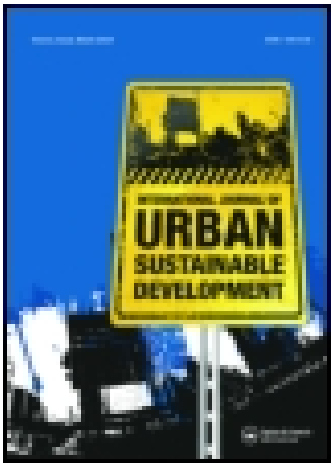

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Beyond the urban: rethinking urban ecology using Kolkata as a case study

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Beyond the urban: rethinking urban ecology using Kolkata as a case study

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Urban ecology is an emerging discipline providing opportunities for inclusion, incorporation and integration of methodologies from numerous disciplines across natural and social sciences. Studies have multiplied over the last few decades and the subject has expanded in scope from sheer dependence on ecological variables to socio-economic, political and cultural variables Within the contemporary context of Third World urbanisation process and urban development, this paper revisits the scope of urban ecology and attempts to further widen the purview of the discipline by incorporating the study of rural/peri-urban and urban linkages and their transforming interactions from political ecology and historical perspectives. By shedding light on the mutually interdependent interrelationship between the city and its peri-urban interface (PUI) and how it has transformed from a mutually reinforcing system to a truncated one, the Kolkata case study strongly emphasises the need for integrating political ecology and historical frameworks to render urban ecology more inclusive.

Keywords: urban ecology; sustainable urbanisation; urban planning; peri-urban; rural–urban; Kolkata

1. Introduction

There seem to be two different approaches in studying urban ecology: ecology 'in' cities and ecology 'of' cities. The first approach is unidimensional, unidirectional, small-scale and located within a city; the second approach is transdisciplinary, multi-scale, incorporating both ecological and human dimensions of urban ecosystems (McDonnell 2011). Much earlier (in 1935) and also in a different context, Tansley categorised urban ecosystems into individual urban ecosystems that included parks, wastelands, etc. and the ecosystem of the entire city (Rebele 1994). To ensure ecological sustainability of the entire city, sustainable flows between the city and its wider ecosystems must be ensured (Elmqvist et al. 2013; Mukherjee forthcoming). However, the present pattern of urbanisation in the developing countries creates a wide gap between the desirable, ideal scenario and expected future development. This gap between the backcasting and forecasting approaches (Quist 2007; Phdungsilp 2011) has to be perceived within the historical trajectory of urban growth and development of a particular city.

Since 2007 urban centres have become the dominant habitat for human beings, making the process of urbanisation one of the most significant global trends of the twenty-first century. Scholars argue that the most important ways in which urbanisation processes today are different from urban transformations of the historical past include the scale, the rate and the shifting geography of urbanisation (Seto et al. 2013). The developing world (especially Asia and Africa) has already entered the high-growth, rapid-transition phase of the urbanisation process, marked by numerous problems and challenges including the changing nature of the rural–urban divide which is evident in

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the emerging literature and theories on urban planning. Massive urbanisation (also called mega-urbanisation or urban sprawl) in developing cities is taking place converting ecosystems into estates, affecting ecological sustainability and the livelihood options of marginal people who depend on ecosystem services provided by ecosystem resources. Against this, urban political and environmental activism takes various forms within particular spatial scales which, however, do not lead to totally different patterns of urban transition as state-led (or municipality-led) urban environmental planning, firmly tied up with the needs and dictates of the global economy dominating the urbanisation process and urban development. The theoretical justifications for urban planning are provided in urban sustainability theories including 'sustainable city programmes' and the more recent agenda of 'sustainable urbanization', with universal prescriptions and recommendations for rendering cities sustainable (UN Habitat 2012).

Within this broad context of Third World urbanisation, this paper revisits the scope of urban ecology and attempts to widen the purview of the discipline by incorporating the study of rural/peri-urban and urban linkages and their transforming relationships from political ecology and historical perspectives. By shedding light on the mutually interdependent interrelationship between the city and its peri-urban interface (PUI) and how it has transformed from a mutually reinforcing system to a truncated one, the Kolkata case study strongly emphasises the need for integrating political ecology and historical frameworks for studying urban ecology moving towards the more inclusive ecology 'of' cities approach.[1]

2. Urban ecology: concept, trends and trajectories

Urban ecology emerged as a sub-discipline of ecology and gained prominence against urban crises including population spurt in urban areas and resource depletion, and its impact on urban settings. Previously, ecology simply implied the study of organisms and their environment but has undergone certain modifications over the years (McIntosh 1985; Krebs 2001; McDonnell 2011). At the outset, human-dominated ecosystems were not legitimate subjects within the discipline, but by the second half of the nineteenth century it was becoming clear that humans had altered – and continue to do so – virtually the planet's entire ecosystem. Compelling evidence demonstrated that more than half of the earth's fresh water is used by humans; nearly half of the land surface has been transformed by human action, more atmospheric nitrogen is fixed by human activities than by all natural terrestrial processes combined, and human activities are leading to significant losses of biodiversity (Vitousek et al. 1997; McIntyre et al. 2000).

An important development occurred as early as the 1920s, with the inclusion of the social sciences approach. While natural scientists concentrated on the patterns and processes of ecosystems (with less emphasis on human beings), social scientists were inclined to study human settlements (Alberti 2008). The contribution of the Chicago School was the earliest in this respect. Drawing upon the works of Malthus, Darwin and Spencer, the Chicago School introduced human ecology as a research agenda for sociology (Grove & Burch Jr. 1997), leading to the development of what came to be known as urban sociology, combining ecological concept in a social matrix. The sudden spurt in America's urban growth to accommodate demographic pressure resulting from mass immigration from Europe and rural America provided the context for its development. 'In the midst of this urban dynamism, a new university was founded on the principles of advanced research and given to iconoclastic experimentation' (Lutters & Ackerman 1996, p. 2). Interestingly enough, this school was influenced by and developed parallel to the emerging fields of the plant and animal ecology of America, conceiving human ecology as an extension of the former. The landmark publication *The City* by Park et al. (1925) was significantly influenced by the works of Bessey and Clements at the University of Nebraska and Coulter and Cowles at the University of Chicago (Young 1974; McIntosh

1985; Hagen 1992; Grove & Burch Jr. 1997). To Lutters & Ackerman (1996), the city was of utmost value as a laboratory for exploring social interaction.

In the 1970s, the United Nations Educational, Scientific and Cultural Organization (UNESCO) initiated the Man and Biosphere (MAB) programme to conserve and study both natural and cultural ecosystems. This contributed to the establishment of the first multidisciplinary ecological studies of human settlements, and it can be credited with consolidating the emerging discipline of urban ecology (McDonnell 2011). Further development did not occur until the 1990s when the American National Science foundation (NSF) funded two urban long-term ecological research (LTER) programmes in Baltimore, Maryland and Phoenix, Arizona (McDonnell 2011).

