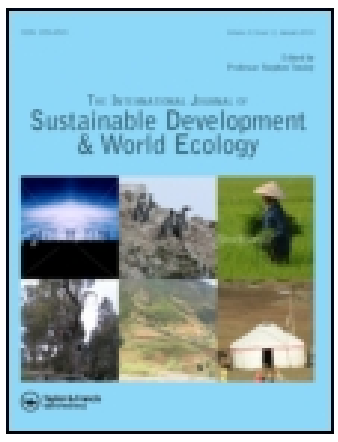
Volume 15 Number 5 October 2008
Published Bi-monthly ISSN: 1350–4509

THE INTERNATIONAL JOURNAL OF SUSTAINABLE DEVELOPMENT & WORLD ECOLOGY

SAPIENS PUBLISHING

LONDON • DUMFRIES



International Journal of Sustainable Development & World Ecology
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/tsdw20

Prospects and challenges for incorporating trees into urban infrastructural developments in Nigeria

Opeyemi Isaac Ajewole
Published online: 08 Apr 2010.

To cite this article: Opeyemi Isaac Ajewole (2008) Prospects and challenges for incorporating trees into urban infrastructural developments in Nigeria, International Journal of Sustainable Development & World Ecology, 15:5, 419-429, DOI: 10.3843/SusDev.15.5:3

To link to this article: http://dx.doi.org/10.3843/SusDev.15.5:3

International Journal of Sustainable Development & World Ecology 15 (2008) 419–429
DOI 10.3843/SusDev.15.5:3

Prospects and challenges for incorporating trees into urban infrastructural developments in Nigeria

Opeyemi Isaac Ajewole

Department of Forestry, Wildlife and Fisheries Management, University of Ado-Ekiti, Ekiti State, Nigeria

Key words: Urbanisation, environment, urban forestry, infrastructural development, developing countries

SUMMARY

Nigeria's major cities are characterised by huge and growing social and environmental problems, such as air, land and noise pollution; non-conducive local microclimatic conditions; and stressful social and psychological living environments. These result from inadequate, dilapidated and overstretched infrastructure, degraded urban physiognomy, increasing levels of unemployment, crime, insecurity and other social vices. These, in addition to inherent technical and economic constraints, make the incorporation of trees into the social and physical fabric of overall planning of towns and cities in Nigeria imperative. This is a natural and cost-effective means of alleviating environmental, social and economic problems in many of the Nigerian major cities. Successful integration of trees/forests into overall urban planning will require the development of appropriate information, policy, administrative and legal frameworks, enlistment of social and political support, as well as appraisal of technical feasibility and environmental suitability of incorporation into the urban landscape. More importantly, sustainable urban forestry development in Nigeria will of necessity require the availability and readiness of NGOs to spearhead an urban forestry movement in the country.

INTRODUCTION

Urbanisation, which is most rapid in developing countries, is causing major social and economic changes, together with increasing demand for basic needs, such as fuelwood, low-cost construction materials, drinking water and water for household use (Carter 1994). These needs are in addition to huge and growing social and environmental problems, such as (i) air, land and noise pollution; (ii) non-conducive local microclimatic conditions; and (iii) stressful social and psychological living environments resulting from inadequate, dilapidated and overstretched infrastructure, degraded urban physiognomy, increasing levels of unemployment, crime, insecurity and other social vices inherent in many urban centres in Nigeria (Ajewole 2005).

The urban environment is generally characterised by impervious surfaces, and highly reflective and radiating materials like concrete, asphalt and metals. These are in addition to the presence of

Correspondence: Opeyemi Isaac Ajewole, Department of Forestry, Wildlife and Fisheries Management, University of Ado-Ekiti, Ado-Ekiti, Ekiti State, Nigeria. E-mail: opeajewole@justice.com

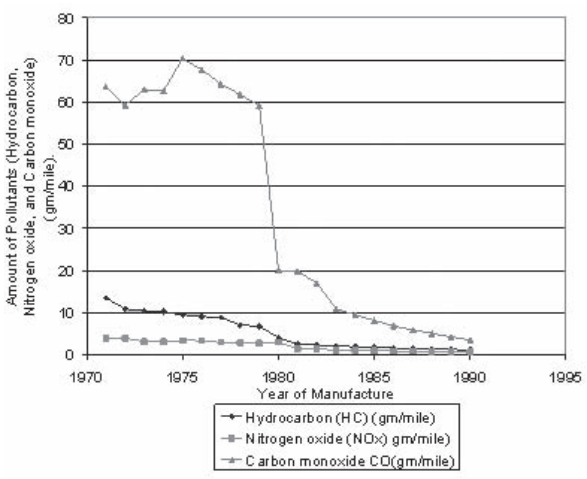


Figure 1 Trend in the Amount of Pollutants Emitted by Automotives According to Year of Manufacture (1971–1990). Source: Adapted from Darnay A.J. (1994) Statistical Record of the Environment, 2nd Edition

heavy industrial and economic activities, such as heating, cooking and transportation. All of these have inherent capacities to produce immense heat, smoke and dust, which severally and collectively degrade the urban environment. The degradation, which often results in environmental hazards such as flood disasters, higher median temperature, drier air and emission of induced haze or fog-blocked sunlight, are inimical to urban residents' health and safety.

