Integration of Green Palette in Desert Cities: *Mitigating Challenges under the Stewardship of Dubai Municipality*

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ABSTRACT

As the Middle-Eastern glamour capital, besides its swanky constructions, Dubai is also largely known for redolent, color-coordinated, immaculately-maintained sustainable landscapes; no mean feat for a subtropical harsh-weathered desert area, with low precipitation and sandy saline soils. This essay relates subjectively to Dubai's urban landscapes that include parks, plazas and public zones, intersections, roundabouts, medians and linings along transport corridors. The study of the impact that the landscape has on roadside conditions is attempted through literature studies, surveys and expert interviews, unabashedly presenting the possible positive attributes in sensory and behavioral patterns while driving, commuting and experiencing green spaces in Dubai.

Literature studies have revealed that majority of the population respond to greenery rather intuitively, aesthetically and reflexively. Though a benign force, landscaping in Dubai is an important component of the socio-cultural heritage and global persona of the city. Data from various nurseries all over Dubai, led to collation and analysis of varieties of soil types. The study focusses on the challenges faced by Dubai Municipality to grow, cultivate, nourish and sustain these painstakingly created landscapes, effectively using home-grown fertilizers, efficient water-management and most importantly the social, physical and emotional impact of these green lungs. These studies were done using three integrated dimension orders: The Developmental dimension, Human dimension and Structural dimension.

The Municipality's varied and diversified approach to landscape and maintenance, using cutting-edge methods of cultivation and technological advancements, have been in close allegiance with the Roads and Transport Authority (RTA) and the combined decades of efforts have led to artistry and landscapes that have personified an oasis-a city where the impossible dare to dream!

Keywords:
Landscaping Challenges, Sustainability, Stewardship and Attributes.

1. INTRODUCTION

“Urban landscapes are rapidly growing environments where we can make an enormous positive impact on resource use and ecological sustainability" (Pitman 2013). Social policy commentators and scientists are starting to converge calls for human society to become more flexible and adaptable, to shift towards more sustainable resource use, activity and governance.

Desserts are among the most fragile ecosystems on the planet. They have sparse life compared to other biomes, especially as compared to forests in order of their productivity. Dubai, a fast-growing Arabian Desert city, is a well-celebrated global urban center with indigenous sandy desert patterns. It is in a subtropical desert area, has very low precipitation and similar to other desert cities, has unique environmental issues like lack of water, harsh climates, saline and sandy soil. Landscape architecture in Dubai is generally regarded as a benign force, but is nonetheless important component of constructing the city’s global image and legitimizing its socio-cultural hierarchy including the paradisiacal image of greening the desert (Bolleter 2012). As a touristic paradise, the city has ample eye-candy to offer with bright textures and exotic plantations along an otherwise monochromatic keystone community.

A 'sustainable landscape' is in harmony with local environmental conditions, including climate, topography, soil and water (Pitman 2013). Within the complex and fragile ecology in Dubai, a sustainable landscape has extensive challenges. Under the stewardship of Dubai Municipality (DM), with an adoptive capacity and best management practices, the city is working collectively towards a green Dubai, balancing environment and culture.

The aim of this study is to identify the challenges and measures of constructed landscaping in desert climate; to appreciate ecological resilience and adaptive sustainable techniques and innovations pursued by Dubai Government, in creating a holistic urban haven by 2020. This analysis will strategize the objective to promote social, emotional, physical, psychological and overall wellbeing, in a subtle urban integration, clearly different from the expected norms of desert landscape.

The possible positive attributes of sensory and behavioral patterns while driving, commuting and visiting green spaces in Dubai are critically reviewed through literature study and a survey.

2. RESEARCH METHODOLOGY

The challenges and management of desert landscaping, analysis of landscape types and the health effects of viewing landscapes are focused chiefly in the literature review adopted in this study. The analysis of a few nurseries in Dubai, as case studies, helped in understanding the practice of soil-use and amendments, use of home grown and synthetic manure, plant types, planting time and water management. Case studies of landscape design and build firms in Dubai was helpful to understand the mitigation measures of desert challenges in landscaping and designs to local requirements for sustainability.