Urban ecology integrates the theories and methods of both natural and social sciences to study the patterns and processes of urban ecosystems (Grimm et al. 2008). It has become clear over the last two decades that the emerging discipline of urban ecology is an amalgamation of several disciplines (Alberti 2008). 'Urban ecology integrates both basic (i.e. fundamental) and applied (i.e. problem oriented), natural and social science research to explore and elucidate the multiple dimensions of urban ecosystems' (McDonnell 2011, p. 9).

The world population today is over 6.5 billion and it is increasing at an uncontrolled pace, unveiling extreme challenges and opportunities (still mostly unexplored and unexploited). Against this backdrop, ecological researches are focusing on human beings as vital components of the ecosystem and more studies are being conducted in urban settings. Ecologists are currently interested in exploring how overall ecosystem structure and function shape, and are shaped by, urban growth and development. In regard to developing cities, which are facing the most rapid and dramatic explosion of urban population, there is an urgent requirement for an analytical approach integrating environmental, political and historical understanding within a complex context of intensifying socio-ecological problems.

3. Theories on urban sustainability and urban environmental planning: the Third World context

The concept of 'sustainable cities' is derived from that of 'sustainable development', popularised in the Brundtland Report (1987) of the World Commission on Environment and Development (WCED), United Nations (UN) and Agenda 21 (1992), the agreement that came out of the Earth Summit held in Rio de Janeiro, Brazil, in 1992 (WCED 1987; UNCED 1992). The shifting geography of urbanisation to the global South provided justification for the implementation of 'sustainable cities', an amalgamation of various independent processes like Agenda 21 followed by Habitat II in 1996, urban environmental movements, decentralisation of local governance structures, etc. (Mahadevia 2001). In the early 1980s, the United Nations Centre on Human Settlements (UNCHS) and the United Nations Environment Programme (UNEP) decided to prepare joint environmental guidelines for environmental planning and management (EPM) of cities. In the early 1990s, this initiative was converted to the joint Sustainable City Programme (SCP) in the global South. SCP was launched as a vehicle for implementing Agenda 21 at the city level, to incorporate environmental management into urban development decision making (Mahadevia 2001) where economic and environmental costs of urbanisation and urban development were to be taken into account and cities were to be designed as compact and energy efficient, self-reliant in terms of resource production and waste absorption (Haughton 1997). Urban problems and solutions in the developing cities were viewed through the northern lens of its developed counterpart, leading to an overarching emphasis on environmental issues such as reduction of resource consumption, local waste absorption and use of renewable resources, but ignoring the critical issue of meeting basic human needs. Mahadevia (2001)

condemned 'The pursuit of sustainable development and "Sustainable Cities" is set against the backdrop of an increasingly globalised world in which the North dominates the South in economic terms' (p. 243).

When the world population reached the seven billion mark in 2011, with massive implications for the current and future dynamics of human development, the post-2015 UN development agenda centred round what came to be known as 'sustainable urbanization' (UN Habitat 2012). The city came to be considered the main platform for transformation, the locus for change and the venue where human agency might be mobilised.

> Cities make countries more prosperous. Countries that are highly urbanized have higher incomes, more stable economies, stronger institutions and are better able to withstand the volatility of the global economy than those with less urbanized populations … Cities around the world are playing an ever-increasing role in creating wealth, enhancing social development, attracting investment and harnessing both human and technical resources for achieving unprecedented gains in productivity and competitiveness (UN Habitat 2012, p. 7).

The report of the UN Task Team also points out that 'in defining a new development agenda utmost attention needs to be given to the city as a whole, particularly in the period after the second decade of the new millennium' (UN Habitat 2012, p. 10).

The first-ever Integration Segment of the United Nations Economic and Social Council (UNECOSOC) focused on 'sustainable urbanization', demonstrating how urbanisation can be an effective tool for the integration of economic, social and environmental dimensions of sustainable development (UNECOSOC 2014b). Like the 2012 UN report, the 2014 background note for the Integration Segment also looks into opportunities and potentials offered by contemporary patterns of urbanisation. It considers urban areas as a source of growth, development and jobs, which if well managed and adequately planned, could offer opportunities for economies of scale and scope in development efforts, in particular in addressing poverty, health and education issues. The document emphasises the capacity of urban densities; it recommends viewing urbanisation not as a problem, but as a tool for 'sustainable development'. This pro-metropolis document manifests the unilinear mainstream perspective of a positive correlation between urbanisation and development and does not take into account the non-linearities and critical approaches (Castro 2004). It points out that 'urbanization has been, and continues to be, a source rather than simply an outcome of development … Governments can use urbanization as a powerful tool for transforming production capacities, income levels and living standards, especially in developing countries' (UNECOSOC 2014a, pp. 3–4).

The thinking behind the growth and development of cities and spread of urbanisation embedded in the gospel of 'sustainable urbanization' fails critically to examine complex problems associated with the nature, scale, pace and pattern of Third World urbanisation, both currently and in the coming decades. It is expected that most of the urban population will be absorbed by the cities and towns of low-income countries, likely to rise from 1.9 billion in 2000 to 3.9 billion by 2030 (Allen 2009). Rapid urbanisation or urban sprawl in the Third World is marked by numerous problems and challenges including the burgeoning slums and squatter settlements; lack of citywide infrastructure such as housing, health, sanitation, privatisation and commercialisation of infrastructure; conversion of ecosystem resources affecting the livelihood opportunities of ecologically dependent marginal communities; and the changing nature of the rural–urban divide.

Contemporary trends reveal that urbanisation is affecting the way in which rural and urban households and individuals straddle the 'urban' and the 'rural' (Allen 2009). The emerging landscapes challenge conventional definitions and perceptions of the city and the countryside with regards to their location, physical structure, functional relation, institutional context and cultural

outlook (Allen 2009). This is throwing greater challenges at the planners because this transition is neither absolute nor complete, with urbanisation spreading and transforming rural areas into urban areas enjoying full urban status while geographical rural–urban borders intermingle to such a degree that distinguishing between them is becoming difficult (Allen 2010).

> Both micro-level development studies of household strategies and macro-level geographical studies of urbanisation, development and rural–urban disparities point to an emerging, irregular and 'lumpy rural–urban continuum' ranging from 'clearly rural environments … through a variety of intermediate or peri-urban forms and on to dense built-up environments culminating in mega cities such as Jakarta and Mexico City' (Allen 2010, p. 32).

Attempts to conceptualise these changing landscapes in development and planning discourses range from emphasis on rural–urban flows, linkages and interactions as unhindered processes rapidly transforming territories, to the notion of the 'peri-urban' as a distinct spatial entity, a term qualifying areas where 'urban and rural features coexist' (Allen 2010, p. 35) or are characterised by either the loss of 'rural' values (loss of fertile soil, natural landscape, etc.) or the deficit of 'urban' attributes (low density, lack of accessibility, lack of services and infrastructure, etc.) (Allen et al. 1999). It is argued that EPM of the peri-urban area cannot be based on the extrapolation of planning approaches and the tools applied in rural or urban areas, but on the construction of an approach that responds to the specific environmental, social, economic and institutional aspects of that discrete interface (Allen 2003).

