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Special issue: What is the scope of nature in cities?



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special issue: What is the scope for nature in cities?

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Cities provide the daily living environment for a growing part of the world’s population. Asia and Africa are experiencing unprecedented rates of people moving in to cities, and, along with Latin America, also of urban land expansion. While these rapid and extensive changes lead to considerable challenges for biodiversity, they also create new opportunities to protect nature in cities and beyond, and enhance the values that nature in cities generates for people.

Cities can and need to support ecosystems and biodiversity, and by that also human well-being. Building on the findings in the Cities and Biodiversity Outlook (CBO) project (www.cbobook.org), jointly led by the UN Secretariat of the Convention on Biological Diversity and Stockholm Resilience Centre, this Special Issue has a particular focus on India, one of the most rapidly urbanising nations in the world, and cities in other countries in the southern hemisphere. It presents some examples of the meaning of nature in cities, and challenges and opportunities associated with urban nature conservation.

The CBO-project and the case studies presented here clearly illustrate that the time is ripe to re-envision cities as something else than asphalt and concrete. It is time to acknowledge that rich nature already exists in cities, is part of our culture as well as our environment, appreciated and actively nurtured by urban inhabitants. It is time to see how the existing green and blue in cities function as ecological corridors and veins, connecting the urban to the surrounding landscapes, supporting the vital functions of cities. It is time to take the next step and truly explore: What is the scope for nature in cities?

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Co-existence

Siroli Village, District Chamoli, Uttarakhand



Sartaj Singh and Sahas Barve

The pugmark of a leopard, the hoof prints of cattle, the scribbling in the mud and the tyre tracks are testimony to the complex relationship between humans and their surroundings in the Garhwal Himalayas.

What is the scope for nature in cities?

A growing majority of the world’s population now lives in cities. The fastest population growth and most extensive urban expansion is expected to take place in the global south: Asia, Africa and Latin America. Much of the growth is expected in some of the world’s most biodiversity rich areas, including the Western Ghats in India, and Sri Lanka. At the same time, the most heavily affected regions and countries often have limited economic resources and institutional capacities to deal with the growth.

Half the increase in urban land globally over the next twenty years will occur in Asia, predominantly in India and China. Africa is the world’s fastest urbanising continent, with the urban population increasing by a mean of 3.4% annually. In Latin America, sprawl rather than population growth is expected to be the predominant challenge in the future, as more than 80% of the population already lives in cities.

The challenges to steering development towards increasing sustainability are enormous - but there are also opportunities.

Recognising the need to increase knowledge amongst researchers, policy-makers and the general audience alike, the project Cities and Biodiversity Outlook

(CBO) (www.cbobook.org) was launched. The CBO was the world’s first assessment of global urbanisation and its effects and dependence on ecosystems. The project has produced the report *Action and Policy*, aimed to reach decision-makers and a wider audience, the video *An Urbanizing Planet*, also available in English, Hindi and Chinese (www.cbobook.org/resources) and the book *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities*. The open access book was launched by Springer in 2013 and can be downloaded from the website.

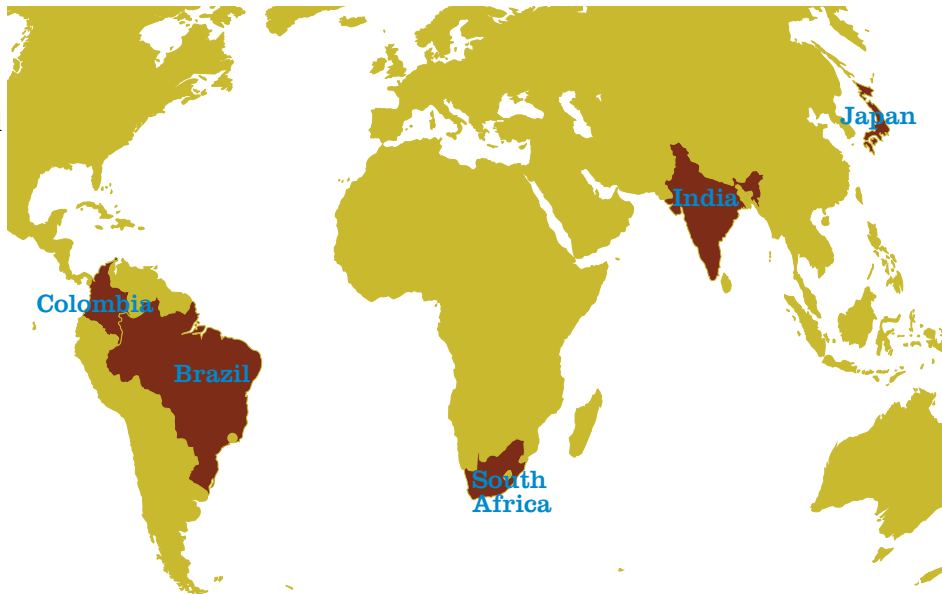
The CBO has produced ten key messages (see Box) presented in *Action and Policy*, providing practical guidelines for decision-makers, planners and the general audience to support a sustainable urban development. Some of the most critical messages—Rich biodiversity can exist in cities; Maintaining functioning urban ecosystems can significantly enhance human health and well-being and Cities have a large potential to generate innovations and governance tools and therefore can—and must—take the lead in sustainable development have guided this special issue.

Cities provide the everyday living environment for a rapidly growing proportion of the world’s population. They also leave footprints in ecosystems in other

parts of the world. Increasing the livability in urban environments and self-sufficiency of cities is thus a crucial step towards increasing sustainability of local and global developments. Ecosystems provide humans with everything from food, to feelings of joy and protection against storms. Much of the well-being of future generations will depend on the choices we make today. It is thus crucial to base urban development trajectories on supporting and enhancing ecosystem functions, which can also provide cost-effective solutions.

It is clear that cities need to step up and take active leadership for their development. In this, it cannot be sufficiently emphasised that everyone can and does play a role in whether nature in cities is supported, at multiple scales of decision making including official decision-makers, the business sector, cause-specific organisations and the general public. Every decision by urban dwellers counts, and conscious choices can be made, for example, in the important areas of transport, energy, and food. The growing business sector can have an enormously positive impact on equitable and environmentally sustainable development, while simultaneously investing in long-term sustainable and cost effective solutions. The creation and implementation of policies can fill a crucial role in accelerating this transition towards greater urban sustainability. Global urban networks, where cities can share experiences and best practices, can be one important way towards urban development based on ecosystem functions that support green cities, for the benefit of today’s populations and future generations alike.

This special issue includes articles on a number of aspects of urban biodiversity and ecosystem services, from locations across the world. We cover heritage trees in urban South Africa, green and blue issues in the rapidly growing city of Bangalore, biodiversity indicators as tools for biodiversity assessments, the growing importance of urban social-ecological themes and policies in Colombia, a retrospective piece on the city of Chennai from three decades in the past, the potential of NGOs to supplement inadequate official policies, and finally, conclude with a portrait of India as it stands at the beginning of what



is perhaps its most dramatic transition phase yet.

Drawing on examples from the regions expected to experience the most rapid and extensive urban growth around the world, with a particular focus on India, we hope that this special issue can serve as to highlight possibilities, inspire action, and contribute to informed decision-making. We hope that you will enjoy reading this issue, and that it succeeds in highlighting some of the enormous opportunities for the world’s cities, while still focusing on the challenges ahead.

Follow us on Twitter! @CBO_assessment and @URBISinitiative

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Box. The ten key messages from Action and Policy, with the three key messages guiding this Special Issue highlighted in bold. Source: www.cbobook.org/resources

1. Urbanisation is both a challenge and an opportunity to manage ecosystem services.
2. **Rich biodiversity can exist in cities.**
3. Biodiversity and ecosystem services are critical natural capital.
4. **Maintaining functioning urban ecosystems can significantly enhance human health and well-being.**
5. Urban ecosystem services and biodiversity can help contribute to climate change mitigation and adaptation.
6. Increasing the biodiversity of urban food systems can enhance food and nutrition security.
7. Ecosystem services must be integrated in urban policy and planning.
8. Successful management of biodiversity and ecosystem services must be based on multi-scale, multi-sectoral and multi-stakeholder involvement.
9. Cities offer unique opportunities for learning and education about a resilient and sustainable future.
10. **Cities have a large potential to generate innovation and governance tools and therefore can -and must- take the lead in sustainable development.**



The wildlife of Madras city

about an hour, though, he said he would be happier to write the piece himself, and gave me, a week later, a perfect typed out article on 'the wildlife of Madras city'.

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The term 'wildlife' connotes the entire uncultivated flora and fauna of any region. The two concepts of flora and fauna are so closely interlinked and interdependent that it is impossible to dissociate them in any consideration of the wildlife of an area without rendering such a general consideration futile. However, specific parts of either of these components can be written about without doing violence to the concept of the whole: so, we can consider the 'Pteridophytes of Tamil Nadu' or 'The Raptors of Rajasthan'. This note will be, in the main, not even about the fauna of Madras city, but only its mammals (naturally, in a city and excluding its varied humanity, extremely limited) and avifauna, with a bare mention of some reptiles. Nothing can be said here about the teeming marine life of this coastal environment: I am a vegetarian.