According to the FAO (2000), rising motor vehicle use – reflecting the increasingly sprawling form of many cities – poses the greatest threat to air quality in urban centres. Transportation causes the emission of carbon monoxide, nitrogen oxides, hydrocarbons (in the form of gasoline and diesel fumes) and lead (Pb). Meanwhile the combination of hydrocarbons and nitrogen oxides produces smog and is responsible for respiratory ailments, while carbon monoxide on its own is very toxic. Darnay (1994) calculated the amount of pollutants produced by an automobile manufactured in 1990 as 3.51gm/mile carbon monoxide, 1.17gm/mile hydrocarbons and 0.67gm/mile nitrogen oxides. These portend grave environmental pollution and hazards in a country like Nigeria, which is flooded with imported dilapidated old vehicles from the Western world, many of which were manufactured over two or more decades ago. These old models emit larger amounts of pollutants to the environment (Figure 1).

Beside transportation, process industries (steel, petroleum, cement, chemicals, pulp and paper) are prevalent in urban areas and are also responsible for large quantities of particulate emissions (ash and dust) and chemical pollutants of various kinds. Moreover, virtually all other industrial production activities emit some form of air pollutant from the combustion of fuels and handling of raw materials, solvents and other chemicals. Thus urban centres – where large quantities of energy are being consumed – are important sources of greenhouse gasses, which pose a threat to the stability of the global climate. In addition to air and land pollution, noise is another major source of pollution in Nigerian cities. Sources of unwelcome noise are machinery, machine operations, air traffic (transportation), religious activities and musical advertisements. Furthermore, Kuchelmeister (2000) showed that conversion of forests and farmland to urban developments reduces water-permeable areas, upsets natural drainage patterns and causes serious flooding.

Control strategies for pollutants are several and diverse, just like the pollution sources themselves, and have been broadly classified as: technical, preventive or social/institutional. However, their expected success has been largely prevented by technical limitations, as well as political and economic snags in developing countries such as Nigeria. Even then, Darnay (1994) still argued that technical procedures merely tend to transform air pollutants into solid wastes, sludge or waterborne wastes, which still require further handling. Other problems associated with urbanisation include production of wastewater which requires treatment and safe disposal, polluted runoff that threatens human health, stressful living conditions, urban poverty, pronounced incidence of crime, unemployment and loss of biodiversity occasioned by the destruction of habitats and the disruption of the ecosystem equilibrium, when lands are converted to urban uses.

The foregoing numerous environmental and social problems characterising urban centres in developing countries, as well as the technical and economic constraints confronting these countries, therefore make the incorporation of trees into the social and physical fabric of overall planning of towns and cities in developing countries very important. This is a natural and cost-effective means of alleviating environmental, social and

economic problems prevalent in many urban centres of developing countries. Collins (1997) noted that the benefits of urban trees/forests are such that, in major centres throughout the world, urban trees/ forests are no longer regarded simply as aesthetic elements of the urban landscape; rather they have become a vital component of the urban infrastructure, essential in maintaining a habitable and sustainable environment. According to Jim (2000), introducing trees into built-up areas fulfils many environmental, social and economic functions, as well as satisfying an innate human need. Therefore, nurturing of greenery in urban centres can be equated with the provisions of an essential urban infrastructure.

BENEFITS OF TREES IN URBAN SETTINGS

The potential benefits of urban trees/forests are environmental, social and economic. The economic or material benefits consist of fuelwood, fodder, timber and poles, spices, fibres, medicines and other non-timber forest produce (NTFPs). These may fulfil subsistence needs or be used as a means of income generation for the urban poor or operators of cottage industries. Environmental and social benefits, on the other hand, include landscape enhancement, recreation, education and general well being; a habitat for wildlife, climate modification, control of air and noise pollution, erosion control, protection of catchment areas for urban water supplies, and the productive use or safe disposal of urban wastes (Ajewole 2005; Carter 1994). Furthermore, trees can be used in urban design to provide shade and shelter, create and define spaces, complement architecture, separate conflicting land uses and screen unpleasant views, among other things (Webb 1999).

