

*Review*

**Establishing the rationale for green infrastructure investment in Indian cities: is the mainstreaming of urban greening an expanding or diminishing reality?**

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**Abstract:** Green infrastructure planning in India has the potential to rationalise current development issues relating to economic growth and rapid urban expansion. Independence from the British facilitated progressive shift to an economically driven development based on modernisation and partial-deregulation of infrastructure provision. The impact of this process has been a decoupling of human-environmental approaches to urban planning and reliance on the utilisation of landscape resources beyond their capacity. Utilising a discussion of Nehruvian and Gandhian perspectives to urban development, this paper argues that whilst both approaches offer valuable mechanism for growth, an integrated analysis which links them provides a more responsive and effective structure for planning to deliver change. Green infrastructure approaches to urban investment are proposed in this paper to create equilibrium between the difficulties of balancing economic growth with sustainable urban development. Through an evaluation of state and alternative investment drivers this paper proposes that urban greening can form a mainstream framework to facilitate a sustainable approach to urban expansion. The paper concludes by stating that approaching investments in green infrastructure through an understanding of a state-interactions provides scope to plan economic development and ecological sustainably effectively.

**Keywords:** green infrastructure; urban development; Indian cities; state-relational frameworks; urban expansion

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## 1. Introduction

Rapid urban growth directly influences the outlook of the Indian nation as its cities continue to evolve. This, in part, is due to a complex interplay of complementary and contradictory factors [1]. Although a large number of Indian cities retain remnants of historic, and in many cases colonial planning, the majority of cities have morphed into dynamic, intricate and innovative amalgams of ecological, economic and social resources [2]. Blending contemporary with traditional approaches to development is therefore a major challenge in India. The outcome of which has been a highly organic and in many cases informal form of development incubated alongside mainstream planning practice. Expansion, especially in the form of unregulated settlements, has thus run in parallel to national and state planning mandates despite calls from planners for all development to follow approved guidelines. The outcome of this process has been the creation of modern cities that house significant informal and unregulated development which juxtaposes the Indian government's rhetoric of growth and wealth distribution [3,4]. In order to understand the mechanisms which control development, as well as those investment objectives deemed appropriate, planners need to reflect upon the institutional capacity of Indian planners (and other stakeholders) if a sustainable approach to development is to be achieved [5].

Adding further complications to this process are discussions of how liveable Indian cities are. Assessments of urban environments identify that the provision of housing, transport infrastructure and utilities all promote liveability [6]. Furthermore, to ensure urban locations are functional a level of interactivity between environmental, social and economic resources is required. However, there appears to be a dislocation between this narrative and those supporting sustainable landscape developments in India's cities. One response to this dilemma can be identified within the growing body of research illustrating the value of urban greening stating that investing in "*green infrastructure*" acts as a mechanism which can help deliver higher quality urban environments [7,8].

At a global scale urban greening discourses propose that a range of functions can be delivered by investment in green infrastructure, with evidence from Asia, Europe and North America tracking its use in addressing urban expansion and renewal, climate change, environmental protection, the greening of infrastructure, and the delivery of widespread health benefits [9-14]. Each of which has been described by Mell [8] as key benefits that can be used to promote investment in urban greening, and to illustrate the multi-functional nature of urban landscapes to politicians, developers and the public. Green infrastructure research in India though is currently limited to a small number of studies evaluating changes in the proportion of green space, urban trees and water management in selected cities [10,15]. Testing the value of green infrastructure in India therefore requires planners to focus their professional attention on this under researched area to assess the value of urban landscapes in a nation where dynamic urban change is the dominant development narrative.

The following paper discusses current opportunities to integrate green infrastructure in the planning of Indian cities. Viewing expansion in India as a fluid shift from central control to regional or private investment enables this paper to examine whether green infrastructure can be debated as a metaphor for contemporary Indian planning. Through an interpretation of the Strategic-Relational perspective proposed by Jessop [16] the conflicting interaction of government, private agency and the public are debated to assess how contemporary approaches to human-centred development unfold. This is proposed, within this paper, as a discussion of a "*Gandhian*" development perspective compared to the neoliberal assumptions outlined in "*Nehruvian*" narratives. By evaluating the use of

urban greening against the backdrop of expanding Indian cities the paper addresses whether it is possible to establish equilibrium between the role of green spaces and other forms of grey infrastructure. It also questions whether the changing structures of planning including the liberalisation of development regulations post-1991 [17], the release of revised urban green space guidelines [18], or the rebranding of the Indian Planning Commission as the National Institution for Transforming India (NITI) Aayog in early 2015 has impacted upon the political structures supporting investments in green infrastructure. To rationalise this debate the paper reflects on the interactivity of the policy, stakeholder investment and advocacy in New Delhi and the National Capital Region (NCR) to consider if green infrastructure can be identified as a strategic development process which can be mainstreamed into urban growth narratives.

## **2. Urban growth in Indian cities: the conceptualisation**

The rapid growth of Indian cities has been described as unmanageable compared to development scenarios in other nations [19]. Alternatively, it can be articulated as an opportunity to shape the future of the country in ways that highlight the innovation and reflexivity of India's rise as a global economic power. India is also becoming increasingly urbanised: the country's urban population is estimated to be 50% by 2050. Current annual growth in New Delhi is 5%, whilst in Mumbai and Bengaluru the rate of expansion is even higher [6]. As a consequence strategic planning holds an increasingly prominent role in delivering infrastructure sustainably. However, current growth rates often outpace the ability of government at all scales, to strategically manage development [1,20]. This has led, in many cases, to the following investment dilemma. A first narrative illustrates an increasing lag time between the production of development policy and meeting implementation needs; whilst a second, unofficially permits development to meet these needs through informal and unregulated development [3,5]. It is therefore possible to argue that both the spatial and temporal dynamics of this process impact directly on the form of urban development in Indian cities.

