

The Vulnerable Road User

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Boots on the Ground

The year was 1965 and DM (as Dinesh Mohan was universally known) had just been elected as Social Secretary of the students' body at the Indian Institute of Technology (IIT), Bombay. He was not in favour of 'ragging' (a sort of lewd harassment) of new batches of IIT entrants by the seniors and wanted to organise a Fresher's Nite for them to display their talents. DM, and I, were a bit late for the event as we had been playing a hotly-contested football match. When we arrived there we faced an eerie silence. It seems a new faculty member, who fancied his singing, had captured the microphone, and then been generously booed by the audience. The Director of IIT, a formidable retired army officer, had forthwith cancelled the event.

DM was furious. Still wearing his football boots and sweat-soaked jersey he marched off to the Director's bungalow with me in tow; rang the bell; and we tracked gobs of mud all over the shining living room floor. The Director was treated to a five minute tirade about how he had exceeded his powers; this was a student-organised event; only students had the right to participate in it; did he want us all to be stupid morons; or did he think that IIT students had intelligence? Leaving behind a somewhat bewildered brigadier, DM nodded to me, did a smart about-turn and marched out again, our boots echoing sharply on the mosaic tiles.

This incident, one amongst many, marked for me DM's two fierce concerns: get your boots on the ground for the underdog; and don't take any faeces from those in authority. This is perhaps what led to his engagement with what he called the 'vulnerable' road user (VRU), and he bent his mind to designing transport to protect this particular user. His fundamental belief was that design must be based on the lived experience of the user, and not merely of the planner.

Contours of Vulnerability

This essay builds upon the same basic concepts but attempts to take the argument further into what could be the lived experience of the VRU that would contribute to the design of a sustainable city. In 1980 DM, along with some of us, co-founded the Sanchal Foundation as a vehicle to fund and promote research for the advancement of the poor. In 1996 I offered to organise the Hazards Centre within the Foundation to actually provide technical and professional assistance to communities facing threats to their survival. For over twenty-five years DM has been a co-traveller in the Centre's efforts to address 'hazards' through research.

In the course of these efforts, at the Centre we had to ask the question, who is the VRU? A user of the road exposed to several hazards, yes, but why is the VRU on the road? We began to understand that the VRU is also a city dweller whose vulnerabilities extend beyond the road to living and working spaces, as well as to all the services that the city has to offer. Hence the design of the city has to encompass these multiple factors of the lived experience of vulnerability. We also learnt that participatory research could be adopted to bring this lived experience to the core of urban planning, thus transforming vulnerability into active design.

DM had defined the VRU as the pedestrian and the cyclist. But our research led us to several VRU occupations. They were 'skilled' workers like machinists, masons, electricians, plumbers, mechanics, bus and car and metro drivers. They were also 'semi-skilled' workers such as vendors, beauticians, auto- and cycle-rickshaw pullers. They were 'unskilled' workers in waste collection, domestic work, load carrying and sewer cleaning. And there were some who did not have a specific occupation but were on the road – slum dwellers, bus commuters, specially-abled, homeless and marching protestors. It was the *bottom-up* perspective that these labouring people offered which could inform the design of a sustainable city.

Planning Models

On the other hand, the *top-down* imagination of planners sees sustainability very differently (**Figure 1**). For them, the city is an 'engine of growth' in the centre, to which labour migrates for powering the engine. But when this mass of labouring humanity proves unmanageable, city governments adopt the 'urban renewal' mission to provide basic services to the working poor. This transforms into the 'smart city' which efficiently uses information technology; followed by the 'circular economy' that recycles waste while maximising production. The latest avatar is 'doughnut economics' which conceives of a just space for humanity bounded by environmental changes on the outside and human needs on the inside.