Urban trees/forests have a positive impact on air quality through deposition of pollutants on the vegetation canopy, sequestration of atmospheric CO_2 in woody biomass and reduction of (summertime) temperatures and associated ozone formation. Links between air pollutants and both heart and lung disease are widely accepted. Asthma sufferers find that air pollution makes their symptoms worse (NUFU 2001). Fine particles and gases such as nitrogen dioxide are significant air pollutants that are produced in part by the combustion of petrol, oil and gas. Trees act as filters and leaves have a surface area up to twelve-times greater than the ground they overshadow, helping to trap dust and carbon particles and absorb harmful gases. On sunny days, shade from urban trees/forests also helps to slow the formation of harmful ozone. Therefore, leafy town parks and tree-lined streets help to clean the air we breathe and make it healthier.

Urban trees/forests are one of the most cost-effective means of mitigating urban heat islands and associated expenditure for air conditioning. Trees also intercept and store rainfall, thereby reducing runoff volumes and delaying the onsets of peak flows. Root growth and decomposition increase the capacity and rate of soil infiltration by rainfall and reduce overland flow. Urban trees/ forest canopies reduce soil erosion by diminishing the impact of raindrops on barren surfaces. By virtue of their proximity to people, urban trees/ forests can provide substantial environmental and recreational benefits to urban dwellers. Trees, as a solar-powered technology, help restore the balance to dysfunctional urban ecosystems. In addition, urban forests are part of the urban fabric that connects people to nature and to each other (FAO 2000). Trees in the urban environment provide a psychological link beyond the purely social environment of the city. They provide an important connection for city dwellers to the living forces of nature. Since their lifetimes are similar to those of people, their growth and changes over the years provide temporal markers to human lives that are growing and changing at the same time.

Stress seems to be a fact of life for those who live and work in cities. It is discernible and measurable in muscle tension and blood pressure, and research has shown that there is significant stress relief when we have access to trees and greenery for as little as 3 min (NUFU 2001). Stress increases the risk of heart disease, which is a serious threat to health. Therefore, the stressfulness of urban living can be reduced through investment in urban forestry. According to NUFU (2001), people recovering from major surgery benefit from seeing trees, they need less pain relieving medication and stay in hospital for a shorter period, so surrounding hospitals with trees can improve healthcare and economic efficiency. Trees also make staff feel less stressed, improve their quality of life at work and make them even more effective. Growing, planting and caring for trees is very therapeutic and has been widely

used to help people with learning difficulties, physical disabilities and those recovering from a stroke. Growing and planting are seen as normal, everyday activities, all abilities can be catered for and the sense of achievement and optimism which these activities promote can be rewarding.

Whether as single specimens, continuous lines, small groups, or large masses, trees can be seen as objects in the overall visual landscape of a city, where they play an important aesthetic role. Much of this comes from their forms, textures, colours and fragrances, even their movement in a breeze. They enliven the view of otherwise monotonous urban landscapes. Most planted urban vegetation contains some of the aesthetic quality of a garden, and this makes a city a pleasant place to be enjoyed in a relaxing way. Urban forest changes the mood of the urban landscape and makes it a place where beauty and grace become public values. It can also serve as a means of educating and improving social behaviour, and providing a peaceful outlet for the tensions of working class life. For instance, the British Select Committee on Public Walks of 1833 believed that a man walking out with his family among his neighbours would naturally be desirous to be properly clothed, and that his wife and children should be so. This desire duly directed and controlled, had a powerful effect in promoting civilisation (Lawrence 1995). Similarly, Americans were reported to believe in the idea of moral improvement through contact with beauty and nature. To this effect Lawrence (1995) reported that Central Park in New York exerted a distinctly harmonising and refining influence over the 'most unfortunate and lawless classes of the city,' an influence favourable to courtesy, self control and temperance.

Bradley (1995) viewed the benefits of urban forests as being both global in nature, such as the potential for reducing urban heat island effects, and very personal, since they answer the human need for exposure to green spaces in order to maintain a sense of well-being. He submitted that the soothing and settling psychological effects that green experiences have on humans provide a renewed sense of well-being. Moreover, opportunities for reflection, undisturbed thought, and invigorating sights provided by urban forests make an individual refreshed and renewed for daily activities. Miller (1997), citing Appleyard (1978), summarised the significance of urban trees under three categories as they apply to our perception of them in the environment: sensory, instrumental and symbolic. As sensory features in the landscape, trees are appreciated as natural forms, ornaments, incense, sound and visual screens, and as a contrast to the harsh lines of the urban landscape. The instrumental functions of urban trees are to provide shade, shelter, environmental protection, recreation, fruits and, to a limited degree, wood. Trees serve as symbols of nature in the urban scene and symbols of one's self or group when identified with a particular area or neighbourhood. For instance, in many parts of Africa, green neighbourhoods are often identified as residential areas of the old colonial masters.

In Africa, trees fulfill an economic function, and those which produce foods or materials that are of domestic or medicinal use are never felled, especially in Sahel villages, which depend directly on them. Thus baobab trees, shea trees, fan palms, doum palms, neem and almond trees, among others, mark African villages out from a distance. Trees also have a social role, playing an essential part in the life of any African community as a place of dialogue, deliberation and education and also of rest and leisure (Rouchiche 1999). Therefore, as cities continue to grow, urban trees will play a prominent role as essential infrastructure, making urban life more conducive and productive. For this reason, it becomes imperative to understand how these trees/ forests can be planned and managed to provide optimum benefits for city dwellers.

