BOOK OF READING IN FORESTRY, WILDLIFE MANAGEMENT AND FISHERIES

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URBAN FORESTRY AND PUBLIC HEALTH

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1.0 Introduction

Although we know intuitively what is "urban and what is rural", there is actually no universally accepted criteria for distinguishing between such settlements. The usual mechanism, common in national censuses, is to take population threshholds. Once a nucleated settlement grows beyond certain threshold, it becomes urban.

However, the United Nations has attempted to standardize data by defining settlements of 20,000 people as "urban", over 100000 as "cities" and over 5 million as big cities (Carter 1994). Bartone et al (1994) further categorised urban areas into four principal classes, comprising:

Large metropolitan areas which are made up of a number of large urban agglomerations with population greater than 2 milion. Large metropolitan areas encompass several

municipal jurisdictions

Large cities which are urban centres with populations ranging from 500,000-2 million.

Intermediate cities with populations of 100000-500000

Small cities and towns which are urban centres with populations of less than 100000.

An urban area is characterized by higher population density and vast human features in comparison to areas surrounding it. Urban areas may be cities, towns or conurbations, but the term is not commonly extended to rural settlements such as villages and hamlets.

Definitions vary somewhat between nations. European countries define urbanized areas on the basis of urban-type land use, not allowing any gaps of typically more than 200 m, and use satellite imagery instead of census blocks to determine the boundaries of the urban area. In less developed countries, in addition to land use and density requirements, a requirement that a large majority of the population, typically 75%, is not engaged in agriculture and/or fishing is sometimes used.

Unlike an urban area, a metropolitan area includes not only the urban area, but also satellite cities plus intervening rural land that is socio-economically connected to the urban core city, typically by employment ties through commuting, with the urban core city being the primary labor market (http://en.wikipedia.org/wiki/Urban_area, 2011).

Presently the number of people living in the world's cities has reached three billion, nearly half of the total population. By 2050 two-thirds of the total population will be living in the cities. The rapid

expansion of the cities and of their populations poses a challenge for a viable global environment (http://en.wikipedia.org/wiki/Urban_biosphere_reserve, 2009). The urban environment is a product of the diverse socio-economic activities geared towards meeting the needs of the burgeoing urban population.

Cities are both engines of growth and at the same time, sources of concentrated environmental problems. For instance:

* In Bangkok, excessive exposure to lead causes 200,000 - 500,000 cases of hypertension, resulting in 400 deaths a year. Rough estimates suggest that children with lead poisoning lose an average of four or more IQ points by the age of seven, with long-term implications for their productivity as adults (Bartone, 1994)
* In Mexico City, annual health costs from air pollution are estimated to exceed $1.5 billion. Abnormally, high levels of suspended particulates have caused an average lost of 2.4 work days per person each year and 6400 deaths every year; lead exposure may contribute to as 20% of the incidence of hypertension in adults and 29% of all children have unhealthy lead levels in their blood (Eskeland, 1992; Schteingart, 1989; and Margulis, 1992 cited by Bartone *et al.,* 1994).
* In Jakarta, health costs associated with selected air pollutants (lead, suspended particulate matter and nitrogen dioxide) are estimated to be $220 million a year. This includes the costs of avoidable deaths, restricted activity days, outpatient visits, hospital admissions, respiratory illnesses, hypertension cases,

heart attack cases, asthma attacks and loss of intelligence in children (World Bank, 1993 cited in Bartone, 1994).

* In metro Manila, the potential productivity impact of air pollution is approaching an estimated $20 million a year (World Bank 1993 cited in Bartone *et al.*, 1994).

Urbanization brings about irreversible changes in production and consumption patterns. About 75% of global energy consumption occurs in cities and 80% of greenhouse gas emissions come from urban areas. Roughly half of these emissions are caused by burning fossil fuels for urban transport; the other half comes from energy to heat or cool buildings and to run appliances.

Contemporary medical and public health approaches to illness and health have been one of the successes of modern science. However the modern society is faced with increasing incidences of poor health, related to modern lifestyles that cannot be addressed by medicine alone. Contributing factors have been identified as an increasingly sedentary population, increasing levels of mental stress related to urban living and contemporary work practices, and hazardous environments e.g. air pollution. Natural spaces and natural elements such as forests and trees have been seen as providing opportunities to ameliorate such trends.