However, even in such a narrowly circumscribed note one cannot ignore the main factors providing the environmental motives bearing on the plants and animals of a place. These main factors may be listed as the climate of a tract, its

I had heard of M Krishnan as one of India's most renowned naturalists; he was also a wildlife photographer par excellence and a conservationist. I had also heard that he did not suffer fools. It was therefore with some trepidation that I went to meet the gentleman, who then in 1990, was in his late seventies. I wanted to quiz him about the wildlife of Chennai for a teachers handbook I was working on for the Indian National Trust for Art and Cultural Heritage (INTACH). Krishnan entertained me for a short while with stories of the erstwhile Madras, covered with shrub and teeming with jackal and blackbuck. After

The first time I met M Krishnan was during the mid-1970s in the Guindy forest at Madras. My friend in natural history pursuits, Selvakumar ("Selvam"), and I were introduced by two friends to a gentleman photographing a cobra brought from the Madras Snake Park. Later that day when we met one of those friends, RK Menon ("Cutlet"), and asked him about the identity of the gentleman with the camera, he exploded, "What? You do not know the great M Krishnan!" We felt quite sheepish; we did indeed know about M Krishnan and greatly admired his writings and his wildlife photographs in the Illustrated Weekly of India, but had never seen a picture of him.

Over the years I got to know M Krishnan quite well. When I began my doctoral research on Asian elephants in the early 1980s, I would go to his house (or rather "the outhouse") in Mylapore to show him my pictures and get his help to age the elephants, or discuss some aspect of elephant behaviour. Sometimes, Krishnan would be working in his dark room and I would wait for him to come out. He would emerge wearing a lungi, holding a large black & white print in his hands to examine it more closely in open light. His eyes would spot a small flaw in what to me looked like a perfect print and he would tear it immediately. That was M Krishnan, never willing to compromise on quality.

In 1994, I published a popular book on my research on elephants. Krishnan wrote a complimentary review of it in the Indian Review of Books. I was especially pleased that he liked my photographs. He disagreed on only one issue—a field method I had used to estimate the height of elephants. Some weeks later, he wrote to me, "Sukumar, I have been thinking about your height estimation method. You are indeed correct." That was M Krishnan, readily willing to admit he was wrong, even to a much younger person.

Krishnan's contribution to Indian natural history from the 1950s through the 1970s was entirely original. He had the ability to comprehend and write interestingly on a variety of animals, not just mammals or birds, and topics in natural history. He was relatively unknown outside the country as he was a recluse who published his work only locally.

Who is M Krishnan to me? Krishnan was a perfectionist, a trait that did not always endear him to everyone. This attention to detail and quality can be seen in his immaculate prose and his superb black & white photographs. He himself told me that more than his writing and photography, he took greater pride in his sketching abilities. More than anything, there was a humorous and a soft side to Krishnan that I had the privilege of experiencing.

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geomorphology and edaphology (i.e., the lie of the land and the nature of its soil), its vegetation (wild and cultivated) and its wild animals, and last but by no means least its humanity. Brief discussions of all these factors follow, but it is possible even at this stage to cut short the argument and state its conclusion. In Madras city it has been a long-drawn engagement between Nature and Man, and Nature has lost in the final rounds: that is, within the past 50 years to which I have been a witness.

Now for the discussion.

1. CLIMATE, GEOMORPHOLOGY AND EDAPHOLOGY

Madras is hot and humid, hot except from November to January and specially humid even then. Summer temperature goes up to 42°C and in December the night temperature comes down to 17°C—in other words, neither the heat nor the cold is extreme, sufficiently extreme to have a marked influence on wildlife. The humidity is generally high: it is seldom desiccating even in summer.

Madras gets both monsoons. The south-west sets in about July and ends by October. The north-east arrives, usually about mid-November, and by January it has departed. High winds and even authentic storms are periodic rather than characteristic during the north-east monsoon. The sea breeze, dutifully noted in newspapers during summer, has little or no bearing on the wildlife of the place.

Madras is low and its terrain fairly level. The land is gently undulant and not given to abrupt depressions and elevations. During the monsoons, parts of Madras get inundated and the low-lying parts partially submerged. Because today there are hardly any vacant plots of land within the tightly built-up city, regular water spreads do not form. Water bodies existed in the city even till the middle of this century: for instance, what is Madras 28 today would be flooded during the rains and a number of water-birds and shorebirds (many of the latter migratory) could be seen at these marshy spreads. Even now, on the outskirts of the city, for example at Velacherry, such pools, puddles and shallow water spreads may be seen late in the year. The acute water shortage that is such a vital feature of the city, is now due entirely to the monstrous increase in the city's human population and the subsequently staggeringly increased demand for fresh water. If one can imagine the conditions still prevailing in the flat countryside around Madras, for example in parts of the Chingleput, where pools, puddles and small shallow water spreads form with the first rains, the same conditions as earlier this century can again be realised in the city.

Madras has the second best beach in the world, a long, broad, level stretch of fin sand extending from the Andhra border on its north right up to Mamallapuram on the south. Nowhere along this impressive length is it rocky, and nowhere does it form dunes or degenerate into a marsh as the eastern coastline of India does much farther south in Tamil Nadu, and to the north of the state towards Orissa. There are no major estuaries in and around the city: the Adyar and the Cooum sneak inconspicuously into the sea. To the east of the beach there are no offshore islands—only the vast, imponderable ocean. To its west is the old city of Madras, long celebrated for its ancient Hindu shrines and only less ancient Portuguese, British and Islamic edifices and shrines.

The soil is not specifically sandy, except on the seashore: inside the city and on its west it is loamy or clayey, and not too permeable. However, in many places it may be saline.

2. THE VEGETATION

The natural vegetation is neither lush nor low-crowned, dry and hardbitten (as it is in coastal tracts farther south, as in Point Calimere). Palmyras, though mainly planted, also occur in straggling lines and small clumps, and the wild date (*Phoenix sylvestris*) is found (growing wholly wild) here and there, especially in the southern reaches of the city where there are still stands of trees. Other native trees worth mentioning are the wood-apple (*Feronia limonia*), *Clausena dentate*, the neem, *Aegle marmelos* in places,

Pithocolobium dulce (naturalised), *Acacia* species, *Samanea saman* (planted and run wild), *Avicennia* species and *Cerbera odollam* (specific name reverted recently) at the Adyar estuary and the latter also along the Buckingham canal, the 'punnai' (*Calophyllum inophyllum*) and the Fortia (*Thespesia populnea*), mainly planted, near the beach, the 'uthia-maram' (*Lannea coromandelica*), and among the lesser trees *Zizyphus mauritiana* and *Zxylopyrus*, *Capparis* species (probably *stylosa*), *Atlantia monophylla*, *Ochna squarrosa*, *Norinda tinctoria* and *Toddalia asiatica*. Madras was specially notable for its great banyan trees, mainly planted along some roads (like what was Edward Elliot road and is now Dr Radhakrishnan road in Madras 4) – only recently, in the past 4 or 5 decades, has an irresistible combination of sudden storms and the Corporation of Madras bent on widening the roads, almost exterminated these grand trees. This should be mentioned as the fruiting banyan attracts a horde of birds.

Among the wild shrubs may be mentioned the following: *Capparis* species (probably *roxburghii*), *Flacourita indica*, *Zizyphus canoplia*, *Rhynchosia minima* (almost a climbing herb), *Dichrostachys cinerea* and species of *Carissa*.

Farther down the coast, brakes of screwpine and *Spinifex littoralis* (Ravanan-meesai) are common. In the city, however, the previously common main sandbinders, species of *Launea* and the goat's-foot creeper, *Ipomea pes-caprae*, even these are rare now.

Note that the above account, which is only an indicative and not even a typical list, has omitted hundreds of trees, shrubs and herbs native to the city, either by intention or by inadvertence. Any location of the size of the city, even in a crowded metropolis, will hold several hundred plants, commonly found in it.

3. INTRODUCTIONS

3.1. Ornamental exotics

Until only 5 decades ago, Madras was very much one of the main garden cities of the country, and right from about 200 years ago has held a number

of enthusiastic horticulturists. These brought in many exotics from tropical America and elsewhere. Among these, large trees still surviving in the city are the 'nagalingam' (*Courouptia guianensis* —the cannonball tree) from South America, the African baobab (*Adansonia digitata*), and also from Africa *Kigelia ethiopica*, much planted along highways leading into and out of the city. Another exotic planted in Madras gardens which has escaped outside its confines is the yellow oleander, *Cascabela thevetia*, the poisonous drupes of which are fatal to men and cattle but eaten with impunity by some birds (mainly the Koel) and some rodents.

These garden plants from distant lands, including many herbs and shrubs, have not affected the native flora or fauna in anyway.

3.2. Unintended exotic introductions

Unintentionally introduced species have established themselves not only in and around Madras but also in most parts of India. Typical of these are *Tridax procumbens*, *Tribulus terrestris* (specific name now changed to *lanuginosis*) and the deleterious weed, *Croton bonplandianum* —all these came in long ago, and like lantana, made a conquest of India. A more recent exotic invader of the city and its suburbs (and also of the rest of the country) is the ubiquitous and pestilent mesquite, *Prosopis juliflora*, hardy, acquisitive and not easily eradicated. The iodine-rich 'lilac terror', (the water hyacinth) has made no inroads worth the mention within the city, with all ponds reclaimed and converted into buildings. The prickly pear which posed serious problems in the early decades of this century has been eradicated to rarity, and another cactus, *Cereus peruviana*, has now established itself as hedge plant, as at Raj Bhavan in Guindy.

The most notable vegetative feature of the city is that north Madras is bare and thinly covered, whereas the south and west of the capital are comparatively better wooded. This has a historic background. Madras was one of the two cities where the East India Company first established itself and acquired power, and it was in the northern part of the town (as it was then) that the offices of admin-

istration, industry and commerce developed and the land was built up into row upon row of houses, warehouses and marts. The harbour then was not where it is now: the ships were anchored at Pulicat lake, the farthest northern part of old Madras. Even the Government House was not where it is today, as Raj Bhavan in Guindy, but near Rajaji Hall in Mount Road. Adyar and Guindy and near around were still not urbanised and retained an almost rustic complexion. That is why, in spite of the way Guindy has been developed as the centre of industry and technological studies, it is in Adyar (around the Theosophical Society) and Guindy national park that one must now look for the best evidence of what the flora of the city was like originally.

