An urban greening action plan to foster sustainable development of south cities

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Abstract

Urban greening contributes notably to environmental quality, quality of life, human health, and ecosystem services in cities. Worldwide, cities are making efforts to enhance urban greening to achieve urban sustainability. South cities are often beset by green space deficit especially in the old cores and neighbourhoods. Urban renewal and new developments could fail to bring relief. Lacking appropriate institutional setup and scientific capability pose intractable bottlenecks. Innovative public policies and greening technologies are needed for long-term improvements. Amalgamating natural and social sciences in a multidisciplinary approach and reinforcing the link between science and public policies could overhaul greening endeavours in south cities. The public and private sectors must work in tandem to insert plantable spaces and amenity vegetation into the urban fabric. Based on extensive field studies in north and south cities, and relevant urban ecological concepts, key domains are proposed for a sustainable urban greening action plan. Green spaces with high degree of connectivity forming a green network to permeate the city are hallmark features of the preferred naturalistic design. Preservation of natural ecosystems and creation of green areas with high nature contents and rich biodiversity offer a new dimension to green space design. The benefits of urban greening could be effectively manifested in economic terms to complement conventional ecological-environmental emphasis. Outstanding trees could receive high-order conservation efforts, and trees in construction sites warrant enhanced protection. Tree transplanting demands an overhaul in concepts and skills. Tree care needs to be upgraded in tandem with relevant professionals and workers. Improving roadside tree planting and maintenance offers a cost-effective way to upgrade the townscape. Ameliorating widespread soil limitations could remove a major hindrance to tree growth. Innovative ideas of development right transfer, street pedestrianization, river and canal revitalization, green roofs and green walls could mobilize hitherto underused plantable resources.

1. Introduction

The creation of cities since antiquity in a way marked the triumph of humanity over perfidious and harsh nature. With freedom from the bondage to the environment, the collective fruits of human ingenuity and inventiveness permitted civilization to flourish. One of the undesirable collaterals of urban living was the detachment from the pleasantries of nature represented notably by vegetation, associated wildlife, and the salubrious ambience. When settlements were small, nature was situated nearby, and humans could maintain frequent contacts with it. As settlements grew to sizeable proportions, nature was increasingly marginalized and it became scarce, distant and often degraded.

Some urbanites began to miss, consciously and sublimally, the innate connection with nature. They endeavoured to find solace in created natural enclaves occluded within the bounds of cities. Surrogates of nature in the form of domestic gardens were established in the comfort of homes. With a utilitarian bent, plants bearing edible fruits were initially domesticated and nurtured in gardens. The universal human preference for aesthetic objects soon triggered the adoption of plants with appealing ornamental traits, such as attractive flowers, fruits, foliage and growth form. Trees with large and dense crowns were cultivated for the comfort of shading from the hot sun.

Since their inception, gardens have been principally private domains for the enjoyment of those who could afford the means and the leisure to create and maintain them. The nobility and the aristocracy would establish them for personal gratification and as symbols of wealth and power. In addition, some would maintain wild or semi-wild grounds for recreational hunting. The plebeians had no access to the blissful green spheres of the patricians. As cities sprawled and expanded to accommodate the multitudes, the private green areas could be occluded in the process. They become important islands of oasis in the sea of artificial structures and roads, literally as nature-in-city gems.

The Industrial Revolution brought factories and factory-workers into cities, together with abject poverty, low-quality housing, excessive building density, poor hygiene and health, and degraded environmental conditions. As a spontaneous response to the deprivation, people began to flock to the meagre open and green spaces accessible to the public, associated with religious and public establishments and cemeteries. In response to the increasingly poor urban environment, governments were urged to provide formal public open spaces, in the form of urban parks, which began to appear in the nineteenth century in Britain. Some private green areas were acquired by municipal governments and opened to the public. The bold and innovative idea of the government providing

green spaces for community use (Lawrence, 1988) was soon adopted by other cities and countries, to become an obligatory and universal amenity.

Cities in developing countries, especially those with a long history, tend to be rather pervasively compact (Jenks et al., 1996; Burton, 2002). As the 'north' commonly refers to developed nations, whereas the 'south' developing nations, cities in the latter are labelled as south cities. With most lands densely covered by buildings and roads, little interstices are left for urban parks. Extensive urban tracts are commonly beset by grave deficiency in public open spaces (Jim, 1989, 1998a). Urban redevelopments, new urban areas and new towns could be built in haste with little regard to environmental quality (Olembo and de Rham, 1987; Herz et al., 2003). The need to dilute the harshness of the built-up matrix with green areas could meet with lip service or neglected altogether (Marcotullio, 2001). Opportunities to improve environmental quality and quality of life for millions of urban residents could be more earnestly and systematically grasped to realize truly sustainable development and smart growth (Hestmark, 2000; Foo, 2001).

This study aimed at developing a comprehensive and operational action plan to overcome the physical, mental and institutional barriers to green cities. The wide range of environmental, ecological, social and economical benefits of urban greening could be maximized by a bold and decisive revamping of entrenched thinking and practices. An important aim is to persuade decision makers to shift from the conventional to the innovative mode, and to adopt an integrated approach to urban greening. To be effective, the entire urban greening package needs meticulous attention, including identification and allocation of plantable sites, planning, design, choice of species assemblage, installation, maintenance, management, governance, and probing and incorporation of community wishes (Attorre et al., 2000; Jim and Chen, 2006a). The gaps in knowledge and practice have been identified and targeted for proposed improvement. The contribution of urban areas to the conservation of regional biodiversity could be included in green space design.

2. Methods

This study is based on literature review, insights distilled from the author's field studies in 25 countries and over 100 cities in Asia, Australia, Europe and North America, and research and practice experience in urban greening and urban nature over a period of 28 years. The examples and best practices, gleaned from cities in both the north and the south nations in different parts of the world, served as the basis and inspiration to develop this action plan that is geared towards the compact south cities.

Besides expounding the underlying principles, the practical and actionable applications have been emphasized. A multi-disciplinary and trans-disciplinary approach, commensurate with the complex and broad-spectrum urban greening issues, has been adopted. The study attempted to encompass the concepts and perspectives of the core as well as cognate bodies of knowledge, including urban biogeography, urban ecology, urban forestry, urban horticulture, urban landscape ecology, urban environmental planning, and urban soil science. The diverse and unique circumstances of individual cities may find some parts useful whereas some may not be so relevant.

The main parts of the paper have been structured according to a natural progression based on three cardinal stages in the urban greening planning and management stream: (1) *application of pertinent ecological principles* to the practice of urban greening design, green space geometry, enrichment of urban biodiversity, and holistic assessment of urban greening benefits; (2) *protection of existing nature in cities*, involving spontaneous natural remnants, champion calibre tree stock, tree preservation in construction sites, salvaging outstanding trees by transplanting, and ensuring the continual supply of meritorious greeneries by timely tree care; and (3) *augmenting new greening opportunities* in urban areas, such as improving planting techniques at narrow roadsides, ameliorating the pervasive soil constraints, and finding innovative ways to introduce greenery into compact urban sites.