Furthermore, there is growing understanding in health policy that sustainable health requires not only effective medical approaches, but also healthy environments and healthy lifestyles. This is the idea of well-being: something more than just the absence of illness. Studies in North America and Europe have shown that forests can contribute by providing natural restorative spaces either near to where

people live, in both rural and urban contexts, or as part of a rural recreation resource that can be easily accessed, for example by car or other transport (Curtis *et al.*, 2002).

The focus of public health intervention is to improve health and quality of life through the prevention and treatment of disease and other physical and mental health conditions, through surveillance of cases and the promotion of healthy behaviors and environment. The urban forests play laudable roles in the health of populations especially in such vital areas as psychological, respiratory and cardiovascular health.

2.0. Urban Forestry

Literature is replete with interrelated definitions of urban forestry and urban forest (Carter, 1994; Grey, 1996; Konijnendijk, 1997; and Kuchelmeister, 2000). However, evolving from the diverse conceptions of urban forestry, Ajewole (2005) gave an all encompassing operational definition of urban forestry to be the planned, integrated, and systematic approach to the management of entire tree and woodland/forest resources in urban and peri-urban areas, for their contributions to the physiological, sociological, psychological and economic well being of the urban society.

Traditionally the urban forest has been viewed as trees in the city - often along streets and in small groups in other public places such as parks. However, another way to look at urban forests is as ecosystems, with many more components (people, animals, microorganisms), a physical environment (sidewalks, soil, rocks), energy flow (sun) and processes (water, nutrient cycles).

An urban forest ecosystem is therefore a collection of living

matter (plants, animals, people, insects, microbes) and nonliving matter (soil, rocks and dead organic matter) through which there is a cycling of nutrients and water and a flow of energy from the sun all within an urban area (Plate 1).

Based on this definition the urban forest ecosystem represents not only the trees but also the other components (including humans, microbes, wildlife and the physical environment) and the interaction of these components. This ecological perspective is more comprehensive, incorporating biological, physical, chemical and social components. This approach offers a great opportunity to enhance the environmental benefits of forests in urban areas.

The environmental benefits gained from a healthy urban forest ecosystem include energy savings, reduction of waste and stormwater costs, water quality improvement, increased recreational opportunities and enhanced wildlife and biodiversity conservation. With this outlook we also have the additional opportunity to think in the long-term and to consider the urban forest as part of the larger landscape.

The urban forest ecosystem can provide many opportunities for ameliorating the drain and stress on our natural resources. For example, by cooling the city with a forest canopy, we are less dependent on outside natural resources for air conditioning. By providing natural areas for water infiltration, storage and evaporation of rainwater, the waste water from our streets and other impervious surfaces is reduced (Duryea *et al.*, 2000).

Over the years urban forests have continued to play significant roles in the conservation of the environment, livelihood patterns of communities and the health of populations. Urban forests

add value to local communities because they are integral to land-use planning, mitigating water and energy shortages, improving air quality, protecting global climate, increasing land use values, and local tax bases, providing job opportunities, reducing costs of city services, increasing public safety and enhancing public health. They are important because of their geographic extent, their impact on local communities, and their proximity to people.

During the past decade, the urban and community forestry paradigm has shifted focus from beautification in the developed especially in the developed societies to one that encompasses all of the environmental, conservation, economic, and social benefits of community trees. This shift has been accompanied by increasing local participation and new partnerships that link professionals, nongovernmental organizations, industry, and government agencies. Increased investment will follow as new markets emerge for the ecosystem services that urban forests produce.

In the years to come if developing economies and least developed countries are to also derive maximum benefits from all that the urban forests offer, there is need to embrace not only a paradigm shift but a holistic and an integrated approach in urban forestry management.

Although urban forestry can provide substantial environmental, social, economic and recreational benefits to urban dwellers, in this chapter we have placed emphasis on the importance of urban forestry to public health, their challenges and the prospects.