4. THE FAUNA

4.1. The Mammals

Fifty years ago the sunset chorus of jackals could be heard in places on the periphery of the city, and there was a Madras Hunt Club, “compleat” with imported foxhounds and a Master of the Hounds, which hunted the jack on horseback on the outskirts of Madras. Jackals could be seen even in the larger compounds of the bungalows in Mylapore (towards Alwarpet) furtively scrounging around late in the evening. The black naped hare, the common mongoose and the palm civet could also be seen in such places, well within the city. Today over most of Madras the only animals that

can be seen are palm squirrels, rats, bandicoots (where there are godowns holding food grain) and mice. Blackbuck, which roamed the scrub around Guindy and Velacherry, are still there, and it is only there that one can still occasionally glimpse a hare, a mongoose or a jackal: the palm civet is still there in places, but being nocturnal, is seldom seen. The pangolin has been seen on the periphery of the city, but is quite rare.

Note: Chital were not part of the mammalian fauna of Madras, even when the city was comparatively wild. They were brought in to provide a decorative touch to Government House, when it was in Mount Road, and kept in a paddock. When the Governor’s residence was shifted to Guindy, the chital too went along with his retinue, and there, finding far greater freedom, have overrun the place to the detriment of the native blackbuck. Chital are among the very few wild mammals of the country that have the fecundity and remarkable adaptability to thrive even in an uncongenial setting—it is no wonder they have made themselves at home in Guindy—introduced into the wholly alien forests of the Andamans, they made a rapid conquest of the islands.

Blackbuck in the south do not attain the bodily and horn development they do in the north-west. The population at Guindy and around is, however, authentically native: other coastal haunts of this antelope are there in Orissa, even in Tamil Nadu (Point Calimere). The bucks at Guindy seem on the decline.

4.2. The Avifauna

‘Eha’ in Bombay, Finn in Calcutta and Douglas Dewar in Madras were the first to write about Indian birds in a popular-scientific way, and they wrote about the avifauna of these principal cities. Birds are much less man-shy and location-tied than mammals, and where there is scrub or woodland or marshland, scrub, woodland and water birds will be found. With the drastic decline in the groves and open scrub and ponds and similar waters in the city, there has been a directly proportional decline in the bird life of Madras, but many of the birds listed by Dewar are still to be seen here and there, mainly in south Madras. A reliable list of these birds has been prepared



Kalyan Varma

by competent observers and is available with the Madras Naturalists Society, and should be consulted for a detailed account. Here, only a cursory list roughly on a habitat basis is given.

5. WATER-BIRDS AND SHOREBIRDS

Little grebe and White-breasted waterhen where there are ponds still. Night herons still nest in trees by themselves in a small colony in places, and feed along the Buckingham canal and other waters. Among the resident water-birds to be seen in and around the Adyar estuary are these: Egrets, Cattle egret, pond heron, occasional grey heron, occasional openbill, vast crowds of black-winged stilts (as passage migrants probably), River tern, Red-wattled lapwing on the shore (the Yellow-wattled lapwing is much more a bird of the Guindy scrub), and farther away, on the thin, sun-baked scrub, the stony curlew.

Many migrants come here during the cold weather, and are briefly indicated: one or two species of ducks; once in a blue moon, a few Greater Flamingos for a halt; one or two of the smaller terns (not the Capsian); the Brownheaded gull; a variety of migratory waders and shorebirds, such as sandpipers, curlew and whimbrel (perhaps no longer);

Little Ringed Plover (also there in the Guindy n.p.); other plovers and the like.

Snipe come to the marshy waters near Velacherry. The magnificent whitebellied sea eagle is not rare along the sea-face; a pair of them nested for many years in succession in a tall tree near Adyar, till the tree was cut down, perhaps they still nest elsewhere in the city.

The tiny common kingfisher prefers a rock or elevation on the bank on which it can sit. The commoner white-breasted kingfisher is mainly a bird of gardens and the neighbourhood of houses. The resident large pied wagtail may be seen around stagnant pools and ponds, as also the migrant white and grey wagtails during the cold weather.

Note: In what follows, the attempted assignment by location may often be misleading: several birds are given to favouring two or more habitats or may shift from one to another as suits them. This rough-and-ready assignment has been adopted only as an aid to list all the common birds of Madras—some may have been missed in spite of this.

Open dry Scrub: Thinly covered and sun-baked, usually not extensive and often miscalled ‘waste-land’: ashy crowned finch-lark, rufous-tailed finch-lark; may be a bush lark and/or a crested lark.



Andreas Trepte, www.photo-natur.de

Scrub jungle and open Scrubland dotted with trees, as in Guindy n.p.: grey partridge, quails, grey and rufousbacked shrikes, black drongo, palm swift where there are palmyras, green bee-eater, Indian roller, redrumped swallows in numbers skimming over water or perched on electric cables, ashy swallow-shrike, Indian robin, pied bush chat, spotted dove (also there in gardens), baya in places, whitethroated and blackheaded munias.

Open, tree-dotted bushland, as also in Guindy n.p., gardens, groves: common iora, redvented, red-whiskered and white-browed bulbuls, common and brahminy mynas, magpie robin, rose-ringed parakeet, koel, notably common hawk-cuckoo (in the course of passage?), pied crested cuckoo (rarely also the red winged crested cuckoo), the coucal where there is a cultivated clump of bamboo or thick bush cover, lesser golden-backed and yellow-fronted woodpeckers, crimson-breasted barbet, Indian pitta in dense cover (passage migrant?), golden oriole, white-headed babbler (common in gardens), tailor bird, paradise flycatcher and white-spotted fantail flycatcher (both somewhat uncommon), purple-rumped and loten’s sunbirds, occasionally ring dove.

Raptors: lesser white scavenger vulture (hardly a raptor!), short-toed eagle, pariah and brahminy kites, blackcrested baza in the cold weather in the Guindy n.p., an occasional harrier in open ground near water, shikra, kestrel, peregrine falcon during the cold weather which comes to the city mainly to take the feral pigeons.

Night Birds: barn owl (mosques, temple spires, decrepit buildings), spotted owlet.

City Birds: house crow and jungle crow—both on the decline, especially the former; house sparrow (definitely on the decline except near grain marts); house swifts at central Madras. Numbers of feral pigeons at mosques and temples.

Finally, the common reptiles: garden lizard or bloodsucker: still very common where there are gardens and fences.

The familiar garden skink is *Mabuya carinata*, the commonest and widest distributed of Indian skinks. Much less commonly the Snake Skink *Riopa punctatus* is also there in Madras, much slimmer, more sinuous and smaller: the infant of this skink has a conspicuous red tail, the colour of which changes to an inconspicuous olive grey with age.

The House Gecko of Madras is the loud-voiced *Hemidactylus frenatus*.

Pond tortoises of the Genus *Melanochelys*, more specifically *Melanochelys trijuga trijuga*, used to be quite common in ponds in Madras. Now uncommon because the ponds have been reclaimed. The terrestrial Starred Tortoise (*Geochelone elegans*) also occurs rarely in Madras.

Snakes of most kinds were common, both poisonous and harmless. With the decline of the thorn scrub, they are hardly to be seen within city limits except in the Madras Snake Park.

Madhaviah Krishnan (30 June 1912 – 18 February 1996), better known as M. Krishnan, was a pioneering Indian wildlife photographer, writer and naturalist.

Keeping room for biodiversity in India’s urban future

India is home to some of the oldest known cities in the world but now the country is in a new phase of urbanisation. Growth is no longer limited to the former cosmopolitan metro regions but new centers of urban growth are added, with many provincial small towns growing into city stature. Cities are also ever more densely packed with more and more people moving in to search for the chance of making better livelihoods. India holds three of the world’s ten largest cities—Delhi, Mumbai and Kolkata— and three of the world’s ten fastest growing cities—Ghaziabad, Surat and Faridabad. The country’s rapidly increasing urban population, currently around 377 million people, is expected to reach 542 million by 2025 according to the UN.

In the past 20 years, the built area in India’s largest 100 cities alone has increased by almost 2.5 times or over 5000 square kilometres. The national network of highways and roads connecting these urban centres has also grown considerably, resulting in mosaic landscapes of cities, towns and farmland customised to service the needs of urban populations, inevitably transforming ecosystems and displacing wildlife species from their natural habitats. Growing urban populations and related lifestyles also typically consume more natural resources from near and far, and increase pollution. However, altered resource use by humans has consequences for ecosystem change and restoration in cities in multifaceted ways. For instance, a recovery of mangrove forests in the Navi Mumbai corridor in southeastern Mumbai along the eastern side of Thane creek since the mid-1990s may be linked to a decrease in the local dependence on fuelwood, due to a shift to compressed natural gas and electricity following urbanisation. The area has since become an important wintering ground for a large population of Lesser Flamingoes in Thane creek. However, the new proposed airport in Mumbai threatens to destroy much of the newly re-created habitat.

Different types of urban growth result in differ-

ent impacts on ecosystems and biodiversity. For instance, former colonial fast-growing cities such as Pune and Bangalore have preserved green space in the city core due to large areas being held by the military and public sector companies. History and cultural preferences for specific types of landscaping and biodiversity are major factors shaping Indian urban ecosystems. In Delhi, the trees in the old city reflect a British colonial legacy, with the arrangement and choice of tree species planted differing markedly from the new gated communities at the periphery, such as Gurgaon. Similarly, in Bangalore, older parks are more wooded, while newer landscaped gardens may be dominated by neatly trimmed shrubbery, primarily appealing to the city’s wealthier residents. However, these and many other cities grow outwards, fracturing the surrounding natural areas into a fragmented mosaic. In many smaller cities like Lucknow, growth is largely in the city core through infilling, causing greater impacts on biodiversity in the center of the city, and inhibiting species movements through the urban landscape. In other areas, large and growing cities merge, such as the emerging city cluster of Pune-Mumbai.