Apart from the debate on whether 'peri-urban' should be incorporated within urban planning to ensure sustainable flows between the urban and the peri-urban, or whether peri-urban planning should evolve and develop as a separate field of planning, it is important to look into the major challenges of urban environmental planning for a developing city from a political ecology perspective. This would facilitate our understanding on the complex environmental dynamics of the urban space (i.e. how particular urban environment is produced and who gains and who loses due to particular power relations influencing changes within the urban environment and beyond). In developing cities, in spite of support by and resistance to the state or municipality-led and directed environmental planning, the latter, tied to the needs of global economy, takes on an authoritarian form dictating urban transition and justifying and legitimising it in urban plans and documents.

4. Urban/PUI: the Kolkata case study

The Kolkata case study is not only a unique reflection of the mutual dependence and symbiotic relationship between the urban and its PUI (Figure 1), but also how the present pattern of urbanisation through urban environmental planning has disrupted – and continues to disrupt – this interdependence, crucial for the sustenance of the entire region.

The sustenance of Kolkata largely depends upon its interaction with the PUI, mostly in the form of wetlands in the eastern part of the city acting as a transitional zone, an urban–rural continuum for the rapidly east-centric urbanising city over the last few decades (Figure 2). The proximity of the wetlands to the city and their interdependence sustains both. The PUI of the East Kolkata Wetlands (EKW) is the world's largest resource recycling ecosystem, fully managed by local inhabitants using intergenerational knowledge. It recycles 810 million litres of waste water generated by the city, inhabited by approximately 14 million people, on a daily basis (Banerjee & Chaudhuri 2012). The canals, artificially excavated during the colonial regime to ensure flow of goods between the city and its hinterland, and also for drainage purposes, divert sewage water to the EKW fish ponds. The wetlands in turn provide ecosystem services and livelihood opportunities to the peri-urban poor who sell their surplus produce in city markets. Most importantly, Kolkata does not have a separate sewage treatment plant like most other populous cities; the wetlands act as a natural sink (often regarded as the 'natural kidney'

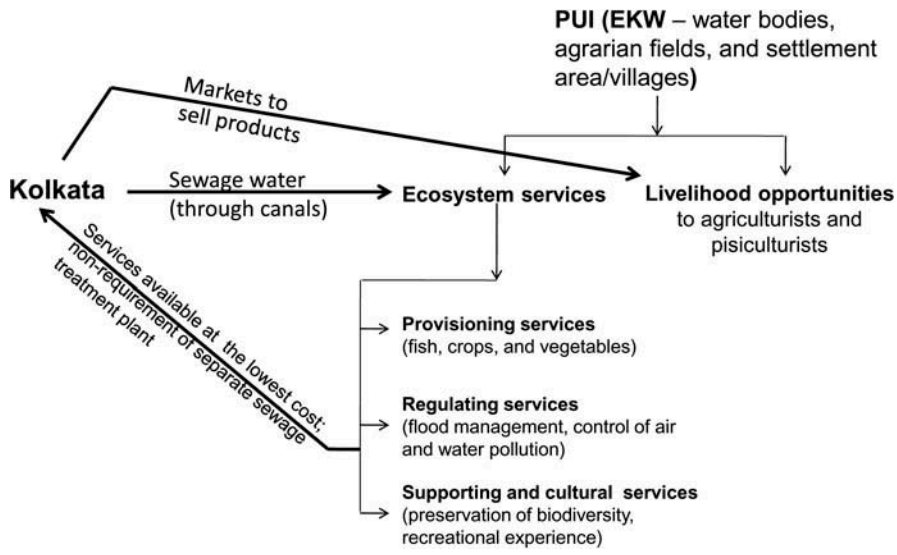

Figure 1. Sustainable flows between the city and the East Kolkata Wetlands (EKW).

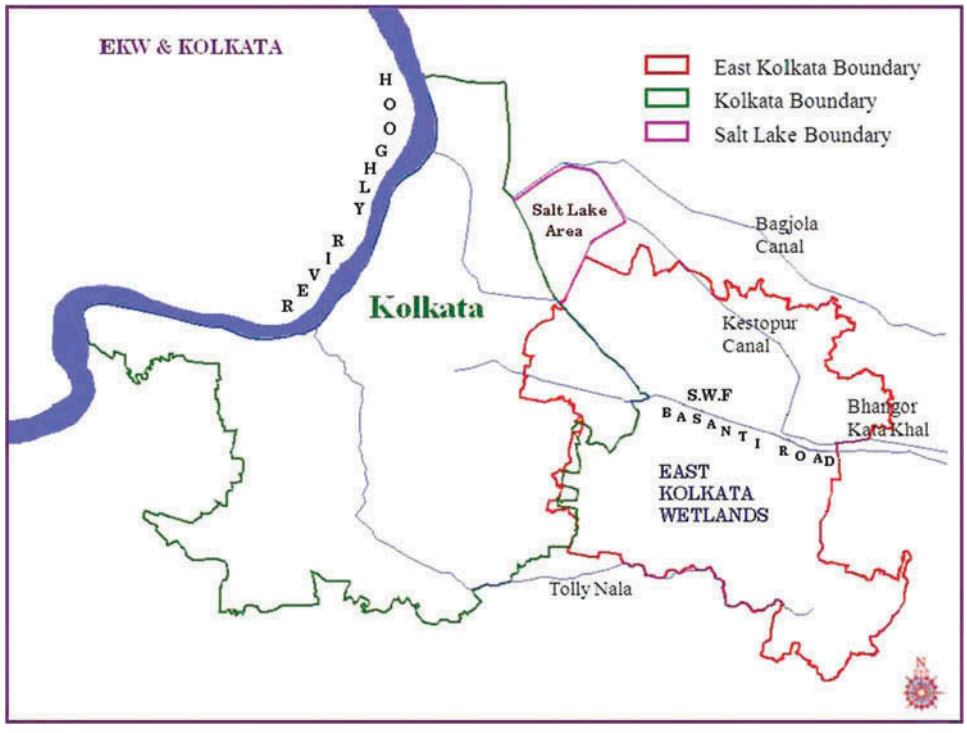

Figure 2. Kolkata and its PUI.

of Kolkata) and provide free services that would have otherwise cost the city approximately US$ 80 million per annum![2]

The complex interaction between Kolkata and its PUI can be traced back to the colonial history of their inception. From archival documents including official data, reports, letters, extracts, maps and plans, it can be argued that the city and its PUI co-evolved as consciously constructed spaces following a hegemonic discourse of domination/subordination, the PUI functioning as an output and input, produced and required by the city (Mukherjee forthcoming). It is fascinating to reconstruct the history of the colonial urban-scape that gradually evolved when the British colonisers tamed, controlled and modified the natural ecology of the area to accomplish the colonial motive of revenue extraction.