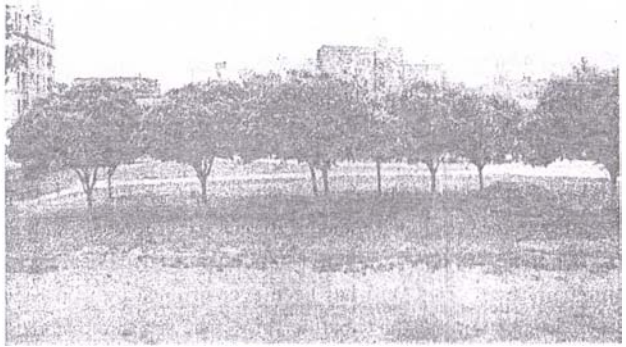

Plate 1: A typical Urban Forest Ecosystem

3.0. Environmental Benefits of Urban Forests

Urban forests play an important role in ecology of human habitats in many ways: they filter air, water, and sunlight, provide shelter to animals and recreational area for people. They moderate local climate, slowing wind and storm water, and shading homes and businesses to conserve energy. They are critical in cooling the urban heat island effect, thus potentially reducing the number of unhealthful ozone days that plague major cities in peak summer months.

3.1 Air pollution reduction

Air quality in urban areas is often degraded due to emissions from various sources (e.g., cars, factories, power plants) associated with urban development and high concentrations of people. In

addition, carbon dioxide emissions, which contribute to global climate change, are considerably higher in urban areas (USDA Forest Service, 2009a).

Particulates, oxidants and other pollutants are also a serious problem in the industrial, urban and periurban areas(Forest Research, 2011a).Studies have identified a correlation between hospital admissions from chronic respiratory diseases and the index of respirable particulates in the air of Seattle, USA. Also, studies have shown that more people are killed prematurely by the effects of pollutants than through car accidents.

However, trees in urban areas have the ability to improve air quality and reduce greenhouse gas concentrations by both reducing emissions and directly removing pollutants from the atmosphere. Trees can reduce pollutant emissions by reducing building energy via tree shade, blocking winter winds and reduced air temperatures. Tree leaves (shade) and reduced air temperatures also affect the levels of ultraviolet radiation at ground level and human comfort (USDA Forest Service, 2009a).Poor air quality in urban environments poses a serious risk to human health. Particulate matter (PM_{10}) is known to cause respiratory illnesses and cardiovascular disorders. Trees have long been recognised for their ability to capture these particles and remove them from the air we breathe.

The most serious pollutants in the urban atmosphere are ozone, nitrogen oxides (NOx), sulfuric oxides (SOx) and particulate pollution. Ground-level ozone, or smog, is created by chemical reactions between NOx and volatile organic compounds (VOCs) in the presence of sunlight. High temperatures increase the rate of this reaction. Vehicle emissions, emissions from industrial facilities,

gasoline vapors, and chemical solvents are the major sources of NOx and VOCs. Particulate pollution, or particulate matter (PM10 and PM25), is made up of microscopic solids or liquid droplets that can be inhaled and retained in lung tissue causing serious health problems. Most particulate pollution begins as smoke or diesel soot and can cause serious health risk to people with heart and lung diseases and irritation to healthy citizens. Trees are an important, cost-effective solution to reducing pollution and improving air quality.

As a result of their large leaf area and the turbulent air movements created by trees, woods, hedges and shelterbelts take up more pollution from the atmosphere than shorter vegetation or other land uses (Fowler *et al,* 1989, Beckett *et al,* 2000). The ability of trees to take up particles has been characterised through measurement of deposition velocities and capture efficiencies in wind tunnels and through micro-meteorological measurement in the field with good comparability of data from different approaches (Freer-Smith *et al,* 2004) (see Plate 2).

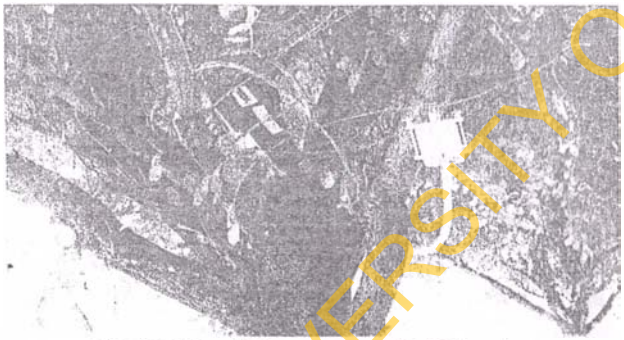

Plate 2: Air pollution assessment within a tree

Trees remove gaseous air pollution primarily by uptake via leaf stomata, though some gases are removed by the plant surface. Once inside the leaf, gases diffuse into intercellular spaces and may be absorbed by water films to form acids or react with inner-leaf surfacesg. Trees also remove pollution by intercepting airborne particles. Some particles can be absorbed into the tree, though most particles that are intercepted are retained on the plant surface. The intercepted particle often is resuspended to the atmosphere, washed off by rain, or dropped to the ground with leaf and twig fall. According to Nowak (2002), in 1994, trees in New York City removed an estimated 1,821 metric tons of air pollution at an estimated value to society of $9.5 million.