Responding to the perceived variance in implementation from stringent enforcement of regulation to a more fluid approach to urban planning thus appears to place development in India in a reactionary position. To date government and planners have struggled in their attempts to reposition growth proactively to address both infrastructure and socio-economic needs [21]. The spatial extent of investment in India also exacerbates the perceived negative impacts of development due to the breadth and pace of growth being witnessed. As a consequence strategic plans are often informed by insufficient evidence or are subject to capacity and application limitations and can become obsolete on publication due to the extended timeframes taken to develop and ratify them. Critics also suggest that the effective management of expansion is being curtailed as the policy used to frame new urban expansion lacks an appreciation of the strategic focus needed to frame infrastructure investment [6,22].

The fluidity of urban planning in India thus offers an interesting insight into the challenges of urban development post-Independence. Fluidity, in this instance, implies that the process of planning policy formation and implementation is not static. Alternatively, we suggest that they are subject to an ever changing number of public and private influences (social, economic and ecological), which shape actions. Furthermore, as central and state government modify the focus of policy it can become diluted or simply dismissed according to political needs. Landscape and green space planning is one policy area where this is a common issue [23].

Independence though presented India with an opportunity to reimagine its role in the process of global development debates, but also, and potentially most importantly, it facilitated a reassessment of itself as a nation [5,24]. This gave rise to two distinct development ideals: one proposed by Jawaharlal Nehru, the first Prime Minister of India, the other by Mohandas Gandhi, leader of the Independence movement [2,20], both of which were used to frame development in India from 1947 to 1991 when a further process of liberalisation was instigated [4].

### 2.1. Nehruvian development

Nehru's approach to India's future identified a need to modernise the country's infrastructure, its economy and political structures based on a drive for modernity [25]. The approach of Nehru's government has been considered by Kalia [26] as a means to promote a nationalist, modern and developed country, which utilised the extensive process of urban development as a visual metaphor for the country's growth. As Vidyanthi et al. [4] suggests this supports the promotion of a coercive polity which was used to argue for a greater level of inclusivity within the planning process. Yet in reality India has retained an elitist structure of political agency related to Nehruvian alignments between government and business leaders. A Nehruvian perspective to planning in India thus uses "development" as a byword for an initial centralised form of government-led planning following by a more liberalised approach to investment across the nation [27].

Nehru's vision can be critiqued as a reframing of the Jessop's discussion of Strategic-Relational control and agency, as a pair of symbiotic development axis [16]. Applied to India Jessop's approach implies that government and the state are not fixed ideals but are conditioned by the wider interactivity of actors, the economy and social needs. Therefore although development can be managed by government, the process of investment is far more fluid in terms of *who*, *what* and *how* growth occurs. Furthermore, Nehru advocated India's move away from the colonial control of the British, i.e. the fixed control of the state, in order to facilitate greater innovation in development policy and practice through agency. Here Nehru implied that there is flexibility in the state's ability to place boundaries on development, thus enabling more dynamic spatial and temporal interpretations of growth to be embedded within government policy [4].

Placing economic growth at the centre of this debate enabled Nehru to position India's development as strategically selective allowing deregulation and Public-Private-Partnership (PPP) to co-exist alongside India's five year development plans [28]. Working from such a perspective provides a framework that promotes the inclusion of various actors into the development process, whilst simultaneously offering greater opportunities for business/private sector stakeholders to shape investment. A Nehruvian approach to development thus argues for a conjoint public-private responsibility for growth that is loosely fixed to government policy. However, in practice deregulation and stakeholder led investment has led to a number divergent delivery trajectories manifesting themselves in India [17].

### 2.2. Gandhian development

In contrast Gandhi's dictum proposed that Indian politics retain a localised conceptualisation of development. Gandhi advocated a reinforcing of existing localised, read *community-led* and *rural*, political control to ensure continuity within development. He extended this proposing that India's

future lay in the promotion of localised agency to support self-sufficiency and advocacy for villagers; thus enabling them to participate in the political process and become “citizens”. From this foundation he foresaw a more sustainable relationship between people, the environment and the state facilitating the evolution of an engaged nation, rather than the control-orientated (and infrastructure led) process of development currently visible in India [29,30]. Approaching development from such a perspective enabled Gandhi to advocate for the creation of small-scale and localised structures to ensure that investment was centred on delivering needs and not solely on economic expansion. The contrast to Nehru was, perhaps, most significant, in the engagement with the process of liberalisation of rural development.

Gandhi’s approach attempted to sustain a bottom-up perspective to growth, which utilised existing knowledge of needs/experience to guide expansion. This, however, runs counter to Nehru’s more centralised and urban presentation of India’s development narratives. Furthermore, the opening up of Indian development to external agencies, such as private corporations, undermined the structural control Gandhi advocated. Gandhian narratives, therefore, offered a counter point to Nehru by promoting a more linear process of development that retained an intrinsic link to pre-colonial/non-British institutional forms and processes in line with Jessop’s original strategic-relational state [16]. This process has been visible in the increasingly influence of Narendra Modi, former Chief Minister of Gujarat and now Prime Minister of India, who drew heavily on the philosophical arguments of Gandhi, as well as, the iconography of localised/internal Indian innovation to promote his modernisation process.