3. DISCUSSION AND ANALYSIS

“It is evident that not all open spaces are greatly used, but rather left deserted. The normal human mind looks out for indicators that tell him that certain open places are attractive, secure and comfortable where he/she can socialize and take part in outdoor activities. A successful open space can be developed by taking into consideration the necessary activities, planning concepts, determining better quality urban context and attractive elements used in the space” (Faiz Ahmed 2013)

With a diversified cultural and social background of Dubai’s population, there was a need for user-specific designs for maximum benefits. Through sustainable considerations in landscape project management and financial support from Dubai government, this city can boast of 127 parks and 98hectares (2008) of roadside landscaping, done along phases. Landscaping of public transport corridors in Dubai, along with roads and easement areas in neighborhood developments by private sectors was an efficient way to amplify the culture of sustainability and urban resilience.

“People move from one location to other all the time making the channels of transportation of utmost importance with regards to safety, aesthetic appeal and comfort” (Mohamed 2011). For all facilities of transport, roads and traffic in Dubai, RTA is working inline with international scientific and technical standards for design and construction. On the occasion of receiving the prestigious 'Prince Michael International Road Safety Award' in June 2013, H.E. Mattar Al Tayer, Chairman of the Board and Executive Director of the RTA stated that the top priority is always traffic safety. For comfortable and joyful commuting, RTA’s Roads Beautification Section, functions taking systematic consideration of road speed, topography, visual and physical continuity, use of native plants, existing views and road accents like changes of routes and turns. Since its inception in 2007, the RTA is continuously upgrading the aesthetics and safety of transport corridors within Dubai for a better experience for road users.

3.1 Sensory and Behavioral Attributes : Studies have been constantly proven that green spaces are green lungs and are extremely beneficial to the visual aspect and the livability of a space (Azwar 2009). Dubai is a personified international model where greenery makes up a strong part of the world-class living facilities that the city has to offer, improving the approach, quality and standards of living.

Velarde 2007 stated that the overall wellbeing of a person and the quality of aesthetic appreciation are largely believed to affect human beings in several emotional and psychological ways. Types of landscapes and their correlation to human health and positive thinking have been a topic of study and debate, where landscape is a key element of individual and physical, mental and social wellbeing. Links between landscape and positive health effects have a range of theories and research approaches dedicated to this debate one among them being the use of "Healing Gardens" and "Therapeutic Landscapes" both theories where environmental perception is not just restricted to vision, but is clearly multi-sensory in approach.
Thus, health effects fall into 3 broad categories: Psychological/Short-term recovery; Physical recovery from varied illnesses; and long term behavioral changes/overall improvement in a person's social interaction. Both qualitative and quantitative methods of survey and research thrive on the notion that natural landscapes are far more visually appealing than well-manicured gardens and most of these studies have seen design approaches focused on hospital and health facilities; little of the urban design of gardens and local parks have been taken into consideration while analyzing green health effects on the human mind (Velarde 2007).

3.2 Stewardship of Dubai municipality in greening Dubai

The political sustainability of landscaping a city requires effective Governance structures, including 'commons' for both the public and private domains (Selman 2008). Under the patronage of the Dubai Government, DM liaises with the RTA for all landscaping works, within both public and investor sectors.

3.3 Organizational structure of DM for landscaping

3.3.(a)Landscaping and Beautification Section: A section of General Project's Department and within the Planning and Engineering Sector; the Landscaping section in DM is responsible for all public landscape projects in Dubai for planning, construction, conservation, maintenance, public awareness and environmental protection.

3.3.(b) Public parks and horticulture Department: The Public Parks and Horticulture Department is located within the Environment and Public Health Services Sector; it is considered one of the most important department within DM due to its influential role in conserving the city's general landscape and aesthetics along with improving environment conditions, fighting desertification, providing and maintaining social activities within leisure and entertainment facilities, providing agriculture services, guiding instructions and supporting social activities. It has four sections: Horticulture Section, with a plantation committee, Horticulture Services Section, Parks and Recreation Section, Zoo Section

3.3.(c) Drainage and irrigation Department: Within the Environmental and Public Health Services Sector of DM, it is responsible for irrigation designs of all new landscape projects under DM.
Drainage Project Design Section, Drainage Construction Projects Section, Irrigation Projects Section, Drainage Services Section

3.3.(d) Sewage Network Department: Responsible for irrigation system operations and maintenance of landscape projects, this department works within the Environmental and Public Health Services Sector. Treated water for irrigation all over Dubai is supplied by the Irrigation Department. For smooth operation, this department is further branched out into: Pumping Station Operation Section, Irrigation Systems Operation and Maintenance Section & Drainage Systems Maintenance Section.