Large healthy trees greater than 77 cm in diameter remove approximately 70 times more air pollution annually (1.4 kg/yr) than small healthy trees less than 8 cm in diameter (0.02 kg/yr).

Air quality improvement in New York City due to pollution removal by trees during daytime of the in-leaf season averaged 0.47% for particulate matter, 0.45% for ozone, 0.43% for sulfur dioxide, 0.30% for nitrogen dioxide, and 0.002% for carbon monoxide. Air quality improves with increased percent tree cover and decreased mixing-layer heights. In urban areas with 100% tree cover (i.e., contiguous forest stands), short-term improvements in air quality (one hour) from pollution removal by trees were as high as 15% for ozone, 14% for sulfur dioxide, 13% for particulate matter, 8% for nitrogen dioxide, and 0.05% for carbon monoxide. Studies on the roles of trees in mitigating pollution in urban environment in the USA showed that trees in Chicago area were estimated to remove 6190 tonnes of air pollution per year, which equates to an average

improvement in air quality of approximately 0.3%. Further improvement in air quality of 5-10% can be gained from increased tree cover.Tiwary *et al.* (2009) also observed that trees reduce pollution through the deposition of particulate matter onto leaf surfaces. The structure of large trees and their rough surfaces cause interception of particulate matter of less than 10 microns in diameter (PM10) by disrupting the flow of air, and trees provide a surface area for capture that can be between 2 and 12 times the area of land they cover.

Studies by Freer-Smith et al (2004) found that the proportion of gaseous pollutants such as SO_2, NOx and ozone that are absorbed by trees depends on species, stomatal conductance, environmental conditions and pollutant concentration in the atmosphere. It was shown that the uptake of SO_2, NOx and ozone was higher in broadleaved species than conifers.They also discovered that conifers capture larger amounts of PM10 than broadleaved trees. This is due to the larger total surface area of needles, giving conifers larger filtering capacity than broadleaved trees.Jouraeva *et al.* (2002) revealed that trees can intercept particle-bound PAHs by accumulating particles of less than 2.5 microns (PM2.5) on the surface of leaves and bark. Some species of tree, such as those with needles, are more successful at intercepting PM2.5 due to high surface area, while

3.2 Temperature Reduction

- Tree transpiration and tree canopies affect air temperature, radiation absorption and heat storage, wind speed, relative humidity, turbulence, surface albedo, surface roughness and consequently the evolution of the mixing-layer height. These changes in local

meteorology can alter pollution concentrations in urban areas. Large shade trees can reduce local ambient temperatures by 3 to 5 °C. Maximum mid-day air temperature reductions due to trees are in the range of 0.04°C to 0.2°C per percent canopy cover increase. Below individual and small groups of trees over grass, mid-day air temperatures at 1.5 m above ground are 0.7°C to 1.3°C cooler than in an open area. In a study in Sacramento County, California, USA it was estimated that doubling the canopy cover to five million trees would reduce summer temperatures by 3 degrees. This reduction in temperature would reduce peak ozone levels by as much as 7% and smoggy days by 50%. Reduced air temperature due to trees can improve air quality because the emissions of many pollutants and/or ozone-forming chemicals are temperature dependent. Decreased air temperature can also reduce ozone formation.(Nowak,2002).

Temperature reduction from shade trees in parking lots lowers the amount of evaporative emissions from parked cars. Unshaded parking lots can be viewed as miniature heat islands, where temperatures can be even higher than surrounding areas. Tree canopies will reduce air temperatures significantly. Although the bulk of hydrocarbon emissions come from tailpipe exhaust, 16% of hydrocarbon emissions are from evaporative emissions that occur when the fuel delivery systems of parked vehicles are heated. These evaporative emissions and the exhaust emissions of the first few minutes of engine operation are sensitive to local microclimate. If cars are shaded in parking lots, evaporative emissions from fuel and volatilized plastics will be greatly reduced. Cars parked in parking lots with 50% canopy cover emit 8% less through evaporative emissions than cars parked in parking lots with only 8% canopy cover.

