



Urban Ecosystem and Biodiversity Conservation

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Introduction

In the last two decades, biodiversity concerns have been in the forefront of conservation efforts worldwide (Environment Canada, 1994; UNEP, 1995). Biodiversity is an all-encompassing notion that covers all forms of life on Earth as well as all the ecological processes associated with life. It bestows the necessities of clean air, water and soil, which combine to support the floral life that in turn prolong the rest of the 10-50 million species that dwell on the Earth at present. For human beings, biodiversity also have spiritual and psychological health impacts (Clair *et al.*, 2010). The Convention on Biological Diversity has taken on the ecosystem approach. It defines an ecosystem as 'a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit'.

Biodiversity is especially important in urban regions because there reside the majority of the human population. Cities form less than 3% of terrestrial surface of the Earth, but they are responsible for 78% of carbon emissions, 60% of residential water use, and 76% of wood used for various industrial purposes. There has been a rapid increase in the pace of growth from 10% in 1900 when the global population was living in urban areas and now this is more than 50% and is likely to further rise to 67% in the next 50 years (Grimm *et al.* 2008). Rapid urbanization in India is fetching multifarious changes to ecology, economy and society (DeFries and Pandey 2010). During the last 50 years the population of India has grown two and a half times, but the rise in urban population is nearly five times (Taubenböck *et al.* 2009). Undesirably, urban areas result in a number of

threats to biodiversity due to the loss, degradation, and fragmentation of habitat (Clair *et al.*, 2010). The rural habitats are considered to be richer in biodiversity than the urban habitats. However, biodiversity can be higher in urban areas than surrounding rural areas by contributing to rich and diverse ranges of plants and animals, which often occur as remarkable or distinctive communities (Angold and sadler, 2006). Urban environments are often sub-divided into green space, grey space, brown field sites and private gardens and balconies (fig. 1). Each of these provides their own opportunities for biodiversity enhancement.

The cover of green space in urban landscape around some portion of the globe has been presented in Table-1 (Singh *et al.*, 2010).

In India, there have been fewer studies and they show only a few patches of urban remnant forests, grasslands or wetlands harbour between a quarters to half the total biodiversity in their biogeographic region (Patwardhan *et al.* 2001). An example is the urban forest in 43 ha. of NEERI campus at Nagpur, Maharashtra has 135 vascular plants including 16 monocots and 119 dicots, belonging to 115 genera and 53 families. The taxa included 4 types of grasses, 55 herbs, 30 shrubs and 46 trees. This small area with such a large number of species is an indication of prosperous biodiversity in this urban forest (Gupta *et al.* 2008). From the point of ecological perspective, urban ecosystems are highly energetic (Gilbert, 1989; Adams, 1994) and are competent of providing beneficial insight into the management of biodiversity in other ecosystems. Urban ecosystems endow with an unparalleled background that supports a diversity of flora and fauna and



