial for transitioning to healthier, more resilient, and sustainable cities.(Gómez-Baggethun et al. 2013).

The environmental health challenges in cities, like air and water pollution, and suggestions for integrated assessments for holistic solutions. case studies showing the health impacts of urban environments, such as the disease burden from indoor air pollution and the effects of urban form on health. It includes a review of how populations have adapted to heat and cold, the health benefits of climate change mitigation, and the role of urban trees in providing ecosystem services. There are potential health co-benefits and risks of climate change mitigation and adaptation measures. A systems approach to urban water and waste management is advocated to ensure net benefits for health. The emphasis is placed on the complexity of urban health challenges and the need for multidisciplinary research and international collaboration. It underscores the importance of engaging communities in research to inform local policies and improve urban health outcomes.(Vardoulakis, Dear, and Wilkinson 2016) Timothy Beatley's book, "Biophilic Cities: Integrating Nature into Urban Design and Planning," argues for the integration of nature into urban environments to create sustainable and livable cities. The book provides many examples of biophilic design but lacks a detailed examination of the processes and quality of these designs. Beatley emphasizes the importance of education and exposure to nature, suggesting that these elements are crucial for a biophilic city. The book is seen as a starting point for examining biophilic case studies rather than a comprehensive guide. Critical Observations The book has been critiqued for not being as visionary as expected and for not critically assessing the performance of the strategies it outlines. It is noted that the book could be

more useful to practitioners if it included more detail, depth, and practical value. There is a call for future work to more critically assess the performance of the strategies outlined in the book.(Szibbo 2011) .

The various design strategies for integrating green infrastructure into high-rise buildings, such as green roofs, vertical gardens, and urban agriculture, highlight their environmental, economic, and social benefits. the challenges are addressed in implementing green infrastructure, including maintenance, water management, and the importance of building codes and regulations. Also, solutions and best practices to ensure the long-term viability of green infrastructure in urban high-rise buildings. The potential for architects, engineers, and urban planners to create sustainable urban environments by incorporating green infrastructure is emphasized.(Aung et al. 2023)

Using nature-inspired designs in railway stations can make cities more sustainable and improve people's well-being. The biophilic design, which includes plants and natural light, can make train stations more pleasant. The Flinders Street Railway Station is an example to show how these designs could work in real life.(Roös et al. 2016)

2. Literature Review

After the last Ice Age, forests started to grow back in Europe about 11,700 years ago, which is when the Holocene period began. These early forests were important for the development of human civilizations, providing food, materials for building and tools, and wood for energy. The process of humans using forests and changing them started around 6000 BCE with early farming communities in Europe Early forests were a source of food for people, providing fruits, nuts, and plants that could be eaten. They supplied wood which was used to build homes, make tools, and create other necessary items. Wood from forests was also an important fuel for heating and cooking, especially before the use of coal and oil Humans, like us today, appeared around 300,000 years ago. They evolved from earlier human ancestors who had been around for millions of years before that. After the last Ice Age, forests spread across Europe and became important for human societies, providing materials like wood for building and energy. As people settled and started farming, they began to use more wood, leading to changes in the forests. In Roman times, forests were managed to supply wood for buildings and other uses, but sometimes there wasn't enough wood nearby. By the High Medieval Period, forests were being cleared more for farming and building, and wood was used for industries like glass making. Concerns about running out of wood in the 18th century led to the start of modern forestry, where forests were managed more carefully Today, forests cover large parts of the world, but they are mostly outside the temperate zones, with 61% of the world's primary forests located in tropical areas. Forests are still very important for people, providing wood for building and other uses, as well as being home to many plants and animals. However, forests face challenges like being cut down for farming or building, which can lead to fewer trees and less wildlife. People are trying to manage forests better to make sure there is enough wood for the future and to protect nature. (Muigg and Tegel 2021)

The GI is a network of natural areas that help wildlife and people by preserving biodiversity and providing ecosystem services. The a lack of consensus on how to map and implement GI, which is important for conservation planning. Common methods for mapping GI, like GIS overlay analyses, have limitations in balancing biodiversity and ecosystem services. There is a structured approach with five levels of complexity to better identify and map GI networks. It emphasizes the need for considering diversity, ecosystem services, and landscape connectivity, known as the three 'pillars' of GI. The paper points out the need for a common definition of GI to move from theory to practice. It suggests improving collaboration across scientific fields and between research and policy for effective GI implementation. Better software and data accessibility to integrate various aspects of GI in planning.(Honeck et al. 2020). The report by the Joint Research Centre supports European policymaking with scientific evidence, focusing on improving the resilience of urban ecosystems through green infrastructure. Policymakers have positively received the scientific results, using them to create guidelines, recommendations, action plans, and further green infrastructure projects. A survey indicated that 83% of scientists agreed their scientific results were effectively used in final policy outputs (Maes et al. 2019).