Therefore, with an extensive and healthy urban forest, air quality can be drastically improved.

3.3 Air quality and Climate protection

Worldwide, more than 1 billion people live in urban areas with unhealthy air. Rising motor vehicle use, reflecting the increasingly sprawling form of many cities, poses the greatest threat to air quality. Urban centres, where energy consumption is high, are important sources of greenhouse gases that pose a threat to the stability of global climate. Urban forests have a positive impact on air quality through adsorption of pollutants to the vegetation canopy, sequestration of atmospheric carbon dioxide in woody biomass, reduction of summertime air temperature and associated ozone formation, and energy savings that reduce power plant emissions. For example, California's 177 urban trees were estimated to save 6,400GWh in annual electricity use for air conditioning, equivalent to seven 100 MW power plants (McPherson and Simpson, 2003).

3.4 Water Resources and water quality protection

Cities produce waste water that requires treatment and polluted runoff that threatens human health, as well as the functioning of fresh water and coastal ecosystems. For example, rapid growth and dependence on ground water has led to aquifer depletion, ground subsidence and implementation of water conservation measures in Mexico City, Houston and Tucson. By reducing runoff from small storms, which are responsible for most annual pollutant washoff, trees protect water quality. Some cities own peri-urban forests that

provide municipal drinking water, and others have invested in conservation easements to protect watersheds instead of investing in new treatment facilities (see Plate 3). Again others own a large tract of urban forest that it uses for land treatment of sewage wastes.

Plate 3: Effects of trees on watersheds and wetlands

3.5. Solid Waste reuse and recycling

Approximately 20% of the urban solid waste stream is yard (organic material from lawns, shrubs and trees) and wood waste. Recycling of this green waste can reduce the environmental and economic costs associated with landfill disposal (see Plate 4). Returning green waste to the soil can benefit plant growth and conserve water. Portable mills are being used in pilot programs to salvage lumber that is used for products such as picnic tables, park benches, flooring and veener.

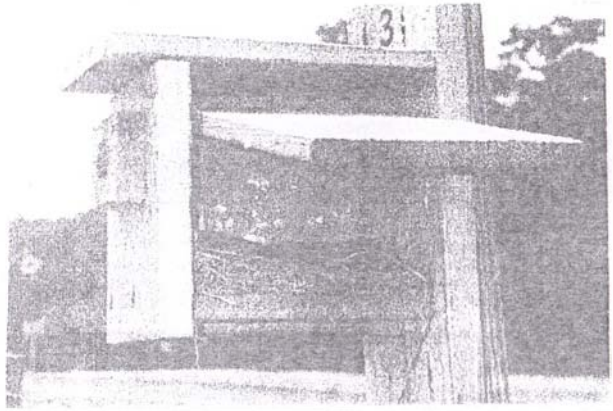

Plate 4: Waste recycling using forest products

3.6. Biodiversity loss prevention

Urban areas affect biodiversity through conversion of land to urban uses. Many cities are rapidly expanding outward, reducing and fragmenting habitat. Greenways, riparian buffers and parks systems can provide continuous corridors that give wildlife cover, food and paths for travel. Expanding urban forest can constrain alien plant (e.g Norway maple (Acer platanoides) and buckthorn [Rhamnus spp] and insect species (e.g., emerald ash borer (Agilus planipennis) that threaten native forest flora (see Plate 5).

Plate 5: Enhancement of Biodiversity

4.0 Urban Forests and Wellbeing

Wellbeing, health and quality of life are holistic terms with a range of contested definitions Forest Research (2011a). In general, these concepts embrace both personal and community wellbeing, and have physical, social, economic and psychological dimensions. There is growing understanding in health policy that sustainable health requires not only effective medical approaches, but also healthy environments and healthy lifestyles. This is the idea of well-being: something more than just the absence of illness. Studies in North America and Europe have shown that forests can contribute by providing natural restorative spaces either near to where people live, in both rural and urban contexts, or as part of a rural recreation resource that can be easily accessed, for example by car or other transport (Ulrich, 1986; Curtis *et al.*, 2002). It is therefore expedient

to explore the relationship between each of these dimensions of wellbeing and urban forests.