REQUIREMENTS FOR SUSTAINABLE GREEN DEVELOPMENT IN THE URBAN ENVIRONMENT

Sustainable urban greening programmes will require the development of appropriate machineries to integrate urban forestry initiatives into the overall urban planning process. These will include the development of social and political support, appropriate information, policy, administrative and legal frameworks, as well as appraisal of technical feasibility and environmental suitability.

Social and political framework

Social and political aspects of urban greening have to do with the enlistment of supporters or an enthusiastic constituency that will garner resources, do the work, and maintain the urban forest landscape.

This is made up of environmental NGOs, donor agencies, business organisations, local groups of residents, individuals, politicians, etc. From the choice of trees to actual planting, tending and (where appropriate) harvesting of tree products, urban dwellers should be able and actively encouraged to participate in decision-making and implementation as much as possible. The essence of participation is that people's needs, opinions and preferences will be incorporated into planning and management. How this is organised will depend on local circumstances. In general, it is likely to be easier in residential areas where there is already a strong sense of communal or participatory project development. However, wherever it is adopted, the participatory process is unlikely to be simple, since urban communities are invariably made up of a variety of people of diverse socio-cultural and economic backgrounds. As a result, conflicts may exist between different groups, while individuals may vary in the readiness with which they express their views and, indeed, their interest in trees. The urban forester must be aware of these differences and try to consider them as much as possible.

Social and political frameworks for sustainable urban green development will have to take into consideration different perspectives on the choice of species to be planted. This is crucial when the person/people making this decision is/are different from those intended as the ultimate users. Whether planting takes place on public or private lands, some consultation regarding species selection is desirable between interested individuals. Carter (1994) noted that in developing countries, despite the spread of community and social forestry initiatives, decisions on species choice (as in other aspects of urban forestry) tend to take place in isolation. Thus, an individual planting a tree on private land is unlikely to consult a professional on the subject. Similarly, local residents are rarely involved in deciding what species are to be planted on public land. The decision seems to be taken in most cases by whichever body is responsible for implementing the planting, with little discussion with other professionals. Yet there may actually be major differences in opinion as to what constitutes a desirable species in a particular circumstance. Conflicts often exist between the perceptions of the technical forester and that of the urbanites, particularly the urban poor, about the desired attributes of trees that should be nurtured in the urban setting. Although such a conflict can be resolved through dialogue, species choice should yet ideally reflect the needs and the desires of local people, among other things.

Another key consideration is the role of politics in sustainable urban forestry development. The influence of politics is a reality, which successful urban forestry development programmes cannot ignore, particularly in situations where different projects are competing for funds. Those programmes and services having key political support are generally well funded. Political support is a manifestation of citizen concern, reflecting the wishes of the public or of key individuals who influence city administrators. Furthermore, there are public and private institutions in every city with which the urban forester may work to effect sustainable urban green development. Each contact provides opportunities to communicate information, obtain funds and services, and work with volunteers. These institutions include recreation clubs, professional organisations, environmental conservation organisations, NGOs, neighbourhoods or community-based organisations, youth organisations, business organisations, civic and service clubs, religious organisations and the media. Thus, it is imperative for the city forester to study the political environment and understand the forces influencing city governments.

Information framework

Information requirements for sustainable urban forestry development can be categorised as social and structural informational needs. Social information needs call for recognition and appreciation of the wealth of knowledge from local situations where people's perceptions are directly influenced by their experiences with urban vegetation. It should not be assumed from a lack of documentation that expertise or knowledge is necessarily lacking. Therefore, before considering any education programme for urban dwellers, it would be wise to establish what they do and do not know. Furthermore, in communicating our understanding of urban forests and the benefits they produce for communities, it is important to know how people learn, why they show interest in some but not in other information, and the processes that individuals go through before they find something to be important. While we may understand a particular idea and its merits, it may take a while for someone

else to understand the concept, why it may be important, how it can be implemented, and its long-term benefits to society. In communicating these ideas, many different methods of 'sending' the information should be explored. If we are to generate and disseminate knowledge about urban forests, then becoming critical scientists, effective transmitters of information, and perceptive listeners are essential to successful development of urban forestry (Kaplan 1995).

Structural information needs for sustainable urban forestry development require the determination of the present condition of the urban forest, in all parts of the urban landscape. Successful urban forestry development requires information on all vegetation and other attributes of the system across the urban landscape. This structural information establishes a basis for comprehensive management that recognises linkages among the multiple land uses and owners of the urban forest. Urban forest structural information also provides a means to estimate the actual and potential physical, biological, social and economic functions of the urban forest. Urban foresters can then develop plans and programmes that provide for these functions across the urban landscape.