The green infrastructure can help London adapt to climate change by reducing risks like flooding and overheating. It shows that green spaces can cool the city, manage water, and provide cleaner air. Examples like green roofs and improved parks were given to show how these ideas are already helping. More collaboration and creative thinking are needed to make the most of green infrastructure.(Sturiale and Scuderi 2019).

G infrastructure (GI) is a way to cool down cities and make them more comfortable for people, focusing on studies from 2009 to 2020. Trees were found to be the most common and effective GI strategy, with studies showing they can lower temperatures and improve comfort. Grass as a GI strategy has a smaller impact on lowering temperatures compared to trees, but it can still help, especially when used with other types of GI. The ENVI-met tool is widely used and trusted for simulating how different GI strategies can change city climates, but it can sometimes overestimate or underestimate certain weather conditions.(Balany et al. 2020).

Installing a rainwater harvesting and treatment system can reduce water loss, meet increasing water demands, lessen groundwater contamination, provide water during dry seasons, and reduce flooding. By using rainwater tanks, the Science and Technology building can save about 59.86% on water bills, which is a significant cost reduction. The rainwater harvesting system is expected to be a feasible project that could be replicated by other

universities, governments, and private entities. The system includes a maintenance plan to ensure water quality and safety, which involves regular inspections and cleaning of various components.(Velita et al. 2023)

The different types of land use, like agriculture, urban areas, and forests, affect the quality of water and air, showing that human activities can lead to pollution and environmental changes. It is found that urbanization and industrial activities often worsen air quality by increasing pollutants and greenhouse gases, while changes in land cover can affect the deposition of air pollutants. The research highlighted that land use changes, especially in urban areas, can increase runoff and transfer pollutants to water bodies, leading to water quality issues. Studies within the review indicated that agricultural practices can contribute to water pollution through the use of fertilizers and pesticides, which can leach into water bodies. The paper also discussed the impact of land use on groundwater quality, noting that in some regions, changes in land use have led to increased groundwater pollution.(Supriya, Aggarwal, and BHARDWAJ 2018)

The economic value of green infrastructure (GI) in two Spanish cities, Barcelona and Badalona, for urban drainage and climate change adaptation. Barcelona showed a higher net present value (NPV) from GI than Badalona, mainly due to flood damage reduction benefits. In Barcelona, the benefits from GI were mostly from flood damage reduction, while in Badalona, the benefits were mostly from additional aspects like aesthetic value and habitat provision. It has been found that the calculated NPV in Barcelona became positive after 10-11 years, but in Badalona, it was mostly negative during the 80-year evaluation period. The research highlighted the importance of including multiple benefits, not just flood damage reduction, in the economic assessment of GI for urban drainage planning.(Locatelli et al. 2020)

There are no major differences in access to urban green spaces (UGS) for different groups of people in Barcelona overall. However, some neighborhoods showed that seniors, children, and less wealthy people have less access to nearby UGS. The use of maps to show areas where low income and low accessibility to UGS overlap, indicating potential areas of concern. The methodology could help city planners improve how UGS are provided to different social groups.(Iraegui, Augusto, and Cabral 2020)

447 projects have been reviewed and found out that green areas like parks and gardens are often used to help manage stormwater and provide other benefits like better economic conditions and learning opportunities. It is discovered that certain features, such as areas that soak up rainwater and pavements that let water through, are commonly used and can lead to multiple advantages for the community. The research showed that having a variety of green infrastructure designs in one place can help with many different community needs, like dealing with climate change and making the environment better.(Locatelli et al. 2020). The investigation of green infrastructure for urban renewal in Taichung, Taiwan, could pay back the additional costs in about eight years due to its positive impacts. Green infrastructure increases the annual economic value by US $1.2 million compared to non-green infrastructure, with higher commercial rents and lower electricity, water, and insurance costs. The green infrastructure not only benefits the specific buildings but also enhances the wider urban environment and quality of life.(Hsu and Chao 2020)