3. Applying urban ecological principles

3.1 Adopt ecological design in urban greening

The rich body of urban ecological principles has seldom been enlisted to optimize the configuration and ingredients of urban greening programmes. Inserting plants in urban spaces could be conducted in various ways to achieve different objectives. The conventional approach is dominated by ornamental or aesthetic considerations. The morphological features of individual plants and their combined landscape effects often take precedence. Most urban green spaces in south cities were designed to achieve neat geometric patterns and well manicured parkland landscape. Nature has to exist on human terms, following human predilection for order, regularity and simplification. Such outdated mentality has a strong inertia to linger in developing countries.

Modern urban greening could be exonerated from the excessive regimentation of traditional mainstream urban landscaping. It could be diluted and transformed by emulating nature's diversity, multiplicity, variability, changeability and flexibility (Henke and Sukopp, 1986; Gordon, 1990; Cook and Lier, 1994). The

naturalistic or ecological principles could be more embraced to create green spaces with more natural species composition, biomass structure, and spatial pattern (Cole, 1986; Cook, 2002). The muffled senses of people living in cities could be revitalized by exposing them to green spaces with high natural ingredients that can offer diverse stimuli through the visual, audio, olfactory and tactile channels.

In practice, wild green spaces for all sites may not be practicable or acceptable. A compromise could be reached between popular human expectations and nature's way in designing urban green spaces. A spectrum of green sites with different degree of naturalness could match local land use pattern (Löfvenhaft et al., 2002). A large site could accommodate a variety of habitats, whereas a small site could focus on one. The pre-urbanization ecosystems and habitats present in the region around a city, including the common and rare types, could be inherited or emulated. Local ecological knowledge has to be reinforced with the help of research to serve as the basis to design the naturalistic green sites.

3.2 Optimize green space geometry and connectivity

The pertinent benefits of creating spatially connected and contiguous green spaces have escaped the attention of some planners in south cities. Natural ecosystems tend to be well connected to each other, with unimpeded flow of material, energy, organisms and propagules across their contiguous boundaries. Urban green spaces, however, are usually isolated entities surrounded by built-up areas. The main green sites, urban parks, are often square or rectangular plots surrounded by roads. Many large urban parks are penetrated or severed by roads. The harsh and alien conditions of the adjacent roads and buildings create barriers to the movement of wildlife and people.

Application of the well-established concepts of spatial planning and landscape ecology (Dramstad et al., 1996) could improve urban green space design and ecological and environmental benefits. Green spaces could be analyzed as three principal entities, namely *patch* (broad green areas), *corridor* (linear green areas), and *matrix* (surrounding built-up areas), in conjunction with the ancillary issue of *edge* (interface between patches or corridors with matrix). The key geometrical properties of green spaces, such as location, size, shape, orientation, and distance from and connectivity with other green patches, could be moulded to enhance their functions (Davey, 1998).

Urban green space design could aim at optimizing the site geometry to maximize ecological and environmental benefits:

(1) Large patches or wide corridors

They can provide ample spaces to accommodate a wide range of habitat types and species, especially those that demand a relatively large minimum site. They could also raise the ratio between site area vis-à-vis edge area, so as to reduce edge impacts where the green space interfaces with incompatible or nuisance-generating land uses.

(2) Connectivity between patches or corridors

If the green sites are located near each other, or better still, contiguous, they could form a green network to permeate the built-up matrix. Green patches should be linked by green corridors or greenways (Flink and Searns, 1993) to form an integrated green space system to enmesh built-up areas (Flores et al., 1998; Jim and Chen, 2003). Where continuity could not be achieved in developed areas, a series of small sites with limited inter-site distance could serve a stepping stones for both human and wildlife users.

(3) Long corridors or linear green patches

They can provide extended edges with the surrounding built-up matrix, so that more residents could have convenient access, preferably by walking for not more than 400 m or 10 minutes to reach the green site (Müller-Perband, 1979; Burgess et al., 1988). For two green spaces with a similar area, the linear one with a larger catchment of potential users is preferred. Well-connected green spaces could permit movement of wildlife (including pollinators and dispersal agents) and propagules between sites. If the intra-urban corridors could be connected to the peri- and extra-urban natural areas, the benefits of such biotic movements could be augmented.

(4) Patches or corridors oriented parallel to natural linear features

The patches or corridors could be located and oriented to run parallel to streams or coastlines. Water bodies could provide an important landscape and environmental element to the planning of greenways and blueways. As people have affinity to water edges such river banks or waterfronts, the parent green spaces could incorporate such natural features to increase its appeal.

(5) High quality edges of green sites

The edges between green and non-green areas could be designed to enhance their ecological and landscape qualities. The edges should preferably be soft (natural), wide, gradual and curvilinear. Thus tall and elaborate metal fences or walls that create an abrupt and unfriendly barrier should be avoided.

The desirable configuration should achieve an intimate mingling of green

patches or corridors with the built-up matrix. Such green areas are situated close to people, to create a nature-in-city ambience. At the urban edge where developments interface with natural areas, tongues or wedges of peri-urban woodlands could be preserved to extend into the built-up areas in an interfingering pattern (Frey, 2000). Small pockets of remnant nature embedded in built-up areas should be kept in the wild state and designated as urban natural areas (UNA) on zoning plans. With peninsulas of nature extending from the countryside into the city, and islands of nature punctuating the city, the landscape, amenity, air quality of natural areas could benefit the interface area with spill-over effects into the city matrix. In land use planning, such opportunities that permit nature to penetrate the city should be assiduously preserved (Carr and Lane, 1993). Existing green sites at the urban fringe could be ecologically upgraded to augment their natural contents and benefits. Nature can best be preserved; if not, emulated nature could be created as surrogates (Baines and Smart, 1991).

A comprehensive assessment of the urban ecological status of a city could establish the knowledge base to prepare an optimized city-wide green space master plan. Many such plans are based on non-ecological information and consideration, often dictated by the overriding locational and economic factors. To usher high-quality nature into the city, such green plans should be contingent squarely on ecological realities and potentials. Existing areas of high ecological value could be identified and protected. The search for suitable sites should not focus only on large patches; small sites with notable natural contents should not be neglected. In particular, small pockets of biodiversity hotspots, unique habitats, remnant native vegetation, or individual heritage trees, should be included in the encompassing protection package. Sites with pristine or minimally disturbed ecosystems are worthwhile candidates, whereas lightly disturbed sites could be evaluated for their recuperative potential with or without human assistance. In neighbourhoods suffering from nature deficit, suitable localities could be identified for future conversion into green spaces.

