The DNA of Metropolitan Growth and the Prospect of Sustainability – New Delhi an Indian Case Study

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Abstract

Metropolitan conurbations across India which have populations of one million plus have crossed the threshold where the new pattern of urban living would lead to an explosion of greenhouse gas emissions. This poses an unprecedented challenge to the commitments vis-à-vis the Kyoto Agreement. The fuel of this “explosion” is the energy consumption embodied in this rapid urban growth. The explosion would leave a “bush fire” in its trail, due primarily to the spread of air-conditioning in buildings.

This challenge can be met by policy initiatives that correspond to the “DNA” of the nature of urban growth that is being witnessed in India and the emergent urban culture. Such an analysis finds that priority must be accorded to reduction in embodied energy as the critical measure, followed by specific attention paid to the phenomenon of air-conditioning. A campaign of public awareness and information requiring professional responsibility, and active support to alternative technologies can mutate cultural trends. It is interesting to note that the DNA of emergent urban culture possesses the enabling structure to effect a beneficent mutation toward environmental sustainability.

1 Introduction

A sustained rapid growth of the Indian economy of 8.0% per annum for the past two years, has prompted the Government of India to announce a far reaching programme of investment in urban development. The Jawaharlal Nehru Mission for Urban Renewal cites 60 cities spread across the country on which approximately 200 million EUR is proposed to be invested for upgrading of urban infrastructure, capacity building in urban management, and to provide housing and social services for the urban poor.
This is occasioned by the realisation that global investment in city-based services and knowledge industries has been the leading factor of recent economic growth. The growth of urban economies, if facilitated by the mission would contribute 65% of the nation’s GDP by 2011.

The natural consequence to the economic growth of the urban economy is the attraction of populations towards urban conurbations from the smaller towns and rural settlements. From 28% of the population living in urban areas today, it is expected that 40% will be in cities by 2021. The future of social and economic advancement would rest on the environmental sustainability of urban systems – not only at the local level, but also at the regional level in terms of the management of natural resources and, most importantly, at the transnational level of curtailing global warming.
So, there are two overarching processes that force the future of cities in India – **Globalisation**: Investment in city-based economic activities serving a global market for profit and, **Urbanisation**: the shift of population toward cities in search of economic security and the prospect of a better life.

This paper focuses attention on the aspect of global warming with respect to the energy consumption in the new culture of building with the acceleration in growth and development of cities in India, rather than on the other relevant dimensions of land utilisation, water and transportation systems.

We examine the case of **New Delhi** to understand the causative structure of this environmental impact on the one hand, and the potentiality of response in the emerging urban culture, on the other. Together, these two are characterised as constituting the two strands of the DNA of the city. Policy initiatives are then suggested as a third, catalytic, strand that can connect between these two strands and mutate growth and change toward environmental sustainability.

### 2 Nature of Urban Development and Growth

#### 2.1 Globalisation

The Master Plan for New Delhi 2001-2021 doubles the urbanisable land to accommodate anticipated growth. Delhi will be promoted as a heritage city for international tourism. The city infrastructure of roads and public spaces is being upgraded to prepare for the Commonwealth Games in 2010.

![Predicted population growth for New Delhi](source www.dnda.gov.in)

<table>
<thead>
<tr>
<th>Year</th>
<th>Population in Lacs (100,000)</th>
<th>Growth Rate %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951</td>
<td>25.6</td>
<td>52.5</td>
</tr>
<tr>
<td>1961</td>
<td>40.7</td>
<td>52.9</td>
</tr>
<tr>
<td>1981</td>
<td>52.2</td>
<td>53.0</td>
</tr>
<tr>
<td>1991</td>
<td>94.2</td>
<td>51.5</td>
</tr>
<tr>
<td>2001</td>
<td>137.9</td>
<td>46.3</td>
</tr>
<tr>
<td>2011</td>
<td>182.0</td>
<td>32.0</td>
</tr>
<tr>
<td>2021</td>
<td>230.0</td>
<td>26.4</td>
</tr>
</tbody>
</table>