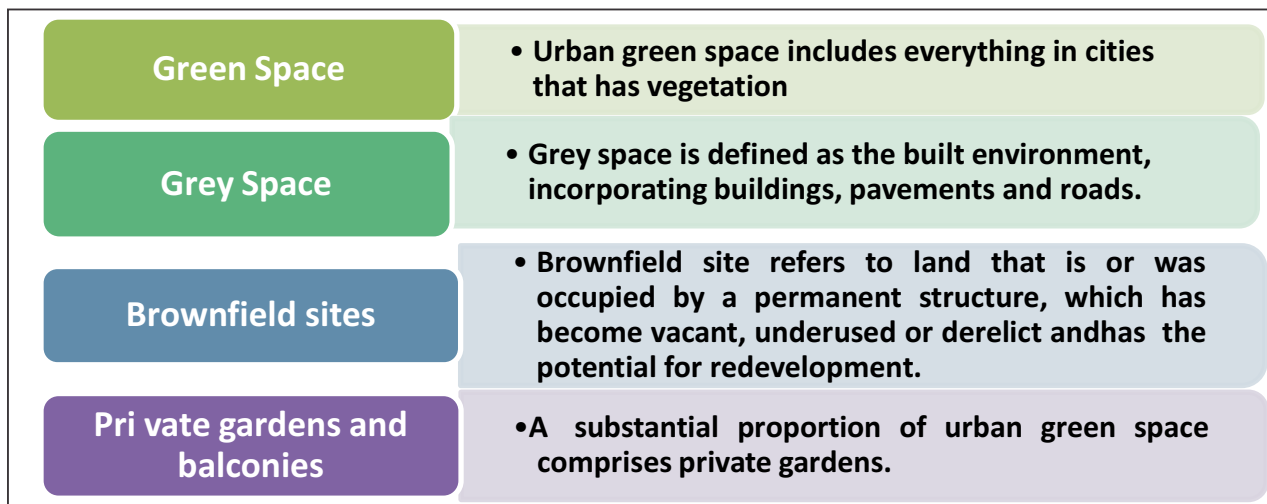


Fig. 1: Sub-division of Urban Environments

Table 1: Estimates on urban green spaces in different regions of world

Region/Country/City	Estimated size of urban green space/woodland resource
Europe	The study of 386 cities suggests 18% average woodland cover. Another study suggests 18.5% cover within municipal limits of 26 large European cities, i.e., about 104 m ² /inhabitant (Konijnendijk 2003).
France/Paris	About 80 m ² of urban forest per inhabitant in Greater Paris region (Konijnendijk 2003).
The Netherlands	Average green space cover is about 19% for 22 largest Dutch cities, i.e., about 228 m ² /inhabitant (Konijnendijk 2003).
Australia / Canberra	Estimated crown cover of about 24 million metre square amounting to 80 m ² /inhabitant (Brack 2002).
USA	Average green space cover is about 27%, i.e., about 32 m ² /inhabitant
China/ Nanjing/ Wuhan	On an average China's cities have 32.54% green cover. This varies greatly in Chinese cities like Nanjing and Wuhan, i.e., 44.3 m ² /person and 10.3 m ² /person respectively (Jim and Wendy 2009).
Hong Kong	Average green space cover is about 1.81%, i.e., about 3m ² /inhabitant.
Singapore	Average green space cover is about 17.8%, i.e., 7.5 m ² per capita.
India/Delhi	Average tree and forest cover is about 20% of geographical area and about 21 m ² /inhabitant (FSI 2009, as per population data 2001).
India/Chandigarh	Average tree and forest cover is about 35.7% of geographical area, i.e., about 55 m ² /inhabitant (Action Plan 2009-10, as per population data 2001).





Fig. 2:Unparallel background of urban ecosystem support diverse life forms

provides the continuously growing human population with direct admittance to nature (Fig.2). Maintaining our connection with nature is a fundamental need and has significant implications for the quality of life of city dwellers. E.O.Wilson has rightly said, **"The larger the pie, the greater number of possible slices big enough to sustain the lives of individual species"**.

Role of Urban Ecosystem in Protecting Biodiversity

Urban areas harbour diverse nature ranging from semi-natural habitats to wastelands, parks, wetlands and other highly human-influenced biotopes with their associated species assemblages (fig.3).

There are many understated services provided by biodiversity in the cities. Some examples are small wetlands that absorb contaminants and buffer surrounding areas from flooding. Urban natural areas support many of the pollinators that are required to sustain both native vegetation and

familiar garden species within the city. The fact is that about 35% of the world's crop species are dependent on animal pollinators, many of which are threatened due to agricultural intensification (Klein, 2007). Urban trees absorb pollutants to improve air quality and reduce the effects of greenhouse gases and, in some cases, they may do so three times more effectively than adjacent exurban forests (Akbari, 2002). Urban adapted species, like Black kites and owlets, eat many of the pest species, like house mice and insects, which multiply rapidly in cities.

Urban biodiversity can also provide organisms that indicate the quality of air and water in the environment. In India, except for a few cities, urban ecosystems are not well-studied in relation to biodiversity supported by them. Some studies have been done in Bangalore (Sudha and Ravindranath 2000, Nagendra and Gopal 2010), Chandigarh (Chaudhry 2006; Chaudhry and Tewari 2010, FSI 2009) and Delhi (FSI 2009). Bangalore is the fastest growing city in India, which





Fig.3: diverse nature of urban areas

spread from 2 km² in 1537 to 360 km² in 1994. A comprehensive study on urban forests of Bangalore showed that 374 species in the different land-use categories. Species richness was found highest in parks (291 species), followed by residential areas (164), institutions (126), temples (107) and commercial areas (Sudha and Ravindranath 2000). Although, density of street trees in Bangalore is lower than many other Asian cities, the species diversity is high (Nagendra and Gopal 2010). Chandigarh, one of the well designed and modern cities of India, has more than 35 % of its geographical area under forest and tree cover, making it one of the greenest cities of India (FSI 2009). In addition to urban forests, private gardens are noteworthy habitats that develop connectivity by performing as corridors and patches, and thus develop the overall network size of urban green spaces. From the perspective of biodiversity, the golden rule is: larger the urban forests, richer the biodiversity. Number of floral and faunal species often increases with increasing size of urban green

spaces. Thus, the maintenance of more green spaces with high diversity may be successful in maintaining plant and animal diversity in urban systems (Khera *et al.* 2009). There are several examples that show that urban areas support the population of species that have been listed in IUCN List. For example the Gwalior Fort and the Jain Temple in Gopanchal Parvat located in the core city of Gwalior in Madhya Pradesh provide the breeding and roosting sites to the Critically Endangered vulture species (Fig.4)