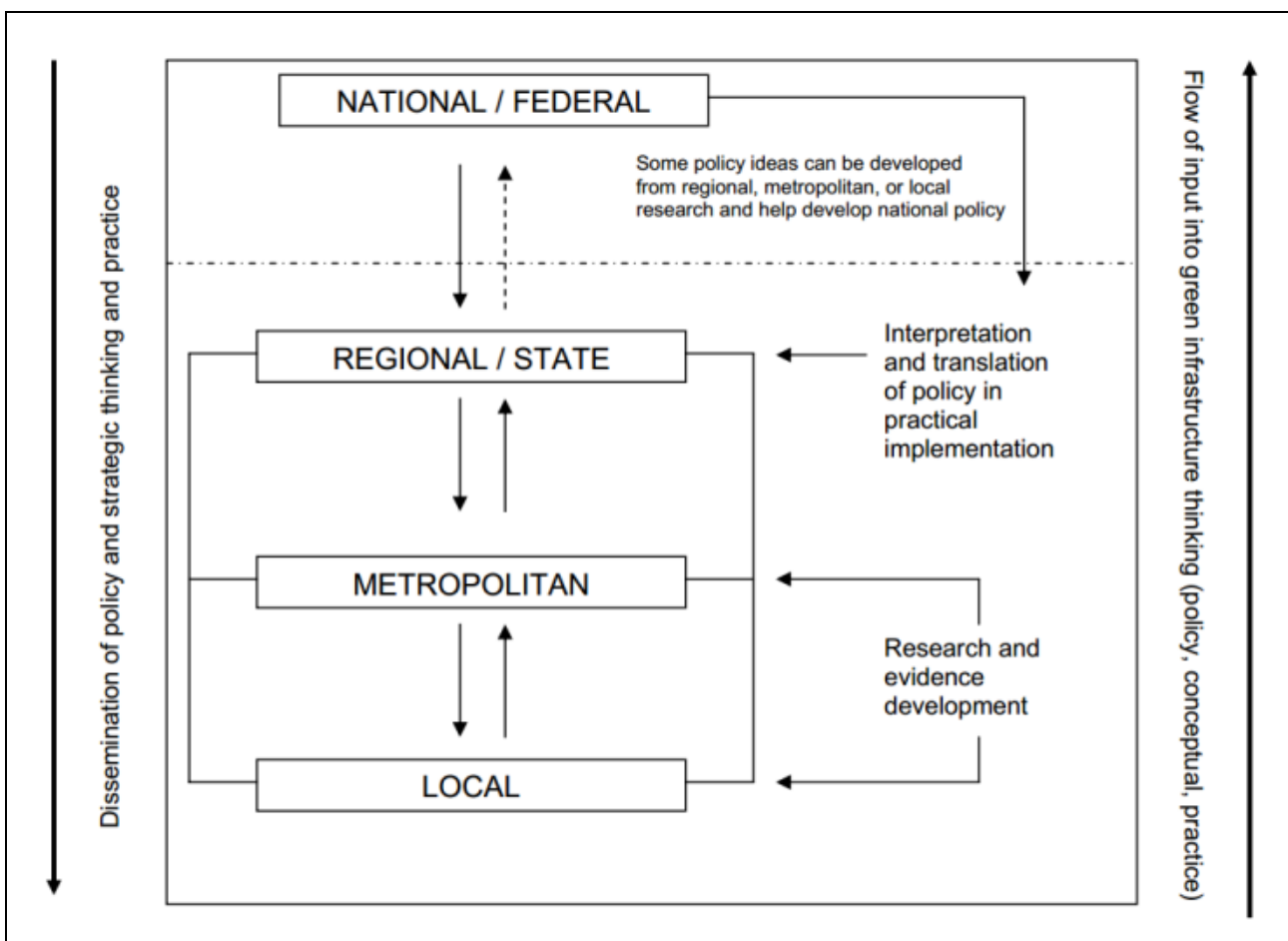
The dualism of Nehruvian and Gandhian approaches does however illustrate one of the most prominent tensions within the Indian state: between those who identified India as needing to accept a more liberalised and deregulated form of development and those who placed trust in existing community led development. Although there have been attempts to mitigate the added complexity of post-colonial development, most noticeably through the formation of a formal planning system, there has been a lack of evidence highlighting its success. Therefore in spite of the positive commentary associated with the application of India’s five-year plans at the local level there are commentators who remain critical of the shift of control from the local to the centre and subsequently to a liberalised market-led development [4]. Unfortunately, the lack of guidance from the central government has led to divergences in what was planned, how it was achieved and who was involved in the process [5]. As a consequence there has been little continuity in the approaches taken to management or evaluation of urban development in Indian cities.

Despite the limitations that this dilemma raises for investment both the Nehruvian and Gandhian perspectives remain visible within Indian planning debates. Nehru’s vision to create new cities that were centrally planned, functional and interconnected illustrated his desire to focus development on specific deliverables (i.e. housing), rather than continue to allow more chaotic and informal forms of urban growth [4]. However, the limitations of developing legalisation and the timeframes needed to plan strategically, coupled with the mistrust of officialdom have raised questions about the validity of the current modernisation process. Counterbalancing this situation Kalia [30] and Das [20] argued that a continued use of Gandhi’s development rhetoric is a more pragmatic method of meeting communal needs (including environmental ones), rather than simply ensuring that resources have the capacity to support economic growth.

In practice both approaches are interwoven into the Indian planning system especially in the Post-1991 landscape of liberalisation and deregulation of construction, development and investment [31].

Consensus between these ideals is though difficult to identify. However, Nehru's promotion of a more flexible policy landscape which shifted a proportion of control to external agencies may actually have facilitated a wider coexistence between formal and informal development.