3.4 Organizational structure of RTA for landscaping

The Roads Beautification and Landscaping Section, under Traffic and Roads Agency, at RTA, is responsible for upgrading and expanding greenery in areas surrounding roads, part of overall urban development expansion plans. Traffic and Roads Agency has an integrated plan for planning and construction of roads and surrounding patios with landscape, including provision of safety and security elements, artistic effects, and environmental requirements (Municipality 2013).

3.5 Preparing Dubai's saline and sandy soil for plant growth

"Water flow in soil is chiefly governed by hydraulic conductivity which is usually considered as an intrinsic soil property" (Hammecker. 2004).
Sandy soils have the largest particles (up to 1000 times bigger than clay) and are very free-draining due to the big air spaces between particles; plants don't get enough time to absorb nutrients and high salt contents in soil, this prevents water uptake by plants, leading to drought stress. "The soils of Dubai area are generally coarse textured, sandy, highly calcareous and undeveloped. These soils are suitable for marginal agriculture only with the support of assured irrigation" (Shahid 2013).
Improving the overall condition of this kind of soil for permeability, aeration and drainage, is a slow process. The key to success in sandy soil is less frequent deeper watering, using slow release fertilizers to reduce the amount of fertilizer run off and environmental pollution and adding as much organic matter as possible to the soil to help hold water, nutrients, and keep plant roots in place. Another key to success is selecting plants that do well in well drained soils. Having soil tested for organic and nutrient content is a good idea before the addition of any amendment.
The best source of organic matter for sandy soil is green manure-fast growing plants that are just as quick to rot. Such plants like clover, vetch, oats, young weeds or plants and nettles of any kind (tilled or turned over) enhance the soil. Other sources of green manure include poultry manure (sans bedding), peat moss, compost, old sawdust, sod, straw, native peat and other garden refuse. Used in the UAE, Emirates bio-fertilizer produces microbial inoculums with trade mark micro-fert that fix nitrogen and increase soil fertility. "The organic matter also helps restore soil structure and acts as additional storage for salts in the soil" (Costaris 2012).

3.5.(a) Mulching: Mulching is essential for sandy soils. Mulches help the soil retain water during hot, dry seasons and helps cooling soil during summer reducing overall temperatures in green areas. The maintenance contractors of Dubai Municipality use a technology in mowing grass covers that allow the cutting and mulching of clippings in one single operation, thereby significantly reducing green waste and improving the impact on the environment.

3.5.(b) Most Effective Way to Fertilizing Sandy Soil: Fertilizer manufacturers have developed a type of fertilizer best suited for sandy soil in the form of plastic-coated or resin-coated and sulphur-coated slow-release fertilizers. These can be used about ¼ times less often as regular granulated fertilizers or water soluble fertilizers. Special attention to be given to the elements like nitrogen, iron, manganese & zinc in any fertilizers, as these elements of desert soil. Source: www.unce.unr.edu/areas/southern.
Dubai Municipality uses 'home-grown' fertilizers and treated sewage from Al Aweer and Jebel Ali sewage treatment plants along with treated water for irrigating roadside landscapes and public gardens and parks. They use manure from livestock like cows and poultry and are locally produced in the Emirates Bio-fertilizer plant in Al-Ain.
"For all landscaping needs, local sandy saline soil has to be mixed with potting soil brands like Ferlite, Zeolite, Agrilite and Peatmoss. Saplings are imported from Italy, Lebanon, Syria, Thailand and China and repotted here, usually from September-February. Besides date palms, trees like Gulmohar, Milantronia, Al Basia,

Neem are grown locally from seeds and widely used" (Karim,2013). Growing of Damas trees was recently banned as the destructive roots of these trees are a threat to other vegetations.

3.5.(c) Watering methods: The frequency and amount of water applied to the landscape depends on the plants being grown, soil type and time of year. Drip irrigation system is the most effective and widely used method here for commercial use, using recycled water from sewage water treatment plant.

3.6 Sustainable Planting Methods and Vegetation Types.

A diverse plant population often increases beneficial organism populations like birds, insects and microorganisms. Considering saline sandy soil in Dubai, grouping of plants should have similar water requirements. Multiple plantings of a single species are less sustainable. The best solution is to plant sand-loving or dry condition-tolerant plants. DM has a list of native and desert-adapted plants.

3.6.(a) Xeriscaping*:* The word xeriscaping, literally comes from a combination of two other words 'xeri' derived from the Greek word 'xeros' for dry and 'scape' meaning a kind of view or scene. While xeriscape literally translates to 'dry scene' in practice, xeriscaping means simply landscaping with slow-growing, drought-tolerant plants, in a bid to conserve water, reduce yard trimmings and effectively save resources.

