

A Study on Passive Sustainable Techniques (PST) in Urban Landscape

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Abstract

Saturated urban centers lack green cover areas and pose challenge to the present relationship ratio between the building mass (largest consumer of global energy) and the open space areas. The study aims at strengthening of urban landscapes with green infrastructure and its maintenance with the implementation of passive sustainable practices and methods thereby ensuring the urban health and safety. The passive approaches include landscape urbanism, urban farming, vertical greening, introduction of water corridor: tree corridor, adaptive reuse of underutilised spaces, urban street art, etc. at macro (city) level and xeriscaping, rain gardens, green roofs, passive solar landscaping, passive drip irrigation, etc., at micro (site) level. In this study 30 different types of techniques have been identified for micro level application. These methods utilize natural gravity, natural processes, natural energy sources and limit to the usage of active energy sources. For each technique, the approach and its environmental effects have been compared and analysed for existing as well as proposed urban landscape. The comparative data of such passive techniques clearly states the result of practicing traditional approaches for urban future. The research identifies the conservation of soil, water, air, energy and species is the prime method for the connection of the fragmented landscapes into one urban green mass. Active involvement of urban planners, landscape architects, urban activists, designers and ecologists improves the concentration of green areas in urban landscapes and characterises the sustainable landscapes.

Keywords: Conservation, Green Cover, Passive Sustainable Techniques, Urban Green Infrastructure, Urban Landscape

1. Introduction

The urban landscape includes residential, commercial, institutional, industrial, cultural land uses¹ open vacant land, forest cover and other green areas like neighborhood parks, gardens and water bodies. The relationship between urban development and ecological conditions has become discontinuous creates challenging environment for habitation resulting species disintegration. The habitat link has to be identified for its sustainable connection thereby ends with emerge of sustainable landscape urbanism. It is a concept of urban planning to organize the cities through the design of landscape by integrating large scale urban infrastructure, housing and open spaces. The sustainability of landscape includes conservation of water, soil, vegetation, wild life species distribution and its life cycle connections and can be achieved by passive

sustainable solutions for the betterment of urban green infrastructure^{2,3}. This study excludes the active energy solutions like using electricity for services and motorized applications into the landscape.

2. Greening of Urban Landscape

Urban landscape functions in its three basic spines called green line (green cover), the blue line (water bodies), the gray line (transit systems). Table 1 shows the various types of green spaces and water bodies in urban landscape. Green infrastructure is the network of natural and semi natural areas which enhances ecosystem and contributes to biodiversity conservation. Urban Green Infrastructure³ includes urban forests, large water bodies and other natural cover. Sustainable planning of city's infrastructure (e.g. like Tianjin Eco-city, China by Mia Lehrer; Vegitecture

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Table 1. Types of urban green infrastructure

Public green space	Private green space	Water bodies
Natural reserves, (Forest reserves, Biological and Zoological parks)	Community gardens (Townships)	Wetlands
Large open fields (Sports)	Other private communal spaces (Corporate campuses, Institutions)	Rivers and Lakes
Other open spaces (Farm lands, Cemeteries)	Domestic garden	Streams and ponds
Greenways	Green roofs	Ground water storage
Nature Conservation areas (Heritage places, Restoration creeks)		
Neighbourhood parks Street Trees		

concept of ZORLU Ecocity, Istanbul by Ken Yeang) within its own boundary is appropriate since the hot concrete core has all opportunities within it rather concentrating on the expansion of the outer layers of the city. This makes the need to design green infrastructure systems such as use of materials with low embodied energy, planting in all possible areas, prevent the exploitation of water and forest resources.

2.1 The Green Line

Green cover destruction resulted habitat fragmentation, zero agricultural farming, less open space, pollution, urban heat island effect, shrinkage in green reserve area, exploitation by massive road construction and uncontrolled land use change. Fragmented landscape imposes threat to the survival of wild life species and disintegrates the spatial connectivity. Thick vegetative cover in some of the institutions, buildings gives way for ecosystem balance in the urban areas. Such green spaces filter air, remove pollution, buffer noise, cools temperature, infiltrate storm water and replenish groundwater; moreover, it can provide food². Provision of multi-use recreational areas and amenities increases the general public’s exposure to the natural environment and promote way for expansion of greenways by connecting the neighborhood parks. Parks

at walkable distance invites children and adults thereby enhance their physical and mental ability resulting social interaction, recreation, safety⁴ and belonging and urban tourism². Other sustainable initiatives include clearing of invasive non native plants like, Prosopis juliflora, Lantana camera, Eucalyptus; promoting native tree species as our cultural identity; introduction of trees with deep rooting system; vertical leveling of parks in high rise building sectors; introduction of tree walk facility by connecting bridges and links with the nearby parks; creating innovative interaction spaces through tree art and sculptures; reducing and converting the hard scape area into soft scape area and planting more amount of street trees for shade to the pedestrians and vehicles creates less polluted urban environment.

