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Review Article

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Urban and Peri-Urban Landscaping: A Spatial Planning Challenge of the Twenty-First Century

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ABSTRACT

Urban and peri-urban areas are economic hubs and sophisticated land markets. Green infrastructure within urban and peri-urban areas has become increasingly important in recent years because of the changing environment. Fresh air, aesthetic view and healthy environment have been a cause of concern across the globe, and have attracted attention for urban and peri-urban landscaping. In this context, a key challenge is to develop different kinds of landscape for the sustainable management of urban and peri-urban landscaping.

Key words: *Urban an peri-urban landscaping, Green wall, Roof garden*

INTRODUCTION

Landscaping is to design and alteration of a portion of land by use of plant materials and land reconstruction. Landscape gardening is defined as the decoration of a tract of land with plants and other garden materials; so as to produce a picturesque and naturalistic effect in a limited space. The peri-urban is area between urban settlement area and their rural hinterland. Larger peri-urban area can include towns and village within an urban agglomeration. Such area is often fast changing, with complex patterns of the land use and landscape, fragmented between local or regional boundaries.

Peri-urbanisation related to those processes of dispersive urban growth that creates hybrid landscaped of fragmented urban and rural characteristics. Outskirts or hinterland at the surrounding area of city, urban space, landscape/area between rural and urban area, rural-urban transition zone are the examples of peri-urbanisation. Urban landscaping is an integral part of modern construction. They help to create a favourable salubrious and healthful environment, determine in part the functional organization of urban areas, serve as recreation areas for working people and contribute to the expressiveness of architectural ensembles. In developing plans of gardens and parks the dynamics of tree growth are taken into consideration, as well as the variation of the colour of tree tops with the seasons.

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Growing trees in urban areas can be potential contributor in reducing concentration of CO_2 in atmosphere by its accumulation in the form of biomass[1].

Need for urban landscaping

A city is often referred to as an urban heat island. It is primarily caused by the absorption of solar radiation by the buildings or urban materials. Cities have less vegetation cover compared to rural areas. This increase in temperature, coupled with air pollutants can result in accumulation of smog. Also increase the energy consumption to cool buildings.

Avenue planting

In landscaping, an avenue is traditionally a straight path or road with a line of trees or large shrubs running along each side, which is used, as its Latin source *venire* ("to come") indicates, to emphasize the "coming to," or *arrival* at a landscape or architectural feature. In most cases, the trees planted in an avenue will be all of the same species or cultivar, so as to give uniform appearance along the full length of the avenue. Avenue trees in urban areas play a vital role to maintain the ecological balance of crowded and polluted environment. Road side trees, because of their proximity to generation of vehicle emissions, are important in reducing pollution [2]. Sometimes the avenues are in double rows on each side of a road. Trees preferred for avenues were selected for their height and speed of growth, such as poplar, beech, lime, and horse chestnut[3].

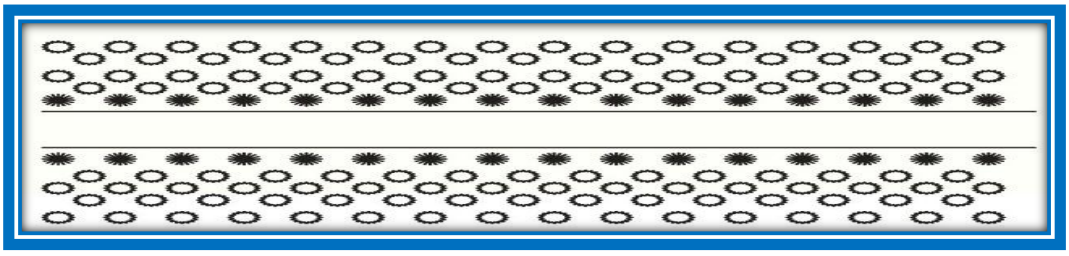
In Toronto, Bahar and Naderi[4] found that the frequency and severity of mid-block accidents decreased after landscape improvements were installed. Mid-block accidents decreased significantly at all the sites studied while there was an increase in the number and severity of mid-block accidents city-wide. Nature scenes may have comparatively positive influence on driver behaviour, since natural settings may tend to have an optimal level of complexity to be interesting[5]. Topp[6] also indicated that appropriate tree planting and landscaping has a psychological effect of reducing driving speed. In other words, streets characterized by a landscaped centre strip or median planting may alter drivers' perception of lane width and therefore reduce driving speeds associated with increases in severity of accidents.