Percentage increase 2001 – 2021: 66.8 %

The dominant impetus of growth as indicated by the Urban Renewal Mission is provided by investment in real estate for an international market - the up-market offices, shopping malls, cinemas, hotels and apartments. The first events of building for this market gain prominence, they become symbols of success to be emulated. These buildings typically exhibit three universal characteristics: they have a stylistic preference for predominant use of glass, stainless steel and aluminium as cladding/finishing materials; they are centrally air-conditioned to “American” standards; and in as far
as they occupy prime locations, they are tall, large-span structures with deep basements. All of this is part of the universal package of the Multi-national Corporation (MNC) lifestyle. In the absence of any regulatory controls on energy consumption, such buildings become enormously energy profligate, whether in terms of the energy expended in the high process-energy materials they use in their construction (embodied energy) or in their consumption of energy to maintain artificially controlled indoor environments (operational energy).

While initially constructed for the 5% fringe at the top of the socio-economic pyramid, this culture of building tends to influence the aspirations and values of the next 10% below it. This sociological process would carry with it the environmental costs of rapidly increasing energy consumption. (Refer figure 3)

**DDA PERSPECTIVE PLAN**

*Delhi Development Authority Perspective Plan 2001 – 2021*

*Projections: Infrastructure Demand*

<table>
<thead>
<tr>
<th></th>
<th>Water (MGD)</th>
<th>Sewerage (MGD)</th>
<th>Power (MW)</th>
<th>Solid Waste (Tons/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirement (2001)</td>
<td>1096</td>
<td>977</td>
<td>3265</td>
<td>7100</td>
</tr>
<tr>
<td>Availability (2001)</td>
<td>705</td>
<td>384</td>
<td>2352</td>
<td>4900</td>
</tr>
<tr>
<td>Projected Requirement (2021)</td>
<td>1840</td>
<td>1472</td>
<td>8800</td>
<td>15750</td>
</tr>
<tr>
<td>Additional Requirement</td>
<td>1055</td>
<td>1086</td>
<td>6440</td>
<td>10050</td>
</tr>
</tbody>
</table>

With increase in population the Plan envisages more efficient utilization of water per capita.

*In the case of Power the Plan envisages a disproportionate increase in demand!!!*

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### 2.2 Urbanisation

The majority of the growing population belonging to the lower end of socio-economic pyramid of the city, will, however, continue to settle on the city’s margins in low-rise high-density formations that are amenable to incremental growth and improvement by self-build operations. In comparison to the mode of shelter provision in the rural or small town contexts, the type of construction of shelter for this majority, too, shifts towards a higher expenditure of embodied energy per unit of built space. The consumption of relatively higher process-energy materials – bricks, cement block, RCC, steel components, transported over long distance from their places of manufacture becomes necessary, replacing the traditional resource base of building materials (earth, stone, timber, straw etc.) earlier employed in the rural situation.

This qualitative shift in demand for high embodied-energy materials and building systems at both ends of the socio-economic pyramid, coupled with the scale and speed of development, causes a veritable “explosion” of CO₂ emissions on account of the fossil fuels burnt for production of building materials. Imagine New Delhi doubling its built space in just two decades!
2.3 Embodied Energy

The discussion on sustainable construction in developed societies accords little emphasis to embodied energy – for in the long run it is a relatively insignificant contributor to CO$_2$ emissions when compared with operational energy. However, in a case such as New Delhi, where the embodied energy component of the construction boom will have an immediate, explosive impact, the need to curtail embodied energy in construction materials & processes takes on great urgency.

What must be emphasised is that this aspect of energy consumption has horizons of concern that lie largely beyond the immediacy of the city and is therefore easily overlooked. This explosion, when generalised over the rapid urban development across the country, will send a powerful pulse of CO$_2$ emissions into the atmosphere thereby exacerbating the trend of global warming.

2.4 Air-conditioning

The growth of air-conditioning industry in Delhi over the past two years is indicative of another important trend. The transition from the conventional circulating fan or evaporative cooler to refrigerant cooling constitutes and 8-fold increase in electricity consumption for thermal comfort (Fig. 2). This demand creeps progressively over the old building stock of the city and much of its middle-class residential space. This upgradation of existing buildings adds to demands of the new centrally air-conditioned office, mall & theatre, referred to earlier. Indeed the shortfall in electricity experienced in Delhi during the months of June and July – which caused power-cuts and widespread agitation – is directly attributable to air-conditioning!