3.3 Enrich green space diversity

The principle that habitat diversity is a major determinant of species diversity could be more earnestly applied to improve green space design. Urban greening could aim at increasing habitat diversity to raise species diversity. For new green sites, the tidy, the manicured horticultural design could be complemented by the naturalistic-ecological approach (Henke and Sukopp, 1986). Based on the hemeroby concept (Jalas 1955; Sukopp, 1972), urban habitats could range from natural to emulated or created natural, semi-natural or ruderal, and entirely

artificial. Most existing urban green spaces in south cities are tilted towards the artificial end of the spectrum. The deeply ingrained inertia towards traditional landscape design has perpetuated the partiality. To redress the bias, new green spaces or modified existing ones could admit more natural elements. Nature-oriented designs are often less expensive to build, and largely self-sustaining with minimum maintenance needs to reduce recurrent upkeeping costs. Most importantly, there is a strong demand for natural areas within and near cities (Johnson, 1990) with features that many over-designed and expensive urban parks fail to deliver (Thompson, 2002).

Conscious efforts could be introduced to enhance biodiversity in green spaces, especially with native species that represent the regional flora (Smale and Gardner, 1999). For relatively large green sites (say >2000 m^2), not less than 25% of the area could be earmarked for naturalistic greening. An ecological survey could identify any existing natural vegetation types or habitats for preservation and incorporation into the naturalistic design. For existing sites, opportunities for species enrichment could be identified in refurbishment schemes. Different sites could be given different functions to be fulfilled by dedicated designs with more ecological elements, to depart from the common visual-ornamental bias. For large new sites, the ecological park design could be adopted to create a mosaic of different representative habitats.

Using natives in urban greening in south cities is often hampered by a knowledge gap. The landscape profession and industry have limited understanding or experience with native species. They tend to adhere to a standard palette of common horticultural species for a given climatic zone. Such a blinkered attitude would generate stereotype landscape designs and species assemblages with a disproportionate amount of exotic species. Local research to identify, test and extend the use of indigenous plants cannot be more emphatically stressed. The south nations could enhance the knowledge repertoire to make better use of their floristic endowments. The research findings could be effectively transformed into practices, including the development of a nursery industry to produce the native planting materials in adequate quantities, and a landscape profession to promote their use.

Advocating native species should not be construed as an attempt to exclude exotics. Cities are characterized by a diverse range of site conditions, far more than its countryside, to accommodate a surprisingly varied urban flora. Some cities register higher species richness than the surrounding natural ecosystems. The capacity of urban green spaces to support a wide assortment of species could be filled by a complement of natives and exotics. Natural sites

could mainly hold natives, whereas semi-natural and artificial sites could be shared by mixture of natives and exotics. A plant introduction office could be established to screen systematically worthwhile exotic species from other places, and promote suitable ones to the landscape industry. This orderly importation could replace the random introduction, legally or illegally, of exotic plants by companies or individuals. Such unregulated activities often operate outside the statutory quarantine regime, and they could induce problems of phytosanitation, transfer of pest organisms and instant pathogens.

3.4 Evaluate holistic benefits of urban greening

In assessing green space benefits, there is a strong and mistaken tendency to concentrate on site acreage or green space per capita at the expense of other pertinent holistic factors. Such a simplistic approach could discourage the adoption of ecological designs, and trap green space work at the conventional level. The indicator of a government's achievement in urban greening, and the benefits that it can bring to the community, could be appraised by a more elaborate yardstick that encompasses the multiple ecosystem services provided by urban greenery. A holistic assessment method based on a scientific, objective and quantitative scoring system, could be developed to gauge the wide spectrum of ecological functions. Key factors such as species richness, species diversity index, native-exotic ratio, remnant natural component, and fidelity to local or regional natural habitats, could be given differential weights. Other factors that contribute to the ecological and environmental well-being of the city could enter the equation, such as biomass structure, vegetation coverage, planting density, vegetation height, leaf area index, open soil and evaporative surface, and soil connected to natural ground.

Different cities, with different natural history, development mode, disturbance regime, nature conservation path, and green space provision record, would demand different tailor-made assessment strategies. Local urban ecological research could acquire the knowledge base and device the assessment scheme. In planning for green spaces, the assessment method could be used to judge the quality of proposals based on their ecological-environmental contributions, in addition to the basic site area data. Thus a relatively small site with high scores could usher more benefits than a large site with low scores. The assessment method provides plenty of flexibility to design green spaces, which could take different approaches to achieve a desired score. The government could emphasize certain criteria to guide and fulfil particular ecological planning objectives. Individual sites could have specific targets, such as the minimum

species richness and leaf area index. Once established, such a green space precision planning methodology could bring a renaissance and substantial upgrading of landscape design with sustainable benefits to urban ecology.

To enhance understanding of urban greening benefits (Dochinger, 1980; Nowak and Dwyer, 2000), cost-benefit analysis could extend to the economic realm. People are more amenable to monetary than ecological values which demand deeper understanding of nature. The benefits and amenities that nature can bring to society could be expressed explicitly in dollars. As nature in city is not a marketable commodity, indirect methods are used for objective and scientific valuation (Chen and Jim, 2008). Two strands of methods have been applied to the economic assessment of urban greening. The contingent valuation method explores the amount of money that citizens are willing to pay to use urban green spaces, or to pay to prevent their loss (Jim and Chen, 2006b). The hedonic pricing method analyzes the home buying behaviour by isolating the proportion of the property transaction price that could be attributed to urban greening and other natural areas (Garrod and Willis 1994; Jim and Chen, 2006b, 2007). The results from these studies could be used to estimate the worth of urban green areas, which could be compared with the establishment and maintenance costs. The monetary values assigned to green spaces could justify the allocation of public funds for urban greening. In times of budgetary constraints, the findings could strength the competition for public funding.

4. Protecting nature-in-city assets

4.1 Preserve and nurture spontaneous nature

Existing natural areas of high ecological worth are too commonly and unnecessarily neglected, replaced or destroyed. Many south cities are expanding at a fast rate. In the course of development, natural areas with spontaneous flora and fauna of high ecological value could be annihilated. Green fields originally lying in the urban fringe or the countryside envelope are intruded by urban sprawl. Some islands of remnant nature embedded within the urban matrix could be enlisted for development. The loss of nature is then partly compensated by emulated natural areas in the form of urban parks and other green spaces. The idea of preserving natural sites within developed areas too often has escaped the attention of city planners. The land for the reprovision urban green spaces have to be prepared at a great cost, often involving elimination of natural features, and replacement by poor copies of nature as stereotype and simple parkland landscape with limited biodiversity, ecological value and ecosystem benefits (Fernández-Juricic, 2000; Hess and King, 2002).