Citizen participation in green infrastructure projects varies across different project stages, with higher participation in the design and maintenance phases than in the delivery phase. Organizational tools like living labs and partnerships, as well as market-based tools like open calls, were used to encourage participation in the design and maintenance stages. During the delivery phase, participation was lower, and the tools used were more about legal requirements and communication, like community events. In the early stages of projects focus on building shared commitment, later stages aim to reduce management costs. Some respondents doubted the effectiveness of the tools used for public participation, indicating a need for further research to find better ways to involve different societal groups.(Willems et al. 2020)

The policies aimed at improving green spaces, like parks and gardens, can make cities better at handling different kinds of problems, such as extreme weather or health crises. It is observed that policies that focus on areas where people are more vulnerable tend to have better outcomes in making the city resilient. The research highlights that getting citizens involved is very important for a city to be able to bounce back from various challenges. The study also points out that having enough money and strong political support are the main hurdles in making these green policies work.(Suárez et al. 2024)

The planning policies in Malaysia emphasize the protection of natural areas and conservation, but they do not adequately address the creation of urban corridors to connect green spaces. Policies like Act 172, the National Urbanization Policy (NUP), and Act 171 support open space provision, but local government policy does not cover the protection of the natural environment. The National Physical Plan and NUP focus on conserving natural resources, but there is a need for better integration of development and conservation efforts. There is a deficit in open space provision in Malaysia, with a need for 0.81 hectares more per 1,000 urban residents to meet policy requirements. The National Physical Planning Council should enforce a uniform policy requiring 10% open space for all developments to help achieve sustainability goals.(Sa'adu Danjaji and Ariffin 2017)

The importance of green infrastructure in urban planning shows that it can provide a wide range of ecosystem services and sometimes also ecosystem disservices. The case studies from various cities, demonstrate the need for systematic inventory and analysis of vegetation, as well as the design of green spaces to enhance urban green

infrastructure. The research emphasizes the role of public participation in the planning and design process of green infrastructure, which is crucial at the local scale. In some urban areas, the amount of green space is insufficient, and there is a need for better control of building regulation adherence to ensure the inclusion of public green spaces. The fragmentation of green infrastructure networks in cities recommends improving interconnectivity and introducing nature-based solutions. Including an analysis of the emotional and social impacts of urban projects, such as the case of Barona Street in Riga, which became a symbol of renovation failure due to various criticisms. (Tóth 2022)

3. Methodology

In this research, we will use the analysis algorithm for reverse engineering of architecture. (Nazidizaji and Safari 2013) the research will be both conceptual and case study-based research. We will conduct a reverse engineering approach to the design.