Development narratives in India therefore follow a hybridised version of the Nehruvian-Gandhian process. Whilst the state has continued to deregulate the formal processes and structures governing development there has been an equally visible rise in community-led dialogue regarding growth. However, as noted above, the interactivity of these two positions is often dichotomous with a predominant narrative of growth/development overriding the needs of the population. The idealised process outlined in Figure 1 illustrates an alternative structure which can be considered as employing a combination of the Nehruvian applications of policy change alongside the inclusion of traditional knowledge-based advocacy. Figure 1 suggests that fluidity in approach can be applied in India which would permit the structural flexibility identified by Jessop [16],



**Figure 1. Idealised structure of green infrastructure development. Source: Mell [8].**

however, it retains the hierarchal planning system which enables more evidence-based policy to populate decision-making processes. In reality this process remains hypothetical as the stages of interactivity proposed are fragmented in Indian planning debates. This is shown by the broken dotted line differentiating national and sub-national discussions indicating that it is common to work within a more fragmented planning system. As a consequence the relationship between the state, strategic

approaches to investment and actors remains relatively open, thus, limiting the application of more sustainable forms of development. One addition to this process would be the inclusion of an additional area of dialogue illustrating the more complex role played by business and other Nehruvian stakeholders in this process. The election of Narendra Modi as Prime Minister in 2014 extends such a conceptualisation, as although he advocated a greater role for dialogue between planning, commerce and industry in the development rhetoric he also provided scope to continue the process of policy deregulation and liberalisation.

### **3. Urban growth in India: the reality**

Current approaches to policy formation and delivery utilised by the Modi led government employ a combination of Nehruvian and Gandhian rhetoric to cope with the broad socio-environmental, economic and political factors which influence planning in India [4]. This can be considered to address the following three issues:

1. Place-based economic development that seeks to leverage investment and civic involvement
2. Infrastructure building that improves the economic integration and development of the nation
3. Welfare increases that aim to selectively target urban and rural poor

In the post-1991 landscape there has been a continuation of this trend leading to further deregulation, the promotion of Public-Private-Partnerships and a liberalisation of state-agency relationships [32]. Urban planning in Indian cities thus needs to be considered as a complex balancing act which requires planners to manage growth, whilst simultaneously identifying opportunities for strategic and sustainable investment. Applying the Nehruvian and Gandhian interpretations of development to contemporary development debates therefore requires an understanding of these expansion discourses and the historical approaches to expansion post-1991.

India's economy is growing at approximately 8–9% per year [22]. To maintain this rate the nation has increased manufacturing, reinforced its financial services sector, and is investing heavily in construction [6,22]. However, maintaining such growth also requires greater flexibility in how development policy is regulated. In addition housing, transport infrastructure and upgraded utilities are needed to service the growing population, yet calls persist questioning how the principles of sustainable development are being embedded in these discussions [3,5].

Unfortunately, due to the rate of expansion the ability of state delivery agents, such as Public Works Departments and city planning authorities, to plan strategically has been constrained. This reflects, in many cases, a lack of grounded statistical evidence of the rate of change [33,34], rising service needs [35], a lack of human and financial capacity/expertise [5], and the time needed to produce and implement policy [20]. Each of these factors has led academics to question whether it is possible to effectively balance the environmental and the growth agenda in India [5,20].

Despite such concerns there are those who view managing development as a challenge, which if approached innovatively through alternative development models, can be successfully achieved [25]. Advances in construction, new governance models, deregulation which shifts the onus of development from the state to private investors, and a better understanding of urban ecosystems have all been proposed as ways to positively address the challenges of urban change [21,30]. One option

proposed as offering a suite of opportunities to address the complexities of urban development is green infrastructure planning.

The concept of green infrastructure remains in its infancy in India and compared to other forms of infrastructure investment is often perceived as offering lower economic and social returns on investment [7,8]. Such a view could be considered to reflect the lack of historical valuation associated with investment in landscape resources compared to other forms of built infrastructure [36]. As a consequence, there is an institutionally weak understanding of the applications that urban greening can offer in India cities. Partially this represents the influence of political stakeholders: the *who*, the lack of continuity in policy-making processes: the *how*, and the capacity and/or ability of planners to apply and enforce planning legislation: the *why*.

Translating policy into practice thus requires planners and other public officials to utilise their education and professional training in practice. This process may though neglect the influence of external agency on the ability of planners to follow legislation and official procedures [5]. Furthermore, a lack of professional awareness appears evident in how “landscape” can act as bridge between Nehruvian and Gandhian planning approaches. To achieve such integration relies on an understanding of a state-agency perspective of human-environmental interactions if planners are to promote the use of local knowledge and expertise within a more formalised process of sustainable landuse [16]. Investment in green infrastructure can thus be framed as offering a structural alternative in the focus and process of planning practices [8]. By engaging with more dynamic development mechanisms, i.e. deregulation and innovation, urban greening can draw on etic (control based) interpretations of investment, whilst retaining the emic (and agency led) knowledge base of localised interactivity with local environmental resources.

However, despite this positive assessment critics warn that growth is aligning development towards a more reactive process, as national or legislative agencies lack the capacity to effectively plan for sustainable growth [21]. Furthermore, the increasingly prominence of informal development has been shown to undermine attempts to strategically manage this process [4]. Therefore although regulation places restrictions on the rate of growth in India informal development has, and continues to play, a central role in place-shaping.

Whilst such an interpretation appears valid planning in India, as in most nations, is attempting to plan conjointly for immediate needs, whilst considering longer-term investment objectives [20]. The central influence on this debate is the actual rate of change. Unlike private investment, which reacts in the short-term to specific investment contexts, i.e. the market, the development of a suite of government planning policies works to a much longer and politically mandated timeframe. However in November 2014 the Indian Government disbanded the nation’s Planning Commission, thus removing one of the most important agencies monitoring policy and practice in India. As a consequence whilst planners are consulting and developing planning goals, additional forms of investment, mostly unregulated continue to occur [6,28].