Kolkata can be considered as 'ecologically subsidized' (Ghosh 2005), the River Hooghly to the west, the saltwater marshes to the east and the Ganges and its numerous tributaries and tributaries (including the River Bidyadhari) intersecting the whole area. These ecological advantages played a key role in the selection of the city as the seat of the imperial capital (Mukherjee 2009–10). The natural environment was gradually tamed, controlled and modified, keeping pace with the development of the universal laws of colonial hydraulics, to create an artificial system that facilitated trade and transportation, drainage, sewerage and sanitation. The British project of urbanisation implied the evolution and successful management of this complex hydraulic scheme.

The East India Company obtained a *firman* (order) from the Mughal Emperor in 1677/78 to conduct trade freely in Bengal. From 1680 onwards a brisk trade developed between the British, Dutch, Portuguese and French in the Hooghly region. The British wanted to establish an independent settlement in Bengal to exploit new trading opportunities (Roy 1982). The villages of Sutanuti, Kolkata (*Kalikata*) and Gobindapur, where Job Charnock had landed with a contingent of 30 troops on 24 August 1690, consisted of a narrow strip of land on the banks of the Hooghly, surrounded by swampy jungles and brackish lagoons on all sides. It was a place of mists, alligators and wild boars; colonial reports and letters shed light on the unhealthy and deleterious environment of the area when the British first settled there (Chattopadhyay 1990). Nevertheless, in spite of such disadvantages the selection of this area was the result of a deliberate judgement on the part of the British, who realised the manifold ecological advantages offered. The River Hooghly tapped the trade of the Ganges valley, and the settlement site was located at the highest point at which the river was navigable for seagoing vessels. The Ganges and its tributaries provided the foreign merchants with an opportunity to extend their trading operations inland over a wide area between Kolkata and other parts of Bengal, including Khulna, Faridpur, Backhergunj and Barishal. On the eastern side, the site was protected from invasion by the presence of an extensive salt lake, the swamps and marshes of which made it impenetrable to any enemy. Moreover, the cost of land acquisition was less because of the marshy environment (Mukherjee 2009–10). Hence, the 'economic logic for the commercial development of the Ganges valley gathered momentum' (Ghosh et al. 1972, p. 8), paving the way for Kolkata's urbanisation.

The colonial history of excavation of canals and reclamation of marshes offers a unique insight into the growth of an expanding city. It connected Kolkata with her hinterland, ensuring an unobstructed flow of raw materials and commodities to the city and its port. The Eastern Canal System (Table 1), along with certain additional channelling and excavations (which were then

Table 1. The Eastern Canal System.

Name of excavated canal	Year of execution
Beleghata	1810
Circular	1831
New Cut	1859
Bhangar (canalised)	1897
Krishnapur	1910

integrated into it), also drained the sewage into the saltwater marshes. When the first city drainage scheme directing waste water artificially into the River Hooghly (against the natural slope) failed in 1803, another underground drainage system was implemented for disposal of sewage and storm water through the same conduit into the saltwater swamps, which were then finally connected to the Bay of Bengal through the River Bidyadhari.[3]

The River Bidyadhari, the main outfall channel, had gradually become defunct by late 1920s and the immediate need was the implementation of an alternative outfall. The Kulti Outfall Scheme on the River Kulti, another channel of the Ganges, was executed and commissioned in 1943, leading to a gradual transformation in the aquatic environment of the area from saline to non-saline – from saltwater marshes to sewage-fed, freshwater wetlands. Previously, the eastern marshes were saline in nature as the Bidyadhari carried saline water from the Bay of Bengal and spilled over the low-lying area. Silting up of the Bidyadhari caused a decrease in the inflow of saline water. Moreover, with the decline of this river, sewage and storm water carried by canals came to be diverted into the saltwater lakes, turning them into freshwater lakes (Ghosh & Sen 1987; Chattopadhyay 1990; Ghosh 2005). The salinity of these salt lakes dwindled from 800–1200 to 500–600 ppm, turning the once-profitable *nona bheris* (saltwater fisheries) into sewage-fed fisheries. Thus, the 'salt water marshes that existed 200 years back between Hooghly and Bidyadhari Rivers gave rise to the present EKW' (Gupta 2005, p. 24). When the Kulti Outfall Scheme was implemented, an adequate waterhead was raised to supply sewage to most of these fishponds by gravity, which resulted in the extension of wastewater fishponds further east and south-east for about 8000 ha (Ghosh 2005). The present EKW lies between the levee of the River Hooghly to the west and the River Kulti to the east, and is distributed nearly equally between the two sides of the dry-weather flow (DWF) channel that feeds into the river. This area acts as the PUI of the city, being used as both output and input, produced and required by Kolkata.

Presently, EKW stretches over two districts, North and South 24 Parganas, and comprises 264 sewage-fed fisheries, agricultural land, garbage farms and some built-up area (Kundu et al. 2008). It is inhabited by 109 villages with a population of 0.15 million (as per household census, 2003). It has a long history of sewage-fed pisciculture and agricultural practices using local traditional knowledge. The fishermen and farmers living on the wetlands produce and sell their surplus to city markets – 74% of the working population draws sustenance through fish farming, agriculture and horticulture (EKWMA & Wetlands International 2010). Every day the city receives nearly one-third of its fish requirement from EKW (about 11,000 metric tonnes per annum) and 150 metric tonnes of vegetables. EKW not only hosts free provisioning services (fish, crops and vegetables), but also provides regulation and cultural services in the form of controlling water and air pollution, groundwater recharging and flooding, preservation of biodiversity and habitat, and recreational avenues for the urban and peri-urban population.

However, the complex interaction and sustainable flows between Kolkata and her PUI are at risk as the wetland faces major challenges from innumerable factors which include silting up of water bodies and canals; encroachment of water bodies leading to reduced employment; social, economic, environmental and political settings; ambiguous delineation of wetland boundaries; lack of infrastructure for aquaculture; lack of development project assessment; absence of clear policy or legislation for preservation of the system; lack of awareness amongst non-users and planners of inherent benefits; lack of funds for maintenance of fisheries and waste–reuse system; limited ability of poor communities to fight encroachment; unclear land ownership and absence of fishermen's rights; insufficient sewerage supply (seasonal); law and order problems and inaccessibility to the general public; unscientific farming and harvesting due to union intervention; weakness of the

fishermen's cooperative; absence of work culture; irregular and insufficient water supply; lack of integrated aquatic resource utilisation; lack of coordination amongst government, NGOs and locals; lack of recognition of fisheries as an industry; discharge of domestic and tannery effluent into the fish ponds; and lack of health and hygiene practices and education. However, rapid urbanisation of the eastern part of the city in the post-independence period is the most severe threat to the wetlands, with potential shrinkage in size and diminishing flows (Mukherjee forthcoming).