CURRENT AND EXPECTED FUTURE DEVELOPMENT AND CHALLENGES

India’s political economy is largely focused on maintaining double-digit economic growth rates, giving short shrift to the environmental consequences of such growth. Cities are now the key focal points of economic activity, as well as its environmental effects. The national capital, Delhi, is now vying with Beijing for the dubious distinction of having the worst air quality in the world, and many other Indian cities are not that far behind. As a result, cities bring new challenges for environmental conservation in a country that has been at the forefront of conservation conflicts and solutions for decades. Yet, most biodiversity conservation efforts remain focused almost exclusively on protecting wildlife in national parks and sanctuaries, ignoring the implications of

the current pattern of urban growth for nature in and around cities. In addition, urban development policies and planning pay little attention to ecological consequences or consider sustainable urban growth as a key goal.

Cities bring new challenges for environmental conservation in a country that has been at the forefront of conservation conflicts and solutions for decades. Yet, most biodiversity conservation efforts remain focused almost exclusively on protecting wildlife in national parks and sanctuaries, ignoring the implications of the current pattern of urban growth for nature in and around cities.

As outlined above, urban expansion presents difficult challenges for ecosystem integrity and resilience, ranging from increasing pollution of water and air, to the encroachment, degradation and transformation of woodlands, grasslands, coastal areas, wetlands and water bodies into urban concrete jungles. The few remaining green and blue spaces in many cities have been dramatically transformed into human-designed, landscaped and pesticide-intensive recreational zones. Pollution leaves habitats vulnerable to invasive species, such as the water hyacinth suffocating many sewage-contaminated urban lakes. Cities can also become nodes for the spread of invasive species, such as the exotic *Lantana camara* introduced to India as an ornamental garden plant, now choking

forest understories throughout the country. Native bird species diversity has been shown to decline with an increase in exotic plant species in Delhi. This has disturbing implications for Bangalore, where 80% of the trees in parks are exotic.

Several challenges are exacerbated by climate change. A great deal of India's projected urbanisation will occur along the coastlines through the growth of coastal cities and major port development. This threatens ecologically fragile coastal regions through destruction of sensitive habitats such as mangroves and sea turtle nesting beaches, and through increased demand for fish, turtle eggs and other seafood. Constructions close to the shoreline also leave cities more vulnerable to flooding and damage from natural disasters such as tsunamis, and to projected sea level rise from global warming. Further, the high population density in many Indian cities and towns creates particular challenges in an era of climate change. This is particularly true for coastal and river-bank cities such as Mumbai, Kolkata and Delhi, which face increased flooding during intense monsoons. Climate change also threatens cities in drier regions such as Bangalore, currently experiencing severe water scarcity due to irregular rainfall. Well-functioning ecosystems are critical in allowing cities to cope with climate change effects. Urban forests help reduce air pollution and decrease urban heat island effects, while urban wetlands and lakes reduce flooding, increase groundwater recharge, and stabilise soil. The most vulnerable urban residents tend to be socio-economically deprived, often living in areas such as slums, at greatest risk of flooding or landslides. Ensuring continued access to well-functioning ecosystems that provide services such as food, fodder, water and timber is critical in ensuring greater food and water security for the most vulnerable in times of climate change.

OPPORTUNITIES FOR SUPPORTING SOCIAL AND ECOLOGICAL WELL-BEING

Ensuring better governance of urban ecosystems is critical. Environmental governance in India involves a complex network of people interfacing on multiple levels. Elected officials, judiciary, city municipalities and planners devise and seek to implement laws and regulations, but the involvement of community groups, corporate and public sector agencies and

NGOs is important to ensure knowledge sharing, implement regulations, and maintain people's engagement. In this context, informal, loose coalitions of different social, economic and interest groups are increasingly influential in negotiating agreements at local to national scales. A classic example is the case of air pollution regulation in Delhi, mandated by the Supreme Court of India, followed by pressure from civil society groups. Indian media also play a key role in highlighting environmental and development issues through newspapers, television, along with the growing role of social media for dissemination by civic and activist groups. Community groups are also critical for knowledge dissemination and implementation of micro-scale sustainability initiatives that become very valuable when accumulated at a city scale, e.g., community-led efforts at wildscaping of local gardens in Pune, solid waste management in Chennai, and lake restoration and governance in Bangalore. They can significantly strengthen the governance capacity of local municipalities, who face knowledge, resource and manpower constraints that restrict their ability to provide effective urban environmental management.

India also has a long and rich tradition of stewardship of nature based in different cultural and religious belief systems. Even today, sacred groves are protected in many peri-urban areas and smaller towns, while massive, centuries-old sacred trees are commonly protected even in densely congested urban neighbourhoods; see the piece on Bangalore in this issue. Typically keystone species, the trees, are the basis for the native urban biodiversity and ecosystems. Furthermore, other habitats and species, for example bat roosts, macaques, langurs, and fish, are protected in certain areas. Water, wetlands and lake ecosystems are also prominent in many cultural traditions, which impose restrictions favouring sustainable management of fresh water resources and



Nasa's Earth Observatory

On November 12, 2012, the Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi NPP satellite captured this nighttime view of southern Asia. The image is based on data collected by the VIIRS "day-night band," which detects light in a range of wavelengths from green to near-infrared. The image has been brightened to make the city lights easier to distinguish.

quality. Although disrupted by urbanisation, many of these practices continue to survive in Indian cities, and offer a unique path for sustainability in India's urban future.

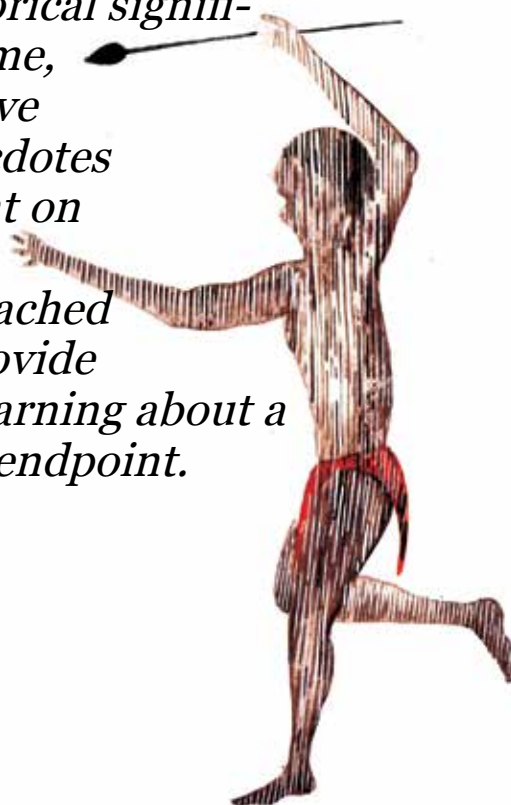
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Heritage trees of Cape Town: beacons of local history and culture

Remarkable old trees can be found in almost any city. They may have led extraordinary lives, witnessing profound landscape transformations, events of historical significance, great suffering and elation. Over time, these 'heritage trees' can develop distinctive personalities, reflected in the various anecdotes that we attach to them. They can shed light on the cultural value systems and economic priorities of bygone generations. If approached with an inquisitive mind, they can also provide excellent starting points for journeys of learning about a city - journeys that have no fixed route or endpoint.



Cape Town—South Africa's legislative capital and second most populated city—lies sprawling beneath the majestic Table Mountain in the heart of the Cape Floral Kingdom, famous for tremendous diversity and endemism of plant species. Despite the obvious ecological stressors resulting from the city's high metabolism and rapid expansion (c. 1.4% per annum), a spectacular richness of biodiversity survives within and around the city limits.

The early European settlers of the Cape, voraciously denuded the region's small patches of native forest. To meet their needs for timber, shade, fruit, aesthetic beauty and even defence from cattle raiders, the settlers also planted trees—primarily non-native trees—extensively. Consequently, many of the heritage trees found in Cape Town today have been introduced, typically from Europe or other distant parts of the world with historical trade links to the city. Yet even non-native trees can have significant value, especially in terms of 'cultural ecosystem services'. One need only ask: why do they stand where they do and what history occurred beneath their branches? Were battles waged? Was power brokered? Were treaties signed and enterprises born? Were slaves sold and convicts hung? Was sweet love made and violated?

Here follows a small selection of Cape Town's heritage trees, that speaks of the city's colourful culture and rich, if brutal history.

THE MONEY TREE IN KALK BAY

Money may not grow on trees, but it often changes hands beneath their branches. In the sleepy fishing village of Kalk Bay in the southern suburbs of Cape Town, the Money Tree (*Cupressus macrocarpa*) is said to have sheltered countless transactions.

From the late 1600s to 1850s, Kalk Bay—as its name would suggest—supported a lime industry which burnt locally abundant seashells in kilns. With the demise of that industry, fishing emerged as the village's economic staple. After each day at sea, it was under the Money Tree, safe from driving rain or blistering heat, that fishing boat skippers would dispense

wages to their crews. So too, traders known as 'langgannas'—a Malay word reflecting Capetonian ancestry—would gather around the Money Tree to purchase cartloads of fish. These they would lug some 30 kilometres north to Table Bay, blowing traditional fish horns at way stations to announce the arrival of their commerce.