Another study found a decrease in crash rates on urban roads after landscape improvements were made[7] and Contrary to what is commonly that high-quality trees play many roles in environmental, social and economic play many roles in environmental, social and economic street trees may buffer pedestrians from hazardous oncoming traffic[8]. Trees provide a visual "edge" to the roadway that helps guide motorists. They also add to the aesthetic quality of a highway. In urban and suburban areas, trees soften the edges of arterial and collector streets. Trees are an important aspect of community identity and carry a great deal of emotional ties with the residents[9].

1. Schemes for tree planting along Highways

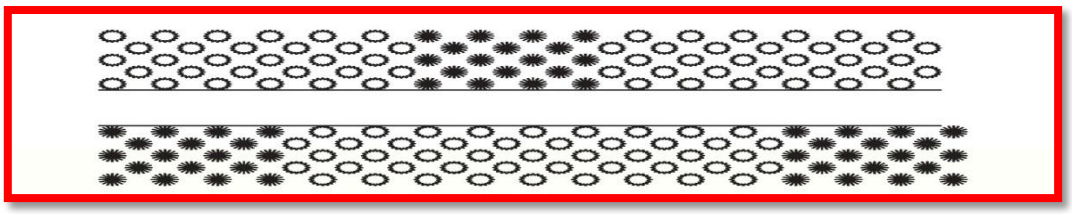
A. Front row of flowering trees and rear rows of utility trees:

Front row should be planted with flowering trees of different species, each for 3–5 km and the subsequent rows should be planted with species of economic importance such as timber, fruit and fuel wood.



B. Mass effect of flowering trees :

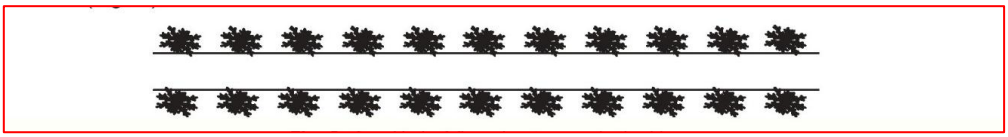
Flowering trees should be planted as large groups for about 0.5 km after every 5 km of plantation of economically important species. Such groups should be arranged alternately on both sides of the road. this will break the monotony of singly planted species.



2) For City Roads: Schemes wherever single row is to be planted

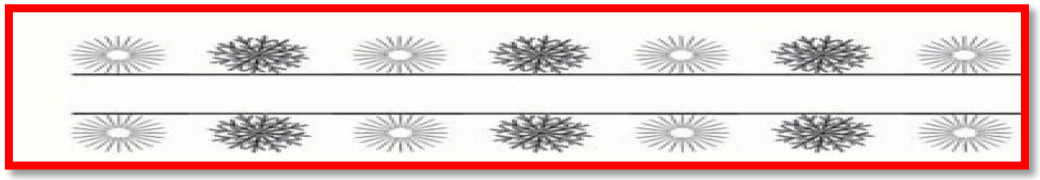
1. One kind of flowering tree on both sides:

In this scheme, when the trees come to bloom, there is riot of colour and the road looks beautiful for a particular period. However rest of the time the road looks dull. Maintenance is easy in this type of arrangement, e.g., *Bauhinia variegata, Cassia nodosa, Lagerstroemia speciosa* etc.