West Bengal received a huge influx of people following Indian independence in 1947, which was accompanied by the partition of the country into two separate states, India and Pakistan. Kolkata, the capital of West Bengal, experienced the greatest population pressure which was one of the official reasons that expansion of Kolkata was advocated through the creation of new townships and development projects. Since then, Kolkata's expansion has been east-centric at the cost of her wetlands. In 1956, the proposal to establish Salt Lake Township was initiated and approved. In 1960, 3.75 square miles of North Salt Lake was acquired; of the 58 in that area, 44 were sacrificed to meet the needs of the expanding city (Chattopadhyay 1990). In the North Salt Lake area, 26 fisheries were taken over by the Salt Lake City housing complex alone (KMDA 1976a). Between 1962 and 1967, 3000 acres (approx.) of wetlands were appropriated to make way for major residential projects in Salt Lake City, and between 1967 and 1972 another 800 acres were converted for further expansion (Kundu et al. 2008). In the 1970s, 1650 and 600 acres were reclaimed for the development of East Kolkata Township and Patuli, respectively. In the 1980s, part of the wetlands was encroached upon to make way for the construction of the eastern metropolitan bypass and municipal solid waste disposal ground.

Few conservation and management initiatives have been taken up. EKW was designated a Ramsar site in 2002, ensuring that it cannot be further encroached upon. The East Kolkata Wetlands (Conservation and Management) Act was passed in 2006, followed by the setting up of a statutory authority called East Kolkata Wetlands Management Authority (EKWMA) responsible for systematic implementation of wise use principles for the management of EKW. Nevertheless, the area suffers greatly from the threat of land sharks. The Ramsar-designated area of 12,500 ha, including 37 *mouzas* (five *mouzas* were later added), is also facing a severe threat from rampant, unplanned urbanisation.[4] EKW still suffers from ambiguous boundary definition and ownership.

To understand why, in spite of being 'one of the rare examples of environmental protection and development management where a complex ecological process has been adopted by the local farmers for mastering the resource recovery activities' (Kundu et al. 2008), EKW has and is still encountering massive encroachment, it is important to examine the entire process of unplanned and uncontrolled urbanisation on the eastern fringes of the city from politico-economic and ecological perspectives. Urban environmental planning in the contemporary period has to be understood within the historical conjecture of the post-independence period, strongly influenced by global and local events and broadly divided into two stages – postcolonial (or command economy) during the nationalist period and post-command/reform economy since the advent of the neoliberal regime (Chakravorty 2000).

The duality and ambiguity in urban planning can be traced back to the formation of the Kolkata Metropolitan Development Authority (KMDA) in 1970 and the publication of the Development Perspective Plan (DPP) in 1976, which emphasised a polycentric model of development along the east–west spatial growth axis of the city. This itself violated the earlier Basic Development Plan (BDP) of 1966, which focused on a bi-nodal strategy along a north–south urban development axis (KMPO 1966; KMDA 1976b). Since the implementation of DPP, the eastern periphery of Kolkata – the PUI – has become a space for real-estate speculation. The KMDA tried to attract

private investment for projects aimed at the development of commercial complexes and market areas.[5] Although the next major plan of 1990, Plan for Metropolitan Development 1990–2015, generated warnings about the negative implications of the east-centric urban sprawl, development projects and urban expansion continued in the same manner at the cost of the city's wetlands (KMDA 1990). It is clear from the planning reports that the actual purpose of this pattern of urban expansion was to capitalise on the enormous development potential in the vast stretch of undeveloped land on the city's eastern fringes.

Since the early 1990s India has followed the economic policies of multilateral funding agencies, specifically structural adjustment programmes (SAPs) and associated privatisation and commercialisation of urban infrastructures (Mahadevia 2001). Environmental programmes for making Indian cities more sustainable have been undertaken for Kolkata (along with Chennai, Hyderabad, Bangalore and Delhi). With the support of the UK Oversees Development Agency (ODA; now known as the Department for International Development, DFID), the first Kolkata Environment Management Planning Strategy and Action Plan (KEMSAP) was initiated in 1995–96 to improve the city environment. The Kolkata Environment Improvement Project (KEIP) was initiated in 2002 under the SCP, with the improvement of canals (including those carrying sewage into EKW) and solid waste management being important components of the project along with the treatment of sewage discharged into the DWF to increase the productivity of EKW fisheries.[6] Nevertheless, in spite of the constant claims of success, few of the provisions have been implemented and no evaluation study has been conducted to date. This is an Asian Development Bank (ADB)-funded project with an estimated cost of US$ 220 million. External agencies have exerted a strong influence on official programmes and the city has fallen into a debt trap with no actual or significant improvement in its urban infrastructure.

This state- or municipality-led/supported urban environmental planning and urban environmentalism (combining ideology and action to 'improve', 'restore' and 'preserve' urban environment) has found both acceptance and rejection from the middle class whose vision collaborated with but also sharply collided with giving rise to pluralities of urban environmentalism(s). Against the changing nature of land-use pattern converting huge areas of wetlands, there were protests and petitions by civil society; middle-class environmentalists 'took the state to the court' (Dembowski 2001) against rampant wetland conversion, acknowledging the creative role of wetland-dwellers in preserving and restoring it. In the 1990s, when city-based NGOs took up the cause of wetlands protection and conservation along with other environmentally minded bureaucrats, it was the first incidence of a movement that had an explicitly environmental goal in the metropolitan area. It forced the state government to take public opinion into account in its urban planning for the very first time. Several cases were fought in both the High Court and the Supreme Court to conserve EKW (Dembowski 2001). Their petition demanded that the State of West Bengal and its officers were legally bound to protect the wetlands in accordance with both the West Bengal Town and Country Planning Act, 1979, section 46(1), Article 51A of the Indian constitution, which states that protection of the environment is among the key duties of the citizens of the country, and Article 21 of the constitution, which implies the right to live in environmentally safe and pollution-free conditions. They won the legal battle, and the court acknowledged the tremendous benefits of EKW to society and environment at large in relation to capitalist materialist benefits (Dembowski 2001; Kundu et al. 2008). The recognition of EKW as a Ramsar site was another step in its conservation and protection against conversion. However, repeated conversions even within the protected area demonstrated the limitations of middle-class environmental activism in contrast to state-led

authoritarian environmentalism that finally triumphed as the dominant/hegemonic discourse and action, and dictated the urban transition of a developing city within the neoliberal context.

5. Rethinking urban ecology: methodological insights

This section calls for the expansion of the scope of urban ecology to render it more inclusive in regard to contemporary processes and patterns of urbanisation, especially within the Third World context. It is important to study urban ecology beyond the urban and ecological variables by incorporating rural/peri-urban and urban linkages and their transforming relationships from political, ecological and historical perspectives.