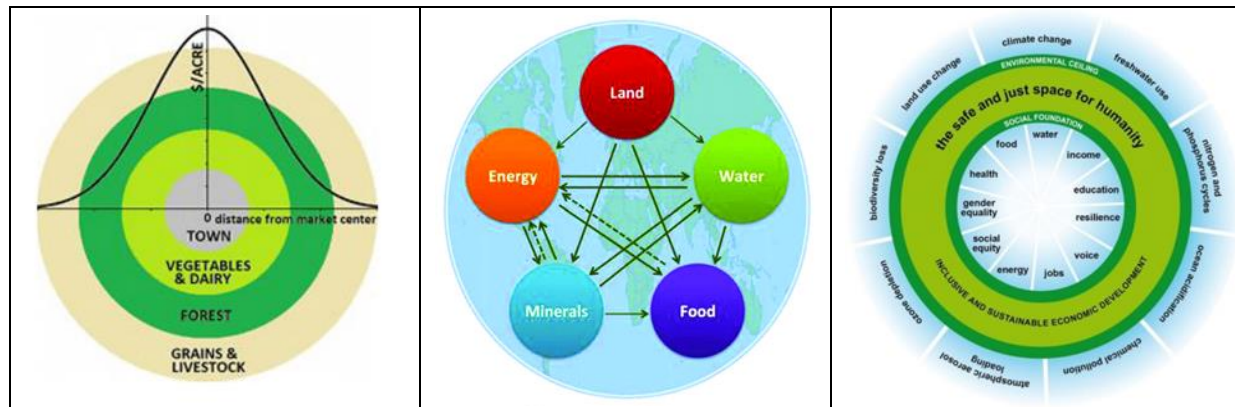


Figure 1: von Thunen's model¹; Nexus model²; and Doughnut economics³: variations on a theme

However, as one concept follows another, each one implicitly demonstrates the failure of the previous one. Why is this happening? Perhaps it is because they all follow the concentric land and resource based model of the city, first put forward by the German economist von Thünen a century ago to explain how land rent in and around towns depends upon market activity. All subsequent models repeat the same assumption: that the main business district is at the centre of the city and all resources flow by virtue of the margin of profit at the centre that dictates production and distribution. Therefore, the sustainability of the city depends upon how rates of profit can be maintained or, better still, increased.

¹ Traditional Von Thunen model of land uses & values, Land Economics, <https://studylib.net/doc/10640337/land-economics--traditional-von-thunen-model-of-land-uses>

² Frone, Simona and Frone, Dumitru-Florin, The Importance of Water Security for Sustainable Development in the Romanian Agri-Food Sector, Bucharest, September 2015, https://www.researchgate.net/publication/282001965_The_Importance_of_Water_Security_for_Sustainable_Development_in_the_Romanian_Agri-Food_Sector

³ Pote, Bon, The Doughnut Economics: definition and critical analysis, July 2022, <https://bonpote.com/en/the-doughnut-economics-definition-and-critical-analysis/>

Work and Shelter

How can we now grasp the perspective on sustainability of the VRU? Of the several imaginations that have emerged out of the work of the Hazards Centre in assisting many groups in different cities, for the purpose of this paper we shall take four cases which would hopefully represent the VRUs as a whole. We begin with the slums in the city. Slum-dwellers may live in the slums, but they come to the city in search of livelihoods. Hence, they are on the road for much of their working lives as they travel in order to supply their labour to the rest of the city. Our attention was drawn to them when an alliance called the Sajha Manch emerged in Delhi to challenge demolition drives.

We began to understand that for Delhi to 'grow' it required investment and, since city governments did not have the capital, it was necessary to make the city 'investor-friendly'. This also meant that the city had to be 'beautified' city for investors and financial institutions to work, produce, trade, live and make profits in and out of infrastructure that was 'world-class'. A logical consequence of this profit-driven mentality was to move 'dirty' manufacturing, transport and slums out of the city. This was reflected in a series of administrative and judicial orders that plagued Delhi from the 1990s onwards⁴.

In collaboration with the Transport Research and Injury Prevention Programme (at IIT, Delhi), founded by DM, we mapped the distribution of slums in the city in 1994. By 2019, the clusters had reduced by 39% and the families by 36%. Taking a cue from DM's early work we have drawn a cell of diameter three kilometres around each slum to denote the easy walking distance from the slum. We call this cell the 'labour-cell' to mark the intimate connection between work and shelter. **Figure 2** shows (left and centre) the status in 1994 as compared to 2019, and the sites (right) where evicted families were moved to prior to 1990 and after 1990, just before the 1980 Asiad Games and the 2010 Commonwealth Games drove the 'beautification' of the city.