Many of Kalk Bay's 'coloured' residents survived the abhorrent Group Areas Act of 1966, receiving dispensation from forced removal. As such, Kalk Bay enjoys a cultural continuity unknown to other parts of Cape Town. However, decades of overfishing have dramatically reduced the size of the fishing fleet and the Money Tree now hangs rotting by the roadside, devoid of leaves, a skeleton of its former glory.

THE TREATY TREE IN WOODSTOCK

On Treaty Road, in the post-industrial suburb of Woodstock, just east of Cape Town's city center, there stands an ancient milkwood (*Sideroxylon inerme*), known as 'The Treaty Tree', which is well over 500 years old.

It was here on Cape Town's original beachfront, that in 1510, the famous Portuguese explorer, Dom Francisco de Almeida, and 64 of his finest men met a gruesome end. A band of enraged Khoekhoe (local indigenous people) armed with only spears and stones slaughtered the Portuguese, revenging cattle raids, abductions and extortion.



In later centuries, the tree became known as the Old Slave Tree. Under its shady breadth, slave masters bartered away humans like livestock, and from its gnarled branches, numerous ‘disobedient’ slaves were hung.

In the early 19th Century the tree was renamed, the Treaty Tree, to commemorate the start of the second British occupation of the Cape. For it was here, following the Battle of Blaauwberg in 1806, that the victorious British Forces regrouped and the defeated commander of the Dutch (Batavian) Forces signed capitulation conditions, effectively ceding control of the territory. The Treaty Tree prevails in good health, now protected as a National Monument.

EUROPEAN OAK IN GROOT CONSTANTIA

This European oak tree (*Quercus robur*) is several centuries old and exceptionally hollow. Presumably it suffered from a fungal disease, perhaps after being struck by lightning or split by violent wind. Appearing at odds with gravity, its thick

heavy branches hang precariously on the trunk’s thin, empty exoskeleton.

This oak is one of many found on Groot Constantia, South Africa’s oldest wine estate. In 1685, the Dutch East India Company (VOC) granted the land to Simon van der Stel, the Governor of the Cape of Good Hope and an avid wine-lover. Van der Stel recruited French winemakers to the colony, who with the assistance of slaves, established vineyards in Constantia Valley, now suburban Cape Town. Rows of oak trees were planted to shield the vineyards from the beating winds of the ‘Cape Doctor’ and to provide wood for making wine barrels. This latter function would have been limited, because oaks tend to grow quickly in the Cape, rendering only low-quality, porous wood. In any case, the wine of Constantia soon became widely admired, especially the desert wine, Vin de Constance, famously a favourite of Napoleon Bonaparte when in exile on the island of St Helena.

SAFFRON PEAR IN THE COMPANY’S GARDEN

Brought to the Cape from Holland during the time of Jan van Riebeeck (the founder of Cape Town) some 350 years ago, the saffron pear tree (*Pyrus communis*) in the Company’s Garden is probably the eldest living cultivated tree in South Africa. Three suckers radiate from the main trunk which died back many years ago. The rot has been scraped away and special sealant applied. Metal crutches and cables now hold the tree in place. Astonishingly, it still produces clusters of white flowers every spring and a bounty of edible fruit every autumn. It must be a surreal experience to taste fruit of the same tree that the traveller, Valentyn, recorded eating from in 1714!

Established by the VOC in 1652, when indigenous hunter-gatherers and migratory pastoralists still roamed the land, the Company’s Garden is a foundation stone of Western colonisation of Africa. The Dutch needed a victualing station to supply fresh provisions to ships that were plying the spice trade or engaged in foreign wars. To this end, the Company’s Garden was designed primarily to produce food. One can still see evidence of the original irrigation furrows and wells.



Russell Galt

The old oak of Groot Constantia

Today, the Company’s Garden serves as a refuge, a green oasis brimming with botanical curiosities, statues and monuments. The pear tree is receiving a new lease of life: in a bid to preserve the tree’s genetic material, city officials have begun to propagate cuttings.

BLACK MULBERRY IN THE COMPANY’S GARDEN

One can also find a contorted black mulberry tree (*Morus nigra*) in the Company’s Garden. This species, which is native to Persia, was cultivated across much of the old world, partly for its sweet fruit and partly for its leaves which are eaten by silkworms (*Bombyx mon*)—a clue to the story of the tree in question.

In 1704, Willem Adriaan van der Stel, who succeeded his father, Simon, to become Governor of the Cape, sought to establish a local silk industry. ‘Die Oude Spinnery’ (the old spinning factory) was constructed on present-day Spin Street, next to the Company’s Garden. Imported silkworms fed on the leaves of black mulberry trees cultivated

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in the garden, and slave children were tasked with unspinning their cocoons. The black mulberry tree in the garden dates to 1800 and is probably the offspring of one planted earlier in support of the silk industry.

The industry failed to prosper and was soon abandoned. One account suggests that the eggs of the imported silkworms did not survive well in the Cape, perhaps owing to the harsh climate. Another possible explanation is that silkworms survive poorly on black mulberry, and actually favour white mulberry (*Morus alba*). Sensing a threat to their commerce, could Eastern silk producers have deliberately provided the Dutch with seeds of the less suitable species?

Many years later in 1753, the Frenchman, Francois Guillaumet, unsuccessfully sought to re-establish silk production. Thereafter, the old spinning factory was converted into a grain depot before





it burnt down in 1792, leaving only the street name and black mulberry as evidence of Cape Town's short-lived silk industry.

THE OLD SLAVE TREE ON SPIN STREET

Silk aside, Spin Street has a deeply sinister history. An old fir tree, the exact species of which could not be determined, stood here for hundreds of years until 1916 when it was cut down. Under this tree, tens of thousands of souls were sold into slavery.

Today, in the absence of that tree, a raised octagonal plaque lies wedged on a traffic island. It is faintly inscribed with the words, "On this spot stood the old slave tree", which are only legible when the sun hangs low. Pedestrians seem largely unaware of the historical significance of this marker, and sometimes walk directly over it when crossing the street.

Slaves were brought to the Cape from other parts of Africa, India and Indonesia from 1658 onwards. They were named by their masters after months of the year, or characters from the Bible and classical mythology. Their surnames were replaced by their country of origin.

Near to the slave tree plaque is the Slave Lodge, which was built in 1679 and eventually housed around 600 slaves. Having served temporarily as the Supreme Court, the building is a now a museum providing a tear-jerking account of slavery in the region. Visitors can still see the squalid, inhumane conditions in which the slaves were kept. It was not until the 1830s, almost two centuries later, that slaves were finally emancipated.

The inconspicuousness of the slave tree plaque is partially compensated by 'The Cape Town Memorial to the Enslaved', unveiled in 2008, in the adjacent Church Square. The memorial comprises a sombre arrangement of eleven blocks of black granite. Each block is engraved with evocative words depicting the names and experiences of slaves.

THE STONE PINES OF GROOTE SCHUUR ESTATE

On the southern side of the highway into Cape Town, zebra and black wildebeest graze in grassy paddocks interspersed with massive stone pines (*Pinus pinea*). The scene is of Groote Schuur Estate, and contrasts strikingly with the concrete jungle on the northern side of the highway.

Stone pines are native to the Mediterranean region and have long, branchless trunks terminating in umbrella-shaped crowns. In Cape Town, the trees often grow at an angle owing to the harsh south-easterly wind. Their cones produce large edible kernels known locally as 'dennepitjies' (pronounced denna-pye-kees).

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Many are over 150 years old and have become regarded as an important part of Cape Town's landscape and heritage, popular for recreational activities and family 'braais' (barbeques). However, the pines are extremely water thirsty and corrode native biodiversity. As such, conservation authorities are at pains to remove them and prevent their regeneration, often in the face of strong public opposition.

The stone pines were originally planted by the Dutch in the 1700s, in response to escalating demand for timber. Later, in the 1890s another wave of planting was conducted, this time at the behest of the controversial British imperialist and owner of Groote Schuur Estate, Cecil John Rhodes (1853-1902). It is these pines which can be seen from the highway today.

Rhodes actually introduced many alien species to the Cape, some of which have become invasive, wreaking ecological havoc. He augmented the diverse stock of African animals kept on Groote Schuur Estate, with llama from Peru and emu, wallaby, and kangaroo from Australia. This folly

of nature resulted in overgrazing and land degradation, for which Rhodes has been criticised. However, he has also been rightly credited for preventing this expanse of prime land from being consumed by urbanisation.

In his will, Rhodes bequeathed Groote Schuur Estate to the nation under strict conditions: that it would be used exclusively for public purposes; that any new buildings would be in architectural harmony with the existing buildings; and that the land would not be sold or developed into a residential area. The conditions have been interpreted flexibly over the ensuing years, allowing for two landmark constructions—namely the University of Cape Town in 1920 and the Groote Schuur Hospital in 1938 (made famous by Dr Christiaan Barnard who conducted world's first heart transplant there in 1967) as well as the aforementioned freeway to infringe on the Estate.

NEW LIFE IN OLD TREES

This article has highlighted only a small selection of Cape Town's many heritage trees, having unfairly omitted such treasures as the wind-sculpted milkwoods of Sea Point promenade, the precarious silvertrees of Table Mountain, the giant figs by the Baxter Theatre, the wild almond of Riebeeck's hedge, and the namesake of the Palm Tree Mosque. It would be convenient to refer interested persons to a centralised database of local and national heritage trees for further reading, but such a facility does not exist. Is there a need for one? Clearly, heritage trees have the potential to make urban landscapes more interesting and enriching. Thus making information on heritage trees freely accessible to the public may constitute a cost-effective means to enhancing our understanding and enjoyment of a city. This year, Cape Town is the World Design Capital presenting urban designers with an abundance of opportunities to trial and showcase their innovations. Surely, at least one such innovation must breathe new life into the city's fascinating, if somewhat overlooked, heritage trees.