The urban planner Robert Lang has suggested that cities are no longer independent but represent a limited number of dominant megapolitan regions across the globe – coalitions of urban centres and increasingly built-up intervening regions (Lang & Nelson 2007; Grimm et al. 2008). The edge of the city expands into surrounding rural landscape, inducing changes in soils, built structures, markets and informal human settlements, all of which exert pressure on fringe ecosystems (Grove & Burch Jr. 1997; Grimm et al. 2008). In the 1990s, scholars urged exploitation of the ecosystem structure and function along the urban–rural gradient which was till then an unexploited opportunity for ecology (McDonnell & Pickett 1990). The gradient paradigm came to be considered as a powerful organising tool for ecological research on urban influences on ecosystems, as urban areas appear so often as dense, highly developed cores surrounded by irregular rings of diminishing development (McDonnell & Pickett 1990). This approach has proved useful to ecologists around the world (Theobald 2004; McDonnell & Hahs 2008) and has also inspired the development of concepts like the wildland–urban interface (Radeloff et al. 2005). Nonetheless, its application is still limited to the domain of natural sciences where scientists use the concept to address various ecological theories like hierarchy and disturbance. The Baltimore Ecosystem Study (BES) and the Phoenix LTER, inclusive of the social science approach, can be considered exceptions and trend–setters emanating from further expansion in the study of urban ecology.

As urban sprawl consuming ecosystems in the fringe areas has become a prominent trend in developing countries, this has to be one of the key components in the study of urban ecology for these regions. Most large metropolitan cities in India have continued to expand laterally and are described by the census term ‘urban agglomeration’ (UA), which denotes continuous urban spread comprising both the city and its adjoining outgrowths (Shaw 2005). The outward expansion of the largest metropolitan areas implies increasing and more complex interactions with the surrounding rural areas and gradual changes in their land uses and occupations, transforming them into semi-urban or peri-urban areas (Shaw 2005). Hence, the impact of such areal spread (Shaw 1999) or spreading urbanisation (Shaw 2005), in the form of changes in land use from agricultural lands and fisheries to residential and industrial/commercial, deforestation, water depletion and pollution, etc., has to be incorporated within urban ecology along the urban–rural gradient.

Urban ecology is making new and exciting advances (McDonnell 2011) evolving into a truly transdisciplinary science (Alberti 2008). The UNESCO-initiated Man and Biosphere (MAB) Programme funded the first integrated urban ecology research that brought together three sciences: natural sciences, engineering/planning and humanities/social sciences (Deelstra 1998), each utilising varying terminologies, paradigms and methodologies encompassing different goals and objectives, and thus resulting in an assortment of definitions and meanings for the term urban ecology (McDonnell 2011). While natural scientists study urban and urbanising landscapes applying similar methods and techniques used in ecology and extending those to urban settings,

engineers and planners focus on designing facilities and services in urban environments with the goal of reducing environmental impacts and creating sustainable cities, while social scientists focus primarily on social structure and the social allotment of natural and institutional resources (McIntyre et al. 2000; McDonnell 2011). Recently, a political ecology approach that considers environmental degradation within historical, political, economic and ecological contexts (Blaikie & Brookfield 1987) is being implemented to understand urban environmental dynamics giving rise to the emerging sub-discipline of urban political ecology (UPE) (Swyngedouw 1996; Braun & Castree 1998; Swyngedouw & Kaika 2000; Swyngedouw & Heynen 2003; Kaika 2005). However, for cities of developing countries like India there have been only a few studies with an explicit UPE perspective (Veron 2006; Gandy 2008).

Again, in social science research on urban ecology, economics, sociology, environmental psychology and even political science play leading roles contributing to and expanding the horizon/scope of the subject. Often these studies also generate socio-economic variables integrated by ecologists in their studies (as social scientists also use ecological variables in their researches). The present research emphasises the importance of the role of history in studying urban ecosystems. Backcasting/forecasting approaches for sustainable city planning can be most significant if these are pursued within large temporal scales of urban growth and development. History would free us from dogmas and biases unchaining the domination–subordination paradigm between cities and countryside where the latter has been used as both output and input, produced and required by the city that intrinsically serves urban needs and interests. A deeper understanding of urbanisation patterns and processes along a broad temporal scale would provide answers to a number of questions relating to current urban problems. Moreover, documentation of best practices, for instance indigenous knowledge systems to conserve ecosystems using oral history techniques (accompanied by other quantitative and qualitative methods), would represent extremely important contributions for ecologically and socially responsible urban planning and policy approaches.

6. Conclusion

Urban ecology is an emerging discipline. For this discipline to advance in the future it will need to enhance, refine and embrace several conceptual frameworks (McDonnell 2011). 'If the discipline of urban ecology is to advance and enhance our understanding of urban ecosystems, it will require the active development of more inter- and transdisciplinary ecology "of" cities studies' (McDonnell 2011, p. 11). This paper is such an attempt which, however, requires further exploration to construct more refined arguments.

Path-breaking works are being developed to address the problems associated with contemporary patterns and processes of Third World urbanisation and urban development from a large, interdisciplinary perspective using multiple approaches and methodologies. The task is challenging and contentious, especially for diversified and populous countries like India. Yet researchers are working hard, applying innovative methods and methodologies and coming up with interesting findings.

The latest treatise, *Ecologies of Urbanism in India: Metropolitan Civility and Sustainability*, focuses on India's major cities with complex historical layers of sociality to understand the present patterns of urbanism (Rademacher & Sivaramakrishnan 2013). The exploration of the Indian experience in its historical complexity and geographical diversity is an important task, especially when eight of the ten mega-cities are in Asia each with a population surpassing 10 million. With case studies from Delhi, Mumbai, Bengaluru and Chennai, the book addresses a wide range of issues: from the political ecology of cities to middle-class environmentalism, which is political mobilisation of the urban middle classes around environmental concerns such as

urban health, aesthetics, recreation and conservation, to aspirations for the ecological remaking of cities. Using a wide temporal scale, the case studies explore ecological trends and ruptures and investigate varied trajectories that pave the way for their unique/specific histories. The Kolkata case study can provide an important contribution to this emerging literature.

Conflict of interest disclosure statement

No potential conflict of interest was reported by the author.