The structural informational needs of the urban forest can be determined in several ways. According to Grey (1996), one can simply observe while riding or walking, and obtain a general idea of whether a particular area is in need of additional planting, hazard removal, corrective pruning or other action. One can also gain information as to relative sizes of trees from low-altitude aerial photographs, while infrared and other photographs can reveal insects or diseases. To determine overall need, one should begin with cover-type mapping of the entire urban forest to identify general vegetation communities. Cover-type mapping should have as its basis the various land-use situations that can be located from standard maps and aerial photographs. Aerial photographs can be used to identify open areas such as grass, tilled fields, wetlands, open water and tree-covered areas by type (hardwood or conifer), size, density and arrangement. Ground checks can then confirm or further refine type identification. The product of the foregoing processes is a general vegetative cover map of the entire urban area by land-use situation. The next step is to superimpose on the map those areas that may be managed directly and those that must be managed indirectly. Where practical, this process may be speeded and greatly refined using geographic information systems (GIS). Using advanced software, computers can scan visual images from aerial photographs, maps and even satellite images, allowing features to be delineated as layers. Coupled with ground checks and other information, fully detailed map images can be developed.

However, urban forest information needs are somewhat different for a functioning city forestry programme from that of a programme in early stages of development. With the former, the need is for site-specific information to facilitate establishment, maintenance and removal. This information must be obtained through formal inventories. With the latter, the need is for overview information to develop a long-range plan or to help make a convincing case for putting in place or improving a city forestry programme. This information can be gathered by less formal surveys.

Surveys fulfil the need to acquire relatively low-cost information to facilitate long-range planning or programme development. Thus, one must obtain different information for lands that require direct management than for lands that require indirect management. In areas for which a city forestry department is responsible and direct management is to be applied (streetsides, parks, other areas), one needs to know: (i) approximate number of trees, (ii) species, (iii) average size and age, (iv) condition and (v) stocking. For areas for which the city/local government is not responsible, and indirect management is to be applied (private and other public lands), one needs to know; (i) vegetation types and (ii) condition. From this information, we can quantify future direct management needs: number of trees to be planted, amount of pruning needed, number of trees to be removed and other practices. Reasonable conclusions can also be drawn as to indirect management needs for species and age diversity, health protection and improved arboriculture practices.

Policy framework

A policy is a document statement that articulates a definite and purposeful course of action capable of affecting a large number of people, and which has important consequences for a significant number and magnitude of resources (Konijnendijk 1997). The starting point for urban forest policy processes

is a given relationship between the urban forest resource and society. Therefore, an urban forest policy is a statement of plans by the government on how the urban forest resources can be used to sustainably meet the diverse needs of the different components of society. Having identified problems associated with sustainable and judicial use of the urban forest resources, alternative policies are formulated and, based on the use of appropriate criteria for policy principles of ecosystem sustainability, economic efficiency, community stability and balanced decision making (FAO 2001), a suitable policy is selected among the alternatives.

It is imperative to note that conflicts often arise in the development of urban forest policy as a result of the involvement of several and diverse actors in its formulation and implementation. The major actors involved in urban forestry policy processes include government (bureaucrats and legislators), the commercial sector, society/public NGOs and experts/scientists. These actors often have conflicting objectives and different ideas about which issues are important. A successful urban forest policy will have to consult widely with these actors, and harmonise their different positions in such a way as to minimise conflicts. Conflicts which reflect structural imbalances within the values and policies related to urban forestry, and within the use of urban forest resources are, however, essential incentives for urban forest policy making.

Administrative framework

An administrative framework relates to the mechanisms established to develop and implement urban forestry or city greening programmes. Such mechanisms include open space and street tree departments, city/urban forestry departments, etc. in charge of creating and maintaining a planting area. The success of urban forestry development programmes is a function of how well the planners articulate their vision and the extent to which they are effective in bringing their vision to reality. This requires a well-developed planning system. Planning should be a part of securing resources through fund raising, legislative appropriations, acquisition programmes, programme development, management and maintenance and long-term monitoring activities. Consequently, successful development of urban forestry programmes requires that someone must orchestrate management of the total urban forest. In essence, there must be an organisation with responsibility, authority and effective leadership. Such function must be that of the city forestry department with responsibility for betterment of the total urban forest within the city's jurisdiction. Its responsibility involves direct management in certain segments and indirect management in other situations. The function of a city forestry department is often vested in an organisation by that title but may also be carried out by other governmental units such as public works, natural resources or parks and streetsides resources. The city forestry programme should be supported and directed by a citizens' tree commission.