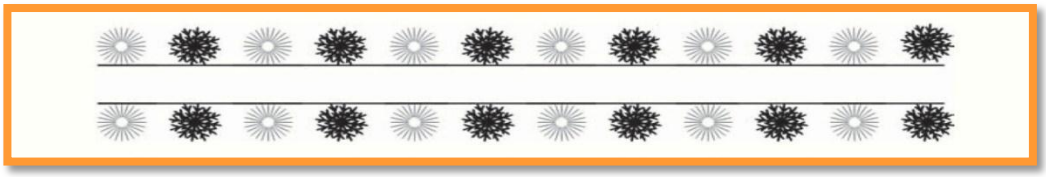
2. Two kinds of flowering trees blooming at one time on both sides :

Here, the two species are planted alternately on both sides of the road and different colours at same time avoid monotony, e.g., *Grevillea robusta* (Yellow) - *Jacaranda acutifolia (Blue),Cassia fistula* (Yellow) - *Delonix regia* (Red), *Cassia fistula* (Yellow) - *Cassia nodosa* (Pink).



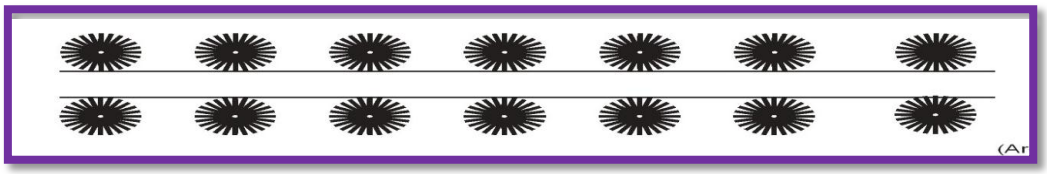
3. Two kinds of flowering trees blooming at different time on both sides :

In this case, one tree flowers in one part of the year and the other in another part of the year. Roads remain colorful for longer period, e.g., *Cassia fistula* (Yellow in May-June) - *Jacaranda acutifolia* (Blue in March-April), *Grevillea robusta* (April) - *Swarna champa* (may).



4. Shady trees only on both sides

This type of arrangement is suitable for roads with heavy pedestrian traffic like approach roads of bus stops, railway stations and government offices, e.g., *Ficus infectoria, Mimusops elengi, Alstonia scholaris* etc.



Kiran and Shah[2] studied the carbon sequestration by urban trees on rode-sides and reported that the urban trees planted on roadsides can help in sequestering CO_2 and mitigate the effects of carbon emitted from the Automobiles. In station road total number of trees on each road sides 242 and total carbon sequestered 11.61 t/km and channi road, refinery road, market road and IPCL road total number of trees on each road sides respectively 78, 71, 61, 45, and total carbon sequestered respectively 7.00, 1.56, 1.16, 3.52 t/km.

Desai and Nandikar[10] studied the carbon sequestration by urban trees on rode-sides of Kolhapur city and reported that the urban trees planted on roadsides can help in sequestering CO_2 and khanvilkar bungalow to line bazaar, market yard to toraskar chowk, DSP office to shivaji university, railway gate to Maruti Mandir (Rajarampuri Main road), Gavat madai to Kolhapur Mahanagar Palika length of road 3.07, 5.55, 5.77, 1.08, 0.80 km respectively and number of trees in 2009 is 262, 504, 528, 54, 76 and number of trees in 2011 is 390, 201, 22, 79, 61 respectively and total carbon sequestered in june 2011 is 15.00, 6.88, 1.83, 1.83, 1.39 t/km respectively.

David and Daniel[11] studied the carbon sequestration by urban trees on rode-sides of different city in USA and reported that the urban trees in New York, Atlanta, Chicago, Jersey is 521200, 9415000, 4128000, 136000 are respectively and total annual carbon sequestration is 38400, 42100, 40100, 800 tC/yr is respectively.