Notes

1. In a comprehensive study on the canal system of Kolkata, A.K. Ghosh et al. (1986) can be credited with the first usage of the term 'urban ecology'; the paper discusses multi-purpose utilities of the system for the city and also how it is degrading due to unplanned development and lack of maintenance, finally recommending restoration of the ecosystem using an 'urban ecological model' (p. 71) that is sufficiently inclusive to emphasise on 'urban-linked rural development' (p. 79). The concept of 'urban ecology' in the context of Kolkata has been further elaborated in two other papers (Ghosh 1988, 1991) providing empirical details on various aspects of the city's ecology including pollution, drainage, sewerage and sanitation. However, the urban/peri-urban continuum was not included in the literature.
2. There are no unanimous data on this. By collating figures from various reports and articles and information from the Institute of Environmental Studies and Wetlands Management (IESWM), this approximate figure has been derived.
3. The storm water flow (SWF) and DWF canals were constructed following a combined drainage system designed by William Clark, sanitary engineer and justice of the peace. The drainage scheme, comprising canals, sluices and bridges and following the natural slope of the land, was completed by 1884 (Ghosh and Sen 1987; EKWMA & Wetlands International 2010).
4. In India, the term *mouza* refers to a type of administrative district that corresponds to a specific land area within which there may be one or more settlements.
5. It is important to mention here that in 1973 the International Development Association (IDA), a soft-loan associate of the World Bank, agreed to provide financial assistance for 44 out of 100 ongoing schemes under KMDA. The credit package amounted to US$ 35 million. IDA–I marked the beginning of a series of such credits for the development of Kolkata. The 278 crore (1 crore = 10 million) rupees allocated for the Five-Year investment plan (1979–83) included World Bank assistance of US$ 87 million for a package of projects under IDA–II (Roy and Roy 1990).
6. Please refer to the official website of KEIP at http://www.keiip.in/bl3/ (accessed 17 Nov 2014).

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References

Alberti M. 2008. Advances in urban ecology: integrating humans and ecological processes in urban ecosystems. New York (NY): Springer.

Allen A. 2003. Environmental planning and management of the peri-urban interface: perspectives on an emerging field. Environ Urban. 15:135–148. doi:10.1177/095624780301500103

Allen A. 2009. Sustainable cities or sustainable urbanisation? [Internet]. [cited 2014 Jul 8]. Available from: http://www.ucl.ac.uk/sustainable-cities/results/gcsc-reports/allen.pdf

Allen A. 2010. Neither rural nor urban: service delivery options that work for the peri-urban poor. In: Khurian M, McCarney P, editors. Peri-urban water and sanitation services: policy, planning and method. New York (NY): Springer.

Allen A, Da Silva NA, Corubolo E. 1999. Environmental problems and opportunities of the peri-urban interface and their impact upon the poor. London: The Development Planning Unit, University College London. [Internet]. [cited 2014 Jul 8]. Available from:

http://discovery.ucl.ac.uk/37/1/DPU_PUI_Allen_Corubolo_daSilva_Environmental.pdf
Banerjee S, Chaudhuri J, editors. 2012. Excreta matters. New Delhi: Centre for Science and Environment.
Blaikie P, Brookfield H, editors. 1987. Land degradation and society. London: Methuen.
Braun B, Castree N, editors. 1998. Remaking reality: nature at the millennium. London: Routledge.
Castro CJ. 2004. Sustainable development: mainstream and critical perspectives. Organ Environ. 17:195–225. doi:10.1177/1086026604264910
Chakravorty S. 2000. From colonial city to globalizing city? The far-from-complete spatial transformation of Calcutta. In: Marcuse P, Kempen RV, editors. Globalizing cities: a new spatial order? Oxford: Blackwell.
Chattopadhyay H. 1990. From marsh to township east of Kolkata: a tale of fresh water lake and salt lake township. Kolkata: K.P. Bagchi & Company.
Deelstra T. 1998. Towards ecological sustainable cities: strategies, models and tools. In: Breuste J, Feldmann H, Uhlmann O, editors. Urban ecology. Berlin: Springer.
Dembowski H. 2001. Taking the state to court: public interest litigation and the public sphere in metropolitan India. New Delhi: Asia House. [Internet]. [cited 2014 Nov 17.] Available from: https://www.asienhaus.de/public/archiv/taking_the_state_to_court.pdf
EKWMA and Wetlands International. 2010. East Kolkata Wetlands Newsletter. New Delhi: The Print Shop. [Internet]. [cited 2014 Jul 8]. Available from: http://www.wetlands.org
Elmqvist T, Fragkias M, Goodness J, Güneralp B, Marcotullio PJ, McDonald RI, Parnell S, Schewenius M, Sendstad M, Seto KC, Wilkinson C, editors. 2013. Urbanization, biodiversity and ecosystem services: challenges and opportunities. Dordrecht: Springer.
Gandy M. 2008. Landscapes of disaster: water, modernity, and urban fragmentation in Mumbai. Environ Plan. A. 40:108–130. doi:10.1068/a3994
Ghosh AK. 1988. Urban ecology: a case study of Calcutta. Calcutta: Institute of Local Government and Urban Studies, Government of West Bengal.
Ghosh AK. 1991. Ecology and environment of Calcutta. In: Dasgupta B, Bhattacharya M, Basu DK, Chatterjee M, Banerjee TK, editors. Calcutta's urban future: agonies from the past and prospects for the future. Calcutta: Government of West Bengal.
Ghosh AK, Sen JK, Sengupta T, Kacker RK, Chaudhuri K. 1986. Canal system of Calcutta. Indian J Landsc Syst Ecol Stud. 9:71–81.
Ghosh D. 2005. Ecology and traditional wetland practice: lessons from wastewater utilisation in the East Calcutta Wetlands. Kolkata: Worldview.
Ghosh D, Sen S. 1987. Ecological history of Calcutta's wetland conversion. Environ Conserv. 14:219–226. doi:10.1017/S0376892900016416
Ghosh M, Dutta AK, Ray B. 1972. Calcutta: a case study in urban growth dynamics. Calcutta: Firma KLM.
Grimm NB, Faeth SH, Golubiewski NE, Redman CL, Wu J, Bai X, Briggs JM. 2008. Global change and the ecology of cities. Science. 319:756–760. doi:10.1126/science.1150195
Grove JM, Burch Jr. WR. 1997. A social ecology approach and applications of urban ecosystem and landscape analyses: a case study of Baltimore, Maryland. Urban Ecosyst. 1:259–275. doi:10.1023/A:1018591931544
Gupta G. 2005. Urban wastewater: livelihoods, health and environmental impacts in India, the case of the East Calcutta Wetlands. New Delhi: Winrock International.
Habitat UN. 2012. Sustainable urbanization [Internet]. [cited 2014 Jul 8]. Available from: https://www.un.org/millenniumgoals/pdf/Think%20Pieces/18_urbanization.pdf
Hagen JB. 1992. An entangled bank: the origins of ecosystem ecology. New Brunswick (NJ): Rutgers University Press.
Haughton G. 1997. Developing sustainable urban development models. Cities. 14:189–195. doi:10.1016/S0264-2751(97)00002-4
Kaika M. 2005. City of flows: nature, modernity and the city. New York (NY): Routledge.
[KMDA] Kolkata Metropolitan Development Authority. 1976a. Area development strategy for Salt Lake Township (Bidhannagar), Report no. 6. Kolkata: Kolkata Metropolitan Development Authority, Government of West Bengal.
[KMDA] Kolkata Metropolitan Development Authority. 1976b. Development perspective plan. Kolkata: Kolkata Metropolitan Development Authority, Government of West Bengal.
[KMDA] Kolkata Metropolitan Development Authority. 1990. Plan for metropolitan development, 1990-2015. Kolkata: Kolkata Metropolitan Development Authority, Government of West Bengal.
[KMPO] Kolkata Metropolitan Planning Organization. 1966. Basic development plan for the Calcutta metropolitan district 1966–86. Kolkata: Kolkata Metropolitan Planning Organization, Government of West Bengal.
Krebs CJ. 2001. Ecology: the experimental analysis of distribution and abundance. San Francisco (CA): Benjamin Cummings.
Kundu N, Pal M, Saha S. 2008. East Kolkata Wetlands: a resource recovery system through productive activities [Internet]; Proceedings of Taal 2007: the 12th World Lake Conference; p. 868–881. [cited 2014 Jul 8].