**INDOOR CLIMATE CONTROL**
*Air-Conditioning the Major Consumer*

![Image of air-conditioning consumption comparison]

Figure 4: The transition into air-conditioning is critical
2.5 Continuing Impact
Notwithstanding the ‘explosive’ impact of high embodied energy construction occasioned by the present boom, what cannot be forgotten is the prospect of a continuing bushfire of high levels of operational energy consumption that would continue beyond the boom period. The energy profligate trends led by the MNC culture of buildings, particularly that of providing air-conditioning without concern for efficiency or economy, may translate into intransigent market habits that will fuel the bushfire for years thereafter.

The first string of DNA structure of urban growth and development that we have looked at represents a growing hunger for energy for buildings: a trend that would be is unsustainable in the face of global warming.

3 Potential Intelligence of New Urbanism
The second string of the DNA structure identifies the potential of the intelligence of the city to modify the behaviour of the first string!

3.1 Youthful Society
The demographic structure of Delhi is representative of the national demographic structure. The city is young. The advantage of urban life is that 90% of the youth has had access to basic education. Knowledge, aspirations and belief of this section of the population will dominate democratic decision making in the coming decade of urban growth.

3.2 Communications Revolution
A potent feature of the new urbanism is the communication revolution. The exponential growth of communications media – cinema, television, radio, internet, and the print media in the past decade has empowered the city populations, to be an-courant and well informed. The networks of the popular media are showing increasing responsiveness to environmental issues. The availability of international TV channels in Hindi, the local language, with local channels reporting and debating environmental issues is already playing a strong role in democratic decision making.2

3.3 Environmental Values
This youthful society also has the benefit of environmental values built into school education. The relationship between human activity and environmental sustainability, or conversely, the security of urban life being dependant on management of environmental resource, is being absorbed into a subconscious structure of belief. The reality of this fundamental relationship is readily grasped by citizens in their direct experience of acute shortage of both water and electricity in day-to-day life in the city. This cultural ground is ready to receive the seed of instrumental knowledge about potential alternatives – to meet their needs of shelter as well as to express the new vibrancy of city life.

3.4 Professional Involvement
The National Capital Region (NCR) has 6 schools of architecture. The content of architectural education and its ethos continues to foreground ethical professional practice – concerning itself with social, cultural and environmental issues of a developing society. These schools and many professionals are actively engaged in issues concerning the development of the city. The exhibition “Imagining Delhi” brought out by the Delhi Urban Art Commission exemplifies this commitment.3
3.5 Low-Energy Alternative Technologies

Over the last two decades professional involvement with NGOs has produced innovative low embodied energy technologies. Costford, Anangpur Building Centre, TARA Nirman Kendra and the Construction Research Centre have established many technologies of construction that cut down embodied energy, are available to small scale local enterprise, and eminently affordable. (Refer figure 5) A recycling trade for practically all building materials is well established as an economic necessity. Similarly, the evaporative cooler, a product of local enterprise, is developing into a practical & versatile home gadget.

These are latent resources that can serve 70% of the city’s new building needs at much reduced CO₂ emissions.

The second strand of the DNA represents the readiness and motivated enthusiasm of a young informed citizenry and a groundswell of responsible leadership from educational institutions, architects & planners. This, combined with the potential of alternative technologies, in this author’s view, is the combination of forces that could usher a sustainable culture of building – to counter the tendencies of the first strand of the DNA.

CONSTRUCTION TECHNIQUES

- Efficiency and reliability with low investment
- Technologies to create wealth and knowledge locally
- Ferro cement
- Shallow masonry dome
- Precast concrete screen
- Stabilized mud block
- Stabilized Fali-G block
- Tensile façade screen
- Woodwork for doors and windows

Figure 5: Low Embodied Energy alternative technologies ready for industrial application
4 The Connecting Strand of the DNA: Policy Initiatives

Buoyed by the initiative of the Delhi Government to legislate Compressed Natural Gas (CNG) in 2001 for all public transport in the city and the growing active debates regarding governance on environmental issues in the media, the climate for new policy initiatives and government programmes on environmental issues is ripe. The policy initiatives that are prompted by the structure of the two strands cited above are as they effectively leverage the second strand to catalyse a beneficent mutation of the first strand.