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Colombian urban-regional environments: Emerging ecosystems, emerging logics



Kalyani Ganapathy

A SOCIO-ECOLOGICAL CONTEXT: EMERGING ECOSYSTEMS

Colombia is an emerging economy, with an increasing shift towards urbanisation: it is estimated that by 2020, more than the 80% of Colombian population will live in urban areas. Even though these statistics define Colombia as an urban country, this definition minimises the complex urban-rural interactions in one of the world’s megadiverse countries which hosts close to 14% of the planet’s biodiversity. Though our cities occupy about 2.5% of the national territory, they have a profound impact on wide territories beyond their boundaries. These small dots, home to so many people, depend directly on the biodiversity and ecosystem services provided by the metropolitan and regional environments, which are dramatically transformed by urban dynamics.

However, these impacts and interactions are not well known because, as in many other countries, the urban system in Colombia has been traditionally approached, defined and managed from economic, social and political motivations, but not in its ecological dimension. Therefore, it’s relevant to promote an ecological reading of the urban phenomena that acknowledges the different typologies of urban systems that exists in a “megadiverse” country.

In this context, Colombia’s urban and rural management present an impressive challenge: on one hand, its natural and cultural diversity across its 1,141,748 square kilometres of continental land and 988,000 square kilometres of marine territories. On the other hand, its complex settlement history that consolidated in a wide and varied system of cities, along diverse ecosystems and not always functional to them.

A national diagnosis found dramatic rates of biodiversity loss in the country and particularly in the regions where cities have developed, mainly in the Caribbean and Andean region, whose ecosystems have been transformed by 72.4% and 62.1% on average respectively. From 2005 to 2010, the Andean Region presented the highest national deforestation rate at 37% (87,090 hectares/year). Ecosystem fragmentation and expansion of the

agricultural frontier, two of the main biodiversity loss causes, are directly connected to human settlement pressures, including, urban expansion.

Despite the drastic ecosystem transformation and degradation, Colombian regions still host rich biodiversity, giving place for new socio-ecological characterisations, determined by the constant dialogue between natural and social dynamics. Cities are probably the most important of these emerging socioecosystems, that still have much to be researched and learned of. Therefore, cities have to be visible and interesting for biologist and ecologist, while biodiversity and ecosystem services have to be appealing for urban planners and architects.

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APPLYING BIODIVERSITY AND ECOSYSTEM SERVICES CRITERIA TO URBAN PLANNING, DESIGN AND MANAGEMENT

In 2012, Colombia adopted its National Policy for the Comprehensive Management of Biodiversity and Ecosystem Services. The Policy, a result of a wide consultation process, is innovative in several ways and gives hope for biodiversity in future urban planning. It highlights approaches towards resilience, uncertainty, changing scenarios, and multi-scale analysis, addressing how crucial it

is to promote biodiversity management not only within protected areas but especially within social-ecological intense interactions.

Taking into consideration the global and national goals, the Alexander von Humboldt Research Institute of Biodiversity designed and has been developing a research line in order to strengthen institutional capability to manage biodiversity and ecosystem services in urban-regional environments in three levels:

- National level: System of cities
- Regional level: Urban-regional context
- Local level: Urban fabric itself

The research line was conceived as a science-policy-society interface project, where the research was meant to generate information and knowledge useful for decision making both for the public and the social sector. The main objective: to promote biodiversity and its ecosystem services management as an innovative way for cities to redefine and re-build their relationship with nature.

In order to achieve this interface goal, the project considers three complementary systems of knowledge:

- Scientific Information and knowledge on biodiversity and ecosystem services
- Public policy analysis
- Social appropriation strategies in order to identify priorities and define collective follow-up mechanisms to biodiversity management.

The first phase of the project focused on the local level, where we found the main challenges and opportunities.

Local authorities have traditionally managed “green and gray” agendas to achieve sustainability within cities. Green initiatives are focused on promoting protected urban areas, generating data on urban flora and fauna, implementing green open spaces and lately, adopting sustainable building outlines and the city’s main ecological structure. Meanwhile, gray plans mainly promote measures related to basic sanitation, pollution mitigation and energy consumption rationalisation.

This research proposes the following criteria in order to achieve real sustainability “in” and “of” cities (meaning by this last term the city and its nearby ecosystems exchanges):

- Throughout all levels of intervention, management of urban natural areas should be based on biodiversity and ecosystem services preservation criteria. Biodiversity and ecosystems services occur everywhere, not just in protected areas; therefore all green spaces should meet both ecological and social functions.
- In urban and suburban areas, biodiversity and ecosystem services are important both in public and in private spaces; management strategies, such as preservation and restoration, applied in rural areas, should be adopted and adapted for urban areas.
- Throughout its different degrees of intensity - infrastructure, roads, sidewalks- hard areas must (i) meet sustainable building criteria, (ii) promote urban inhabitants wellbeing and, (iii) ensure biodiversity and ecosystem services preservation “in” and “beyond” urban spots.

In this regard, the institute is developing working plans with environmental authorities, academic centers/research institutes and local governments. The way that alliances are established, ensures the pertinence and level of commitment required to implement this project: an institutional base to start with. Currently, two case studies, Bogotá Distrito Capital and Medellín, have been carried out and were selected as examples of Colombia’s diverse urban systems and ways to adapt, respond and mitigate both anthropic and natural changes.

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Sacred trees in the urban landscape of Bangalore, India

Sacred ecosystems across India are immensely valued and protected resources. Deeply etched in the cultural and spiritual realm of the society, sacred sites have been found to contribute to biodiversity conservation and generation of ecosystem services. In the urban context, such cultural protection of biodiversity has been less acknowledged and recognised. This is in spite of the fact that urban green spaces are under strong pressure while still representing important values for the physical as well as psychological well-being of urban residents.

In cities like Bangalore in southern India, sacred sites act as pockets of greenery in a highly fragmented urban landscape. Bangalore is a rapidly growing metropolitan area which was once famed as ‘Garden city,’ characterised by its charming tree-lined avenues and bounty of parks. Although trees and green spaces in Bangalore are protected under the Karnataka Preservation of Trees Act (1976), the city has witnessed indiscriminate felling of trees in recent years, to accommodate large scale infrastructure development projects. Yet, sacred ecosystems/sites in the city, so far, seem to show great resistance to the pressures of urbanisation and have survived such rampant incidents of urban deforestation. While passing through the city, one witnesses many instances of sacred trees protruding into well paved streets. It may seem odd to a passerby to see a tree or group of trees intruding into the streets. However, these are simply examples of avenues that have been widened to accommodate more traffic and in the process, lost most of their tree cover except the sacred ones.



Many trees along K.R. Road in Bangalore were axed to make way for an underpass construction and wider road.

Sacred trees in Bangalore provide excellent examples of culturally protected ecosystems. In Bangalore, sacred ecosystems can be comprised of trees within a temple site, a heritage site referred to as Ashwath Katte or even randomly occurring single trees or group of trees.

Sacred trees in Bangalore provide excellent examples of culturally protected ecosystems. In Bangalore, sacred ecosystems can be comprised of trees within a temple site, a heritage site referred to as *Ashwath Katte* or even randomly occurring single trees or group of trees. Temple sites may have sacred tree species as described in holy texts, and ornamental species and fruiting trees that are used in ceremonies. The *Ashwath Katte* is an area with a slightly raised platform, generally with sacred fig (*Ficus religiosa*) and neem tree (*Azadirachta indica*) planted together under which one often finds idols of serpent gods. Other sacred species, specifically the *Ficus* species, may also be found in a *Katte*. Single sacred trees or a group of sacred trees may be growing on streets, within parks, commercial areas or residential areas that are worshipped by the locals and generally adorned with holy symbols. Sacred figs, neem, coconut trees (*Cocos nucifera*), banyan (*Ficus benghalensis*), Indian blackberry (*Syzygium cumini*), Banni (*Prosopis cineraria*) and Bael (*Aegle marmelos*) are a few common sacred tree species found in Bangalore. There are also examples of culturally protected trees at Christian, Muslim and Buddhist sites of worship, for example the tree cover on burial sites and mango trees (*Mangifera indica*).



An *Ashwath Katte* with sacred symbols and idols of gods

The old city centre of Bangalore—*Pete*—tells a fascinating story that portrays the resistance capacity of sacred ecosystems. Established in the 16th century, it is an intrinsic part of the historic and cultural identity of the city with a mud fort and mote around it. *Pete* remains an important commercial centre since when it was first built, which is interlaid with residential layouts. With the city having grown enormously over the centuries, in the present day, *Pete* comes across as an extremely congested area, still home to many city residents. It has undergone many changes over the centuries due to various political turmoils, including social, economic and geographic changes. In a sample survey conducted to map the tree cover in *Pete*, we found that the remnants of tree cover in the sampled plot were mainly sacred. The scattered sacred trees were predominantly sacred figs (*Ficus religiosa*), that form tiny islands of greenery in the highly built up environment.

Sacred figs are tall trees with huge trunk areas and large canopies. While saplings of other species do not survive the pressures of urbanisation with the landscape being highly managed, sacred figs are commonly noticed growing in crevices of buildings, abandoned land, etc. The saplings of sacred figs are successful in establishing themselves in disturbed places and are one of the few spontaneously growing species in the citiscape. They are native to the region with many medicinal properties and are actively used in traditional medicine. By and large, fig trees are known to be biodiversity hotspots that nurture the urban wildlife including insects, birds and mammals such as squirrels, bats and monkeys.