The entrenched practice would establish urban green spaces from scratch. In extreme cases, natural remnants inside lands designated for urban parks could be removed to make way for humanized greenery. Occasionally, isolated pockets of well wooded religious sites or sacred groves could be retained and embedded in built-up areas (Jim, 2003a). However, their original natural features of landform, soil, water and vegetation tend to be disrupted, modified or partly replaced (Williams et al., 2005). Urban living has probably muffled if not distorted our value judgment of nature. Wild areas have been commonly and erroneously construed as inferior or unsuitable urban green spaces (Mazzotti and Morgenstern, 1997). Nature has to exist in urbanized areas on human terms, to be simplified, sanitized, contained, tamed, regimented and manicured. Rather than inheriting and preserving precious nature in cities, we disregard, dislike, degrade and destroy it. The persistent attitude is still very much alive, resulting in unnecessary elimination or degradation of otherwise high calibre green spaces for both humans and wildlife. Paradoxically, in their place we invest much public funds to create parodies of nature that incur high capital and recurrent expenditures.

The land use zoning stage would benefit from a major revamp to rescue nature in cities (Goldsmith, 1988; Jim, 2002a). Instead of the rather routine practice of treating the land as a blank sheet, the new development plots in green fields could be carefully scrutinized to identify high grade sites for designation as *urban natural areas* (UNA), to be bestowed the protected area status analogous to conservation areas in the countryside. Natural areas in the form of patches and corridors could be preserved as far as possible in their pristine state (Henke and Sukopp, 1986), preferably in a green network with enhanced connectivity between sites and with the city's countryside (cf. Section 2.1). Spokes, fingers or tongues of linear UNA lands extending deep into built-up areas would create a desirable spatial pattern to maximize the benefits of nature. Such greenways (Flink and Searns, 1993) could also permit fresh air, clean water and wildlife to enter the city in natural expressways. Residential areas could have UNA in proximity, convenient accessibility to nature, and enjoyment of ecosystem services. Citizens could choose between artificially created or natural green spaces for their outdoor recreational activities. They do not need to travel long distance to reach real nature which otherwise exists only in the far-away countryside.

Where natural areas are deficient in existing urban areas, they could be nurtured with the help of careful site and soil preparation, and selection of native plant species to establish the biotic composition, biomass structure and ecological linkages of the regional wooded ecosystem (Johnston, 1990; Lee and Thompson, 2005). Disturbed natural areas could be repaired or restored by enrichment

planting, and allowed to recuperate so as to reconstitute the natural soil-water-vegetation complex (Borgmann and Rodewald, 2005). Suitable parts of existing urban parks and other manicured green sites could be transformed into natural areas. Where the climatic zone permits, the most complex woodland ecosystem could be established by a well-planned afforestation programme (Tartaglia-Kershaw, 1982; Harmer, 1999). River banks are particularly appropriate for linear woodlands to create a desirable greenway-cum-blueway UNA, which could accompany riverine ecosystem restoration and water quality improvement. The overarching spatial planning principle is to create adjacency and interpenetration between natural and urbanized areas. The health and vigour of UNA could serve as an indicator of urban liveability and environmental sustainability. Cities that could permit nature to thrive are likely to permit humans to thrive as well.

4.2 Conserve champion quality trees

Champion quality trees, as the most outstanding remnants and representatives of nature in cities, are frequently damaged advertently and inadvertently. In the course of urban development, a tiny proportion of trees could perform exceptionally well to express their biological potentials of tree form, stature, vigour and life span. Local residents often develop sentimental attachment to them, sometimes elevated to the level of veneration or worship. The cream of the tree stock in cities could be identified by virtue of six criteria: species, dimensions, structure, performance, location, and special considerations such as extreme species rarity, special ecological value, unique habitat, unusual tree form or dimensions, connection with notable personalities or events, landmark specimen, and historical significance (Jim, 1994a, 1994b).

In many cities, the special cohort of the most precious urban trees, unfortunately, has not received adequate attention and protection against avoidable damages by natural and human causes (Jim, 2003b, 2005a). The alarming losses echo the lack of effective understanding and protection of an irreplaceable community heritage. The major predisposing causes were related to construction and trenching-roadwork activities, with some succumbing to age and health related problems.

Champion trees are truly the ecological and cultural gems of cities. Most cities have inherited only a small number. The fast development and renewal of some south cities have threatened or destroyed this precious endowment. The scientific and institutional regimes are often inadequate for effective protection. Some cities treasure their champion trees and put them under an intensive monitoring and care regime, and a strict legislative umbrella. Cities could learn

from the best practices to improve their own protection work.

Statutory protection and substantial upgrading of tree care and maintenance are necessary if these venerable doyens were to continue to grace south cities. A systematic champion tree survey could build up a scientific database of the natural heritage (Council of Tree and Landscape Appraisers, 2000). Such data could permit deep understanding and appreciation of tree heritage value, and provide a baseline to reinforce tree management. They also constitute a benchmark to determine the level of compensation and penalty in case the trees are damaged (Jim, 2004a, 2004b).

The same dataset could be employed to develop a monetary valuation of the prized trees (Jim, 2006). A dedicated urban tree ordinance (Jim and Liu, 2000; Jim, 2002b) could be enacted, with a section covering special measures to guard them against harm. Following the examples set by other cities, the champion tree register should cover all developed lands and sites earmarked for development, and it should form an integral part of the ordinance (Randall and Clepper, 1977). Professional guidelines that adhere to the highest international standards of tree care could be developed to ensure that the top trees will not be damaged by low-quality maintenance. Tree workers entrusted with their care should be trained to a high standard to shoulder the high-level responsibilities.

Rather than protecting outstanding trees in isolation, they could be conserved collaterally with their sites, and better still, their environs and ambience. Heritage trees would have witnessed the vicissitudes of their surroundings for decades if not centuries. Nearby urban fabrics of historical significance could have lingered with their natural partners, to deserve co-conservation and co-management with the elite trees. Some neighbourhoods are endowed with a pleasant bequest of fine mature trees that permeate a large proportion of the lots and roadsides. The overall townscape, including the housing styles and the varied and high-quality vegetation cover in private lots, merit to be preserved as a holistic conservation entity.

The conservation area concept that protects countryside and natural habitats could be expanded to cover localities with high-calibre trees in cities. A sizeable area with a notable number of high-grade trees could be designated as *tree conservation areas* (TCA). Roads lined with champion trees could be designated as *tree conservation roads* (TCR). Smaller sites including a special habitat for special vegetation, such as a remnant woodland enclave or an old stone wall with mature trees clinging on it (Jim, 1998b), could be designated as *tree conservation sites* (TCS). A commendable tree conservation strategy should traverse the temporal dimension, to take into account the past, present and future

considerations in the spirit of transgenerational urban forestry and arboriculture.

Tree conservation should pay special attention to the protection of present and future growth spaces. Besides the above-ground expansion space for the crown, the subterranean rooting room, often neglected, has to be assiduously guarded against intrusion and degradation. For individual trees, a three-dimensional *tree protection zone* (TPZ) should be delineated. In the above-ground environment, the lateral extent and height of the TPZ should be defined by the maximum crown spread and height of the tree, plus a minimum of 3 m buffer belt on all sides.