Another example is from Lucknow City where the Near Threatened Painted Storks come to nest and breed on the trees located in the centre of the city (Kanaujia *et al.*, 2014). They arrive the city in August and stay till March to complete their breeding cycle (Fig.5)

There are several other examples where the monuments located in the urban areas support the diversity of plants and animals. The campuses of educational and research institutes also shore up





Fig.4: Vultures residing in the core of Gwalior City, Madhya Pradesh



Fig.5: Painted Storks roosting in the centre of Lucknow city

rich diversity, thus play an imperative role in urban ecosystems (fig.6)

Threats to Urban Biodiversity

Primary treats to global biodiversity include habitat destruction, degradation and fragmentation, introduced species, and overexploitation by humans. Habitat degradation includes secondary effects such as pollution and climate change. In spite of the richness natural areas are permanently lost to development. This rate of loss exceeds the rate at which other natural areas have

been protected. The natural areas are degraded due to multiple factors. Some of these include illegal activities, such as mining, cutting of large trees, and the dumping of toxic wastes. The potential natural habitat is degraded by activities like cutting down and pesticide application to support human activities or traditional aesthetic values.

Urban ecosystems are highly dynamic and in unvarying progression. Like in natural ecosystems, wildlife communities fluctuate and evolve. New species invade urban areas (Morneau *et al.*, 1999) and some species blow up in abundance creating





Fig.6: Monuments and institutes in urban areas sustain rich biodiversity





conflicts with people (Cooper, 1987). These conflicts need to be properly addressed and they create quite a challenge as they are often caused by inadequate human behavior. Furthermore, since there is insufficient documentation of urban ecosystems, the management actions often have unexpected and unsatisfactory results. Pigeons and starlings sometimes are a nuisance in urban areas. Like urban biodiversity, management of urban bird problems requires a multi-scale approach as well as a sociological component. Regrettably, till now little research has been done on human awareness and admiration of urban wildlife (Brown *et al.*, 1979; Lemoine and Sauvage, 1996). Additional degradation of habitat occurs passively through the spread of injurious weeds, competition with hostile urban-exploiting species, and the menacing effects of climate change. One of the most prevalent forms of habitat degradation is caused by the categorization of natural areas to support the transportation network. This problem is very prevalent in the hearts of cities, but it is intensifying speedily on the periphery of the cities to support the spread out of residential neighbourhoods. Habitat fragmentation is a meticulous trouble for natural areas because it compromises the viability of remaining populations, whether they are comprised of trees, insects, fish, reptiles, birds or mammals. Small, isolated populations are more susceptible to extinction from chance events like draught, floods, disease outbreaks, and severe storms. Additionally, these populations gradually lose the genetic diversity that uphold the health of individuals (Soulé, (Ed.) 1986.). Fragmentation and other confronts to biodiversity are causing the worldwide destruction and threats that have been already warned by conservation biologists and environmentalists. All of these threats are a result of human population growth and consumption, which already chomp through approximately 1/3 of the Earth's primary productivity (Groom, 2006).

ecological patterns and processes in urban ecosystems is obligatory:

- The first step in the essential urban ecological research is to find out what variety of nature that exists in cities.
- The knowledge about ecological processes significant in urban nature is required. The ecological processes in urban areas are identical to that in rural areas, except a few of them, for example invasion by alien species is more prevalent in urban areas than in rural.
- Based on ecological knowledge and information, management schemes to sustain the diversity of urban nature should be designed and planned. These procedures should have provision for the protection of urban nature, e.g. in urban national parks, forest regions etc.
- As ecology alone cannot provide the multi-faceted information about human pressure on urban ecosystems, interdisciplinary research involving natural and social sciences is crucial for a holistic approach to integrating ecology into the process of urban planning.
- Birds are highly noticeable and quite sensitive to changes in habitat structure and composition. Bird species richness in urban ecosystems is influenced both by local and landscape qualities therefore a multi-scale approach is essential to its proper management. Three species have adapted particularly well to urban ecosystems and have populated them universally: the Common Myna and the Rock pigeon (fig. 7).
- Urban ecosystems are quite similar worldwide in terms of structure, functions and constraints. They differ in terms of their geographical location, their size and the type of landscape they modify. It is essential to consider landscape factors in the management of urban biodiversity since they greatly influence plant and wildlife species that will be found within the new artificial ecosystem. For example, a high breeding density of





Fig.7. The view of population of Myna roosting of electricity towers.