Available from: http://wldb.ilec.or.jp/data/ilec/wlc12/G%20-%20Pollution%20Abatement/G-1.pdf

Lang RE, Nelson AC. 2007. Beyond the metroplex: examining commuter patterns at the "megapolitan" scale. Cambridge (MA): Lincoln Institute of Land Policy.

Lutters WG, Ackerman S. 1996. An introduction to the Chicago School of Sociology. Interval Research. [Internet]. [cited 2014 Jul 8]. Available from http://userpages.umbc.edu/~lutters/pubs/1996_SWLNote96-1_Lutters,Ackerman.pdf

Mahadevia D. 2001. Sustainable urban development in India: an inclusive perspective. Dev Pract. 11:242–259. doi:10.1080/09614520120056388

McDonnell MJ. 2011. The history of urban ecology: an ecologist's perspective. In: Niemelä J, Breuste JH, Elmqvist T, Guntenspergen G, James P, McIntyre NF, editors. Urban ecology: patterns, processes and applications. Oxford: Oxford University Press; p. 5–13.

McDonnell MJ, Hahs AK. 2008. The use of gradient analysis studies in advancing our understanding of the ecology of urbanizing landscapes: current status and future directions. Landscape Ecol. 23:1143–1155. doi:10.1007/s10980-008-9253-4

McDonnell MJ, Pickett ST. 1990. Ecosystem structure and function along urban-rural gradients: an unexploited opportunity for ecology. Ecology. 71:1232–1237. doi:10.2307/1938259

McIntosh RP. 1985. The background of ecology: concept and theory. New York (NY): Cambridge University Press.

McIntyre NE, Knowles-Yánez K, Hope D. 2000. Urban ecology as an interdisciplinary field: differences in the use of "urban" between the social and natural sciences. Urban Ecosyst. 4:5–24. doi:10.1023/A:1009540018553

Mukherjee J. 2009–10. The victory of site over situation: exploring ecological dynamics behind Calcutta's selection as the seat of colonial capital. Quart Rev of Hist Stud. 49:40–55.

Mukherjee J. forthcoming. Sustainable flows between Kolkata and its peri-urban interface. In: Swilling M, Allen A, Lampis A, editors. Untamed urbanisms. London: Routledge.

Park RE, Burgess EW, McKenzie RD, editors. 1925. The city. Chicago (IL): University of Chicago Press.

Phdungsilp A. 2011. Futures studies' backcasting method used for strategic sustainable city planning. Futures. 43:707–714. doi:10.1016/j.futures.2011.05.012

Quist J. 2007. Backcasting for a sustainable future: the impact after 10 years [PhD thesis]. Delft: Faculty of Technology, Policy and Management, Delft University of Technology.

Radeloff VC, Hammer RB, Stewart SI, Fried JS, Holcomb SS, McKeefry JF. 2005. The wildland-urban interface in the United States. Ecol App. 15:799–805. doi:10.1890/04-1413

Rademacher AM, Sivaramakrishnan K. 2013. Ecologies of urbanism in India: metropolitan civility and sustainability. Hong Kong: The Hong Kong University Press.

Rebele F. 1994. Urban ecology and special features of urban ecosystems. Global Ecol and Biogeog Lett. 4:173–187. doi:10.2307/2997649

Roy B. 1982. Marshes to metropolis Calcutta (1481–1981). Calcutta: National Council of Education.

Seto KC, Parnell S, Elmqvist T. 2013. A global outlook on urbanization. In: Elmqvist T, Fragkias M, Goodness J, Guneralp B, Marcotullio PJ, McDonald RI, Parnell S, Schewenius M, Sendstad M, Seto KC, Wilkinson C, editors. Urbanization, biodiversity and ecosystem services: challenges and opportunities. Dordrecht: Springer.

Shaw A. 1999. Emerging patterns of urban growth in India. Econ Polit Wkly. 34:969–978.

Shaw A. 2005. Peri-urban interface of Indian cities: growth, governance and local initiatives. Econ Polit Wkly. 40:129–136.

Swyngedouw E. 1996. The city as a hybrid: on nature, society and cyborg urbanization. Cap Nature Soc. 7:65–80.

Swyngedouw E, Heynen N. 2003. Urban political ecology, justice and the politics of scale. Antipode. 35:898–918. doi:10.1111/j.1467-8330.2003.00364.x

Swyngedouw E, Kaika M. 2000. The environment of the city or…the urbanization of nature. In: Bridge G, Watson S, editors. Reader in urban studies. Oxford: Blackwell Publishers; p. 567–580.

Theobald DM. 2004. Placing ex-urban land-use change in a human modification framework. Front in Ecol Environ. 2:139–144. doi:10.1890/1540-9295(2004)002[0139:PELCIA]2.0.CO;2

[UNCED] United Nations Conference on Environment and Development. 1992. Agenda 21. [Internet]. [Cited 2014 July 8]. Available from: http://sustainabledevelopment.un.org/index.php?page=view&nr=23&type=400&menu=35

[UNECOSOC] United Nations Economic and Social Council. 2014a. Achieving sustainable development: integrating the social, economic and environmental dimensions. [Internet]. [cited 2014 Jul 8]. Available from: http://www.un.org/en/ecosoc/integration/pdf/integration_segment_concept_note_20-march2014.pdf

[UNECOSOC] United Nations Economic and Social Council. 2014b. Sustainable urbanization. [Internet]. [cited 2014 Jul 8]. Available from: http://www.un.org/en/ecosoc/integration/2014/

[WCED] World Commission on Environment and Development. 1987. Our common future. Oxford: Oxford University Press.

Véron R. 2006. Remaking urban environments: the political ecology of air pollution in Delhi. Environ Plan. A. 38:2093–2109. doi:10.1068/a37449

Vitousek PM, Mooney HA, Lubchenco J, Melillo JM. 1997. Human domination of earth's ecosystems. Science. 277:494–499. doi:10.1126/science.277.5325.494

Young GL. 1974. Human ecology as an interdisciplinary concept: a critical inquiry. Adv Ecol Res. 8:1–105. doi:10.1016/S0065-2504(08)60277-9