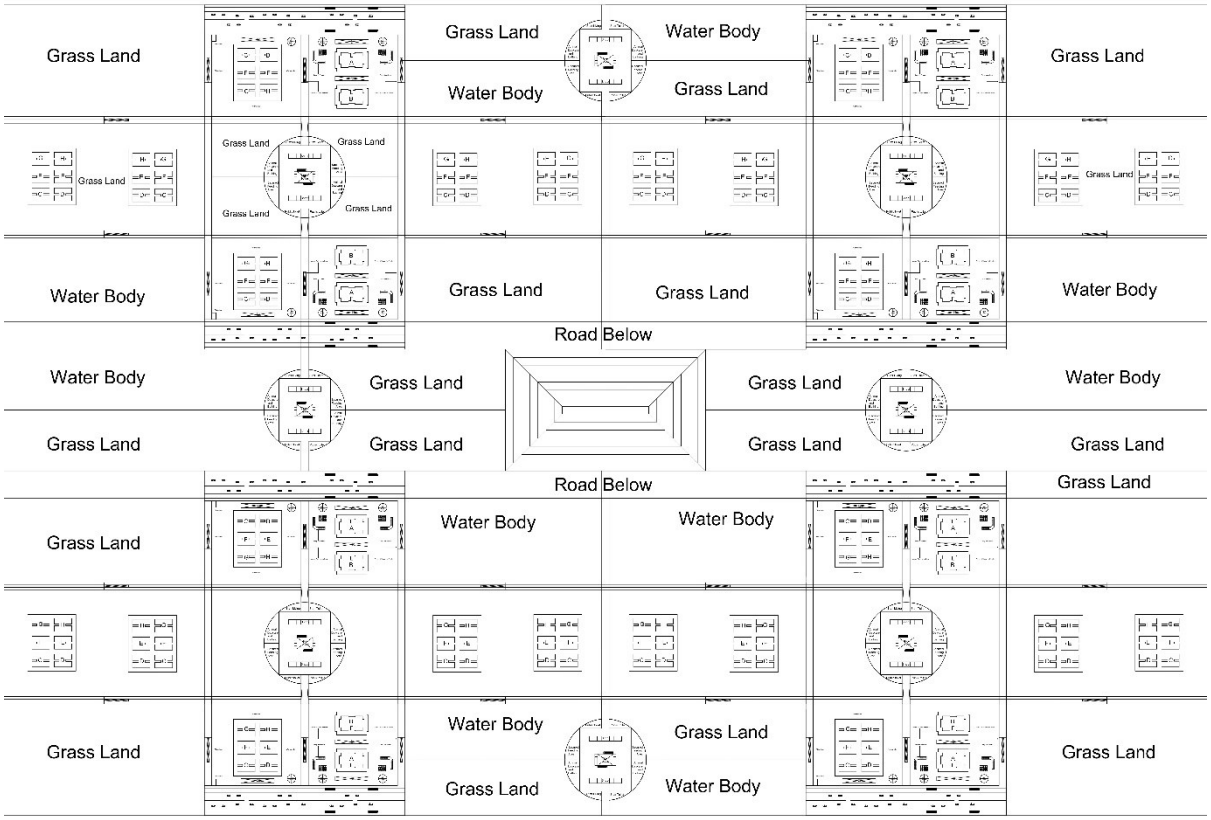


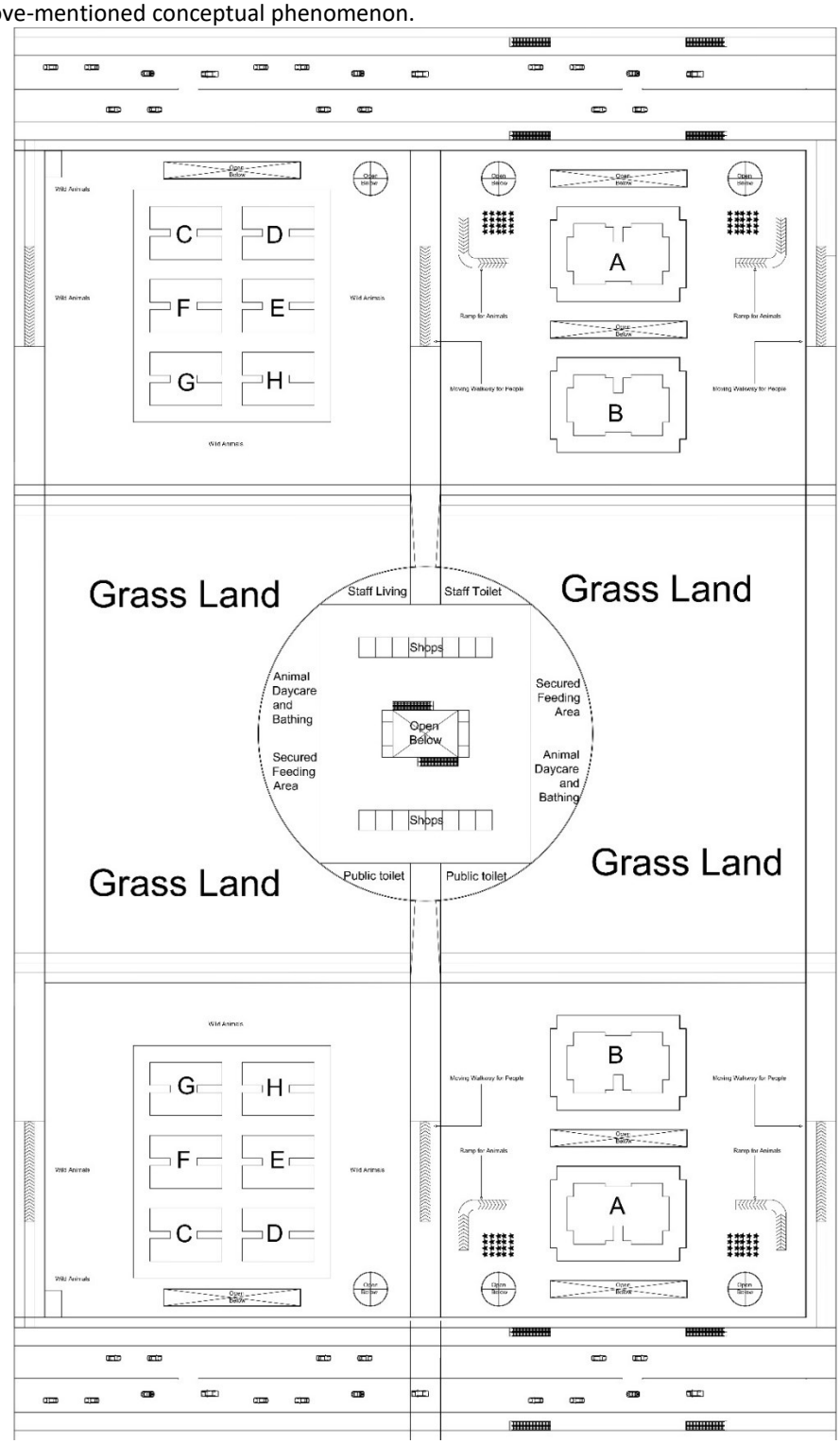
Figure 1: Forest - City Model

The Design of incorporating forests back into cities follows an order. It has skyscrapers, and regular apartments already built. Then either incorporating the place for animals or the surrounding forest area for animals the forest and animals will be grown and raised systematically. The animals both wild and domestic will have food chambers and feeding areas. The dome consisting of the feeding area will consist of space for pedestrian circulation. This area will have shops for food with staff and visitor toilets.

Outside in the open Area, there will be pathways that will be fenced high enough so that animals cannot pass through without human intervention. The animals will have a food chain running within the area of grazing. There will be aquatic animals as well as on-land mammals and reptiles. They all will be fed every day by the sanctuary staff. This in turn will increase employment opportunities for people. Between the apartment and the forest, there will a some space for not the animals hampering the inhabitants of the building. At the same time, the tenements will have a clear view of the forest. And animals. There will be water bodies along the pathway so aquatic life will be visible. The design of the city will take place in modules with a module at a certain walkable radius with transparent fences where the people circulating will be safe from wild animals and reptiles etc. There will be special provisions for animals that can climb on fences such as monkeys. this modular city framework will be repeated again and again in a controlled manner and the forest will nourish back into the place it originally was. With space for animals back just like their ancestors.

This framework will work in two ways wherever necessary podium can be created with ramps and escalators with fire escapes. Or else if lad space is permitted use ground coverage instead of going stories. This will save both

construction costs and the microclimate of the forest. In Figure 1 you can see the Forest – City Model. Which indicates the above-mentioned conceptual phenomenon.



The Animal care center consists of apartments and a central dome where there will be a movement for the public with shops toilets and an Animal feeding area with storage. As shown in figure 2. And Figure 3