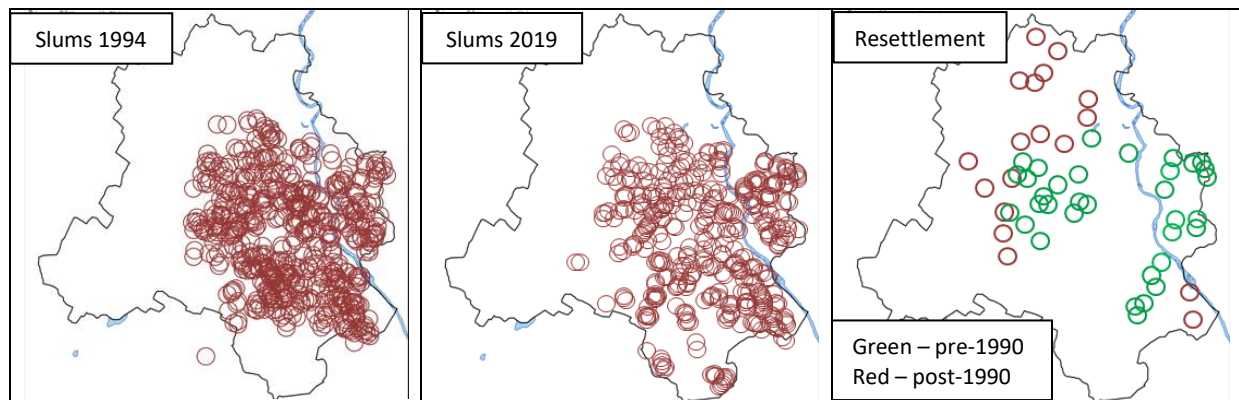


Figure 2: Slums in Delhi in 1994⁵ and 2019⁶, resettlement sites⁷ from 1970 to 2020, with labour-cells

⁴ Roy, Dunu, Whose city?, Seminar, No. 648, August 2013, https://www.india-seminar.com/2013/648/648_dunu_roy.htm

⁵ Mapped by Sandeep Gandhi, Transport Research and Injury Prevention Programme, Indian Institute of Technology, Delhi, 1996

⁶ Based on a map uploaded by the author, sourced from Delhi Development Authority, Vora, Sejal and Bhowmik, Titas, Outreach And Performance Of Co-Living As A New Rental Housing Format-A Case Of Noida & Gurugram, CEPT University, 2020, Sejal Vora, https://www.researchgate.net/figure/Location-of-Slums-in-Delhi-One-can-see-that-the-slums-are-located-all-across-the-city_fig8_348097020

Such a labour-cell plan clearly demonstrates how between 1994 and 2019 the city has been emptied of slums. The associated labour-cells are no longer distributed all across the city but clustered around work sites near arterial roads and industrial or commercial areas. Therefore, labour has to now move beyond its immediate labour-cell to find work in the empty spaces. In the relocation sites the distance to work increases to between 20 to 40 kilometres, way beyond the boundary of the associated labour-cells. Labourers can no longer walk to work⁸ but have to depend upon motorised public transport. When diesel buses were replaced (and reduced) in 2001 to reduce air pollution, those among the working (but no longer walking) poor who could afford it began to transition to fossil-fuel driven two-wheelers.

In effect, 'green' policies of beautification, sports, tourism and pollution mitigation differentially impact upon different VRUs, but in such a manner that the entire system of livelihoods, shelter, services and transport moves towards greater and unsustainable use of energy and resources. From the perspective of the VRUs the labour-cells must be distributed uniformly across the city so that they can all safely walk to work⁹. This means that work, whether domestic or commercial or industrial, too has to be distributed evenly across the city, and so does shelter – all within the frame of the labour-cell. Such a *labour-use plan* becomes a decentralised one that treats workers as human beings and privileges their needs.

Riding on Wheels

For our second case, we take cyclists, again as VRUs who are on the road because they have to get to and from work. The city of Kolkata is unusual because the traffic police banned cycles in 2013 from plying on 174 roads on the grounds of causing congestion. This was reversed after a public campaign by cyclists successfully challenged the ban. A study by SwitchOn Foundation then revealed that the number of cycles increased by a dramatic 10.5 times between 2013 and 2020 – although they constituted only 7% of the modal share. In the same time period, two-wheelers went up by 6.4 times while constituting about 28% of the modal share, perhaps mainly because trams declined by 6.8 times¹⁰.

