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Urbanization and its Impacts on Land Use, Biodiversity and Ecosystems in India

Abstract | India, a predominantly rural country, is going through a slow but constant and broad transition towards urbanization. The amount of cities and mega cities has increased from 5,161 to 7,935 in 2011. The united Nations predict that, by 2031, 15% of the urban population of the world, about 600 million people, will be living in Indian cities. This increase in urban population will cause repercussions in terms of environment, ecology and sustainability, which will manifest themselves in demands on urban services and governance of the urban ecosystem. In addition, urbanization generates significant tension in terms of land cover, native habitats, biodiversity, protected areas and services to the ecosystem that are basic for human wellbeing. In this paper we analyze some challenges and opportunities for urban development in India that include the participation of governments, private agencies, NGOs, and citizens from different social and economic strata.

Keywords | environmental services – governance of ecosystems – biodiversity – climate change

Introduction

INDIA, A DOMINANTLY rural country, is undergoing large-scale, rapid transformation towards urbanization. In 2010, India accounted for 11% of the world's urban population with 377 million people living in cities. Yet by 2031, the UN projects 15% of the world's urban population will come from India, with as many as 600 million people living in Indian cities (United Nations 2011). Within the country, between 2001 and 2011, the number of million plus cities and urban agglomerations has increased from 35 to 53, while the number of towns and cities

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has increased from 51,161 to 7,935, leading to an increase in the overall proportion of urban population in the country from 27.8% to 31.2 %. Of this, about 25 % of this urban population lives in India's largest 10 cities (JNNURM 2011). Most of the population growth between 2001-2011 has come from towns undergoing a rural-urban conversion, as well as from rural-urban migration (JNNURM 2011). Thus, India which was a predominantly rural country is undergoing a slow but steady transition to urbanization.

Such a transition will have a major impact on human sustainability, created by the increased urban footprint of large mega-cities, the expanding impacts of smaller cities and towns, and distal impacts on rural environments (Shaw and Satish 2007). Urbanization generates significant stress on land cover, native habitats, biodiversity, ecological commons and the ecosystem services that underpin human well-being (Narain 2009, Janakarajan 2009). Demands from urban populations decrease the supply of natural resources in far off areas, and increase pollution within and outside cities. This

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is often exacerbated by both lack of appropriate policies for managing these effects, and poor regulation and enforcement (Narain 2009). Urbanization in India also has major impacts on rural areas, reshaping lifestyles, livelihoods, and patterns of consumption and waste generation (Sanyal, Nagrath and Singla 2010). Thus, the ongoing and anticipated massive increases in urban population across India are bound to have significant implications for the country's environment, ecology, society and sustainability.

Yet urbanization in India also presents some opportunities for the environment. For instance, between 1993 and 2005, the percentage of urban households using fuelwood for cooking declined from 30% to 22%, with over 70% of Indian states and union territories showing a decrease in urban fuelwood demand, due in large part to a shift to modern fuel sources such as liquefied petroleum gas for domestic use (DeFries y Pandey 2010). Such changes can have a positive role in reducing the pressure on forests and wooded areas near urban centers, as has been witnessed in some locations such as in Navi Mumbai, where decreased pressure on mangrove forests due to a transition in fuel use has led to a remarkable recovery of these threatened ecosystems in the past two decades.

Patterns of urban expansion

India currently contains three of the world's ten fastest growing cities—Farid-abad, Ghaziabad and Surat—as well as three of the world's ten largest cities, Delhi, Kolkata and Mumbai (United Nations 2011). In the past 20 years, the area of urban cover in the top 100 cities alone has increased by almost 2.5 fold, by an extent of greater than 5000 km^2 (Sudhira, et al. 2013). Further increases in urban cover are taking place as several large and growing cities merge into city clusters (such as Chennai-Hyderabad, or Pune-Mumbai).

Urban growth in India is often nucleated, with newly urbanized land usually seen in a tight band around the older parts of the city. In high growth cities like Bangalore and Pune, the city center maintains a fairly steady population be-cause of a scarcity of land, while the city grows outwards, leading to increased fragmentation at the periphery (Taubenböck, et al. 2009). In the smaller city of Lucknow, growth is largely in the city core due to infilling, which can lead to greater impacts on biodiversity in the center of the city, and can impede species movements through the urban landscape.