Attempts to rationalise growth in response to existing environmental and social problems thus illustrate the dilemmas which underpin development in India. Furthermore, whilst the government supports economic liberalisation, the somewhat fractured nature of Indian politics creates social and political tensions where the needs of citizens are not met. Planning in India therefore suffers from



what Roy [5] calls a political malaise<sup>1</sup>. Moreover, the process of planning becomes increasingly constrained by variance in political agendas and has led to a lack of transparency in decision-making [28]. Inconsistency in policy and action though could be thought of as highlighting the fluidity that has enabled Indian cities to diversify their urban form [37]. Consequently, the rationale for whether Indian cities are planned proactively or reactively becomes somewhat redundant, as its dynamic nature appears to indicate that a state control-agency perspective is being applied simultaneously. This debate raises an interesting question over how landscape and urban resources are managed. Given the complexity of actor involvement and with the flexibility of the structures of planning praxis traditional approaches to environmental planning can become maligned. Green infrastructure planning thus offers an alternative process that is attempting to align the changing policy and implementation landscape of Indian planning.

#### **4. Planning for green infrastructure in India cities: rhetoric and reality**

Green infrastructure planning unlike the approaches to urban ecology or ecosystem services provides a more flexible, yet integrative, process through which to develop urban areas. Ecosystem services have been considered as too mechanistic in how they characterise landscape resources as provisioning, supporting, regulating and cultural services [38]. This limits the interactivity of services and functions to some extent and can lead to a silo mentality in applying appropriate management techniques [39]. It is equally difficult to align the principles of urban ecology to Indian planning scenarios as it minimises the role of socio-economic and human behaviour on the functionality of urban ecosystems. Whilst the notion that urban ecology can be effectively applied in high density locations, such as Indian cities, the lack of human-centric integration into this process limits its use [40].

As an alternative green infrastructure planning is an approach to urban development that advocates an equal role for ecological resources within a human-centred understanding of how landscape and other built infrastructures interact. In urban areas it helps to establish and/or maintain the network of spaces that meet biodiversity, water management, social and economic functions [12]. A number of authors have also proposed that green infrastructure is the natural life support systems underpinning development [7]. This is of particular importance in locations that are developing rapidly. However, some critics have questioned whether it has been attributed an equal value to other forms of investment.

As a consequence in rapidly developing cities, such as those in India, green infrastructure resources can become marginalised as open spaces are redeveloped to meet urban infrastructure needs. However, although the physical form that a city takes including its spatial distribution of green space, the ecological or socio-economic focus of these resources and the scale of investments at a local, city or regional level, are intrinsically variable, the multi-functional benefits that “greening” delivers are promoted as paramount in green infrastructure thinking [25,35]. This highlights the possibility that conflicts can arise between state and delivery/development agencies

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<sup>1</sup> Roy’s discussion of political malaise advocates the view that the number, breadth and influence of actors have a negative impact on the formation and implementation of Indian planning policy. External actor, as well as, government officials are therefore considered to lack the power to enact policy and alternatively are subject to an ever growing set of legislative and administrative constraints.

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who argue whether green infrastructure provides benefits and subsequently if they are a valid form of investment in India [23].

As a consequence the application of green infrastructure in India remains in its embryonic stages. Whilst research has focussed on the role that green space plays in urban development [41], in some areas of New Delhi its use has become marginalised within broader expansion debates [19]. Urban greening in India thus remains a variegated process within wider development narratives, often considered as an optional extra, especially where deregulation is allowing rapid urban expansion at the expense of environmental management [15]. The status quo in India thus places less value on environmental resources and rarely advocates for the protection of the landscape if and whether other forms of development will be impacted upon. Furthermore, promoting environmental needs over the development of built infrastructure is prone to attract criticism from developers, particularly if they are required to allocate funding to landscape enhancement or management practices. This perspective is beginning to change as planners become increasingly aware of the impacts of climatic change, fluctuating water supplies and the growing realisation of the need to provide both a functional and attractive urban environment [8]. Challenging the prevailing understanding of urban greening in the consciousness of politicians, developers and state actors is therefore one of the greatest challenges to achieving a more sustainable form of urban development.

Various approaches to urban greening have been taken globally, each offering solutions to environmental, as well as, social and economic development constraints [12]. Applying green infrastructure to urban growth discussions, especially those undertaken in conjunction with sustainable urban development principles, highlights a key delivery dilemma faced by Indian cities. Research from Europe and the USA indicates that investment in street trees [43], sustainable urban drainage systems [7] and green building technologies [44] can all facilitate effective reactions to urban problems. Moreover, new developments which integrate green technologies and apply ecological network principals can be considered as creating a long-term and self-supporting green infrastructure resource base [7]. However, despite the complexities of growth in India these western applications can potentially be translated to Indian contexts. Although growth may have marginalised the value of the landscape, for example in parts of southern New Delhi and the wider NCR area, where ecological and social benefits are deemed less important than economic development, green infrastructure offers an alternative delivery option which encourages a more effective dialogue between planners and developers [23,37].

Table 1 provides an indication of how and where this process can be identified within Indian cities. The data populating Table 1 was gathered from an academic literature, policy and practitioner document review which assessed the level of discussion and evaluation of green infrastructure, urban green space planning and environmental management in named Indian cities. Each of the sources cited were published in academic journals or by international organisations and were available online. In each of the examples quoted an analysis of urban greening was made by the authors of the research to illustrate how these resources/processes have been integrated in urban landscape management debates. Table 1 does not propose to be exhaustive list of reported research but a synthesis of the main green infrastructure arguments being presented into published reports and academic papers on Indian green space. Consequently, it could be argued that although environmental discussions have been constructed within strategic-relational narratives as proposed by Jessop [16], there is a growing awareness that the benefits of green infrastructure that moves beyond simple classifications (i.e. brownfield, development zones, transport infrastructure, flood

plains and environmental protection zones) of urban landscapes can be applied more widely to meet the needs of development [45].