This change in travel pattern of VRUs may be explained by the distribution of slums across the city on the left of **Figure 3**. If a grid of labour-cells of diameter three kilometres is superimposed on this distribution of slums (as suggested by our first case), then not only is it clear that cells at the centre of the city have been emptied of labour who have been moved to cells at the periphery, especially towards the eastern lowlands. The pattern is quite similar to Delhi's. In the same study SwitchOn Foundation measured the speeds of different modes across approximately three kilometres on ten major roads. Two of these roads are mapped in bold red lines on the right in Figure 3: they represent the Howrah Bridge to Sealdah Station segment in the north and the Tollygunge Metro to Bansdrone Vidyalaya segment in the south. The former had the slowest average speed for cyclists at 10 kph (kilometres per hour) and the latter had the fastest at 20 kph.

⁷ Ghertner, Asher, *Rule by Aesthetics: World-Class City Making in Delhi*, Oxford University Press, 2015, <http://mitdisplacement.org/delhi-1>

⁸ These actually come much later than the resettlement colony because they have to wait for the oustees to invest in making the land habitable while drawing in basic service lines of electricity, water, drains and roads.

⁹ Roy, Dunu, *Organising for Safe Livelihoods: Feasible Options*, *Economic and Political Weekly*, Vol. 35, No.52/53, <https://www.epw.in/journal/2000/52-53/discussion/delhi-organising-safe-livelihoods-feasible-options.html>

¹⁰ Based on *Kolkata Needs to Think beyond cars - Part 2*, SwitchON Foundation, Kolkata, www.switchon.org.in

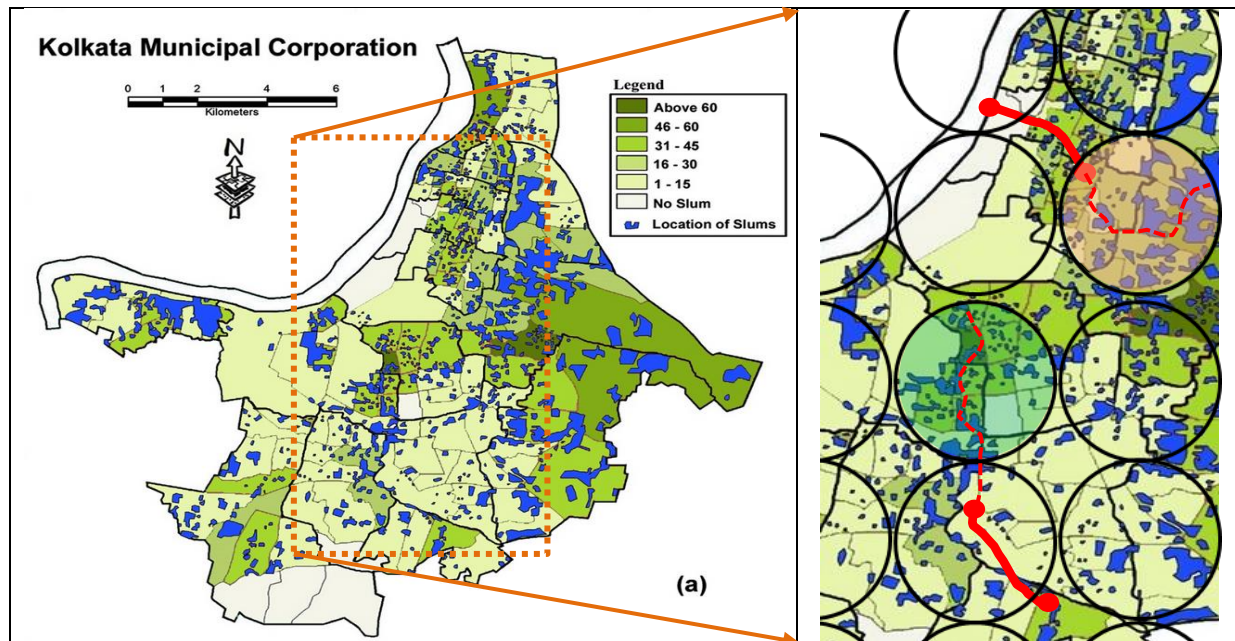


Figure 3: Slum distribution in Kolkata in 2021¹¹ and travel routes in North and South

If the slums further east (shaded orange) of Sealdah Station (which is a major transport node) are to be also linked to Howrah Bridge (the other major transport node) then this makes a perfect case for developing a separate cycle path (given as a red dashed line) along the enable route to enable cyclists to reach 20 kph and over. The same argument would apply if the slums to the immediate north (shaded green) are to be linked to the Tollygunge Metro station. In other words, a sustainable city for the VRU not only consists of an even spread of labour cells to enable walkability to work, but also cycle lanes to link one labour cell to another where the distance to work is greater than three kilometres.