No matter how the city forestry programme is organised, someone must have overall authority and responsibility. Authority is generally established by ordinance or charter, which establishes the departmental function and provides the legal basis for operations. In some cases, by ordinance, the authority of the city forester is only for trees on city (public) property, with no stated responsibility for indirect management on other ownership, while in other cases there may be implied responsibility. Ideally, however, such responsibility should be clearly provided by ordinance. Nevertheless, ordinances can provide only the legal basis for individual performance. It is the city forester and staff, often supported, or administered by a citizens' board, that must orchestrate management (Grey 1996).

Legal framework

For effective, planned and systematic management of trees in cities, a measure of legal control is necessary. Laws may be necessary both to protect trees from removal and to protect residents from hazardous trees. Local ordinances provide, in many cases, the basis for street tree and urban and community forestry programmes. These ordinances essentially empower governments to develop, fund and staff programmes to acquire, preserve and maintain urban green spaces. As urban forestry matures beyond the confines of street tree programmes, to broader concepts of urban green development, it will be necessary to be more innovative in the use of legal mechanisms to achieve urban forestry goals. These innovations will include regulations, but to be long-lasting and gain broader acceptance, they

must also include incentive programmes and the acquisition of property through a variety of mechanisms that are acceptable to landowners as well as affordable for local and state government. According to Grey (1996), the general legal environment in which urban forestry operates has three primary components; ordinances, regulations and liability considerations. This classification does not ignore the total legal environment affecting society as a whole, but it is specific to legal matters concerning urban forestry operations.

Technical feasibility and environmental suitability

Technical issues in urban forestry development revolve round factors affecting tree establishment and management. Such factors include site conditions, future management requirements, availability and choice of planting stocks and removal of tree waste.

Site conditions

The nature of urban site conditions is highly complex and constitutes peculiar problems for tree cultivation and growth. Common problems are low levels of available nutrients, high compaction due to the impact of human and vehicular traffic and low soil organic matter levels. Consequently, the type and species of tree chosen for urban forestry projects must reflect known adaptability to and tolerance of such conditions (Table 1).

Future management requirements

In choosing a particular tree species or combination of species for planting, thought should be given to the need for future management. Factors that should be borne in mind include: growth rate and habit, water requirements, susceptibility to disease and weeding requirements.

Table 1 Site conditions common in urban environments and desirable attributes for trees planted on such sites

Site conditions	Desirable attributes
Soil compaction and poor drainage	*Robust rooting system *Tolerance to some anaerobic conditions
Low soil nutrient levels	*Nitrogen fixation or other microbial associations (e.g. mycorrhizae) *Deep rooting *Low physiological demand for nutrients
Low soil water availability	*A variety of mechanisms to reduce water stress, either based on maximising water uptake or limiting water loss
Soil pollution: e.g. saline conditions caused by salt applications to roads (in temperate countries); high heavy metal levels, etc.	*Tolerance to the pollutants in question
Air pollution: levels of pollutants vary in different locations	*Tolerance to pollutants in question, general characteristics that render the trees better at removing pollutants from the atmosphere
Proximity to buildings and other structures	*Rooting system: non-aggressive, deep rooting *Tree height: short trees preferable; large trees may interfere with overhead lines, and provide excess shading to buildings
Exposure to salt spray (in coastal locations)	*Tolerance to salt spray
Exposure to strong winds (more likely in coastal locations)	*No tendency for branches to split and break in strong winds *Deep rooting system

Source: Carter (1994)

Availability and choice of planting stock

The choice of tree to be planted depends ultimately on planting stock that is readily available. Planting material may be produced in nurseries run by public bodies (municipal councils or departments such as forestry, horticulture, roads or others), in private nurseries, or by individuals for their own use (or perhaps distribution among neighbours). Private commercial nurseries exist in many Third World towns and cities, and are often engaged in the production of ornamentals and fruit trees and may add significantly to the total available choice of species. It is crucial in urban settings to plant nursery stock of good form and quality, with a healthy root-to-shoot ratio. Saplings without this are unlikely to survive in compacted urban soils, and even if they do, they may become a hazard in later life, being more prone to wind throw, or other damage than trees with a well-developed root system. Similarly, saplings with damaged stems will grow into trees with an unbalanced branch system that may not only look unsightly, but could also be dangerous. The size of seedlings or saplings planted in urban situations is often considerably larger than those used in normal plantation forestry. However, the use of seedlings more than 60-cm high is now considered better as they are often more vigorous than larger saplings and catch up in size with the latter after a short period (Carter 1994).

Removal of tree waste

Key issues in the removal of tree waste are public safety, utilisation of removed material as appropriate, and limiting the spread of pests and diseases. Tree waste may serve a variety of useful purposes, from firewood to timber. Furthermore, in North America and Europe, many urban authorities make use of tree prunings by shredding them for compost or mulch, and such recycling is becoming an increasingly important feature of urban forest management. Inevitably urban trees will grow old and must be removed before they cause any damage. Technically, there are often complications in this due to the close proximity of buildings and other urban infrastructure. However, perhaps the most important issue for urban foresters is advance planning – ensuring that removal operations are timed to avoid any public hazard, rather than responding to a problem.