3) Rural Roads

Rural roads are the most neglected ones throughout the country as far as tree plantation is concerned. Here, preference should be given to planting of multipurpose trees which besides providing shade and flowers, also provide economic products such as fuel wood, timber, fruits, fodder, etc. Roads should be planted with small to medium sized trees preferably on the southern side, so that fields are not shaded.

BIO-AESTHETIC PLANNING

Professor Lancelot Hogben coined the term 'Bio-aesthetic planning', which was defined as planning of flora and fauna with the object of beautifying the country. With the development of wild life conservation as a specialized subject, aesthetic aspect dominated the concept of bio-aesthetic planning, although increase in plant biodiversity also creates suitable habitat for many species of birds and small animals. In India the theme was propagated by Dr. M. S. Randhawa[12]. Bio-aesthetic planning was thus recognized as the aesthetic branch of horticulture, which deals with planting of ornamental plants to create a picturesque effect. With the greater realization of environmental, ecological and socio-economic benefits of plants, scope of bio-aesthetic planning has increased further. Bio-aesthetic planning can play important role in environmental improvement of urban and industrial areas along with their beautification.

Bio-aesthetic planning not only beautifies the environment but also makes it more livable and ecologically stable. It improves microclimate, mitigates pollution, helps in noise abatement, creates habitat for many animal species, adds variety of form, colour and texture to the environment and brings about positive changes in human behavior[12]

Suvarna lakshmi[13] studied air pollution tolerance index of various plant species growing in industrial areas of Visakhapatnam. For her study she collected Leaf samples from 24 tree species of different locations. The Air Pollution Tolerance Index (APTI) was determined by calculating the ascorbic acid[14], chlorophyll, pH and relative water contents in

leaf samples[15]. From these experiment she resulted that the APTI values of less than 16 are reported in 20 species and they can be used as indicators of air pollution. The species *Ficus religiosa* (25.77), *Zizypus jujuba* (22.32), *Phyllanthus emblica* (18.88) *and Cassia fistula* (18.69) showed their moderate response by changing their biochemical contents and are identified as moderately tolerant to air pollution.

APTI= [A (T+P) + R] /10

Where, **A**= Ascorbic acid (mg/g dry wt.), **T**= Total Chlorophyll (mg/g dry wt.),
P= pH of leaf extract, **R**= Relative water content of leaf tissue (%).

Roof gardening

The concept of roof gardening is not new. There is reference that in ancient Mesopotamia (600 BC) plants were grown on terraces. During 21st century, scarcity of land has driven us again toward development roof gardens. A roof garden is a garden on the roof of a building. Besides the decorative benefit, roof plantings may provide food, temperature control, hydrological benefits, architectural enhancement, habitats or corridors and the practice of cultivating food on the rooftop of buildings is sometimes referred to as rooftop farming. Rooftop farming is usually done using green roof, hydroponics, aeroponics or air-dynaponics systems or container gardens[16]. The plants that go into a green roof are usually sedum or other shallow-rooted plants that will tolerate the hot, dry, windy conditions that prevail on most rooftop gardens. With a green roof, "the plants layer can shield off as much as 87% of solar radiation while a bare roof receives 100% direct exposure" [17]. In strong roof structure with the waterproofing system, the area can be laid out with lawns and herbaceous borders which require at least 30 to 45 cm soil depth. Ornamental stones, sculptures and other decorative pieces may be suitably arranged in the roof garden.

Why roof garden?

To prevent seepage of water the roof is to be treated with bitumen compound or fitted with moisture proof wood shutters. Polythene sheet may also be used for this purpose. Rooftop gardens can delay peak flow and retain the run-off for later use by the plants[18]. If widely adopted, rooftop gardens could reduce the urban heat island, which would decrease smog episodes, problems associated with heat stress and further lower energy consumption[18].