Interestingly enough, the SwitchON study also revealed that the average speed of cycles on the ten roads matched that of the motorcycles and was greater than that of cars and buses. Only the auto-rickshaws were commuting faster than all other modes. This indicates that suitably dedicated cycle lanes that are segregated from other traffic and have appropriate signalling at crossings and intersections would not only enable cycles to move at a brisk pace but also increase the modal share significantly, thereby replacing motorised vehicles and benefiting the VRU as well as the entire city.

Infrastructure of Services

The third example we shall take is of VRUs who constitute an essential service to the city but are rarely 'seen'. They are the workers who keep the sewerage system of a city functional. Sewers in cities are part of the road infrastructure; hence the sewer worker would also be a VRU. But he is rendered invisible by the filthy nature of his work, and the public's repugnance to the sight and scent of their own defecation. Since sewers need a gradient to permit gravity flow they tend to become deeper with distance. If they exceed two kilometres in length then intermediate pumping stations may have to be introduced to lift the sewage to just below the surface so that gravity flow can again be induced. Since sewers tend to

¹¹ Based on Paul, S., Bhattacharya, S., Mandal, B. et al. Dynamics and risk assessment of SARS-CoV-2 in urban areas: a geographical assessment on Kolkata Municipal Corporation, India, *Spat. Inf. Res.* 29, 365–378 (2021), <https://doi.org/10.1007/s41324-020-00354-6>

have joints, junctions, bends and turns, sewage has a tendency to choke up at these points. All these require a constant maintenance crew to keep the system functional.

Figure 4 indicates the distribution of slums in the city of Bengaluru (on the left). By superimposing a grid of three kilometre diameter labour-cells over the city it is possible to see that most of the slums are in the cells at the periphery of the city. It is from these slums that the labour is recruited for descending into sewers and septic tanks to clean them manually. As systematically documented by the Safai Karmachari Andolan¹², the work is appallingly dirty, hazardous and demeaning so it is the lowest caste of ‘untouchables’, or Dalits, who are given this work, mostly on a contract basis. Only 30% of households in Bengaluru are said to be linked to the sewer system; the remaining have to depend on septic tanks or open defecation. Thus labour for cleaning sewers and septic tanks is needed in every part of the city.