In slum settlements of Bangalore, sacred figs came across as hotspots of social activities, in addition to being worshipped. Slum dwellers were often seen to be gathering and conversing under the canopy of sacred figs and even carrying out livelihood activities such selling flowers, fruits and vegetables. The multifunctional nature of sacred sites in slums was further evident when *Ashwath Kattes* were used as play grounds by children. Tree canopies provide much needed shade from the harsh solar radiations in Bangalore. In slums, due to severe space constraints, most trees encountered were small or medium sized. The large sized trees with huge canopies were predominantly sacred belonging mainly to the *Ficus* genera, providing an excellent platform for social activities.



Slum dwellers selling vegetables and fruits under the canopy of an *Ashwath Katte* comprised of *Ficus religiosa* and *Ficus benghalensis*.

The sacred fig is believed to represent fertility and rightly so, considering the large amount of fruits it produces which are much sought after by urban wildlife. In fact, the *Ashwath Katte* represents the marriage between the sacred fig and the neem tree. There are various beliefs on the significance of marrying the two trees. One such belief is that the male god resides in the sacred fig and the female in the neem—symbolising fertility, therefore, the marriage between the two. During Hindu wedding ceremonies in certain South Indian communities, the bride worships the two trees and circumambulates the Ashwath Katte with the belief that she becomes as fertile as the sacred fig to bear offspring.

The banyan tree, on the other hand, is a huge – trunked tree with dense canopy and areal roots. It is the national tree of India and often considered a heritage tree. Within the Bangalore urban district, is one such 400 year old individual called the Big Banyan Tree – a heritage tree that also attracts tourists. Children are commonly seen playing with the areal roots of banyan trees across the city. In general, sacred trees are intertwined with the social, cultural and economic elements of the society.

Similar to the sacred fig, most other sacred tree species are native to the region and used in traditional medicine. The neem, Banni and Bael are medium sized trees with small or medium sized canopies. In popular culture, the leaves of the neem tree are often used to adorn doors on festivals. During Ugadi, the New Year’s Day in Karnataka and some other southern Indian states, neem leaves (bitter to taste) are consumed with jaggery (sweet to taste) to welcome the New Year wholeheartedly—accepting both bitter-sweet experiences that it may bring along. The healing properties of neem are widely recognised by people. In Bangalore, many residents are often seen consuming neem leaves early in the morning as part of daily health upkeep. In and around a few parks of Bangalore, juice vendors are frequently spotted in the morning, selling various herbal drinks, including fresh neem juice. The banyan tree, on the other hand, is a huge-trunked tree with dense canopy and areal roots. It is the national tree of India and often considered a heritage tree. Within the Bangalore urban district, is one such 400 year old individual called the Big Banyan Tree—a heritage tree that also attracts tourists. Children are commonly seen playing with the areal roots of banyan trees across the city. In general, sacred trees are intertwined with the social, cultural and economic elements of the society.

The most impressive features associated with sacred sites in Bangalore are those of care and continuity. Devotees and other residents of the locality were often seen to be nurturing and protecting sacred trees. These trends are not limited to species described in sacred texts, but include trees worshipped due to personal beliefs. Further, upon death of a sacred tree, a sapling belonging to the same species is planted and nurtured in the site. Such practices may not be striking enough to the outside observer, but, when seen in relationship to the rapid loss of trees in Bangalore and the planting patterns of the city authorities, their real significance appears. Although the city authorities engage in greening projects, the choice of species planted are of a different kind. The city authorities have a preference towards ornamental and exotic species with small canopies including the Indian mast tree (*Polyalthia longifolia*) and the royal palm (*Roystonea regia*) that fail to perform the



Google Earth image of the Pete area of Bangalore that shows the canopies of sacred trees, demarcated in yellow.

important social and ecological roles of native and large canopied trees. Furthermore, the saplings planted by the municipality often lack proper care and may not grow into sturdy trees, in contrast to culturally important species that are actively nurtured by local residents.

Active citizens and environmental groups have often come together to protest against the large scale deforestation of Bangalore. While protests have been successful in some locations, yet, the denudation of the city’s tree cover continues. Urban development seems to be the primary agenda of the city authorities. However, sacred trees, heritage trees and other culturally protected trees have so far portrayed resistance against the pressures of urbanisation. Cultural ecosystems across the world are some of the best protected areas, securing biodiversity values as well as spiritual and other cultural values for humans. To secure pockets of nature in rapidly developing

cities, there is great potential in better recognition of the values and practices by urban residents that protect and nurture trees and other ecosystems. There are lessons to be learned for how to design parks and green spaces that engage people in their protection and management, as well as for maintaining a green infrastructure of trees, parks, and other green spaces, that sustains human well-being in the city.

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Beyond business as usual: Why urban biodiversity indicators matter

How can we change ourselves, move beyond “business as usual”, and revert the trend of biodiversity loss in general and in urban areas in particular? Knowing the status quo and monitoring trends in your neighbourhood is one way to go about it. This is where indicators can play a role.

Since its development in the 1970s at the Organisation for Economic Co-operation and Development (OECD), various instruments have been developed for environmental issues in the city. It started from simple indicators such as urban green areas but the limits were already clear at its early stages. Indicators were unable to deliver its performance because they were split into different categories, mostly according to the administrative units or scientific disciplines. The economic sections monitored trends of housing and energy use, while environment sections looked into green areas and water use. Ecologists monitored species abundances while school activities are analysed by pedagogics. For certain cities, economic growth was attained at the expense of environmental deterioration. Trade-offs and synergies of different aspects were not taken into consideration. There was a growing awareness that indicators should not be observed as individual numbers but more holistically, monitoring whether your city is moving towards more sustainability or not.

The City Biodiversity Index (CBI, or Singapore Index) is set of indicators to self-monitor such trends for the cities. It was developed under the framework of the Convention on Biological Diversity when the local authorities in implementing the goals of the Convention were recognised and adopted in 2008. Singapore led the process as urban biodiversity was uniquely important for the nation mostly consisting of urban areas.

Various cities and experts joined the development and application of the index, including former hosts of the Conference of the Parties, Curitiba (Brazil, host city of COP8), Bonn (Germany, host city of COP9), and the City of Nagoya (Japan, host of COP10). The index rests on the pillars of ecology, ecosystem services, and governance.

In the book *Urbanization, Biodiversity and Ecosystem Services – Challenges and Opportunities*, the scientific foundation of the Cities and Biodiversity Outlook project (www.cbobook.org), published in 2013, experiences of applying the CBI in different contexts are reviewed and lessons are shared. Besides the technical or terminological difficulties for measuring or definitions, a number of cities expressed difficulties in monitoring ecosystem services and their indicators. Unlike compiling number of endemic species, where datasets are mostly available

in existing institutions, setting baselines for ecosystem services were causing difficulties. In some cases, there were no available ready-made data sets for e.g., costs of water purifications, or carbon storage.

These “difficulties” can be constructive if it can shake up the “business as usual” mindsets. The purpose of indicators is not development or the application per se. It can easily become a routine if ready-made datasets are applied. The development of process indicators can be instrumental in promoting dialogues amongst administrative units to create datasets. In order to monitor ecosystem services, environmental sections will need to talk to construction sections. Ecologists will need to discuss with economists or other social scientists. By doing so, these indexes will promote reflexive thinking for policy makers and scientists. Experience of Japanese cities showed on a diverse range of green coverage and species richness. Osaka and Kawasaki were relatively grey for example. The range of “greenness” of Japanese cities is wide, since they are formed by their individual histories and economical cycles. In contrast, governance indicators have indicated more similarity across cities. The strategy for greener cities might thus need to be attuned to individual cities with their respective starting points and, in the context of Japan, take into consideration a rapidly aging society.

In 2014, the slogan “think globally and act locally” means acting in urban parks or forests, school gardens, remaining lands amongst the skyscrapers, or farmlands adjacent to the urban areas, at least for half of the world’s population. Monitoring trends and changes in urban settings will be critically important for the future. We will not be able to address environmental problems unless the studies and tools used include nature in cities and the resource-producing areas that cities depend on. Indicators in your town matters for these purposes.

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Challenges and opportunities for nature conservation in Rio de Janeiro: Peninsula and Inhaúma

Rio de Janeiro has a history of biodiversity restoration and conservation dating from the 1800s. The area was originally covered by the Atlantic Forest complex (or Atlantic Forest *senso lato*), a mosaic of ecosystems including rainforest, mangroves, restinga (sandbanks), wetlands and beaches. The Atlantic Forest is one of the biodiversity hotspots of the planet but only about 11-16% of its original area remains. Urbanisation and agriculture have drastically transformed the landscape, not only by deforestation, but also by elimination of entire hills, indented to allow urban expansion along the shore and in flood-prone lowlands. Economic agricultural cycles, mainly coffee cultivation, were responsible for most of the hills' biodiversity degradation until the 1800s. During this period the city went through a severe drought, which led to the decision to reforest the Tijuca massif in

order to restore specific ecosystem services, such as fresh water supply, local climate regulation, botanical explorations, and recreation for the growing population. Today, more than 150 years later, the forest still provides numerous services and is protected as part of the Tijuca National Park. The remnants of the native ecosystems are located in private and public areas, mainly in Federal, State and Municipal Conservation Units. Forests, mangroves, and other natural ecosystems are estimated to cover about 18% of Rio's urban area.

Urban nature is so important that the city received the UNESCO's World Heritage Site award in 2012, as "Rio de Janeiro: Carioca Landscapes between the Mountain and the Sea". Beaches and parks are assets that attract residents and tourists. The city is

physically divided by the massifs of Tijuca and Pedra Branca. The slopes are mostly covered by restored Atlantic rainforest and exotic tree species.

Like many of the Global South cities, Rio has high social-ecological contrasts and inequities: built-up areas adjoin slums (favelas), mostly located in vulnerable deforested slopes and flood-prone lowlands, spread in the urban tissue; expensive residential and commercial developments are located closer to coastal zones; and the inland region is characterised by densely living, lower income populations, poor infrastructure (sanitation and public transportation), and land mostly deprived from vegetation and public spaces.