European Starlings in a residential area can be due in part to the presence of extensive lawn surface in neighboring areas or parks where birds feed. (Savard *et al.*, 2000).

- There are various concepts related to biodiversity management such as scale, hierarchy, species identity, species values,

fragmentation, global approaches etc. These can be implemented to manage urban biodiversity and may yield important insights for the management of natural ecosystems.

- Local actions as well as regional actions are equally important. In urban areas home-owners can take various actions that produce the best results (fig.8). It is essential that home-owners realise that their own local action can contribute to a larger collective effort that would conclude in the creation of a real biological corridor that assist the movements of numerous species throughout the urban ecosystems (Savard *et al.*, 2000).
- Individuals can also support the retention of natural habitat, increase the abundance and diversity of native plants on both public and private lands, and decrease the demand for suburban neighbourhoods and roads that result in habitat fragmentation and destruction. They should be aware about the urban ecosystem and its biodiversity and engage in its promotion and conservation.



Fig.8: In urban areas home gardens are important for biodiversity





Fig.9: Promote plants that are butterfly-attracting to enhance the biodiversity around homes



Fig.10: Increase tolerance for other species and benefit from the natural bio-controllers



Fig.11: Plant shrubs

- Seek out local opportunities to support biodiversity. Simple acts, like replacing a lawn or an empty lot with native plants, promoting plants that are butterfly attracting and saying no to pesticide use can significantly enhance the biodiversity around homes (Fig. 9).
- Increase tolerance and compassion for other species. A society that tolerates wild pasture, House Sparrows, tree pies, and parrots will benefit from the urban amphibians, reptiles, sensitive insect, mammal and avifaunal diversity, natural bio-control for pest, and result in a better and healthy ecosystem (Fig.10.)

Some activities to enhance urban bird diversity are:

1. **Plantation of trees and shrubs:** Several bird species nest and forage in shrubs so that addition of shrub thickets to an area would

increase bird species diversity (Fig. 11).

2. **Provision of artificial nesting structures:** Several bird species in urban ecosystems are being limited by availability of nesting sites. Example is House Sparrow. Artificial nest boxes help in solving the problem (Fig. 12).
3. **Provision of bird feeders:** Bird feeders are quite efficient in increasing local bird diversity especially in winter (Fig. 13).
4. **Regulating human behaviour:** Urban problems related to birds are usually due in part to human behavior. For example, improper storage of human waste may attract large numbers of scavenging birds.
5. **Creation, restoration and management of natural areas:** Parks or other green spaces within urban areas can act as a source of birds for neighboring residential areas .





Fig. 12: Provide Artificial nest boxes



Fig. 13: Provide bird feed

Conclusion

The presence of prosperous biodiversity in urban areas provides additional environmental and economic benefits that include fresh air and clean water, more beautiful properties and recreational areas. Because of the highly dynamic nature of urban ecosystems small efforts in management can have a great effect on faunal abundance and diversity. Research priorities should include a better understanding of people and wildlife interactions. Such research will require cooperative approach and efforts by sociologists and ecologists and is crucial in the pursuit of sustainable urban biodiversity. Research priority should also include a greater and deeper understanding of the significance of landscape features in local areas and of the dynamics of exchanges between urban and rural areas. People

and wildlife conflicts are an integral component of wildlife management in urban ecosystems and must be addressed. Enhancement of biodiversity in urban ecosystems has a positive impact on the quality of life and education of urban dwellers and thus facilitates the preservation of biodiversity in natural ecosystems. There is no other ecosystem that supports such high human population so the urban residents must form an integral part of biodiversity management in urban ecosystems. Enhancement of biodiversity in urban ecosystems, if well done, will have a significant and positive impact on the quality of life and education of the increasingly growing urban population and thus, indirectly smooth the progress of the conservation of biodiversity in natural ecosystems. Urban ecosystems need to be painstakingly managed and sustained if human beings need to live a better life on this planet with the other living organisms.

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