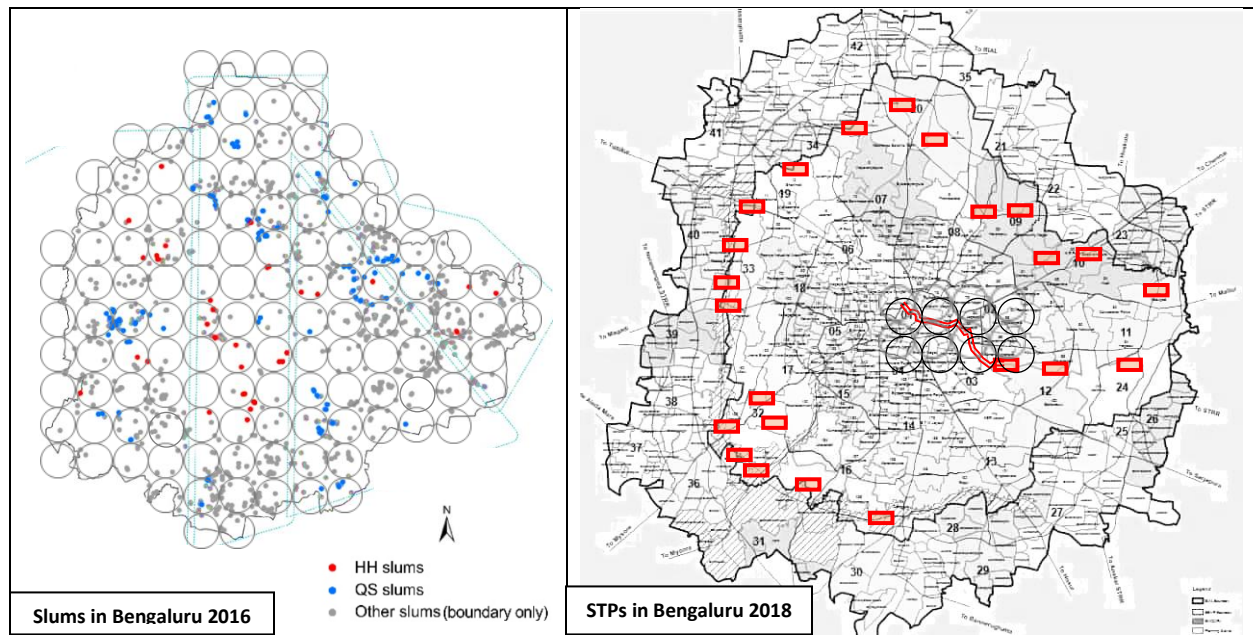


Figure 4: Slum distribution (2016)¹³ and Sewage Treatment Plants (2018)¹⁴ in Bengaluru

Figure 4 (on the right) gives the locations of the existing and proposed Sewage Treatment Plants (STPs). These are located even further away towards the periphery. Bengaluru is divided almost in half into two major valleys on either side of a low north-south ridge. These valleys also drain to the south. Hence, it is only sewers leading to STPs in the south that can benefit a bit from gravity flow. All the others require more energy for pumping. For instance, for a household in the centre of the city, the shortest sewer to the nearest STP (given as a red double line) would have to pass along the roads through four labour-cells, or 12 kilometres. This necessarily involves regular maintenance.

¹² The Safai Karmachari Andolan is a movement that aims to completely eradicate manual scavenging from India, <https://www.safaikarmachariandolan.org/>

¹³ Based on Ajami, Alireza, Kuffer, Monika, Persello, Claudio and Pfeffer, Karin, Identifying a Slums’ Degree of Deprivation from VHR Images Using Convolutional Neural Networks, <https://www.mdpi.com/2072-4292/11/11/1282>

¹⁴ Based on Bengaluru’s blueprint for 2031 is open for public comments, Citizen Matters, November 2017, <https://bengaluru.citizenmatters.in/revised-master-plan-2031-for-bengaluru-22286>; and Prasad, Seema, BWSSB projects March 2021 deadline for sewage network in 110 villages, 2018, <https://bengaluru.citizenmatters.in/110-villages-to-get-sewage-network-by-march-2021-bwssb-25723>

To protect sewer workers, technical experts immediately suggest cumbersome safety equipment or automation as solutions, not recognising that these pose a threat to the livelihoods of this most 'vulnerable' of VRUs. From the perspective of the sewer worker, a sustainable city should not only require less energy but should also make work dignified and safe. So an alternative would be to change from anaerobic decomposition of sewage to aerobic methods. Some experiments by the People's Science Institute, another institution co-founded by DM, demonstrate that when faecal matter is directly exposed to sunlight and air: it produces gases that are not toxic to workers; rates of decay and destruction of pathogens are significantly faster; and long sewers, pumps and STPs are not required¹⁵. Why cannot such a decentralised aerobic system be technically viable?

Energy and Engine

Finally, we take something of deep concern: the use of non-renewable (and unsustainable) energy that leads to global warming. The biggest energy consuming country in 2020 was China, using 1.6 times more than the United States of America and 4.5 times more than India¹⁶. However, when the per capita use of energy is computed for these three countries then the USA towers 2.6 times over China and 11.4 times over India. As **Figure 5** shows, if energy-consuming cells roughly 300 kilometres in diameter (as distinct from labour-cells) are evenly distributed across the two sub-continent, then the energy-guzzling urban centres of India are more evenly distributed over the nation than in the case of the United States.