**Table 1. Values of green infrastructure in Indian cities.**

Value	Activity/Process	Location	Evidence
Ecological	Trees (water, climate and pollution); Water (supply, regulation, pollution); Managed green space Generic green space (regulating, pollution, habit, biodiversity); Generic green space (regulating, pollution, habit, biodiversity)	Chennai; Bengaluru; Mumbai; New Delhi; Karnataka; Kochi	[10,25,35,42]
Economic	Tree commerce; Retail/property values; Consumer/employee well-being; Health costs	New Delhi; Kolkata; Mumbai;	[5,6,21,22,33,34]
Social	Communal engagement/cohesion; Sports and recreation; Health and well-being (mental and physical); Housing	Chandigarh; Gandhinagar; Bhubaneswar; Kolkata	[5,6,19,22,30,34]

Interpretations of development in India also indicate that there is potentially a two-tiered system of application for policy/practice which impacts upon green infrastructure investment. Although policy is developed and used to guide investment from the national government through to the state and city level, there is also a further tier that applies more informal approaches to investment [3]. Examples include the former ruling Congress government developing legislation that is subsequently enacted by the New Delhi Government, the National Capital Territory administration and more localised civil administrations in Noida or Gurgaon. Within this paper informal development is proposed as that which has limited legal support within the planning system i.e. those activities which fall outside of planning policy, applications and official approvals, and as a consequence occur more organically [5]. One implication of this is the difficulty that planners have managing this process as the timeframe for instigating legal proceedings is often prohibitive. Furthermore, some development although informal, is supported by influential stakeholders so becomes informally approved, and yet remains outside the legal frameworks of planning control. The parameters of what is permitted and what is legal therefore illustrate the shift from state control to the alternative development structures proposed by Jessop [16]. Such a process illustrate the difficulties that planners face in applying policy when there is a government and private sector push to promote Nehruvian deregulation and liberalisation in parallel with formal praxis [32].

A further consequence of this process is the lack of a strategic overview in some locations as government officials are unable to control informal development. In the most drastic cases this can, and has, led to changes in policy. Pressure on green infrastructure management can therefore be identified at each scale in this process. At the national level the main driver of development is economic, whilst at the city-scale there are greater interactions, and subsequent confluence of socio-economic factors influencing decision-making; although it is noted that economic development remains the key driver of this process. The informal-tier is though where greatest pressure is

witnessed on the management of green spaces and environmental resources. Examples of which include changing landuse in Dwarka in western New Delhi [46] where green space and informal settlements have been redeveloped into apartments and along large tracts of the Yamuna floodplain have been cleared of their ecological resources to allow development [33,47]. Furthermore, where informal development occurs there are fewer restrictions on resource use due to the diminished level of formal (i.e. legislative or regulatory) involvement with the planning system with a shift in focus to local agency [5]. There is also a growing discussion of the utility of Green Belt designations along the “Ridge” area in New Delhi where environmental legislation is being challenged by some landowners, developer and politicians as it is deemed as difficult to enforce by the city’s planners [48]. Legislation therefore becomes increasingly difficult to regulate where a greater flexibility to the development realm is established following Nehruvian policies and post-1991 liberalisation [32]. Moreover, despite the growing evidence base supporting investment in green infrastructure there still appears to be a set of structural planning issues which can be identified as constraining the development of greening projects.

## 5. The barriers to investment in urban greening

Although the debates relating to how Indian cities are developing can be conceptualised within the Gandhian-Nehruvian narrative there are a number of additional, and more procedural, barriers that can also be identified as hindering effective green infrastructure planning. Each can be seen in practice in a number of locations and at a number of scales across India highlighting the complexity that planners are subject to when investing in urban greening [49]. Previous sections outlined a number of barriers to sustainable urban development in Indian cities including: the rate of population change, the drive for economic growth, and the changing policy structures that struggle to manage the speed of expansion. The following sections discuss additional barriers which directly influence the integration of green infrastructure into planning practice. Furthermore, even though all of these issues can be considered as being an influence of, and therefore, also an influence on economic development they need to be discussed as individual issues in their own right.

### 5.1. Political will

Politically the influence of economic liberalisation underpins assessments of each of the factors noted above. Although India’s growth rate dropped to between 5–6% in 2012–2013 [28], the process of deregulation and expansion is proceeding exponentially. How green infrastructure planning is integrated into this process must therefore be approached from a benefits/valuation perspective if its visibility is to be raised. Whilst it may be politically expedient to support growth over environmental sustainability, Williams [50] suggested that by moving away from simple dualisms, and thus Nehruvian perspectives of *growth-no growth*, towards a nuanced understanding of the intersections between processes and urban form provides greater opportunities for investment in green infrastructure. In doing so a reframing of economic valuation (and associated cost-benefit returns) can be made which examines the value to green space to health, climate change, ecosystem services and water management. However, following the structural shifts in development planning towards more deregulated investment there appears to be a continuing reluctance in government and practice to prioritise environmental sustainability at the expense of economic growth. This is made more

prominent when the changes to the accountable planning body, i.e. NITA Aayog, are included in the discussion [1,5]. Once again this raises the conflict between expansionist development debates and those of national and/or local institutions calling for more focussed development. As a result there are multiple contestations within the development arena that undermine the contextual viability of development. For example, in New Delhi between the city's government, the National Capital Region (NCR) administration, developers in Noida and Gurgaon and the proposed Delhi Metro link extension [18,33]. Furthermore, there is an intrinsic difficulty in identifying deliverable green infrastructure values within political agendas, as they are normally debated collectively as one element of other forms of development rather than as a standalone agenda. Environmental politics in India, as noted by Bowonder [51] and more recently by Baud & Dhanalaskshmi [52], therefore needs to integrate more effectively the complexity of landscape resource management inherent to planning but has, to date, failed to divorce sustainability from economic growth.