In many desert cities in South-western United States, a single family typically uses 60%–90% of their total water consumption for landscape irrigation. The southern Nevada Water Authority partnered with the US Bureau of Reclamation and funded a five-year-study (1995–2001) for the economic and conservation effects of converting turf landscapes to low–water–use xeriscapes. Results indicated that conversion to xeric-landscape produced significant water savings, upto 55.8 gal/sqft annually. Homes that converted from turf grass to xeriscape realized a 30% in yearly total household water use, which equates to 96,000 gal annually. Xeriscape also provided savings in labor and money (Sovocool 2006).

3.6.(b) Wildflower planting: Based on soil and climatic suitability wildflower planting can be an alternative to otherwise high-maintenance-demanding ground covers near roads; all without disturbing the environment, other plant species, any significant indigenous vegetation or human health. These are visually appealing and result in cost savings.

4.0 Variables : The correlation study of developmental and structural dimensions for landscaping by DM uncovered a feasible practice and good management against all challenges. Eight human dimensions were studied as independent variables against both developmental and structural as dependent variables.

4.1 Developmental Dimensions

Integrating infrastructure, technology, standards and regulatory requirements in landscape sustainability and educating and awareness programs

Table 1: Mapping the Developmental dimensions and role of DM and RTA

Activity	Public parks / Plaza / Community Facilities	Roads- lining and median	Remarks
Integrating infrastructure	DM facilitates and support reinforcing infrastructures in developmental dimensions of landscaping.	RTA's greening dimensions of Safety, Ecology, Character, Minimal maintenance and cost effectiveness in transport corridors at all stages of development.	Making It an effective aid for tourism.

Technology	Application of renewable energy technologies like solar energy to operate the lighting and irrigation system and use of green roof in many projects. Internet Access for information and online services for all DM projects. **Research:** Dubai central laboratory department of DM does the material testing for all construction materials for roads, pavement and other landscaping materials for hardscape. Continuous research of locally grown seeds, the use of native plants and water saving technologies.	Use of native vegetation is an important operation for all RTA road projects. Use of solar energy to irrigate 34 roundabouts in Dubai using waste water.	"Dubai Municipality aspires to construct public parks, neighborhood gardens and public squares by relying entirely on the solar energy sources to operate all facilities of these parks as well as operating the lighting elements and irrigation systems for trees and green spaces (Zero Energy parks)". (Muhairiy Fatima,2013).
Standards and Regulatory Requirements in Landscape Sustainability	Reconciling development and environmental goals, landscape policies by DM are formulated as to fit in with the objectives of sustainable development. Ecology and Landscaping is part of Section 3: Ecology and Planning of Green Building Regulations and Specifications of DM. Department of Planning and Development, Port, Customs and Free Zone Corporation has landscape regulations (environmental regulation no. EN/006, July 2010) including a comprehensive list of suitable plants for UAE.		
Educating and Awareness programs	The Parks and Horticulture Department (PHD) takes care of All Public Awareness Program through schools, Distribution of Saplings, Bill Boards, workshops, etc. At times Parks and Horticulture Department also receives and entertains programs forwarded by Dubai Electricity and Water Department (DEWA).		

Source: www.dm.gov.ae

4.2 Structural Dimensions

Project planning, construction, conserving, operation and maintenance**.**

Table 2: Mapping the Structural dimensions and role of DM and RTA

Activity	Public parks / Plaza / Community Facilities	Roads linings and Medians	Remarks
Project Planning	**DM** –A special team at PHD to study sites and design plantation project, enabling decision on the area of plantations, kind of flowers, fertilizers to be used and other details of the project. An in-house team of architects and civil engineers decides on the Project design. The landscape department at DM also provides consultancy to private developers.	**RTA -** Landscape and greenery is included in the road development projects of RTA, since 2007. The planning and design is done by DM.	Number of public parks in Dubai is numbered at 127, including residential green zones and 6 major public parks. DM & RTA have won awards for many projects.
Construction	**DM -** Planting is carried out by the PHD and Horticulture department. Other participants include the Landscaping and Irrigation and Engineering departments	**RTA -** Road construction& hardscapes.DM does all the planting. Landscaping and beautification projects also includes water features, illumination,greenery, shaded sitting areas, cycling and jogging tracks.	
Conservation	Site Dependent, usually under the Urban Planning section. Ex. Bastakiya & Shindaga		