For champion trees that have not attained their potential dimensions, the TPZ should allow for future growth. In the below-ground environment, the diameter of the protected soil mass should be the same as the above-ground span plus the buffer belt, and it should be at least 2 m deep to ensure the integrity of the roots and to permit future extension. No excavation should be permitted in and below the protected soil area. For a cluster of trees, the outer perimeter of the group as defined above should form the boundary of the TPZ. For trees that are at present cloistered by adjacent developments and do not have sufficient rooms to demarcate the TPZ, any future changes should prevent deterioration of tree growth conditions. Ameliorative measures could be applied as far as possible to improve site conditions for tree growth. Redevelopments adjacent to them should provide setback to enlarge the TPZ.

Champion trees, TCA, TCR and TCS are comparable to cultural heritage (antiquities and monuments) in terms of their intimate association with the community and cultural lineage (Jim, 2004c, 2005b, 2005c). They denote outstanding representatives of nature in cities, and hence they could be construed as the collective natural-cum-cultural heritage of the community.

Such meritorious tree stock, regardless of their size, could be marked on statutory zoning plans using a dedicated cartographic conventional signs. Instead of denoting the tree location only, the boundary of the TPZ should be shown on the map. In this connection, it is not uncommon for some cultural relicts with a size smaller than a large tree to be marked on zoning plans. The explanatory notes that accompany the zoning plan could provide details on tree species, dimensions, protection justifications, and precautions to prevent damages.

Developers and professionals involved in the development process, who are familiar with the planning system, could interpret the zoning plans and participate actively in their protection. An integrated approach to the supply of conservation information in urban areas under one statutory umbrella can highlight and publicize the protection status of the exemplary greenery. It can

also furnish accurate information on protection justifications and guidelines to align with conservation objectives.

4.3 Protecting trees in construction sites

Many south cities are undergoing fast redevelopment and expansion, with a high probability of incongruous encounters between trees and construction activities, especially in private land (Bowers, 1999). Construction activities often conflict with existing trees dwelling inside or at the periphery of the sites (Watson and Neely, 1995). Based on the effectiveness of statutory controls, trees affected by developments, including large and outstanding specimens, could be felled without the need to obtain permission from the land, planning or conservation authorities. Even for trees that have gone through the application procedures and prescribed for in situ preservation, they are often badly mistreated, resulting in degradation of tree form, massive injuries or death. The special skills and skilled workers required to protect trees in construction sites are often lacking. It is not uncommon to find some preserved trees inadvertently felled or killed due to improper treatment, poor protective measures and the lack of worker supervision. Deliberate attempts to remove trees before and after planning permission cannot be ruled out. Some south cities are losing a significant number of trees often unnecessarily. Decisive measures could be adopted to salvage more high calibre trees in construction sites.

Planning for tree preservation in construction sites requires detailed site plans, especially with regard to building footprints and foundation spread, access roads and ancillary paved areas (Jim, 1988). The commonly adopted development process could be modified to match modern environmental protection practices. Instead of routinely treating the development site as a blank sheet, an ecological site survey should be conducted before detailed development planning. The study could identify the trees or ecological habitats that deserve preservation. A precision building design that takes into account the real-world site conditions could then be applied. An overhaul of the conventional mindset may be necessary so as to treat outstanding existing trees as assets rather than liabilities. Development plans that are apathetic or antagonistic to natural site elements could be converted to sympathetic ones to accommodate trees worthy of conservation. The size, shape, orientation and location of buildings and roads could be adjusted to cater to the identified conservation needs. The inputs of landscape or tree professionals, who should be treated as full rather than peripheral members of the team, are required at the early rather than the late stage of the development stream.

Evaluation of tree protection practices in construction sites in south cities

demonstrates ample rooms for improvement (Morell, 1992). Besides the low standard of work, which is rather pervasive, tree protection is frustrated by the lack of supervision of site workers. Above all, the half-hearted efforts and cavalier attitudes are linked to a common lack of commitment to protect trees. Some site crews are inclined to take calculated risks to expedite construction work at the expense of protected trees. Construction requirements too often take precedence over tree protection needs. Clearly written guidelines should be prepared and enforced (Matheny and Clark, 1998). Seminars and workshops could be conducted to disseminate the relevant concepts, skills and regulatory requirements. The knowledge transfer should permeate all levels from the management to the professionals, technicians and workers. Developers and the construction companied could be apprised of the tree-survey requirements and preventive and precautionary measures at the earliest opportunity (Ames and Dewald, 2003).The whole spectrum of development professionals need to work in unison to contribute to tree protection stipulated in planning approval conditions. The engineers and architects at the frontline of the construction project should shoulder the pertinent responsibility of quality control and adherence to guidelines. For tree preservation, timing and timeliness are the most critical factor but often the weakest link. As an incentive to tree preservation, that high quality trees could augment property value (Anderson and Cordell, 1988) should be more emphatically brought home.

A common weak link in the tree protection regime is the poor and inconsistent quality of the tree survey reports (TSR) in relation to trees affected by developments. The judgments and decisions on trees are contingent upon the TSR quality. A poor or inaccurate TSR could mislead and muddle. The specific requirements of a TSR could be clearly spelt out in a guideline, and explained with the help of a sample report. A professional calibre TSR should cover information on every tree situated within the work site, including tree locations marked on a large-scale map of at least 1:1000 scale, species, dimensions (tree height, trunk diameter and crown spread), structural integrity, health, performance, habitat condition, tree defects and disorders, special features, future growth prognosis, and colour photographs of the whole tree as well as its notable parts and environs. It should contain specific recommendations and justifications for retention in situ, transplanting and felling. Every effort should be taken to minimize transplanting and felling. The key task of conducting the tree survey and preparing the TSR is too important to be left to inadequately or inappropriately trained personnel. It should only be carried out by a landscape architect or a tree specialist.

4.4 Transplant trees as the last resort

High quality trees affected by development are too indiscriminately recommended for transplanting rather than preservation in situ. For trees conflicting with construction, developers are commonly tempted to remove those that are regarded as obstacles to construction activities and the development itself. Whereas the approval to fell low quality trees could be obtained without much difficulty, for outstanding trees it is usually denied. Instead of outright removal, application for transplanting is often attempted to transfer the trees to other locations within or without the subject site. In judging such requests, discrimination should be made between ordinary and outstanding trees. The option of transplanting the high value trees, especially large specimens, should be taken as the last resort. This is because moving a large tree will invariably weaken and often disfigure it, thus substantially reducing its landscape value and useful life span, and negating the very purpose of keeping it (Jim, 1995; Watson and Himelick, 1997; Harris et al., 1999). The idea of providing compensatory planting in lieu of preserving trees should be scrutinized with caution, for no amount of new planting could make up for the loss of a magnificent old tree.

