Urban Forest

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Abstract: *Urban forests are the key elements of green infrastructure and play a decisive role in the sustainable development strategies of metropolitan areas and address the challenge of maintaining biodiversity while improving human health and well-being. Urban green spaces are integral components of urban ecosystems, contributing to enhanced environmental quality, quality of life and sustainable urban development. Scientific evidences in the last two decades have emphasised the crucial necessity of green areas within urban social-ecological systems to ameliorate several problems of city-culture. Role of parks and gardens has become much more important in view of ever-increasing population of cities, particularly in developing countries. Tangible and intangible benefits provided by these green assets are often taken for granted by the public and some city authorities. Like other developing economies, India is being urbanized at a faster pace. Generally, cities of developing countries have lower per capita availability of urban green spaces in comparison to the developed countries. Urban forestry studies, involving technical and social science aspects are lacking in developing countries, including India.*

Keywords: Intangible benefits, Green Infrastructure, Ecosystem services and Community forestry

1. Introduction

The world is fast becoming an urban place as nearly two third of the world's population is expected to live in urban areas by 2025 [1]. Due to this urbanization trend, distance between city inhabitants and nature is increasing. Urban greenery/forestry is one of the ways to bridge this gap between people and nature. Urban forests or urban green spaces are one of those green infrastructures, which are more known for their non-priced benefits (like pollution control, energy conservation, leisure/recreation, carbon sequestration, etc.) than priced benefits in urban settings. Urban green spaces or parks/gardens contribute to an improved quality of urban life in many ways, even though these functions are often taken for granted by the public and city authorities, mostly in developing countries. [2]. In India the urban population has grown nearly five times due to mitigation and spatial expansion. To accommodate the increasing hordes of migrants, pristine forests and green spaces are converted to concrete jungle. Therefore, city planners and urban dwellers have long since emphasized the concept of having small pockets of trees, woodlots or urban forests wherever land is available to cater to the ecological and sociological needs of the urban population.

2. Defining Urban Forest

Urban forests can be defined as networks or systems comprising all woodlands, groups of trees, and individual trees located in urban and peri-urban areas; they include, therefore, forests, street trees, trees in parks and gardens, and trees in derelict corners. Urban forests are the backbone of the green infrastructure, bridging rural and urban areas and ameliorating a city's environmental footprint. [3]

Urban trees and woodland also contribute to an attractive green townscape and thus communicate the image of a positive, nature-oriented city. Indirectly, urban trees and forests can promote tourism and enhance economic development. At the local level trees contribute to the quality of housing and working environments and their benefits are reflected in property values.

The same urban woodland areas and trees may have multiple benefits that reinforce each other. Recreational woodland, for example, also reduces wind speed and traffic noise as well as improves the landscape in a nearby residential area. [4]

3. History of Urban Forest

The term "urban forestry" was coined in 1965 by Prof. Erik Jorgensen at the university of Toronto. This unusual juxtaposition of "urban" and "forestry" arose in scholarly definition of urban forestry: "a specialized branch of forestry (that) has as its objective the cultivation and management of trees for their present and potential contributions to the physiological, sociological and economic well-being of urban society." Furthermore, he believed urban forestry does not deal only "with the city trees or with single tree management, but rather with the tree management in the entire area influenced by the urban population." It was in the United States that urban forestry first took root and developed into a national movement.

In traditional forestry, trees are management for timber harvests and to provide other goods and services. But in urban forestry trees are cultivated mainly for their aesthetic and environmental qualities, to be "harvested" only when die or become hazardous. A traditional type of forest set aside for the good of a community sometimes is referred to as "community forests" and may be considered a part of the larger urban forest that also include trees within the town. A community forest at Zurich, Switzerland, has provided timber, firewood, recreation and watershed protection since 853 AD; the oldest community forest in America was established in 1640 at Newington, New Hampshire. [5]

4. Urban Forest Sustainability

The importance of sustainability associated with urban forests and urbanization is related both to decreasing tree covers within urban and community areas, but also the decline of rural forests and agriculture lands as urban areas expand.

Globally, the area consumed by urbanization in the next 40 years will be equal to an area three times the size of France.

As urbanization displaces other functional lands which provide ecosystem services, including rural forests, the importance of maintaining urban trees to offset forest loss elsewhere is compounded. [6]

Sustainable urban forest management is related to the concepts of resilience and robustness, the latter being significant for SESs, in particular. [7] Robustness is the ability of a system to maintain important functions in the face of external, unpredictable perturbations, or when there is uncertainty about the values of internal design parameters. [8] Urban forests are SESs and prime examples of systems that face internal (and emergent), as well as external disruptions, but little empirical research addresses the characteristics of robust urban forest SESs. In fact, it is even difficult to operationalize the broader term of sustainability to urban forests. [6].