2.2 The Blue Line

Water, the basic need becomes scarce due to massive urbanization. This insists certain

sustainable techniques unavoidable. The amount of fresh water sources is getting polluted and various treatment processes are being undergone for its revival. This includes the concept of bio filtration which uses aquatic plant species like Canna sp., Water Lily, Eichornia (Water Hyacinth)⁵ thereby purifies waste water and retains the ecosystem balance in streams, ponds, rivers, watersheds, wetlands and lakes. Approaches towards rectification of infiltration loss include adopting proper central planter medians in the urban streets; application of Sustainable Urban Drainage System (SUDS) for prevention of polluted ground water; tree corridor along the roadways for large canopy spread; deeper pits for storm water storage; regular maintenance of water front development areas and raising of flood bunds for the development of wetland conservation. The visual image and health of the city can be improved by the identification and connection of all minor and major water resources into a long water corridor. It involves public participation and support for its sustainable development. One such massive hit is the restoration of first urban wetland park - the XiXi Wetlands China.

2.3 The Gray Line

Gray infrastructure systems contain a network of facilities and conduits that deliver a defined service or product. It includes roadways, railways, airways, waterways and all underground public service connections and corridors. Expansion of the outer core of the city ends with

Table 2. Passive Sustainable Techniques

S.No.	Technique/Method	Description	The Approach	Environmental effects
Conservation of soil				
1.	Healthy Top soil conservation	<i>Topsoil</i> is defined by the <i>top</i> two to seven inches of <i>soil</i> that has the greatest organic matter content and microorganisms.	During construction top soil has to be separated and conserved for planting trees within the site and for street trees from road construction.	Fertilizer reduction, Organic farming with rich natural nutrients. Preservation of bio micro organisms.
2.	Phytoremediation	<i>It is the bioremediation process which uses various types of plants to remove, transfer, stabilize and destroy the contaminants in the soil and groundwater.</i> ⁶	Various types of remediation processes include absorption of contaminants in plants roots, shoots or controlling of mobilization of toxic agents results in biodegradation by microorganisms.	Natural way of converting brownfield into Greenfield.
3.	Slope stabilization	Stabilise the slopes from soil erosion in high altitudes with plantation.	Steep altitudes can be treated with plantations, rubbles, gabions, stones and sandbags.	Controls the soil erosion
Conservation of species				
4.	Restoration of plants and animal species.	Preservation of Wild life habitats and plant species within the site or in the large green space	Clearing of invasive plants and restoring the native species. Include them in the design concept.	More species attraction in the larger green space. Way for biological reserves and ecological balance.
5.	Preserving every possible existing tree	Conserving the existing mature trees within the site before the construction phase	Marking of trees using tree survey. Identifying large canopy trees.	Evolution of contextual unique design avoids environmental exploitation.
6.	Vegetative buffers	Trees act as buffer zone between the buildings in and around the site.	Planting adequate no. of various types of large canopy trees around the site and roadways.	Reduction in noise and air pollution.
7.	Greening every sq ft	Conversion of all possible spaces(wastelands, backyards, frontyards, parking bays) around the building into green areas.	Planting native plants, trees, mounds and groundcovers.	Maximize the cooling effect through evapotranspiration (the loss of water from the plants).
8.	Plant trees first in construction.	Initiation of planting trees as per landscape concept with proper protection.	Plant trees by marking its exact position and watering it effectively. They should be protected from construction materials and debris.	Mature trees after the completion of construction. Increase the cooling effect and visual landscape.
9.	Selection of Native species	Native plants have adapted to the climate of a geographical area, making them naturally healthy. Wildlife has evolved using them for food, cover and shelter.	Use of Medicinal plants and herbs, fast growing plants with respect to the soil. Native trees attract native wild life species.	Fruitful growth of species with suitable climate. Increase in population of species.