In case it is necessary to transplant large champion trees, a team composed of a tree specialist and a structural engineer should be formed to jointly plan and execute the complex task. Most importantly, the tree has to be prepared well in advance to reduce the transplant shock and to increase the chance of success. The indispensable phased root pruning stage is, unfortunately, too commonly omitted. Ideally, a tree should be transplanted with all its roots together with the soil that envelops them, in an undisturbed soil mass call the root ball. During the move, the soil in the root ball must not be disturbed or deformed, or else the roots will be seriously injured or broken. In practice, moving all the roots is not possible, because the root ball will be too large and heavy. Based on tree science research findings, the compromise is to move a manageable amount of roots, such that the root ball could be lifted and transported with available construction equipments to the receiving site.

The recommended minimum width of the root ball should be ten times the trunk diameter at breast height (DBH) (Watson and Himelick, 2005), and depth 1-2 m, depending on tree size. As tree roots commonly spread to a soil area much larger than the recommended dimension, they have to be cut in preparing the root ball. Adhering to the prescribed root ball size often entails losing over 80% of a tree's roots. This root loss is too drastic for trees, and it will impose tremendous stresses on its normal function and health (Jim, 1995). Some trees that cannot tolerate such losses may perish. Others may struggle to survive in a

badly emaciated state. It will take a long time for the injured tree to recover, and often full recovery may not be feasible. To reduce the harmful effects of massive root amputation in preparing the root ball, root pruning has to be implemented in phases with intervening recuperative periods to permit the tree to overcome the acute stresses. For a large tree, root pruning should be divided into at least four phases, each to be separated by at least six months. It means that the transplant work should be initiated two years in advance. Unfortunately, for most construction projects, this advanced planning horizon cannot be realized due to ignorance of transplanting concepts and practices.

The receiving site should be carefully chosen and prepared to make sure it will permit the continued healthy growth of the new migrant. It should provide adequate rooms to accommodate the tree plus extra spaces for future expansion. As the need to reserve rooms for continued growth is often neglected, clear guidelines on the design of receiving sites could be written to help the relevant professionals. The soil and drainage at the receiving site should match those at the source site to reduce the problem of poor adaptation to alien growth conditions. Similarly, the microclimatic environment should as far as possible be matched, so that wind and solar exposure, temperature and humidity parameters would not unduly stress the transplanted tree. Such precision arboriculture based firmly on tree research findings should find their way into modern urban forestry practice.

4.5 Upgrade tree care quality and timeliness

The low quality and delayed tree care could not nurture the next generation of healthy and robust trees. Arboriculture and urban forestry in south cities are constrained by some weak links and gaps in relevant knowledge and applications. Trees tend to suffer from inadequate and unprofessional maintenance (Watson and Himelick, 1997; Harris et al., 1999). Newly planted trees may receive more attention mainly due to the post-planting maintenance and warranty of one to two years, which is included in the landscape planting contract. Long-term and preventive tree care, however, often do not receive sufficient attention. The mature trees, including outstanding champions, tend to be neglected until they develop discernible distress symptoms. As most urban trees encounter more growth problems than their countryside cousins, they require more care which is often not forthcoming. The urban tree management package could be revised to channel more attention to tree care, especially to treat the work as a long-term enterprise (Jim, 2000). A cradle-to-grave approach could include systematic planting, care as well as felling.

Urban trees in south cities are often inflicted by problems that originate from

poor quality planting materials. The common arboricultural maladies could be traced to poor nursery practice, which is unable to provide modern and consistent standard in plant production. For urban trees, the common weaknesses include lack of vigour, crossed branches, v-crotch, unbalanced crown, crooked or curved trunk, multiple stems, wounds, decays, sparse foliage, kinked or girdling roots, injured roots, pest and disease infestation, and tiny root ball (Jim, 1997c). Such inherited problems appearing from seedling and sapling stages, would in time develop into long-term liabilities and potential hazards. The root cause of these problems lies in the nursery, where the lack of selection of seeds and seedlings to eliminate weaklings, and little corrective pruning and branch training. To bring improvements, it is necessary to overhaul the nursery production methods and installations, aiming squarely at turning out high-quality planting materials. A more vigorous specification of planting materials could set the requisite technical standards, which require the cooperation of the landscape professions for effective enforcement. There is a need to institute a rigorous plan to scrutinize planting materials and reject the substandard ones. None should be permitted to scrape through the net and planted in the landscape.

The poor tree management in south cities could be partly ascribed to the lack of tree inspection. To provide prompt treatment of problems, urban trees should be regularly inspected by following a comprehensive proforma and a schedule. The visual tree assessment based on the latest advances in the concepts and practice of body language of trees should be supplemented by instrumental tests, to be conducted by a qualified specialist to identify the symptoms in good time. Some problems could be forestalled by the application of preventive or pre-emptive maintenance to reduce the future need for care. The problems could be classified into different grades in terms of the degree of exigency, and should be given timely treatments accordingly. Procrastination will incur more problems and more needs to tinker. What is lost is more than time, for it could include losing the trees, as well as properties and lives.

The tree care staff should be trained to a high level of competence in terms of knowledge and its application. Training should be commensurate with the staff grade and job responsibilities. Junior staff at the worker level should receive basic training. In addition, technical skills in horticulture and arboriculture could be provided by on-the-job training and formal courses offered in conjunction with local technical colleges. It is important to educate tree specialist to serve as urban foresters, who should receive formal education to the degree level in urban forestry or urban horticulture. Where resource is available, the staff should attend overseas university programmes to the master degree level. The specialist staff

could take up continuing professional development (CPD) to keep them abreast of the latest concepts and practices. The establishment of an urban forester post with an attractive compensation package could provide leadership to the government's tree team. Overseas secondment and professional visits could encourage exchange of ideas and best practices based on first-hand experience.

Urban forestry knowledge especially on native species is lacking in south cities. Relevant researches, hitherto mainly conducted in developed countries, may not be directly transferable to the developing world. The general shortage of applied research work on urban forestry in south cities is hindering urban greening work. With a large pool of potentially suitable species and wide variations in native species composition, research support could be strengthened to build up the local knowledge repertoire and local capability. The enhanced networking of scientists and practitioners in an urban forestry league, to be grouped by geographical regions, will facilitate the sharing of research resources and findings. The construction of databases of local amenity trees, and of relevant researchers and practitioners, coupled with regular communications, meetings and exchanges, will gradually establish the necessary scientific infrastructure to further the cause of urban forestry in south cities.