5. Urban Forest Benefits

5.1 Ecological Benefits

5.1.1 Air Quality

Improving air quality has been an imperative of environmental policies throughout the 20th century. Installation of filtering devices in power plants, the switch to less polluting fuels and other technical measures have achieved significant improvements in this respect. Yet air quality remains a major concern. While the concentration of air pollutants such as sulfur dioxide has been successfully reduced in urban areas, other – mainly car induced – pollutants such as nitrogen oxides, ozone and volatile organic compounds are of increasing concern. Climate change is likely to add further to these air quality problems because rising air temperatures and higher levels of radiation can lead, for instance, to higher concentrations of ozone in the air [4]. Trees remove gaseous air pollutants by uptake via leaf stomata or 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 surfaces. 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 [9].
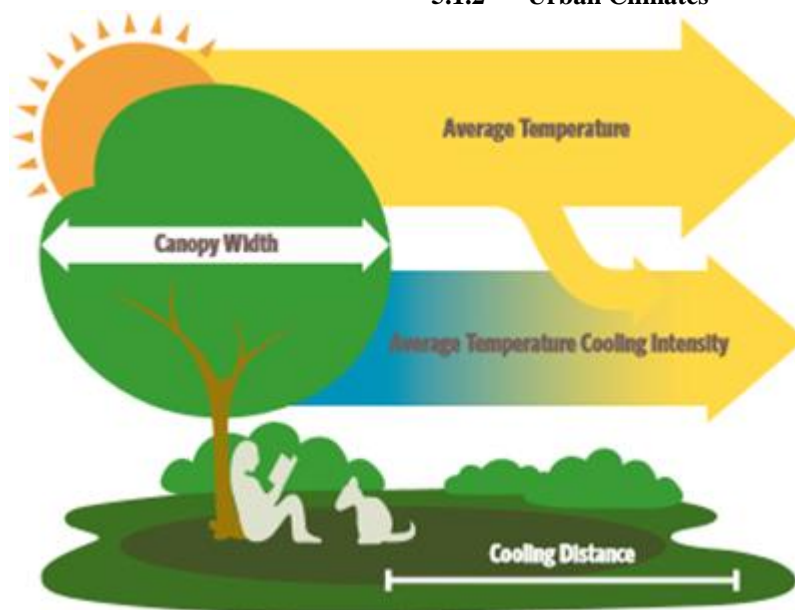
5.1.2 Urban Climates

Figure 1: Temperature mitigation by trees (Source: Illustrator Mackinzie Jones)

Trees and other vegetation can mitigate extreme air temperatures in two ways. First, vegetative cover shades impervious surfaces and prevents the sun's rays from hitting them, thus preventing heat storage (ΔQS) and later release, which would contribute to the urban heat island effect. Trees that are tall enough to create a large shaded area under their canopy are more useful than short vegetation. Trees also transpire water as they grow, increasing latent heat storage (QE)- essentially some of the sun's energy goes to converting water from its liquid to vapor form (latent heat), rather than increasing air temperature (sensible heat). From the perspective of mitigating extreme temperatures, this latent heat storage is a good thing since it prevents an increase in air temperature, although in some dry climates the loss of water from planted trees may put a strain on scarce water supplies. Both the transpirative cooling and the shading effect of trees individually can substantially lower maximum summer daytime air temperatures in streets at pedestrian level. However, shading of sealed surfaces under tree canopy has a particularly critical effect on pedestrian thermal comfort because it dramatically lowers surface temperatures and the mean radiant temperature to which pedestrians are exposed [10].
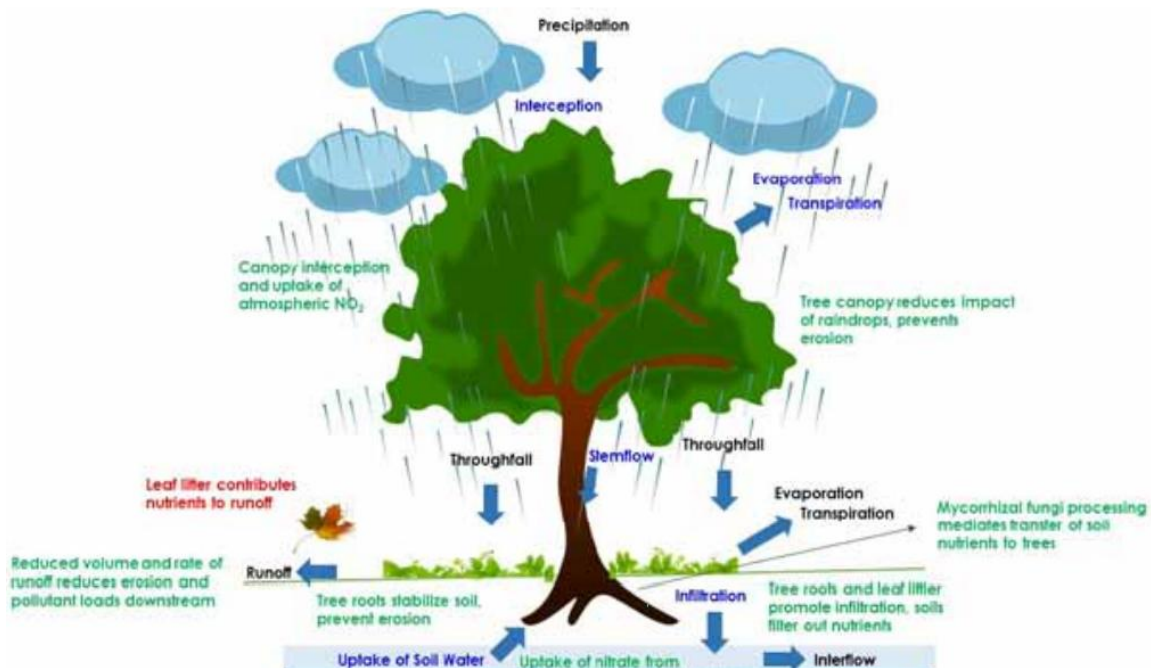
5.1.3 Urban Hydrology