Rio de Janeiro faces many challenges related to urban expansion, such as floods and landslides, increasing urban heat island effect, severe traffic congestion, and air and water pollution, among other hazards to human health. Nowadays, the expansion is sped up by public and private investment flows to promote several international events that have boosted the city's image worldwide, mainly the 2016 Olympic Games. These investments support real estate developments over lowlands in the city's west zone, causing radical landscape transformations that follow the historic occupation patterns of eradication of ecosystems and biodiversity, even with alterations in environmental legislation.

Despite the ongoing negative trend, tools and mechanisms that can help to support biodiversity and ecosystems in Rio do exist, as the following two examples will show.

PENÍNSULA – TOP-DOWN INITIATIVES OF ENVIRONMENTAL LEGISLATION AND OWNER-SHIP RIGHTS

Environmental legislation was responsible for the implementation of protection and restoration of biodiversity in the late 20th Century. The most successful case is located in the Jacarepaguá lowlands—a lagoon system. In this area, a modernist urban plan designed in 1969 by the architect and urban planner Lucio Costa, envisioned the future city center in a wetland, with sprawled car-based gated communities and shopping malls along the main highways. In the plan, the lowlands were divided in glebes—large lots

of land—that attracted powerful real estate investors. In the following decades, after the opening of a new road system, the occupation was fast, and led to a deep transformation of the landscape: from native ecosystems to lawns and "homogenised" ornamental gardens with few exotic species. However, the area has still today about 30% of vegetated land cover.

In order to enable the development of a strategically located 750,000 square metres residential gated community named Península, in 1986 the glebe's owner hired Fernando Chacel, a famous ecologically oriented Brazilian landscape architect, to restore and create a 77,000 square metres ecological park on a three kilometres long lagoon-front land parcel. In this manner, the glebe's owner could comply with the legislation and add value to his land. He foresaw a business opportunity and envisioned a park that could be a magnet for new residents in his property. He also promoted the restoration of mangroves and associated transition ecosystems in a contiguous park, Mello Barreto, and had to protect a 207,061.26 square metres in an adjacent Northern glebe. Today, residents recognise native biodiversity and adapted species as one of the main assets of their community.

INHAÚMA – THE BOTTOM-UP INITIATIVE OF VERDEJAR

The northern district of Inhaúma is one of the densest and poorest areas in Rio. It has about 118 inhab-



Cecilia Herzog



Verdejar restoration area - Inhaúma

itants per hectare, and only 1.6% of its territory is covered by green areas. In the late 1980's, a resident known as "Luiz Poeta" (Poet Luiz), started to plant native tree species in one of the few non-built slopes of the region. Other residents joined him in his effort to restore the rainforest, so they could enjoy a better local climate, protection against landslides and further illegal occupation. The informal actions gave place to an active NGO: Verdejar. The transformation is remarkable: large portions of the slopes are now covered by forests, and residents that got engaged in this process started studying to be better prepared to work for enhancing their community. Their many activities combine nature restoration and conservation with local culture and arts. Local production of fruits and vegetables is another target of the organisation. It is a bottom-up approach: people value the biodiversity and the ecosystem services that the forest, agro-forestry and vegetable gardens provide. It is a successful combination of nature restoration and positive social change.

Verdejar is one of the many organisations in Rio that are engaged in social and ecological actions. Together, they have the potential to constitute an efficient network of stakeholders that can influence the political agenda. It is, however, crucial that decision makers of the city develop a deeper understanding of the role of urban biodiversity and the ecosystem services it provides, in order to promote a systemic socio-ecologically oriented urban planning and design. In this manner, Rio could achieve its full potential to be a real biophilic city.

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Coexisting with biodiversity in the city

A blank map of the world fills the screen as 200 students look up at it in a darkened classroom in California. The blankness represent an early time in human history when there weren't so many of us around. It is an animated map designed to illustrate the growth of the human population across the globe. As the animation moves forward in time, a few dots appear in some parts of the world, and start filling up the blank spaces. Each dot represents a significant center of human habitation, a town or city holding a large number of people. The dark dots start appearing at a faster rate as we get into recorded history, with the pace slackening only in the Americas in the decades immediately after the Old World "discovered" the "New" one. Over the last couple of centuries, the pace really picks up, even in the New World, at our post-industrial exponential rate illustrating how Paul Ehrlich's (and Thomas Malthus' before him) population bomb started really going off all over the Earth during the 20th century.

Alongside this map is a graph showing the rate at which species have been going extinct on Earth over the same time period as the map's animation. At least, our best estimate of how many species have gone extinct. There is a familiar yet disquieting cadence to this dance as the line on the graph sweeps and bounces upwards to keep pace with the rhythm of the dark dots pattering across the map. The lesson couldn't be made more obvious: as people have increased in number, so have we been pushing ever more and more species off the cliff of extinction. It is the biggest cautionary tale of this Anthropocene, one that every young student must surely absorb deeply if we are to hope that the human juggernaut can be turned around and many non-human lives saved.

Yet, as the young mixture of blank and anxious faces stares at the screen, and up at the professor hammering in the point about how the human population explosion is a leading cause of species extinctions, I can't help but notice something different. The students have naturally focused their attention mostly

on the Americas and on Africa, large land masses with which they are familiar as home, for themselves or for wild animals. These are also places where the recent population growth and extinctions are most prominent, making them more animated on screen.

Yes, we've lost the Cheetah, and many other species hover at the brink, but compared to much less populated North America, the Indian subcontinent has managed to retain quite a number of even large fierce species. How has it been possible for a land so full of people as to inspire Ehrlich to write "The Population Bomb" four decades ago, to also hang on to so many wild animals crowded into this tiny corner of the world?

Over on the Indian subcontinent, though, the dots dance to a different rhythm. This corner of Asia seems to get filled by people quite early in our history, and remains relatively more filled than most other places throughout subsequent millennia. Yet, it is not a region that has seen spectacular extinctions quite

like those elsewhere. Yes, we've lost the Cheetah, and many other species hover at the brink, but compared to much less populated North America, the Indian subcontinent has managed to retain quite a number of even large fierce species. How has it been possible for a land so full of people as to inspire Ehrlich to write "The Population Bomb" four decades ago, to also hang on to so many wild animals crowded into this tiny corner of the world?

A recent global collaboration (in which I play a part) compiles a database of biodiversity (starting with plants and birds) in the world's cities. As the database starts filling up with lists of plant and bird species now known to be regularly occurring in 147 (and counting) cities, a number of interesting patterns emerge, fueling further research on urban biodiversity on a global scale. As I have noted in this column before, studying biodiversity in cities and understanding how species find ways to survive and sometimes thrive in the interstices of human habitats is key to how we navigate our way out of the current Anthropocene extinction crisis.

One in five of the world's bird species (and one in twenty of the plants) now occur in urban areas. More interestingly, over 95% of the bird species found in

cities are native to the region. In other words, bird diversity in any city continues to reflect its region's unique natural history heritage, even as cities seem more alike in this globalising world culture of shopping malls and airports, high-rise apartments and office buildings. Cities may be simpler (compared to a rainforest) or more complex (compared to a grassland) than the natural ecosystems they displace. Yet, the niches in these novel ecosystems are filled mostly by species who evolved in those displaced native habitats. Not really by design or intention, the cities we have built for ourselves somehow serve as arks for more native biodiversity than we imagine. We need to imagine better, and to improve how we design cities so even more species may find ways to cohabit with us on this urban planet.

Yet again the picture from cities in India fuels my unreasonable and skeptical optimism. For here in this land of over a billion people, a land which has always been more heavily peopled than almost anywhere else on earth, even the largest megacities contain over 300 bird species. And hardly any of them are exotic invaders who managed to gain a foothold and usurp habitat from native species. This is in part because the world's most widespread city-slicker species (the house sparrow, the rock pigeon) figured

out how to live with humans early in these parts, and along with the mynahs and parakeets, managed to invade other urban areas while retaining their hold on their native cities in India. The same may hold for primates and some other mammals. But maybe not for plants where people brought in some pretty exotic species which ended up escaping from their gardens to become the most notorious ineradicable outlaws choking the jungles and grasslands across the subcontinent.

Is it India's mainstream culture of revering nature and finding gods in various animals which allowed so many of them to live among humans? Is it more simply that the early onset of urbanisation in the the Indus valley, in Harappa and Mohenjo-daro, has allowed more time for the native birds (and other wildlife) to adapt to city life? Or is it that the collapse of those once rich cities into deserts burned some ecological lessons into unconscious cultural memory, allowing subsequent development to hang on to bits of wildlife and nature amid human enterprise?

Wherever the answer may lie, we better find it soon. Because it has the potential to help not only India, but cities everywhere in conserving more of the world's wild species even as more humans turn to

city life. Even now, even in anarchically sprawling megacities like Mumbai, something remarkable happens: mangroves come back in Thane creek, paradoxically protected by the newly urbanised populace of Navi Mumbai. And every winter a sprinkling of pink brightens the grey of the tide flats and the dark green of the mangrove canopy, when lesser flamingos by their tens of thousands show up to add color to urban life. We don't quite know what brings the flamingos into the city, nor why mangroves grow back along the shores of Navi Mumbai's new suburbs even as developers continue to cut them down elsewhere in the metropolis.

Perhaps it is part of that different rhythm to the dance of the urban human dots on that map in that California classroom. Somehow, both Indian culture and biodiversity have remained surprisingly resilient even as humanity transformed the entire planet. The real challenge ahead will be to not throw that cultural and natural historic legacy away, but to show the rest of the world how human development can be reconciled with conserving other species.

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Megha Vishwanath

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