### *5.2. Influence of economic development*

As discussed throughout this paper the drive for a consistent upward trajectory of economic growth is undermining the ability of government and planners in India to plan sustainably for green infrastructure. Such rhetoric promoted by the Indian government and its business leaders, and extended through the liberalisation of development policy place excessive pressures on the capacity of the environment to support development. Since Independence development studies research in India has focussed on the complexity of this process highlighting the systematic damage caused by overuse and mismanagement of resources [53,54]. The negative outcomes of expansion can be seen in New Delhi where the city's green infrastructure network has diminished through conversion to "grey" infrastructure, whilst it has retained its position as one of India's greenest cities, to facilitate investment in roads and housing. Any discussion of New Delhi therefore illustrates the influence that economic development holds over planning for sustainability. Furthermore, due to the relative ease of access to governance structures made available to business there is greater potential for external actors to shape planning policy compared to some government officials [28].

### *5.3. Competition from other forms of built infrastructure*

Further complicating this process is the overuse of urban landscapes for built infrastructure. Investments in transport, utility/services and housing have been discussed as key elements supporting Indian development [1]. However, the rate at which development occurs minimises the effectiveness of urban ecological systems to equalise needs and actions. The recent promotion from the Modi led government on Smart Cities has been observed as one policy mechanism which may be able to redress this perceived imbalance [55]. Urban water courses are of particular importance in this process and along with urban street trees are often the most visible resources which become marginalised from development [35]. For example the redevelopment of the Sabarmati riverfront into a promenade lined with manicured street trees in Ahmedabad is less ecologically diverse than the former floodplain, and the subsequent replication of this process on the Yamuna River in New Delhi where floodplain habitats have been cleared in favour of managed parks illustrate how investment in urban greening can be viewed by some as a positive and by others as a negative [47,56]. Planners and advocates can therefore propose that supporters of sustainable urban growth in India appear to be

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aiming to maximise both the proportion of urban greening within development plans, as well as, its physical visibility as a green space. Examples of land conversion to transport/housing infrastructure have been witnessed to the east of the Yamuna River in New Delhi where investment in the Commonwealth Games facilities and a large temple complex has placed greater pressures on the availability and access to green space [45,57], in Gurgaon where rapid suburbanisation has led to the local government to continue to invest in the management of the city's green spaces in order to maintain its environmental quality [58], and in Noida where urban growth has placed additional pressures on larger green/blue spaces without a corresponding investment in smaller sites, all of which highlight how such conflicts occur when green infrastructure developments is not proposed as an equal to transport, industrial or housing infrastructure.

#### *5.4. Lack of awareness of the value of environmental resources*

Previous sections outlined a number of the economic and political factors influencing why investments in sustainable urban planning and green infrastructure have faltered. To contextualise these issues further it is also necessary to examine how a lack of awareness of urban greening is also hindering this process [59]. Enshrined within the Indian constitution is the right for citizens to use environmental resources to support livelihoods. As a consequence attempts to enforce limits on environmental resource use runs counter to the legislative ideals of the nation. In reality two approaches have been adopted for this process loosely tied to Gandhian and Nehruvian perspectives. Gandhian interpretations focus on environmental stewardship and the maintenance of a balance between development and sustainability. However, this contrasts with the rights of business/developers to drive economic growth through resource use. This second interpretation sees the environment as a resource that should be used to support development but in practice this often leads to conflicts over environmental sustainability [53]. The removal of extensive urban tree coverage to facilitate growth of New Delhi's satellite towns highlights the scale of this process [60]. To foster a more sustainable approach to resource management an increased awareness of environmental value is needed between developers, citizens and government in order to identify the ecological capacity of development. This should be undertaken through additional stakeholder dialogue which enables all interpretations of land use to be integrated drawing on both the etic understandings of landscape value and the more growth orientated ideals.

#### *5.5. Professional training and education*

Whilst raising awareness in political and community groups is a key aspect of promoting sustainable green space management, this process needs to be coupled with a corresponding level of capacity in India's planning professionals. As the renaming of the Planning Commission to NITA Aayog suggest the Indian government may not fully support the process of regulation and procedural decision-making which forms the foundations of planning [5]. This reflects one of the institutional issues within planning: a lack of dialogue between stakeholders limiting the capacity of professionals to shape development [5]. Although planners have high quality reasoning, negotiation and spatial skills they can be undermined if a strong political system does not support their use. Therefore the promotion of growth by Nehru and the post-1991 liberalisation process has limited the use of Gandhian knowledge-based approaches that planners have. As a consequence the ability to plan

spatially, for multiple purposes simultaneously and strategically can become unaligned as less formal development narratives becomes more prominent. Attempts to relocate planning, and planning professionals, within this process is key to ensuring that the knowledge of policy, law and practice are engaged effectively within planning debates.