Figure 2: Temperature mitigation by trees (Source: Illustrator Mackinzie Jones)

Protection of riparian woodland can be of particular importance for surface water quality. The hydrological function of urban woodland and trees is increasingly stressed as protection of drinking water resources. For example, in Denmark new woodland areas established close to cities consider this function as a primary one next to recreational benefits [11]. The primary way that trees and forests affect water quality is by reducing storm water runoff. Trees reduce runoff through rainfall interception by the tree canopy, by releasing water into the atmosphere through evapotranspiration, and by promoting infiltration of water through the soil and storage of water in the soil and forest litter. In the absence of tree canopy, rain falling on urban surfaces such as parking lots, streets and lawns picks up various pollutants as it runs off the landscape. The cumulative effect of tree canopy is to temporarily detain rainfall and gradually release it, regulating the flow of storm water runoff downstream and thereby preventing some of the pollutants in rainfall and on urban surfaces from being transported to local waterways. Trees provide additional water quality benefits through uptake of pollutants from the atmosphere, soil and groundwater, and may contribute nutrients to surface waters through leaf litter, but these components are more challenging to quantify given the available data and its variability. The specific amount by which an individual tree, group of trees or forest patch reduces runoff is highly variable and difficult to measure. [12].

5.1.4 Air pollution
Air pollution is generally considered as a major concern in urban areas, and as being among the major risk factors contributing to the global burden of disease, with for example high levels of particulate matter (PM) air pollution being associated with excess mortality and morbidity in the urban population [13].

Paoletti carried out a rare longitudinal study, applying the American UFORE model to look at air pollution reduction by the largest park in Florence, Italy, comparing data for1984 and 2004. Results showed that the forest growth compensated the losses due to cuttings and damages by extreme climatic events, so that the overall amount of pollutants removed from the air did not change (and remained positive) from 1985 to 2004.

Although the removal of pollutants per tree increased over time, the total amounts slightly decreased, still because of the reduction in the number of trees, so that the total amount of pollutants removed from the air in the eight plots showed just a small 5% reduction from 1985 to 2004 [14].

5.1.5 Biodiversity
Human well-being strongly depends on the ongoing provision of ecosystem services, which, for example, support food production, maintain soil fertility and stability, and provide water purification services. The expansion of cities, however, is causing the destruction, degradation and fragmentation of natural ecosystems in and around urban areas, with a consequent loss of biodiversity and ecosystem services and an exacerbation of human–wildlife conflicts. Such destruction, degradation and fragmentation is not limited to the physical boundaries of urban developments: cities can also be the indirect causes of landscape degradation and resource impoverishment in peri-urban and rural areas.

Although all green spaces can contribute to biodiversity conservation, it is important to conserve as much of the original natural vegetation – grasslands, forests, wetlands and riparian corridors – as possible because these are unique habitats for native plants and animals and are also important for maintaining local "identity". Semi-natural areas such as roadside corridors and home gardens can help connect natural areas and thereby reduce fragmentation and increase

the resilience of natural ecosystems to human pressures and disturbances.

Cities with well-managed urban forests are able to maintain a surprisingly rich variety of habitats and native species while, at the same time, helping conserve natural landscapes beyond city boundaries. Biodiversity conservation is intertwined with other management agendas, and, like all sustainability issues, it requires local knowledge, governance capacity, and an integrated, multiscalar approach [3].