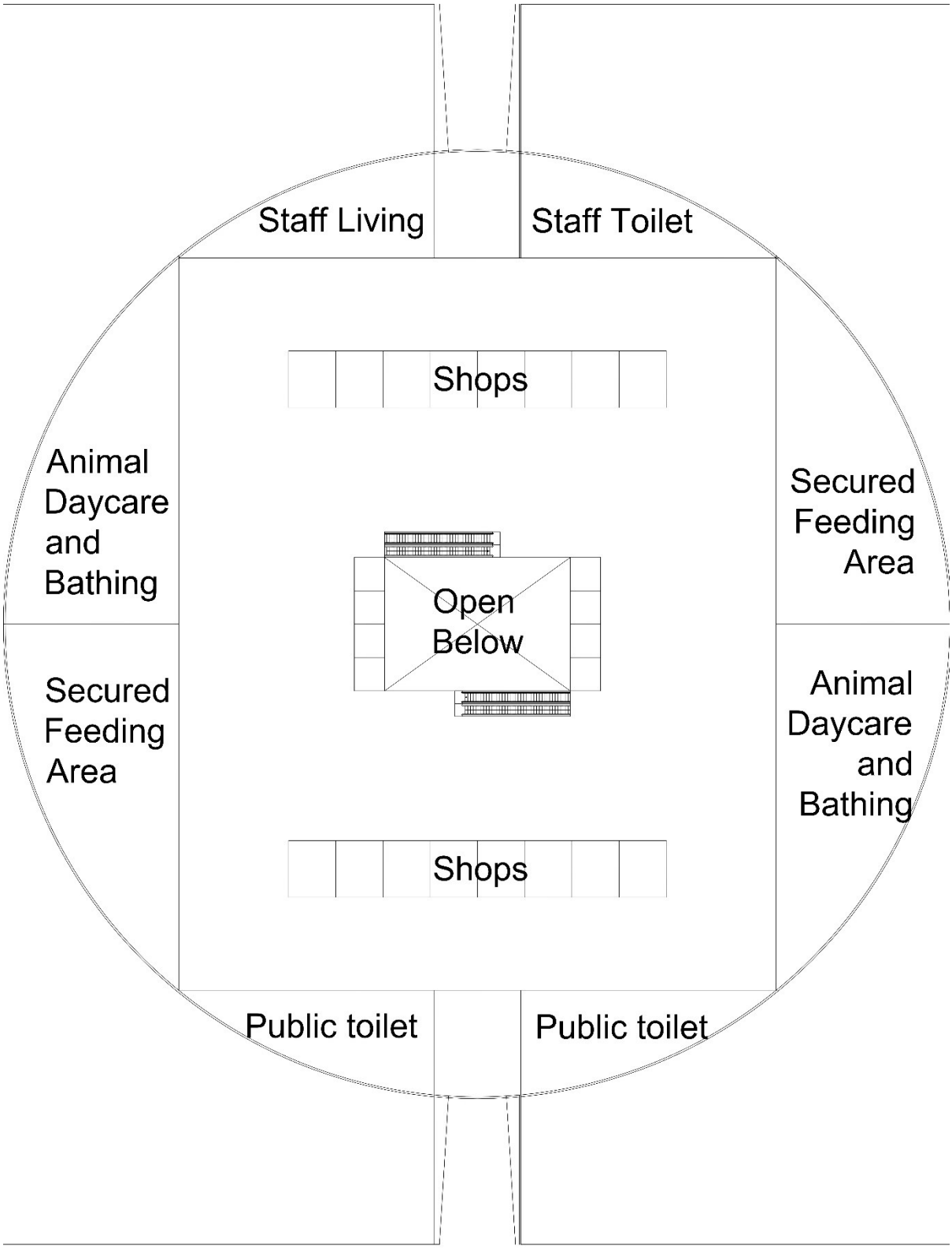


Figure 2: Detailed Plan of Animal Care Centre

4. Discussion

Such A Conceptual design can be a breaking point and improve life on earth, not prioritizing humans first but also all forms of nature such as plants, trees, and animals. this will add up to the existing infrastructure or become a completely new design application. this will help in reducing the temperature in cities and also the air pollution. the food chain will get better.

Table 1: Architectural Analysis of Urban Forestry (Nazidizaji and Safari 2013)

Table of analysis process to reach reverse engineering		
Sr. No.	Building analysis	Results
1	Theoretical Principles	The principle is to bring back the forest and combine it with the city.
2	Concept	The Concept is to travel back into history and reinforce the idea of forests all over the world. Before civilization took place and bringing it back to its original space in a controlled manner having wild animals and domestic animals around. Maintain their living as well as aquatic animals.
3	Urban Scale	The Urban Forest module will be repeated all over the land. To get a symmetrical grid pattern. It will scale from a module to several modules.
4	Site	The Design will adapt to the topography of the urban land. Most of the land will be worked out by the cut-and-fill method. To achieve uniformity and order.
5	Form	The form will consist of towers with central dome sand liner pathways. Forming patches of grassland and ponds.
6	Climate	It will bring down the temperature of urban areas drastically and help in positively impacting the environment.
7	Construction	The structures will be made in R.C.C. and Other Favourable Construction Techniques.
8	Geometry	The Module will be vastly symmetrical in case of newly built habitable structural towers. In the case of already built towers, it will be a highly asymmetrical growth.
9	Materials	The Materials will be R.C.C. and Steel also favorable materials developed in the future.
10	Elements	The elements will be ramps, escalators, pathways, slabs, railings, fences, elevators, domes, doors, and windows.
11	Function	It will function and transform the urban area into a living zoo or sanctuary. Everywhere possible.

5. Conclusion

This concept can be taken in further research and forest can be completely brought back into the urban environment. It is important for the future of urban design and planning which speaks further than just providing green spaces. The animals both wild and domestic get a chance to inherit the spaces they already used many years ago before the destruction of forests.

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Conflict of Interests

The Author(s) declare(s) that there is no conflict of interest.

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