These roof garden has many advantages viz., support urban food production, promote individual, community, and cultural diversity, improve air quality and reduce CO_2 emissions, delay storm water runoff, increase habitat for birds, insulate buildings, increase the value of buildings for owners, create job opportunities in the field of research, design, construction, landscaping/gardening, health. Besides the decorative benefit, roof plantings may provide food, temperature control, hydrological benefits, architectural enhancement, habitats or corridors for wildlife, recreational opportunities. The therapeutic value of gardening on physical and mental health can be utilized to its fullest advantage in such gardening. The environmental and aesthetic benefits to cities are the prime motivation. It was calculated that the temperature in Tokyo could be lowered by 0.11–0.84 °C if 50% of all available rooftop space were planted with greenery. This would lead to a savings of approximately 100 million years[19].

Plant surfaces however, as a result of transpiration, do not rise more than 4–5 °C above the ambient and are sometimes cooled[20]. Recreational reasons, such as leisure and relaxation, beautifying the environment, and greenery and nature, received the most amounts of votes. Planting roof gardens on tops of building is a way to make cities more efficient[19]. Green roofs offer several benefits in comparison to conventional roofs. They improve storm water management, as well as reduce air pollution and noise. Green roofs increase vegetal and animal biodiversity in cities and they also reduce a city's carbon

footprint by converting carbon dioxide to oxygen through photosynthesis[21].

Disadvantages of Roof Gardening

Roof gardening has some disadvantages viz., the quantity of growing media much less here hence, the supply of moisture and nutrients to the plant is limited, shallow depth of soil results in poor anchorage subjecting the plant to lodging, specially by wind, the velocity of which is greater on an open roof.

Intensive green roof & Extensive green roof

Green roofs may be defined broadly as intensive or extensive systems; of great concern to their design are the elements of weight, biotic components, substrate, succession, drought tolerance, and the roof as an environment. The depth of the substrate layer defines green roof systems into two general categories: intensive and extensive[22]. Extensive roofs are more important from the point of view of a sustainable urban ecosystem, being lightweight they can be installed on more rooftops. More often now, elements of both systems can be found combined on one rooftop[23]. Intensive green roofs however have a substrate layer greater than 150 mm and are frequently treated as a garden or recreational space. Intensive roof systems can be as thick as the structure can support. Vegetation types are more diverse, and include vegetables, grasses, perennial herbs, shrubs, and trees. The pitch of intensive green roofs is generally less than 10 degrees.

In roof garden plants used as trees (e.g. *Cycus spp., Thevetia peruviana, Plumeria spp*), shrubs (e.g. *Angelonia grandifolia* , *Acalypha hispida, Jasminum spp.*), ground covers [e.g. *Epipremnum aureum* (Money Plant), *Ficus pumila* (Creeping Fig)], annuals (e.g. Alyssum , Antirrhinum, Cosmos, Marigold, Petunia), succulents [e.g. *Agave americana* (Century Plant), *Epiphyllum oxypetalum* (Pipe Cactus)] and bulbous (e.g. Canna, Caladium, Gladiolus, Hippeastrum, Zephyranthus, Belladonna lily).

Issa and Rafik[24] studied the indoor air temperature for three typical days with green and conventional roof and reported that in cold winter, sunny winter, hot summer maximum indoor air temperature respectively in conventional roof 19.0, 21.8, 30.1ºC and green roof 19, 21.4, 28.0. They also studied the indoor air temperature along with different insulation levels and reported that as thickness of insulation gets increased, the relative importance of additional insulation by green roof becomes negligible.

Noorazlina *et al*.[25], The result shows that the surface temperature of non-insulated building without green roof are varied from 42 to 48˚C while the surface temperatures of the green roof upon non-insulated building are lower and ranging from 28 to 40˚C. They also concluded that the existence of large temperature differences due to the installation of green roof could contribute to energy saving potential. Green roofs can absorb sound, it has been stated that a green roof with a 12cm substrate layer can reduce sound by 40 decibels while a 20cm layer can reduce by 46-50 decibels.