5.1.6   Water pollution and soil

Urban runoff, streams, and waterways frequently experience pollution. The capacity of urban trees to remove nutrient pollutants and some heavy metals from storm water can be better exploited to provide water quality and pollution reduction benefits. Denman provide evidence for this in an elegant WSUD mesocosm study with four common urban tree species. Trees were able to reduce oxidized nitrogen and reactive phosphorus in comparison to unplanted controls. There were no significant differences among the four tree species in their ability to reduce storm water nutrient pollution, but Denman suggest that future research should target the most promising tree species based on their traits [15].

5.2   Social Benefits

Urban forests provide major social benefits to the population as given below

5.2.1 Human health and well being

In many settings, the rate of urban growth has exceeded the capacity of health systems to serve growing populations, and urban and peri-urban dwellers face many health challenges. Sedentary urban lifestyles, high levels of air pollution, and peculiarities of the urban microclimate may lead to substantial increases in illness and disease, including mental stress; thermal discomfort and dehydration; cancers associated with air pollution or insufficient physical activity; diabetes and cardiovascular disease; and obesity. Moreover, rapid urban growth can result in the proliferation of slums and other impoverished settlements that create highly unhealthy conditions.

Urban forests can perform three health-related functions:
1) disease prevention; 2) therapy; and 3) recovery from illness. They can reduce the direct and indirect causes of certain non-communicable diseases and urban stressors, such as ultraviolet radiation and air and noise pollution, and they can help in cooling the environment. Urban forests are now being designed and managed to support convalescence programs; for example, healing gardens are being installed alongside traditional healthcare structures. Designs to maximize the psychologically restorative potential of urban forests and other green spaces are now included in landscape architecture and UPF courses worldwide [3].

5.2.2 Urban Parks

Nature and green spaces contribute directly to public health by reducing stress and mental disorders , increasing the effect of physical activity [16] reducing health inequalities and increasing perception of life quality and self-reported general health Indirect health effects are conveyed by providing arenas and opportunities for physical activity[17]. increasing satisfaction of living environment and social interactions [18] and by different modes of recreation. All these indicators correspond well to the definition of health established by the World Health Organization (WHO) (1946), including both physical, mental, and social components in the health concept. In addition the definition of public health [19] even further emphasizes the efforts by society and communities for promoting health and preventing diseases. Thus, to support and improve public health varied actions are required by local administrators and policy makers. Within this field creating healthy urban environments is an important contribution. Considering the high level of global urbanization urban parks are imperative for maintaining and improving public health. This section demonstrates the scientific evidence for health effects, direct or indirect, from urban parks. [20]

6.   Urban Forest Policies

Urban forestry policies Lack of awareness about the potential of urban forestry, of information exchange, and of strategic, coordinated action so far means that the full potential of the urban forestry concept remains to be realised. This is particularly the case in the developing world [21]. FAO has been among the first organisations taking up the challenge of promoting the concept - under the name urban and peri-urban forestry - as a framework for action, with emphasis on the developing countries and countries with economies in transition, and urban forestry's contributions to food security and poverty alleviation. FAO's activities have included a review of existing activities within urban forestry, as well as an identification of needs for further development. It has encouraged partnership and information sharing between localities and countries. With a state of the art assessment and institutional and policy strengthening as a basis, the role of urban forestry thinking in sustainable development could be enhanced and developed. One of FAO´s recent initiatives is an outlook study of urban and peri-urban forestry in countries of West and Central Asia as part of the Forestry Outlook [22].

7.   Conclusion

Urban forests and green spaces are in the public eye. All kinds of tree-related events, such as planting or felling, removing dangerous branches are often discussed in public and reported by the media. For these and other reasons, urban forestry should be based on scientifically sound principles and be transparent to the public. These objectives can be met if options are compared and evaluated, if management is demonstrated to the media, and if management activities are continuously monitored on a short and long-term basis [23]. Developed countries are doing excellently on this front but the same is not true in case of developing countries like India. There is a lack of a comprehensive research database on urban forestry in the country. Reasons for this deficiency are not difficult to find. There is inadequate financial support for urban forestry development and research work. Researchers and practitioners in this field have not been able to convince

bureaucracy-laden research funding agencies on the multiple contribution of urban forestry to human society in a populous and developing country like India. To compete with other kind of city expenditures/budgets, it is essential for urban forestry to raise its public profile and publicise its multiple contributions to city dwellers at large. Another reason is the paucity of trained and skilled researchers/ scientists on different aspects of urban forestry. The ultimate purpose of taking up urban forest research studies is to address comprehensive planning and scientific management of this valuable resource. Quantification and valuation of ecosystem services provided by urban forestry could not only permit comparison between alternate land-use options but also help to justify and augment municipal investment in this green infrastructure (McPherson et al., 1997). Therefore accumulation of scientific evidence and findings on urban forests for creating a knowledge database is the urgent need of the hour in India. For the development of India's environmentally sustainable cities, a greater awareness of the ecosystem services provided by city's urban nature has to be fostered among political leaders, administrators and general public [2].

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