In addition, the development patterns of Indian cities are also shaped by their history. For instance, cities such as Pune and Bangalore retain significant green space in the city core despite rapid development and growth due to the presence of institutions such as the military and public sector companies within the city core, that protect large green patches (Nagendra, et al. 2012).

Impacts on urban ecosystem services and biodiversity

Accelerated urban growth presents several difficult challenges for the natural environment in Indian cities. Increasing pollution of water and air degrade eco-systems (Narain 2009, Janakarajan 2009). A continuous encroachment and transformation of ecosystems from woodlands, grass lands, coastal areas, wet-lands and water bodies into urban concrete jungles often takes place, leading to further degradation (Nagendra, et al. 2012). The remaining green spaces in many cities have been transformed from their original state and species compo-sitions to human-designed, landscaped and pesticide-intensive parks, dominat-ed by exotic species (Nagendra and Gopal 2011).

Further transformation of urban ecosystems is driven by their vulnerability to invasive species, such as the water hyacinth suffocating many urban water bodies across India (Aggarwal and Butsch 2012). Cities can also become nodes for the spread of invasive exotic species into surrounding non-urban habitats, such as the exotic Lantana camara, which was introduced to India as an orna-mental garden plant, but now chokes forest understories throughout the coun-try. Native bird species diversity has been shown to decline with an increase in

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exotic plant species in Delhi, and the same has been found in other cities in the world (Khera, Mehta and Sabata 2009). This has disturbing implications for Bangalore, where 80% of the trees found in parks are exotic (Nagendra and Gopal 2011). Enhancing the amount of green areas in cities with native species, as has been done in some cities such as Mumbai, holds the potential to offset some of this development.

The high population density in many Indian cities and towns creates particular challenges to mitigate the impact of climate change. A major challenge will be to manage scarcities and excesses of water (Sanyal, Nagrath and Singla 2010). Coastal and inland cities located near rivers, such as Mumbai, Kolkata, and Delhi will have to deal with increased risk and intensity of flooding. The most vulnerable urban residents tend to be socio-economically deprived (Aggarwal and Butsch 2012). They also tend to live in informal or traditional settlements, located in areas at greatest risk for flooding or landslides and at greatest risk of eviction during environmental crises.

Problems of water scarcity due to unpredictable rainfall will intensify as climate change accelerates, especially affecting cities in semi-arid areas such as Bangalore. Measures such as rainwater harvesting need to be intensified. Well-functioning ecosystems can be critical in ensuring greater food and water security for the most vulnerable in times of climate change. Urban trees have the potential to reduce air pollution and decrease urban heat island effects (Vailshery, Jaganmohan and Nagendra 2013), while urban wetlands and lakes can reduce flooding, increase groundwater recharge, and stabilize soil. Improving solid waste management is also critical to maintaining the quality of urban ecosystems and life (Sanyal, Nagrath and Singla 2010).

A major element of India's projected urbanization will take place along the coastlines through the growth of existing coastal cities and proposed and ongoing development of major new ports. This threatens important coastal regions through increased tourism as well as destruction of sensitive habitats such as mangroves and sea turtle nesting beaches, and increased demand for seafood (Noronha 2010). Building construction close to the shoreline, along with mangrove destruction, also leaves cities more vulnerable to flooding and other damage from natural disasters like cyclones and tsunamis, and projected sea level rise from global climate change (Puthucherril 2011).

Traditions of conservation in India

History and cultural preferences for specific types of landscaping and biodiversity play a major role in shaping Indian urban ecosystems. In the capital city of Delhi, the trees in the old colonial center differ clearly in distribution and spe-

cies composition from those planted in the new gated communities at the periphery (King 2007). Similarly, in Bangalore, older parks are more wooded, while newer landscaped gardens tend to be dominated by neatly trimmed shrubbery, which may appeal more to the wealthier of the city's residents (Nagendra and Gopal 2011).