Physical Wellbeing: Urban greenspaces are places that people can use to be physically active through walking, jogging, cycling and conservation activities. Pleasant, tree-lined streets, accessible greenspaces and networks that link sites are important to an area's green infrastructure, and may encourage people to walk and cycle rather than using the car. There has been a growing recognition that green infrastructure can help deliver key benefits for public health and well-being.

Mental Wellbeing: Urban greenspace has been shown to have restorative effects, reducing stress and mental fatigue and contributing to people's enjoyment and enhancement of wellbeing. Researchers suggest that urban greenspace may hold vast potential in helping people during difficult times, whether they have health challenges, are socially or economically disadvantaged, or face major life changes.

Social Wellbeing: Urban greenspace can contribute to meeting social goals such as community cohesion, and increasing social capital and social inclusion. This can take place through communities being involved in decision-making about their local space, and being involved in creating or maintaining greenspaces. Urban greenspaces are often used to hold a range of community events that can bring together different sections of society.

Ecohealth: This is an emerging concept that explores how changes in ecosystems can impact on people's wellbeing. These changes might be biological, physical, social or economic. It acknowledges that the natural environment plays a crucial role in human wellbeing, and that humans have an inherent need for contact with nature. Research has also shown that urban biodiversity can sometimes be higher than in surrounding rural areas.

5.0. Health Benefits Associated with Urban Forestry

5.1. Improving levels of physical activity and health

Inactivity is often a significant factor in many major illnesses: obesity, heart disease, kidney disease, some types of cancer and Type II diabetes. Active involvement of people in outdoor activities in forests and green areas therefore has direct significance for health. Forests and green areas provide a haven to escape to from stress. Contact with nature can extend a positive influence on the physical and mental health of human beings in increasingly urbanised societies.

Strong associations have been found between access to green space and higher levels of physical activity, which can dramatically improve individuals' health. Green spaces have been shown to independently promote physical activity, thereby enhancing the health profile of the people who use those spaces. For example Kaczynski and Henderson (2007) observed that living closer to parks or recreation/leisure facilities is generally associated with increased physical activity.

Nielson and Hansen (2007) also observed that the further away residents are from green space the less likely they are to visit it; for those individuals under 25 years of age, the further they lived from green space, the more likely they are to be obese.

The Green Gym Scheme run by the British Trust for Conservation Volunteers (BTCV) helps people to take exercise outdoors while participating in activities that improve the environment. Nine out of ten participants with poor mental or physical health showed an improvement within seven months. Evaluation of the scheme concluded that the overall physical health of participants improved significantly, with the strongest effect for people with the poorest physical and mental health. Green Gym schemes have also shown that 'participants in the initiatives were more likely to continue with exercise than those on more traditional gym-based regimes' (Brown and Grant, 2005).

Visiting green areas in cities can counteract stress, renew vital energy and speed healing processes (see Plate 6). A study of relationships between green space and human health found that people living in a greener environment show more signs of healthy living (de Vries *et al.*, 2003).

Plate 6: Recreational center in a typical park

5.2. Improving psychological health, mental and social well-being

Nature and green spaces have been shown to provide a restorative environment which helps alleviate stress and mental fatigue. There is a strong evidence which suggests that green spaces have a beneficial impact on mental well-being and cognitive function through both physical access and usage as well as through access to views Furthermore, the restorative benefits of green space generally come at no direct cost to the user whereas other forms of relaxation (such as yoga) or medical treatment usually do. Green spaces can also help improve mental well-being by encouraging social activity and interaction

According to Van den Berg *et al.* (2007) physical activity in green environments has greater psychological and physiological benefits than physical activity in other settings. Similarly, it is widely

believed that passive or less strenuously active contact with green spaces can also be psychologically and physiologically restorative, reducing blood pressure and stress levels. Furthermore, a study by Hartig *et al.* (2003) provided evidence of the positive impact of natural settings on improved attention functioning, emotional gains and lowered blood pressure.

Using a large postal survey of residents in nine Swedish towns and cities, Grahn and Stigsdotter (2003) suggest that the more often a person visits urban open green spaces, the less often he or she will experience stress-related illnesses.