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Conservation of water					
10.	Rain water harvesting	<i>Rainwater harvesting</i> refers to buildings which catch rainwater and store it in underground or above-ground tanks for later use.	Use of Rain barrels, rain water collection tank or constructed underground sump to collect and filtered through mediums like coal, sand and used for drinking, washing and gardening purposes.	Controlled water usage. Towards zero water consumption within the building.	
11.	Rain garden	It is a depression that collects runoff from a roof, driveway or yard and allows it to infiltrate into the ground.	Rain gardens are typically planted with shrubs or perennials and can be colorful, landscaped areas.	Ground water recharge	
12.	Bioretention	Bioretention is the process in which contaminants and sedimentation are removed from storm water runoff.	Storm water collection using the natural slope from areas like parking lots, driveways into treatment area which consists of a grass buffer strip, sand bed, ponding area, organic or mulch layer, planting soil, and plants.	Storage of water can be reused for farming and infiltration purpose.	
13.	Root zone treatment	The root zone wastewater treatment system makes use of biological and physical-treatment processes to remove pollutants from wastewater.	Waste water passes through the filter bed consists of sand, gravel and soil system resulting treated water. Biodegradation of waste water by micro organisms in the soil and oxygen supply from the roots of the wetland plants. (Phragmites australis, Typha latifolia) ⁷	Treatment of polluted streams, nallas, rivulets and water-bodies. First step for reviving urban water resources.	
14.	Bioswales	A <i>bioswale</i> or vegetated swale is used to partially treat water quality, attenuate flooding potential and convey stormwater away from critical infrastructure.	Design of swale as per natural slope. Connects all site drain points.	Helps in watering the nearby species. Infiltration of pure ground water.	
15.	Xeriscaping (Eco friendly landscapes)	Xeriscape landscapes are defined as “quality landscaping that conserves water and protects the environment”	Selection of less water consumable plants from the list.	Effective planting for urban future	
16.	Passive drip irrigation/ Gravity feed drip irrigation system.	Supplies water directly by gravity force to the root zone of the plants through pipe connections	Water source kept at high elevation for water pressure. Using pipes and irrigates the garden through gravity force.	Effective way of water treatment to the plants. Less use of water.	
Conservation of Energy					
17.	Composting	Compost requires the green waste and break down into humus after two weeks. One of the method is Vermiculture - cultivation of earthworms, especially in order to use them to convert organic waste into fertilizer.	Organic wastes like kitchen waste, old newspaper, old leaves are separated and collected. Convert them into compost by allowing the growth of microorganisms into the ground.	To avoid chemical fertilizers. Prevent non toxic storm water runoff.	

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18.	Sustainable green roofs	Growing of plant species from grass to trees over the roofs.	Preservation of top soil during the foundation and use in on the roofs within the site building. Planting the native species with water proofing layers and proper drainage system. Plastic buckets, large drums can be reused as planter boxes.	The topsoil conservation, Thermal reduction in buildings, Urban heat island effect reduction. The green visual balance through remote sensing.
19.	Sustainable Pest Management	Organic way of applying solutions instead of pesticides and herbicides, this includes and cultivation of beneficial organism for plant pests.	Some predators and parasites of plant pests are beneficial organisms. To achieve this diverse landscape in large areas are preferable. Efficient pruning provides good air circulation thereby reduced likelihood of diseases.	Ecosystem balance. Healthy productive cultivation of plant species.
20.	Domestic gardens ⁸	Effective use of kitchen and balcony space in the residences with vegetables and fruits. Vertical plantation in high rise buildings.	Vegetation in Planter boxes. Kitchen waste can be used as fertilizers.	Organic healthy living. Visual retreat.
21.	Evaporative cooling	Conversion of liquid state of water to gaseous state causes cooling effect. Plants also breathe out moisture called evapotranspiration.	Introduction of water bodies around the buildings. Creating greener spaces.	Better cooling effect in and around the building.
22.	Passive hydroponics	Method of growing plants without soil, instead a porous medium transfers water and essentials minerals to the roots by capillary action.	Water and fertilizer are held in a reservoir and conducted to the roots as necessary and providing a constant supply of water to the roots. Coconut husk, sand, charcoal, shredded newspaper. It is important in passive sub irrigation to wash out the system from time to time to remove salt accumulation.	Reducing labour, say no to fertilizers. Method of urban farming in very less space.
23.	Orientation	Positioning the buildings with respect to sun's orientation.	Openings as per microclimate of pertaining site.	Thermal comfort
24.	Passive solar landscaping	Tree casts shade directly beneath the canopy around noontime and shadow elongates as the sun angle extends. Position of trees and shrubs as per building height, could be used as perfect shading devices.	Selection of heavy foliage deciduous trees on south and southwest side. Dense evergreen trees on south and west sides for late sun. Vertical shading for east and west walls in summer by vines on frames. Horizontal shading for south facing windows. ⁹	Helps to provide reflected light. Deciduous trees leaf out to provide shade in the summer, then shed their leaves to let the sun shine in during the winter. For vertical high rise buildings, trees around each unit give good result. (BOSCO Verticle by Rem Koolhaas)
25.	Permeable pavers	Increase of rain water infiltration to the ground with the use of permeable pavers.	Application of permeable asphalt and permeable concrete in driving areas, bike ways, pathways.	Increased rate of infiltration. Ground water at reachable height.