POTENTIAL PROBLEMS OF TREES IN URBAN AREAS

Threats to human safety

Poorly planted or inappropriate tree species can be a hazard to urban inhabitants, either directly (through falling branches or trees) or indirectly. The former may be particularly likely in countries where typhoons or hurricanes are regularly experienced. It is possible that they are also more common in former colonies, where trees planted in colonial times are now over-mature and in need of replacement. Whereas, in many developed countries, there is provision for ensuring the removal or treatment of dangerous trees, this may not exist or fail to be implemented in some developing countries. The general result is that there is probably more cause for genuine concern about the safety of trees in cities of developing rather than developed countries. Careful planting and choice of species, regular maintenance and a clear line of responsibility for dealing with dangerous trees would help to improve human safety. Indirect threats to human safety caused by trees include branches resting or spreading on overhead power lines, tree canopies obscuring vision and thus causing accidents, and trees serving as a screen for assailants. The former two, and to certain extent, the last can be generally avoided by a careful choice of species and regular maintenance. However, discouragement of would-be attackers requires additional measures, particularly in urban parks. A possible solution to this menace is to ensure that paths are covered by ground vegetation that tapers upwards into bushes and then into trees only some distance from the path. Furthermore, the choice of tree species should be restricted to those that will never grow large enough to provide adequate cover for an assailant in the areas where urban dwellers are likely to be more vulnerable to attack.

Structural damage

The roots of street trees often cause cracking of roads and pavements and sometimes water pipes. Urban trees can also cause structural damage to buildings, both at foundation level due to their roots, and through the falling of whole trees or branches. However, as with human safety, such problems can be minimised by careful species choice and maintenance.

Vandalism and browsing

Damage may be inflicted on trees simply out of intent to destroy, out of casual disregard as a consequence of harvesting tree products or by browsing livestock. In the developed world, deliberate and casual vandalism are generally a problem, while all four of the aforementioned problems occur in Third World cities, making Third World cities a more difficult environment to raise trees. The most important issue in combating all forms of human and animal-induced tree damage is gaining local people's support for and active involvement in tree cultivation. Apart from this, urban amenity planting can be planned in such a way as to minimise the likelihood of vandalism. For instance, trees planted within cultivated ground tend to be less susceptible to deliberate or casual damage than those surrounded by tarmac or concrete, as are those planted in groups compared with lone trees (Carter 1994).

Furthermore, the damage to trees when harvesting their products is primarily an issue revolving around the purpose of urban trees in different places. This can be minimised by public education on appropriate methods of harvesting such products. In a similar manner, damage from livestock may be minimised by the choice of non-fodder species, and the erection of individual tree guards around vulnerable plants (notably roadside sapling).

CONCLUSION

Many state capital cities in Nigeria, such as Lagos, Ibadan, Ado-Ekiti, Kaduna, Kano, Calabar, Makurdi and the Federal Capital Territory, are presently at different stages of city greening development. Moreover, Ajewole (2002, 2003, 2005) found that Ibadan and Lagos metropolitan public have great interest in supporting urban greening projects in the metropolitan centres. These developments signify good prospects for urban greening programmes in the country. However, current urban greening efforts are uncoordinated, both at national and regional (state) levels, and therefore might not be sustainable. Achieving sustainable urban green development in Nigeria will require the urgent consideration of the following aspects.

1. Development of policy and legal frameworks Available information on many urban greening projects showed that there is no substantive policy document to direct and guide sustainable urban forestry development, neither are there any substantive and appropriate legal instruments that are essential for sustainable urban forestry development. Yet policy and legislation provide the basis for street tree and urban forestry programmes and also empower governments to develop, fund and staff programmes, as well as to acquire, preserve and maintain urban green space. Therefore, it is crucial for states engaged in urban greening to put in place policy and legal frameworks to engender sustainable urban greening.

2. Development of an administrative framework Administrative mechanisms for urban tree establishment and management in Nigeria are generally situated in the forestry departments, either in the Ministry of Agriculture and Natural Resources or in the Ministry of Environment. For states such as Lagos where the forestry department is located in the Ministry of Agriculture, there is often conflict and ambiguity on whose responsibility it is to coordinate tree establishment and management. Thus, activities are grossly uncoordinated and without vision. This implies that there is an urgent need to establish a substantive urban forestry unit/agency to orchestrate urban forestry development efforts in all the states engaged in urban greening.

3. Establishment of a national urban forest agency Sustainable urban greening in Nigeria will of necessity require the establishment of a national urban forest agency. This agency will give leadership and direction in urban forest policy formulation and legislation for state governments. It will also coordinate urban forestry activities on federal lands and liaise with other federal government agencies that might have a stake in such lands.