Direct evidence has been found of the restorative effects of green space on mental health. Taylor *et al.* (2001) studied 96 children suffering from Attention Deficit Disorder (ADD) and found that the children experienced fewer problems if they had access to green space for play and the 'greener' the setting, the less severe the ADD symptoms. Guite *et al.*'s (2006) study in Greenwich confirmed an association between the physical environment and mental well-being across a range of areas. 'Escape facilities', such as green spaces and community facilities, were highlighted as being amongst the most important independent factors.

Hospitalised patients may recover faster if they can see trees (as opposed to buildings) from their window, while periods spent out of doors can have therapeutic value for patients and residents of hospitals and old people's homes. Our senses relax and are infused with fresh energy when we view and experience natural landscapes which include trees and other vegetation. The study by Hartig *et al.*

(1996) of environmental influences on psychological restoration, through two laboratory experiments, also underlines the importance of restorative environments, such as woodlands, as an antidote to stress. Atlantis *et al.*(2004) reported that exposure to natural settings and sports activities are helpful to achieve restoration from illness, and that a combination of both is most effective.

5.3 Reduction in cardiovascular problems

The provision of green walk ways promotes trekking. This in turn helps to stimulate some form of physical activity especially for people who by nature of their work are confined to sedentary lifestyles. Engaging in regular and moderate physical exercises therefore reduces obesity and associated cardiovascular problems.

5.4 Reduction in airway diseases

The removal of air pollutants such as sulphur dioxide, ozone and particulate matter helps in purifying the air and reducing air pollution. With cleaner air most air pollution related morbidities such as upper and lower respiratory infections and the exacerbation of asthma would be reduced.

5.5 Reduction in heat stress

The formation of green belts and green canopies that shield populations from excessive exposure to ultraviolet radiation helps in conserving energy and reducing thermal related syndromes such as heat stress, heat crams, heat exhaustion and heat stroke in very extreme cases of exposure.

5.6 Reduction in sun burns and other skin disorders

In the absence of green cover in most urban cities, populations are exposed to the direct effect of the sun ultraviolation radiation. Excessive exposure has negative implications on the dermal system and skin morphology.

5.7 Therapeutic benefits

A number of forest-derived products, such as certain nuts and berries exhibit pharmaceutical activity and values that are beneficial to human health. They may be used in the orthodox and or alternative medicine sector.

6.0 Challenges of Urban forestry in the developing economy

Although there is a great potential for urban forest to mitigate a variety of impacts associated with development, there are also a number of obstacles to overcome before significant urban forest benefits can be realized. Resolving these limitations will require coordinated efforts among cities, regions and countries (Meza, 1992).

Available growing space is limited in city centers and this problem is compounded by pressure to convert green space, parks and vacant lots into building sites (Glickman, 1999). In suburban areas, sprawling development seldom includes enough park space or makes provision for the funds required to maintain them.

Municipal tree care programs are inadequately funded and the resources needed to respond to natural catastrophes (eg. droughts, floods, wind storms), conduct urban forest inventories, develop

management plans, enforce adoption of ordinances that regulate street tree removal and types of species planted, protect trees during construction, preserve heritage trees, and plant trees in new development sites are lacking

Other specific challenges are as follows:

* Harsh growing conditions, such as soil compaction and drought
* Lack of information about the tolerances of tree cultivars to urban environmental constraints
* Poor tree selection which exacerbates maintenance problems
* Poor nursery stock and lack of adequate care after planting
* Lmited genetic diversity
* Inadequate tree care practices by citizens
* Lack of working tree inventories and urban forest management plans
* Limited grass-root participation in urban tree planting and stewardship
* Inadequate public awareness about the benefits of healthy urban forests

7.0 Future directions on urban forestry

The attainment of maximum benefits in urban forestry especially in developing economies can be achieved when the following concerted efforts are made: capacity building, policy formulation, research and development, execution of pilot projects

and routine monitoring and evaluation.

7.1 Capacity building

Basic teaching about trees and their importance in the environment should begin at the rudimentary stage of a child's life (see Plate 7). This can be done by integrating tree planting science, modules and techniques into the school curriculum. Making the students participate actively via organized groups such as environmental clubs may guarantee sustainability and more positive results (Ana *et al.*, 2009). At a higher level there is a need to invest in the development of more expertise in tree management.