## 6. Opportunities for green infrastructure investment

In spite of the perceived limitations that these issues present there is a growing view which accepts that green infrastructure potentially has a role to play in promoting more sustainable urban development in India [4]. Unfortunately, to date, there is not a coherent narrative supporting this process. Historically urban greening may have been overlooked because it lies outside the established economic narrative of government, which lack the holistic and more integrated approach promoted in green infrastructure research. Personal and community spaces though play a more important role in supporting ecological networks in such locations, as they address the changes in urban form more directly [61]. Although as Mell [8] argued the physical size of a location is not the only contributing factors to its cumulative value. Alternatively Mell stated that value is established as a response to needs and the creation of multi-functional spaces. Thus, green infrastructure may be considered as both an effective and economically efficient form of development when a grounded set of investment characteristics are promoted in India cities.

To achieve this six key characteristics need to be relayed to planners, developers and citizens in India:

1. *Responsive green infrastructure*: (a) investments in urban greening need to be responsive to the specific development scenarios of each location, this includes an understanding of the rate and scope of population change to investment and the identification of sufficient resources to meet local, and in some contexts city-scale, needs; (b) responsive environments are planned to take into account the capacity of the resource base and the extent to which it can meet built and ecological system needs; (c) react proactively to changes in political authority to ensure longevity to environment sustainability; and (d) establishing a rationale which engages with Nehruvian-liberalisation narratives to co-locate green infrastructure investment alongside other forms of built infrastructure.

2. *Appropriate green infrastructure*: investments are identified as being (a) located in areas of need; (b) planned strategically to ensure systems resilience; (c) address specific ecological, economic and social needs; (d) extend the existing provision of green urban networks to ensure that resources are accessible and functional; and (e) are planned for long-term use

3. *Robustly evidenced green infrastructure*: proposed investments are grounded in ecological, economic and social evidence to ensure investment and development provides multi-functional landscapes.

4. *Scaled green infrastructure*: (a) investments should be developed to support a hierarchal network of green infrastructure resources to provide provisioning, servicing, supporting and cultural services for a number of communities; (b) this should take into account the extent of the existing resource base and its existing functionality to ensure that investments are complimentary; and (c) promotes wider accessibility to all members of society and is delivered in a number of number of locations and sizes.

5. *Bold and future-orientated green infrastructure*: (a) investment should be planned to embed sustainable development principles at the centre of planning discourses; (b) to achieve this a

reflexive approach to development and management is needed to assess where value can be added and traded in urban environments; (c) where possible any negative impact on the green infrastructure resource base should be compensated within a given location; and (d) city and state government should consider investing in city-scale green infrastructure resources.

6. *Educated and insightful professional*: (a) planners should lead the process of strategic decision-making based on an understanding of policy and practice; (b) that professionals are engaged with both public and private sector development; and (c) that value is attributed to public planning bodies who act as the responsible and legally accountable agencies for development.

If Indian cities are to maintain their existing green spaces then action needs to be taken to ensure they remain “green” and do not become increasingly compromised through further “grey” infrastructure development. New Delhi is though starting to address this issue as it is currently experiencing the climatic effects of changing landuse (i.e. higher temperature, increased flooding, and pollution), in part because they have allowed large proportions of the city’s landscape to be developed [41]. Given the current expansion projections put forward by the Asian Development Bank [22], it appears likely that India’s cities will continue to expand, and whilst redeveloping green spaces into built infrastructure meets development needs it diminishes the ability of urban ecological systems to function effectively.

## 7. Conclusions: a “greener” future for Indian cities

Urban areas provide the spatial platform to deliver a broad range of investment. Furthermore, due to the interaction of stakeholders these spaces can promote reflexivity in terms of the application of policy into practice. Translating practice from global green infrastructure research to an Indian context may require greater adaption to the investment process which draws on a suite of evidence and agency to promote a strategic-relational knowledge exchange at the local scale. Such a shift from the international to the national, and from nationally controlled development to a greater actor/stakeholder led influence may in the long-term provide greater scope to think innovatively about urban growth. Although, this may highlight that the equilibrium between sustainability and development is often disjointed it also provides stakeholders with an opportunity to integrate the Nehruvian-Gandhian ideals into more appropriate forms of investment. The role of green infrastructure within this discussion can thus be considered to facilitate engagement between planners, policy makers and developers who are willing to embark in a dialogue that identifies the relationship between green infrastructure, economic growth and sustainable forms of urban development. However, planners and advocacy agents must refrain from assuming that planning can create an idealised state for sustainable growth. Even where investments in urban greening are applied a more reflexive process of integrated planning needs constant reinforcement from government and development stakeholders [50]. The multiplicity of actions, policy directives and the dynamism of practice may, as a consequence, present barriers to the effective promotion of sustainable urban forms but also provide opportunities for more innovative thinking [61].

Further complications though are still evident following India’s evolution to a market-led state of economic liberalisation, which has in many locations, minimised the role of public bodies and local knowledge in shaping development. However, there is a growing consensus led by environmental bodies such as Greenpeace India who are engaging government in dialogue to challenge the established Nehruvian approaches to deregulation by advocating localised and



culturally based management. How planners interpret and apply green infrastructure approaches within this debate will thus be central to the development of greener and healthier cities.

The role of green infrastructure in Indian cities may therefore appear, at present, to be marginalised compared to other built development needs. However, as New Delhi has experienced, reducing a city's ecological resource is viewed as effectively decreasing liveability and increasing unsustainable development; a process it is now redressing through its masterplan and with financing for urban street trees and improvements in water body quality. To maximise the benefits of green infrastructure Indian cities need to negotiate the dualism of Nehruvian and Gandhian politics by balancing the flexibility of growth with an understanding of human-environmental interactions. If this can be achieved Indian cities can move towards a more sustainable form of urban development that promotes economic and social well-being within an ecologically resilient form of planning. Finally, green infrastructure planning in India potentially offers a third way to address urban development that harnesses the shifts from centralised investment to increased local or private sector agency.

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### **Conflict of interests**

No conflicts of interest are related to this paper or the discussions held within.

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