4. Development of training facilities Sustainable urban forestry development cannot be achieved unless universities identify and grasp the changing demands and challenges of planting and managing trees in the modern urban environment. This requires producing graduates capable of meeting these challenges. Urban forestry curricula must be flexible enough to ensure that sufficient courses from supporting areas are included and designed, and professional courses in urban and environmental forestry need to be floated in the Nigerian universities.

5. Development of urban forestry movements Achieving the foregoing recommendations vis-à-vis

sustainable urban forestry in Nigeria depends largely on the availability of NGOs that are well placed, capable and ready to spearhead an urban forestry movement. This will shadow organisations such as the International Society for Arboriculture, the Society of American Foresters and the American Forestry Association in the USA, the Arboricultural Association in the United Kingdom and the Environmental Conservation Organisation in the Republic of Ireland. The Forestry Association of Nigeria (FAN) is well placed to take up this responsibility. FAN can set up urban forestry working committees which will, according to Ajewole (2006), play the following roles: serve as an engine room to start an urban forestry movement, articulate and disseminate urban forestry vision, mobilise government and public support for urban forestry development, and establish a network of all categories of crucial actors essential for urban forestry development in Nigeria. By so doing, FAN would succeed in establishing concrete foundation for sustainable development of urban forestry in Nigeria.

REFERENCES

Ajewole OI. Moving Nigerian Forestry Forward Through Urban Forestry Development: Lessons from the United States Experience. In Popoola L (ed.), *Proceedings of 31st Annual Conference of Forestry Association of Nigeria*; 2006:279–88

Ajewole OI. *Social and Institutional Determinants of Sustainable Urban Forestry Development in Lagos*. Ph.D Thesis, Department of Forest Resources Management, University of Ibadan, Ibadan, Nigeria; 2005

Ajewole OI. The Use of Tobit Models in Evaluating Prospective Participatory Financing of Rehabilitation of Ibadan Urban Forest Reserves. *Journal of Tropical Forest Resources* 2003;19(2):1–10

Ajewole OI. Prospect for Participatory Urban Forestry Development in Ibadan Metropolis. *Journal of Tropical Forest Resources* 2002;18(1):97–116

Appleyard D. *Urban Trees, Urban Forests: What Do They Mean?* Proc. National Urban Forest Conference, ESF Pub. 80–003. Syracuse: SUNY; 1978:138–55

Bradley GA. *Urban Forest Landscape. Integrating Multidisciplinary Perspectives*. Seattle and London: University of Washington Press; 1995:3–12

Carter EJ. *The Potential of Urban Forestry in Developing Countries: A Concept Paper*. Rome: FAO Forestry Department; 1994:90 pp.

Collins KD. Editorial. *Irish Forestry*. 1997:54:2–3

Darnay AJ. *Statistical Record of the Environment*. Detroit, Washington and London: Gale Research Inc; 1994:16–17

FAO. *Urban Forestry Issues in North America and Their Global Linkages*. North American Forest Commission; 2000:4–8

FAO. *Governance Principles for Concessions and Contracts in Public Forests*. Forestry Paper 139. Rome: FAO; 2001:14–16

Grey WG. *The Urban Forest: Comprehensive Management*. Oxford: John Wiley & Sons Inc. 1996:5–35

Jim CY. *The Urban Forestry Programme in the Heavily Built-up Milieu of Hong Kong Cities*; 2000:271–83

Kaplan R. Informational Issues: A Perspective on Human Needs and Inclinations. In Bradley GA (ed.), *Urban Forest Landscapes: Integrating Multidisciplinary Perspectives*. Washington DC: University of Washington Press; 1995:60–71

Konijnendijk CC. *Urban Forestry Overview and Analysis of European Forest Policies. Part 1: Conceptual Framework and European Urban Forestry History*. European Forest Institute Working Paper 12; 1997:17–25

Kuchelmeister G. Trees for the Urban Millennium: Urban Forestry Update. *Unasylva* 2000;50:49–55

Lawrence HW. Changing Forms and Persistent Values: Historical Perspectives on the Urban Forest. In Bradley GA (ed.), *Urban Forest Landscapes: Integrating Multidisciplinary Perspectives*. Washington DC: University of Washington Press; 1995: 17–40

Miller RW. *Urban Forestry Planning and Managing Urban Greenspaces*. New Jersey: Prentice Hall; 1997:24–6

NUFU. *Sustainable Urban Forestry: Benefiting Public Health*. The Science Park, Stafford Road, Wolverhampton, WV 10 9RT, UK; 2001

Rouchiche S. Urban and Peri-Urban Forestry in Africa; A case study of the Sahel. In *Urban and Peri-Urban Forestry; Case Studies for Developing Countries*. Rome: FAO; 1999:2–28

Webb R. Learning from Urban Forestry Programmes in South East Asia. *Arboricultural Journal* 1999; 23(1):39–56