Vertical gardening

Vertical Garden is the term of used to refer to all form of vegetated wall surfaces[26]. Green walls can absorb heated gas in the air, lower both indoor and outdoor temperature, providing a healthier indoor air quality as well as a more beautiful[27]. A green wall is a wall partially or completely covered with greenery that includes a growing medium, such as soil. Most green walls also feature an integrated water delivery system. Green walls are also known as living walls or vertical gardens. They hold or slow rainwater, providing food and shelter for wildlife[28].

Benefits of vertical gardening

1. Covers up views of plain walls and provide building protection: decreased temperature fluctuations reduce the expansion and contraction of building materials and extend the building's lifespan. Green Walls shield the building envelope from ultra-violet rays and acidic rain by reducing cracking and carbonization of the building envelope, the buildings durability is improved and its service life extended[29].

2. Decrease voice level: Soil and plants which used for plantal arrengements in Vertical Gardens have a voice absorption feature. For this reason they perform to decrease voice function which happened both in building and its close area Green Walls provide a noise buffer which significantly reduces outside noise and vibration (up to 40dB) inside our homes and workplaces[30].

3. Reduces CO_2 levels and increases oxygen and improved air quality: Plants act as bio-purifiers and can play a dramatic role in improving the quality of city air through a number of biochemical processes by removing and breaking down airborne contaminants from both inside and outside a building. Approximately 1 square foot of vegetated wall area will filter the air for approximately 100 square feet of office area. Considered in very general sense, planting one wall of any house which situated 50 houses on the street is equal to plant 50 trees on this street[31].

4. Prevent from dust and harmful microorganisms: Air quality improvement from plants has been shown to reduce coughs by 30% and dry throat and irritation by 24% also, the plants clean the office air by absorbing pollutants into their leaves and transmitting the toxin to their roots, where they are turned into food for the plant. With cleaner office air building occupants are less likely to be sick and rooms with plants contain 50% to 60% less of airborne moulds and bacteria than rooms without plants[32].

5. Live plants decrease stress levels, create peaceful ambiance: They help ease physiological and psychological pressures of city life by providing a spiritual and physical connection to nature. The beauty of a green wall (covering concrete and steel) can rejuvenate our minds and physical fatigue is greatly reduced. The presence of plants in the office is not only reducing stress but also helps increase workers productivity. who worked in an environment with plants were 12% more productive and less stressed than those who worked in an environment with no plants[33].

Binabid[34] proved that the vertical garden simply limits the heat transmission into wall and reduce the surface temperature of wall by examined the average energy consumption of a five-level building with and without vertical garden. Average Energy Consumption without vertical garden (kWh) for Heating from Natural Gas, Cooling from Electricity, Lighting from Electricity, Hot Water from Natural Gas, total Average Energy Consumption without vertical garden is respectively 220, 78, 27, 70, 395 kWh. And average energy consumption with vertical garden is 216, 66, 27 70, 378 kWh.

Patients with a view of trees were hospitalized shorter (7.96 days) than patients who had a view of the brick wall (8.7days). Brick wall-view patients had more negative nurses notes (3.96 per patient) (examples of negative notes--"upset and crying" or "needs much encouragement"; examples of good notes-- "in good spirits" and "moving well") than tree-view patients (1.13 per patient). Patients with nature window views received fewer analgesic doses 2-5 days after surgery. The tree-view patients more frequently received weaker pain medications like aspirin or acetaminophen while brick wall-view patients who needed stronger pain medications such as narcotics[35].

CONCLUSION

Urban and peri-urban landscaping not only beautifies the environment but also makes it more reliable and ecologically stable. It improves microclimate, mitigates pollution, creates habitat for many animal species, adds variety of form, colour and texture to the environment and brings about positive changes in human behaviour. Roof plantings may provide food, temperature control, hydrological benefits, architectural enhancement, habitats or corridors for wildlife, recreational opportunities. It may even have ecological benefits. Vertical gardens is provide building protection and reduces CO_2 levels and increases oxygen, improved air quality, prevent from dust and harmful

microorganisms, live plants decrease stress levels and also reduces disease.

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