5 .Augmenting greening opportunities

5.1 Hone planting techniques at narrow roadsides

Adherence to conventional tree planting techniques cannot be expected to increase the quantity and quality of roadside trees in compact south cities. In compact south cities, the roadside space above and below the ground is commonly inadequate or unsuitable for trees (Chevallerie, 1986; Jim, 1997a, 1997b). In old urban areas, buildings are usually constructed at 100% site coverage with little setback from the lot frontage for trees. Pavements are usually too narrow or too heavily used to afford tree planting (Kuhns et al., 1985; Evans et al., 1990). Buildings in high-density areas usually have awnings or arcades built above the pavement. In medium- and low-density areas, where setbacks are sometimes provided, it is usually cordoned off by a wall, within which the land is often paved with concrete to serve parking or other non-green uses.

If a minimum setback of 3 m could be established along roadsides, a tree strip could be created in many densely-packed urban areas. The setback could be created by urban redevelopment. If not, a tree strip could be created by converting one vehicular carriageway. Building awning and other appurtenances, especially advertisement signs, should not intrude into the growth space. Similarly, the

underground space in the tree strip should also be reserved for tree roots, and buried utilities and other subsurface installation should not infringe. To ensure that trees can grow well, the tree strip should have a soil depth of at least 1 m. Where space is not available, a narrower roadside planting strip of 1 m wide or less could be provided for shrubs and herbaceous vegetation.

To encourage more common occurrence of setback which is essential in enhancing tree planting in old areas, incentives such as the transfer of development rights of the setback strips to the remainder of the plot, or the reward of bonus plot ratio, could be given. More importantly, wider setback strips should be encouraged to accommodate large trees and to bring notable landscape improvement (Jim, 1999). The planting strip land should be accessible to the public. For sites that can provide generous setback wider than 3 m, considerations could be given to creating a road-median planting strip in addition to the lot-frontage one to bring more notable streetcscape improvement. Hard landscape features could accompany the new green strips or areas to make the roadside environment more pleasant and less stressful to pedestrians. South cities could establish a comprehensive and integrated approach to introducing greenery into old city areas. It should be added that roadside trees are the most cost-effective and conspicuous way to significantly enhance the cityscape.

5.2 Ameliorate pervasive urban soil constraints

Urban soils especially at roadsides, often not conducive to healthy tree growth due to common occurrence of physical and chemical limitations, are seldom improved in greening programmes. The main problems are the shallowness of the soil layer, rocks within the rooting zone, building foundations, utility junction and control boxes, excessive amount of stones and sand, poor soil structure, soil compaction, and sealing of the soil surface by concrete or asphalt (Jim, 1993; Perry, 1994; Jim, 1998c). The soil environment has poor aeration, limited moisture holding capacity and impeded drainage (Jim and Ng, 2000). The poor chemical properties of urban soils are also unfavourable to plant growth. They tend to be contaminated by construction rubbles which contain calcareous concrete and cement fragments that raise the soil reaction to the harmful alkaline range. Urban soils are the sink for pollutants brought by run-on water, rainfall and gravity settlement from the atmosphere (Craul, 1980; Jim, 1998d). The shortage of available nutrients, especially the essential nitrogen and phosphorus, also dampens tree growth (Jim, 1998e, 1998f).

The fact that poor soil cannot be expected to support healthy trees, albeit a truism, has all too often been neglected (Bullock and Gregory, 1991; Craul,

1992). There is a widespread misconception that any soil can grow trees, and soil deficiencies can be easily rectified. As a result, urban trees are commonly planted in poor site soil without the benefit of improvement. Inferior soil trapped in the urban landscape after construction of buildings and roads is difficult to ameliorate or replace. The intractable deficiencies in the growing medium will linger. Trees growing in such poor soil cannot be expected to perform well and may incur heavy management liabilities. As soil materials are relatively inexpensive, poor site soils should be replaced by a good soil mix before trees are planted. Soil replacement should cover a broad area down to about 1 m deep (Lindsey and Bassuk, 1991). Localized improvement within a tree pit will not help, as the small improved soil volume will soon be outgrown by the tree. At roadsides, a continuous soil corridor could be installed, with a reinforced concrete cover to return walkable surface to pedestrians. Adjacent trees can share the soil to spread its roots to enhance tree growth.

5.3 Mobilize innovative greening ideas and sites

The planners and managers of urban greening often fail to think out of the box to find innovative opportunities and solutions. In old urban areas, redevelopment could offer chances to increase plantable spaces within and at the frontage of the site. In neighbourhoods where the built-up density is exceptionally high and green space provision is grossly inadequate, brown sites could be converted to green spaces to bring relief. The development right of the enlisted land parcel could be transferred to another site outside the neighbourhood in question. It is often transferred to new development areas where built-up density is lower and green space provision is sufficient. Such shifting of plot ratio or development right could be applied systematically to gradually improve the landscape and environmental qualities of old urban areas. Incentives could be offered and planning laws could be amended to encourage developers to participate in the land use restructuring.

Many side streets are hardly used by vehicles. Vehicular flows could be diverted to nearby roads so that they could be pedestrianized and planted. Simple planting with beautiful flowering trees is probably more welcomed by residents than expensive hard landscape installations. However, the need to provide clearance for emergency vehicle access often restricts planting opportunities in pedestrianized streets that are narrow. As a result, planting has to be limited on the edge and on one side only; where the streets are too narrow, planting is often not permitted. To overcome this constraint, small trees can be planted in containers that can easily be shifted.

The amenity value of old river courses or canals are sometimes neglected in

old city areas. Some may become contaminated or clogged, and others may be covered by a deck. They could be restored and revitalized by cleaning the water course in conjunction with greening of the banks to create blueways bordered by greenways. As people have strong affinity for water, particularly the land-water interface, such transformed amenity strips could serve as linear urban parks. The water surfaces together with vegetation could lower air temperature and ameliorate the urban heat island effect. The waterfront area facing the harbour in some cities could similarly be upgraded to create a green promenade with attendant benefits.

Many city areas have on-street parking spaces at the kerbside. Where such road sections do not have sufficient spaces to plant trees in tree strips or tree pits, the area between parking spaces could be mobilized to plant trees. If necessary, a tree pit with a metal grille could be installed at grade to minimize the loss of parking spaces. Alternatively, a raised planter could be placed at the same locations, which will reduce the total number of parking spaces. In this way, streets that are otherwise treeless could be adorned with roadside trees.

Some cities have tramways or railways laid along roads, often at the median position. The land surfaces between the rails are conventionally paved with concrete, asphalt or stones. Such long strips that penetrate different districts do not need to remain hard and harsh. Instead, they could be replaced with soil and planted with herbaceous vegetation. Besides laying a turf cover, the use of native flowering herbs could significantly improve the streetscape. Where the tracks are shared with other vehicular traffic, a porous paving system could be adopted to carrying the traffic load whilst allowing for some grass growth. Many European cities have extensive track sections greened in this manner, adding a new dimension to the urban greening stock. South cities could learn from this good practice, test the methods and modify them to suit local conditions.