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26.	Sustainable maintenance and practices of landscapes	Efficient ways of planting techniques of the species results in reduce use of energy	Separate areas that require different maintenance levels such as grouping of water intensive plants. Consider "right plant right place" as well as "right plant right purpose". Proper pruning of diseased wood and hedge shapes.	Create maintenance less landscape.
27.	Green transit mode	Aims at reducing the carbon emission through vehicles and create alternative solutions for polluted transit systems.	Installation of bicycle tracks. Use of public transit mode. Pedestrian friendly pathways and green foot over bridges.	Mass control in air pollution. To achieve the green surroundings with higher oxygen levels.
28.	Efficient planning methods	Enforcing guidelines and regulations for betterment of the ecosystem.	Rules for Street width and height ratio provide ventilation. Use of movable shading devices, wing walls ¹⁰ , pocket parks, roof ponds.	Reduced energy consumption.
29.	Reuse and Recycle	Use of waste materials for construction purpose.	Pet bottle construction for seatings, plastics and waste chips for fillers in landscape construction.	Material reduction. Less pollution. Reduction in time, energy and cost
30.	Create the awareness	Aims at public participation for the betterment of environment.	Awareness through urban art in transit systems for the use of Traditional methods, native trees and materials, Organic land care.	Towards sustainable ecocity

various complex mix of land uses and increases the travel distances from the central core urban mass. In contrast, the highest levels of accessibility and thus little travel time are usually achieved in densely built areas where work-places, shops, services and activity centers are in close proximity and the transportation infrastructure (road network, public transport) is most developed⁴. Enhancing this gray landscape into green involves urban art depicting cultural values, art and sculptures icons out of wastes, graffiti along the bridges, green roofs over parking lot and railways; urban streets and furniture with bright colors invites people to relax and get the awareness about the pollution and planting of evergreen fast growing trees along the pedestrian pathways also give way for healthy urban street character. Cheonggyecheon river restoration, Seoul is one of the urban development projects where polluted urban river was closed for elevated highway and transformed back with green solutions which retained the urban ecosystem from heavy traffic congestion and lack of green space. Such measures include the conversion of underused urban infrastructure, such as rail corridors, underutilized back alleys, urban streets, abandoned transport or utility corridors and remediated brown fields into green recreation and bring out the city's image^{2,4},

3. Overview of Passive Sustainable Techniques (PST)

Passive Sustainable Techniques deal with the methods that utilize natural gravity, natural processes, natural energy sources. The Table 2 shows the 30 different types of methods with traditional practice that ensures the conservation of soil, species, water and energy.

4. Conclusion

Urban landscape lacks green and blue prints because of rapid high rise non degradable constructed structures. Traditional approaches always supplement with possible outcomes such as enrichment of top soil by organic methods like composting, vermiculture; promoting urban farming which produces edible urban greenery; planting native species by clearing invasive species; application of mud architecture and using recyclable materials for construction. Reviving land's natural ecosystem like restoration of wetlands, rivers and urban forests increases the wild-life habitation. This connects the fragmented landscapes

and brings the conservation of soil, water, air, energy and species. Also enhances the visual corridor with high visual perception quality viewpoints¹¹ which sets an urban pattern through remote sensing. Proper planning in the initial design stage makes the maintenance free solutions. Further researches to be explored on zero waste solutions with the use of materials and services. Perhaps leaving nature undisturbed is the first sustainable approach. But the active involvement of urban planners, designers and ecologists is also essential to articulate strategies for urban green space that explicitly advance public health, environmental equity and social justice in urban communities² and develop sustainable ecocities (green compact city).

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