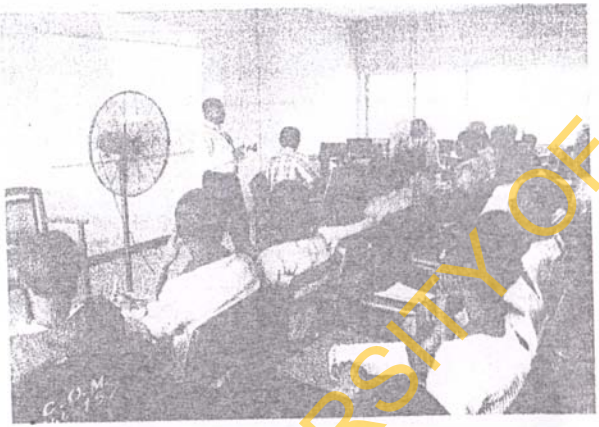

Plate 7: Training school children on Environmental Conservation

7.2 Policy formulation

Most developing countries lack policies on urban tree planting and conservation practices. This explains why trees and ornamental plants are rarely seen in residential buildings, public and private institutions. Where there are trees planted during the colonial days they are not maintained and no plans to replace them. A policy framework and implementation can address this anomaly.

7.3 Research and Development

The development and growth of economies is driven by science and technology. Nature is not static, it keeps evolving and for this reason more investigations need to be carried out to match the fast changing world. Tree planting requires a sound knowledge of appropriate species suitable for the various and peculiar environmental conditions of the urban environment, agronomy, botanical and climate variables. Currently, Geographic Information Systems (GIS) and Global Positioning Systems (GPS) can be used to develop models of expanded walkable green spaces, urban forestry fitness trail" and a jogging/fitness par course.Arieal photographs and remote sensing can also be used to capture sceneries of different urban forest ecosystems (see Plate 8).

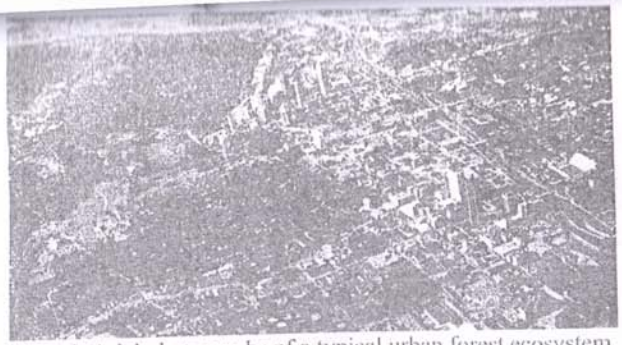

Plate 8: Ariel photographs of a typical urban forest ecosystem

7.4 Execution of pilot projects

Small scale tree planting pilot projects must be encouraged all over the urban settlement areas such as residential buildings, schools, offices, parks and industries. This reduces the tendency of waiting for government to initiate the large scale projects in the communities. The former would certainly complement the later as illustrated in the tree planting campaign in a typical school environment (see Plate 9).

Plate 9: Pilot tree planting projects in schools

7.5 Routine monitoring and evaluation

Any successful management scheme must have a robust monitoring evaluation plan and exercise in place. Tress in homes, schools, offices, public areas, gardens/parks need care and maintenance. This can only be achieved if deliberate and conscientious efforts are made to routinely observe the plants.

8.0 Conclusions

Urban forestry has great potential to contribute significantly to public health and total wellbeing of people, especially in a developing country such as Nigeria. With such services as removal of environmental pollutants, mitigation of global warming, lessening of incidence of environmentally related diseases, provision of restorative support for recuperating patients and succor from the harsh urban environment, the urban forest no doubt plays major and critical role in the promotion of public health and wellbeing. Whereas the developed economies have explored most of these gains optimally, the developing economies including Nigeria are still lagging behind. Some of the reasons for this include inadequate knowledge and awareness among health practitioners in the developing countries, the salient position of a well designed and managed urban green infrastructures in public health and wellbeing, lack of enabling institutional frameworks such as policy, legislation and administrative infrastructures prerequisite for sustainable urban forestry development and inadequate expertise among others.Overcoming these limitations, thereby sustainably harnessing the benefits of of urban forestry to public health will require concerted efforts by the academia, development agencies, non

governmental and community based organisations involved in public health and environmetal conservation advocacy and government agencies to put in place institutional infrastructures and training programmes, raise awareness about the benefits of urban forests to public health and mobilize the public involvement in sustainable development of urban forestry.

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