As many south cities have pervasively compact developments, the amount of plantable spaces available at the ground level is limited. The many thousands of flat roof tops of existing buildings, however, remain largely barren. Such above-ground sites could be earnestly explored for green roof installation. Where the loading capacity is limited, the light-weight extensive green roofs could be adopted. Where the roof slab is strong enough to bear heavy loads, the intensive green roofs that include small trees and shrubs could provide high quality gardens literally in the sky (Jim, 2008). The green roof sites could offer additional recreational areas to supplement the ground-level green space stock. Moreover, they could bring a host of environmental and ecological benefits such as temperature cooling, air pollutant removal, noise reduction, storm water discharge reduction, storm water quality improvement, and wildlife habitats

(Dunnett and Kingsbury, 2004).

In the above ground environment, the numerous building facades and walls in general offer many vertical greening opportunities that have hardly been enlisted by south cities (Alexandri and Jones, 2008). The materials and methods of setting up green walls could be evaluated to develop appropriate technology that suit local conditions. In particular, the native species, preferably flowering climbers that could enliven vertical habitats, could be screened and tested by field experiments. Green walls could bring benefits similar to green roofs, plus the more prominent visual amenity to invigorate the townscape.

6. Conclusion

Urban greening in many south cities has a long established tradition, but it is beset by multiple and vexing constraints. Fast urban expansion has strained the quality of the environment and urban life. Urban greening could be degraded, left behind and swept aside in the hasty rush towards economic development. It is advocated that development and greening could go hand in hand to contribute to sustainable development and smart growth. Urban greenery could be construed as an indispensable infrastructure, rather than dispensable elements to fill left-over, odd and confined niches. The urban planning process would need to be overhauled to encompass this fundamental tenet. The modern naturalistic or ecological approach could bring a new dimension to the design of urban green spaces. Aligning the spatial pattern of green spaces with nature in a well connected network that permeates the city could significantly improve their benefits and functions. A pleasant bonus is the reduction in the capital and recurrent costs of the urban greening programme.

The technical obstacles should not be difficult to overcome, but they would need to be appropriately adjusted or modified to render them appropriate to the local environment. People could receive training to master the relevant urban forestry and arboricultual concepts and skills to strengthen this aspect of the greening equation. The quality of tree professionals and workers, and associated equipment, should be amenable to improvement. The more difficult hurdles lie in the institutional bottlenecks and psychological barriers. To upgrade urban greening, south cities would need to revamp its administrative and statutory regimes. Enacting a comprehensive urban greening ordinance will provide impetus and a structured framework to greening work. Encouraging public participation and engagement could make urban greening relevant and welcome by citizens. The persistent adherence to the modern and urbanized strand of environmental determinism, that compact cities cannot become meritorious

green cities, has stifled initiatives and enthusiasm. The general neglect of tree care could be rectified by adopting a long-term vision of transgenerational urban forestry and arboriculture. The inertia of sticking to the old fashioned, anachronistic and often erroneous tree-related techniques presents another hindrance. Cities could be compact and green, with the help of meticulous attention to every aspect of the urban greening complex. The overriding concern of quality has to permeate all greening plans and tasks. There are no shortcuts, but there is the way if there is the will.

The knowledge gap in south cities, with particular reference to the use and care of native species in urban horticultural applications, would need to be filled by research. This would bring up the issue of adequacy in the research infrastructure, well-trained research scientists, research funding, and an enabling research environment. There is a pressing need to break out of the rut and to move into the innovative and inventive mode, so as to bring tree knowledge and practice to a higher standard. The principal factor that will make or mar the urban greening endeavour is the quality of the clinching tripartite: researchers, practitioners, and decision makers. If they could nurture a fruitful synergy and excel in unison, urban greening work could move forward with facilitation and in strides; if not, it may stall or even falter.

A major difference between a developed and developing economy is that the former takes efforts where it is justified to find a balance between development and nature, whereas the latter tilts very much towards development. A developed economy also tends to put more emphasis on research and the integration of research findings into policies and practices (Mazzotti and Morgenstern, 1997). A well-recognized hallmark of a truly liveable and sustainable city is the embodiment of sufficient natural and green ingredients in a permeating and intermixed configuration with the built-up matrix. The basic precept is to include trees into a plan (Petit et al., 1995), that is wherever and whenever we build, we also plant. It is not a Herculean task and it is entirely feasible. The major obstacles lie in the administrative, political and policy realms (Duvernoy, 1995; Bowers, 1999). We need determination, innovative spirit and vision to take our urban greening ideas and ideals to fruition.

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خطة عملية للتشجير والتطوير المستدام للمدن الجنوبية

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الملخص:

تشجـير المناطق الحضرية يحسن من مستوى البيئة ومستـوى المعيشة وصحة الانسان والنظام البيئي بالمدن. والمدن في جميع انحـاء العالم تبذل الجهود تجاه التشجـير والخضرة لتحقيق الاستدامة الحضرية. الا ان المدن الجنوبية تعاني باستمرار من قلـة الفضـاءات الخضـراء وخاصة في الاحياء والمراكز القديمة. كمـا ان التجديد العمراني والتطويـر الحالي ربما لن ينجح في حـل هذه المسألـة، وقلة المعرفة تزيد مـن الصعوبات. بالتالي هناك حاجـة للسياسات العامة المبتكـرة وتقنيات التشجير الحديثـة للتحسـين طويل الامد. والتكامل بين العلوم الطبيعية والعلوم الاجتماعيـة في منهجية عديدة التخصصات مع تقوية العلاقـة بـين العلوم والسياسات العامة مـن شأنه ان ينشط جهود التشجـير في المدن الجنوبية. ويجـب ان يتعاون القطاعان العـام والخاص لايجاد فراغات خضراء وغرس النباتات في النسيج الحضري. واعتمادا على دراسات مكثفة للمدن الجنوبية والشماليـة ومبـادئ البيئة الحضرية يقترح البحث محـاور رئيسية لخطة عملية للتشجير وخلـق الفضاءات الخضراء. واهم سمات التصميم المقترح هو سلسلة من الفضاءات الخضراء المتصلة لتكون نسيج يخترق كافة المدينة مع الحفاظ على النظام البيئـي الطبيعـي وخلق فضاءات متنوعة الخضرة. ولا بد ان تشمل المنفعة مـن التخضير الحضري الجانب الاقتصادي ايضا ليكـون مكمـلا للجانب البيئي. يشمل ذلك حماية الاشجار في مواقع البنـاء والحفاظ على الاشجار المميزة. ويتطلب ذلك رفع مستـوى مهارات غرس والعناية بالاشجار على جوانب الطرق، بالاضافة الى تحسين نوعية التربة. كذلك الحاجة الى الافكار الخلاقـة لايجـاد مناطق المشاة الحرة من السيارات، واحياء القنوات والانهار، واستخدام اسطح المباني الخضراء والجدران الخضراء مما يضيف المزيد من المساحات الخضراء.