India needs long-term biodiversity monitoring in urban landscapes

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Global and Indian long-term ecological research

Understanding plant compositional patterns over long timescales has greatly improved the foundations of community ecology[1]. Data from long-term forest monitoring sites form the core of community ecology research, and a global network of several such sites continue to generate valuable data on global change[2–4]. India also has such long-term ecological research programmes operating since many decades[4–7]. Despite the overall increase in such long-term networks, the world's urban landscapes are not adequately represented compared to their forested counterparts[8]. As a prominent example of this bias, out of the 24 Long Term Ecological Research (LTER) sites established till 2003 in the United States, only two focus on urban landscapes[2]. Out of these two, research at the Baltimore LTER site is based on three guiding questions that relate urban patch dynamics with biophysical, functional and social domains[9]. The first of these questions deals with understanding the spatio-temporal changes in the socio-economic, ecological and physical features of urban landscapes[9]. In the next three paragraphs, we highlight some key (and non-exhaustive) findings pertaining to structure, function and socio-ecology domains respectively, from the two urban US-LTERs and present examples of relevant work from India.

One of the key findings on biophysical characteristics of the Baltimore LTER is that urban regions are biodiverse[9]. Contrary to the earlier generalization that urbanization is detrimental for biodiversity, studies across the world conclude that cities can be a hotspot for biodiversity[10]. In line with these findings, Indian cities show high biodiversity of several taxa[11–14], including remnant populations of globally threatened species[15]. Recent research also continues to document new species to science from such urbanized regions[16]. We now have some understanding of the relation between physical features (e.g. roads[17]), degree of urbanization (rural–urban gradient[18]) and habitat strata (e.g. parks[19], domestic gardens[20,21], sacred spaces[22]) with the plant and animal community structure.

With respect to ecosystem functions and services, biodiversity in cities plays an important role in carbon regulation[9]. Data from Indian cities indicate that they sequester large quantities of carbon[23]. However, the impacts of urbanization on net carbon uptake vary according to previous land use and forest cover type[9]. Urban vegetation in Indian cities also offers several other services such as reduced air and road temperatures, and reduced suspended particulate matter in the air[24] that help curb the urban heat island effect.

Urban biodiversity is largely driven by socio-economic factors, and landmark concepts in urban ecology, such as the 'luxury effect' (which predicts a positive correlation of human wealth and biodiversity), are an outcome of the Central Arizona-Phoenix LTER initiative[25]. Although we do not yet have studies that test this concept explicitly in India, a few from Bengaluru provide insights into how socio-economic factors such as apartment size[21] and poverty[26] affect biodiversity. Along with these, studies in Delhi[27] and Pune[28] document perception and attitudes of urban green space-users.

Thus, despite the recognition that Indian cities are biodiverse, and that this biodiversity in turn provides crucial ecosystem services, we lack long-term (>10 years) datasets to understand the underlying patterns and processes. With this background, we introduce the 'Fergusson College Long Term Vegetation Monitoring' (FCLTVM) initiative.

The Fergusson College initiative

Pune is the second largest city in Maharashtra. The Fergusson College campus – an urban green space – is located centrally in Pune city and harbours a rich floral[29] and faunal[30] assemblage. By collating the available historic records and data from the most recent studies, we now have baseline data for several taxa recorded in the campus[29,30]. Considering the need for long-term urban diversity studies, and using these baseline data, we have started the FCLTVM initiative. We focus on woody perennial plants at this stage since they are a prominent structural component of the ecosystem[4], and easy to identify and monitor.

In congruence with the first fundamental question of the Baltimore LTER[9], we broadly aim to understand the structural and functional changes in the woody vegetation of the campus, and their key drivers over time. Specifically, we ask: What are the ecosystem-service-based traits selected by the planters?[31]. How do these vary temporally? How does this translate into a non-random change in plant composition and structure?

In order to understand these changes, we have set up permanent vegetation-monitoring transects in the campus following the broader guidelines of international protocols[3,32], with modifications appropriate for the study area. The detailed protocol along with the 2018 data are made freely available online[33]. In June 2018, we established 50 transects in the campus, each of dimensions 10 m × 2 m (area sampled = 1000 m^2), and also undertook a census of two gardens (approximate area sampled = 11,825 m^2). In each transect and the two gardens, we marked all woody perennial individuals >1 cm diameter at breast height, recorded abundance of each species, and measured their girth and height (881 individuals belonging to 108 species recorded in 2018). We aim to continue this monitoring annually, at least for the next ten years.

Potential insights from an Indian long-term urban biodiversity network

This initiative is the first of its kind in the country, and today, a biodiverse country like India needs more such initiatives. Given the low-cost protocol, we hope that this initiative will be replicated in other urban green spaces, especially campuses of educational institutions across the country. Data from a network of such initiatives will contribute in bridging key knowledge gaps in urban ecology. For example, predictions of the

'biotic homogenization hypothesis' (that urbanization leads to more homogenous communities compared to those in natural habitats) have not yet been widely tested[34]. Testing this hypothesis in Indian cities can lead to an improved understanding of how urbanization affects community dynamics over long timescales. Another example is of the landmark luxury effect mentioned earlier. Very few studies from the tropics have examined this effect, and it has not yet been tested in India[31,35].

Results from these academic opportunities can directly contribute in developing sustainable cities. Greater biodiversity promotes greater well-being of the citizens[8], and academic research (e.g., on the luxury effect) can help provide an objective framework to quantify and alleviate the inequality of biodiversity based on resources[35]. Long-term studies are also useful from an urban-planning perspective, given that the contribution of ecosystem service-based traits varies with plant functional groups[31]. Understanding temporal changes in the preference of these traits can thus aid planners in developing a framework for selecting the right species for a given region.

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ACKNOWLEDGEMENTS. We thank Dr Harini Nagendra (Azim Premji University) for her inputs, Vignesh Kamath (Gubbi Labs) for archiving the data on the portal, and the Principal and authorities of Fergusson College, Pune for support.

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Addressing poverty in India's Revised National Tuberculosis Control Programme: are we failing to harness the opportunities?

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Implications of reduction of poverty in relation with TB control programme

The bi-directional relationship between poverty and tuberculosis (TB) is well established. Poverty aggravates material disadvantage, social exclusion, discrimination in participation across a wide range of socio-economic and behavioural activities along with undernutrition, overcrowding, lack of access to healthcare and other social determinants of health; it also exacerbates TB and its spread[1–4]. India being a high TB burden and lower-middle income country accounted for 27% of the world's 10.4 million new disease cases in 2017 (ref. 5). Nearly 27.5% of India's population is