First:
Energy conservation is to be declared as a priority and an integral part of environmental sustainability along with the currently popular themes of water conservation and pollution control.

Second:

4.1 A public information campaign

Through the mass media directed toward the young citizen to be undertaken:

a) Explain the connection between the use of high embodied energy building materials and construction technologies and global warming and climate change.
b) Explode the myths perpetuated by certain glazing and air-conditioning companies that sell “life-style” at the cost of environmental security.
c) Advertise the availability of low-energy alternatives.
d) Insist on simple energy efficiency measures in building design that can be demanded from design professionals and real-estate marketeers.
e) Promote a cultural value for a “Green Life-Style at Home and at Work”.

Young citizens building an environmentally responsible culture are the key to a sustainable future.

4.2 Support the development of low-energy technologies by:

a) Fiscal and institutional support to
   • available and tried technologies to raise levels of industrial production and product reliability
   • Draw entrepreneurship of the next generation small scale industry into building materials and technologies: stabilised earth bloc, fly-ash block, stone panel cladding, small double shutter windows, insulation from waste, shade awnings, evaporative coolers, hybrid comfort conditioning systems.4

b) VAT rebate and excise exemption for energy saving products.

c) Penal electricity tariff for air-conditioning installation greater than 1TR per 30 Sq.M. of conditioned area.

Policy and legislative measures must be built on a platform of public awareness and support on the one hand, and the availability of viable alternatives for building technologies on the other hand.
Conclusion

The resurgence of the Indian economy is centred on urban development. Urban development responding to the process of “globalisation”. This will cause an explosion of CO₂ emissions on account of the embodied energy of building construction, followed by a bush fire caused by the spread of air-conditioning. The negative environmental consequence of this process can only be countered by a policy of information / education coupled with entrepreneurship in alternative technologies to meet the needs of urban shelter that takes advantage of the positive opportunities of the emergent urban culture. We argue that this is eminently feasible.

References


Notes

1. The aluminium and plate glass curtain wall aesthetic imported wholesale without the ability to meet the high cost of thermally efficient double/triple glazing systems results in constructing “solar cookers” that collect heat, which are then converted into “refrigerators”. The air-conditioning load is further increased by an insistence on closed external skins and maintenance of unnecessarily low chilling temperatures as per ASHRAE standards. Such external skins typically incur 20 times the embodied energy when compared with traditional brick work with stone cladding and shaded windows not exceeding 20% of wall area. The embodied energy in large span structural systems of buildings greater than 6 storeys in zones of earth quake vulnerability rises exponentially with height due to the increased consumption of structural steel hybrid cement concrete. Tall buildings also incur relatively higher operational energy in conveyance of people services and goods up against the force of gravity.

2. The National Capital Region has 7 FM radio channels which mostly address a young audience. Most TV sets have access to 50 local, regional and international channels. Local language and English newspapers devote considerable space to address the younger generation; the same goes for the ever growing number of magazines on sale in every market. Government responsiveness and accountability has palpably improved over the last five years due to the mass media.

3. The Delhi Urban Art Commission, under the chairmanship of Charles Correa, brought out an exhibition “Imagining Delhi” in April 2006 to which a large number of professionals and student groups contributed in projecting a positive vision for Delhi’s future. Volunteer professional groups have also played an important role in developing recommendations and debating various issues for New Delhi’s Master plan 2001 – 2021.

4. Nearly all of these technologies have proven their effectiveness but they remain dispersed cottage industries or systems of on-site construction. They have the potential of delivering economies of scale with higher product reliability if they rise to the level of small scale industrial production. Unfortunately, this is inhibited due to the application of taxes and excise on formal production units. Tax exemption and fiscal support would release the positive potential of these technologies.