India also has a long, rich tradition of conservation associated with sacred religious and cultural beliefs. Sacred groves are conserved in many peri-urban areas and smaller towns, while it is quite common to find massive, centuries-old sacred trees being protected in densely congested urban neighborhoods across India (Gadgil 1991). These trees act as important keystone species in denuded urban environments, and provide important support for urban wildlife (Krishen 2006). Other habitats and species such as bat roosts, Bonnet macaques, hanuman langurs and fish are protected in certain areas. People also feed urban wildlife during certain times of the day

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(Jaganmohan, et al. 2012). Water, wetlands and lake ecosystems also occupy a prominent position in many Indian cultural traditions, with traditional restrictions on the conservation and management of fresh water resources, maintained through worship of local lake deities. Although disrupted by urbanization, many of these practices continue to survive in Indian urban areas. Such traditions can be very influential in providing a unique, India-specific path for sustainability in an urban future.

Challenges of governance

Governance of ecosystems in India is characterized and shaped by a complex network of actors interfacing on multiple levels, including but not confined to the judiciary, elected officials, city municipalities, corporate and public sector agencies, Non-Governmental Organizations (NGOs), local community groups, research institutions and activist groups (Nagendra, et al. 2012). Elected officials, judiciary, city municipalities and planners can 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, and willingness to follow regulations. In this context, informal, loose coalitions of different social, economic and interest groups are gaining increasing influence in negotiating local-scale agreements about resource use, and in providing important links with official institutions (Shaw and Satish 2007). They also

strengthen the governance capacity of local municipalities, who face knowledge constraints and resource and manpower limitations that restrict their ability to effectively implement regulations limiting the over-use and exploitation of urban ecosystems. Such groups can also increase knowledge dissemination within their own groups and implement sustainability initiatives at a micro-scale that can become very valuable when accumulated at a city scale. Examples include wildscaping of local gardens in Pune, solid waste management in Chennai, and lake restoration and governance in Bangalore (Nagendra 2010).

Poverty and inequity in many Indian cities presents an especial challenge for environmental governance. Most Indian cities have a very low per-capita green space availability for instance, far below World Health organization (WHO) recommended standards (Chaudhry, Bagra and Singh 2011). Yet access to green spaces can be very important for the poor. In the slums of Bangalore, plants were found to provide many crucial services to inhabitants, acting as sources of shade, physical support, food and medicine, as well as being important for cultural and religious ceremonies and beliefs. While trees and plants in wealthier residential areas in Bangalore are of aesthetic and cultural value that can be seen as an extension of people's lifestyles, greenery in slums is very much a part of people's livelihoods, with many slum residents managing their daily activities outside under trees, practicing professions such as flower selling, broom making, incense sticks making, and the running of a mechanic shop, tea stalls and telephone booths (Gopal 2011). Yet despite the importance of trees in slums, the density of trees in these areas was quite low, only 11 trees/ha in comparison to 28/ha found in other residential areas (Jaganmohan, et al. 2012), highlighting the lack of importance paid to environmental services for the underprivileged in Indian cities.

Conclusions

India's massive increase in urban population, from 377 million people in 2010 to 600 million in 2031, is bound to create massive challenges for the environment, ecosystems and human well-being in India. These challenges need to be addressed upfront. City planning, infrastructural development and the consumption patterns of urban inhabitants will impact ecosystems within cities as well as far beyond the city boundaries, with implications for the quality of life for people across the country (Aggarwal and Butsch 2012).

Cities can and do harbor great biodiversity, managed and maintained by the Government, private actors and citizens from different socio-economic strata. Many long-standing Indian cultural traditions of nature protection further add to the resilience of urban green and blue spaces (Gadgil 1991). Yet, there is a

need for informed, inclusive decision-making for ecosystem protection, management and restoration, which will be of increasing importance in the era of climate change (Puthucherril 2011). For this, sustainable planning and implementation is required, building on inclusion of people and groups from all levels and backgrounds. Increased interaction, debate and cooperation is required between official governance institutions, civil society groups and individuals, with a focus on social and ecological well-being, especially for the most poor and vulnerable sections of society.

As this paper highlights, there are opportunities and success stories, as seen in the large scale involvement of NGOs, civil society groups and local communities from diverse socio-economic backgrounds, including the most underprivileged, in ecosystem protection and biodiversity maintenance (e.g. Nagendra 2010, Gopal 2011). Such community initiatives to reduce urban ecological footprints, improve solid waste management, rainwater harvesting and lake restorations, hold out significant opportunity for scaling up to the national level.

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