<table>
<tr><td>Operation and management (Managing, Monitoring Advocating)</td><td>Up to 1 year of construction (Defect Liability Period) DM maintains parks, plazas and community areas in coordination with the Horticulture and Parks department, DEWA and the Irrigation department.
After 1 year, the maintenance of a park for both soft landscaping and irrigation are outsourced to encourage local business.
Street lights, toilet blocks and other support structures are maintained by DM.</td><td>DM carries out maintenance for all landscaping along streets, interchanges and highways.</td><td>“Public participation and accessibility with safety and security in a park or plaza is a part of social sustainability of landscaping” (Selman 2008)
Last year, more than 6 million people visited parks functioning under the supervision of DM.</td></tr>
<tr><td>Future plan</td><td colspan="3">The 2020 plan: DM aims to make Dubai green by 2020 by turning 4% of the city into parks and filling up 1/4th of the Emirate with nurseries and cultivated land. The per-capita green area is aimed at 25 sq km / person, half of which has already been achieved in 2013.

<table>
<tr><th colspan="4">Planting Statistics of DM and RTA</th></tr>
<tr><td>Year</td><td>Green area in Dubai</td><td>Roads lined with trees</td><td>Number of trees grown nursery.</td></tr>
<tr><td>2003</td><td>191,655 square kilometers</td><td></td><td>19887 million</td></tr>
<tr><td>2012</td><td>529,827 square kilometers</td><td>168 kilometers</td><td>34127 million</td></tr>
</table>
RTA is embarking on an ambitious plan to expand the network of cycling track to upto 850 kilometres from the existing 100 kilometres by 2030 (GN, June 30, 2013).</td></tr>
</table>

Source: www.dm.gov.ae

4.3 The Human Dimensions

The underpinning benefits of landscapes to human wellbeing, in urban spaces, are vast; from visual amenity and supply of food and water to promoting socio cultural and environmental health (Selman 2008). Many people respond to landscape rather subjectively, however, landscapes are a familiar part of everyone’s daily sight and play a vital role in a person's sense of belonging to a place and community. Residents and visitors interpret landscape as a underlying factor in their quality of life and it contributes to physical and mental well-being. Thus, eight interdependent 'human dimensions' of green spaces are identified in the studies: aesthetics, safety, accessibility, naturalness, appropriateness of development, stress reliever, therapeutic healing and long term well-being. Collectively, these dimensions form an essential set of apprehensions concerning to how people identify and use the green spaces for recreation and related experiences.

5. INFERENCES FROM SURVEY

The Human dimension shows superior uniformity and is supported by literature studies and a survey. The questionnaire for the survey was designed to understand the effectiveness and perception of public on landscape from the city level to neighborhood level. Variables like quality, hygiene, facilities and activities were also considered apart from the eight interdependent ‘human dimensions’. The analysis from the survey strategizes the psychological & physiological wellbeing of the drivers and commuters, emphasizing on the need of effective landscape design in the cityscape. The survey results illustrate how human dimensions are inferred upon by diverse participant groups in different extents of the green palette. Nonetheless, maximum responded towards landscaping as a reason for good health and social well-being.

6. CONCLUSIONS

Despite the fact that Dubai’s landscaping has been often referred to as cosmetic, the city’s tourism graph and the residents endorse strong acceptance of turning this desert city into a green palette following the government's initiatives in mitigating all challenges. Thus, in spite of the limitations, to an untrained eye and

the majority of population, Dubai is a visually appealing metropolis and that aesthetic appeal is what holds great value. The city's parks and green retreats have high rates of visitors that peak during the winter months; this promotes socio-economic, emotional, psychological and physical benefits to a population otherwise confined to 'mall-crawling.'

With proper irrigation techniques, home-grown fertilizers and advanced systematic drip-irrigation systems, Dubai has managed to grow landscapes that are both aesthetical and functional. However, the ecological and environmental variables are yet to be fully understood and implemented; further studies are needed to establish, especially laboratory and clinical related empirical findings.

Our interviews with officials at DM confirm their initiative of research on soil, seed and water; these are already in progress with reference to their future green proposals. Also, our literature review identified that desert soil can be amended by using the right kind of organic matter, mulching and fertilizers.

The purpose of this study was to establish the positive behavioral attributes of landscaping in Dubai. Although the truth is undeniable that there are several negative attributes, especially soil and air related, we cannot rule out the nuances associated with any positive attributes that are related at a metropolis level. The research undertaken is a nascent step in the direction for further green initiative and research that could be proposed particularly with funding from government officials, NGOs and public and private sector organizations.

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