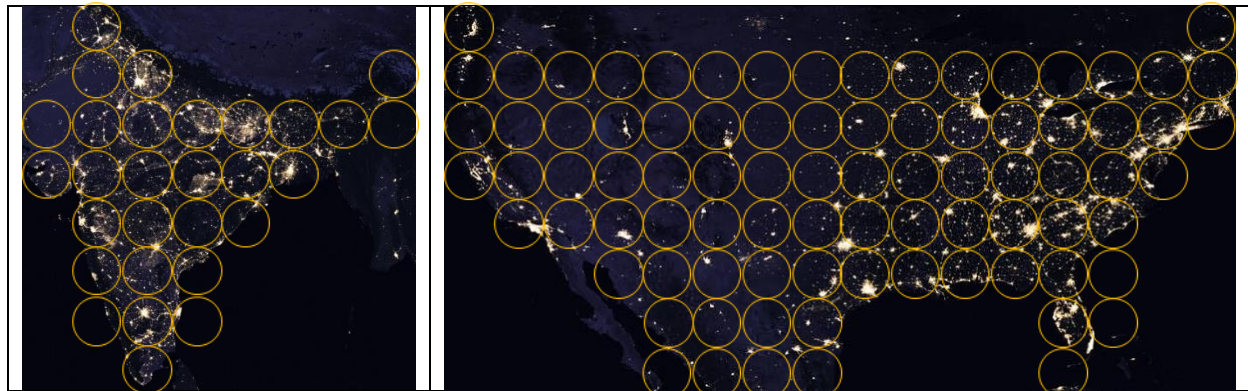


Figure 5: Urban concentrations in India and the United States of America at night¹⁷

The consequence of this energy consumption is visible in its impact on climate change. Thus, the annual carbon footprint of the average US citizen is 13.7 tons as compared to the average Chinese figure of 8.2

¹⁵ Based on (a) Bai, F. and Wang, Xiao-chang, Effect on Biodegradation of Organic Matter and Change of Biomass in Aerobic Composting of Human Feces from Temperature, 2011 International Conference on Environmental and Agriculture Engineering, IPCBEE vol.15(2011) IACSIT Press, Singapore, <https://www.semanticscholar.org/paper/Effect-on-Biodegradation-of-Organic-Matter-and-Change-Bai-Wang/740eb7dde70c3e81e01f90f1da088a961d25a244>; (b) Tare, Vinod and Yadavand, Kunwar D., Fate of Physico-Chemical Parameters During Decomposition of Human Feces, Global Journal of Environmental Research 3 (1): 18-21, 2009, [https://idosi.org/gjer/gjer3\(1\)09/3.pdf](https://idosi.org/gjer/gjer3(1)09/3.pdf); and (c) Excreta Results, power point presentation, unpublished, personal communication with People's Science Institute, Dehradun, <https://peoplescienceinstitute.org/>

¹⁶ Based on Energy Consumption by Country 2023, World Population Review, <https://worldpopulationreview.com/country-rankings/energy-consumption-by-country>

¹⁷ Based on New Night Lights Maps Open Up Possible Real-Time Applications, NASA, 2017, <https://www.nasa.gov/feature/goddard/2017/new-night-lights-maps-open-up-possible-real-time-applications>

tons and just 1.7 tons for India¹⁸. But if one were to look even closer into these figures, the average for India is low because 80% of the population earns less than \$4 per day, while the minimum wage is defined as \$2 per day. In contrast the federally mandated base pay in the USA is \$58 per working day of 8 hours. This does not mean that the average American worker works any harder than his/her counterpart in India. It is just that the American worker uses energy-consuming machines to a much greater extent than the Indian one and is hence considered to be more 'productive'.

In our own research in 2011 in Delhi we found that families earning above \$650 per month in HIG (high income group) government houses had a carbon footprint of 5.5 tons, compared to 1.2 tons for MIG (middle income group) houses earning between \$215 and \$650 per month, and 0.7 tons for LIG (low income group) houses earning less than \$215 per month¹⁹. The huge numbers who fall below the \$4 per day (\$120 per month) income level are obviously contributing much less to carbon emissions and to India's low per capita emissions. From the perspective of the VRUs, those who provide the most energy for the city's 'engine' are also those who consume the least energy to preserve the city.

Ideas on Sustainability

Many more examples could be shared from our participatory research over three decades with auto-rickshaw drivers, vendors, waste-pickers, pavement dwellers, brick kiln workers, auto parts supply chain workers and many other variants of the VRU. Our contribution at the Hazards Centre has been to help this VRU community to understand their problem, to design a study of the problem, and arrive at the solution best suited to their circumstances. Hence, the research remains the property of the community and much of it is never able to reach the world of published papers in peer-reviewed journals because of publishers' increasingly restrictive understanding of how knowledge can be produced and disseminated.

However, the lessons that we can glean from these four examples may be taken to represent the perspective of the VRU on how a city should be sustainable – while accepting that different VRUs may occupy different social and economic spaces. What could be this common perspective? It appears to be structured around four ideas.

The first is that the settlements in which the VRUs live should be preserved as the centre of labour-cells that are within easy walking distance; and these labour-cells should be uniformly distributed through the city. The second is that work too should be accessible within the cell, but if it is at a distance of more than two cells then cycle paths are essential to conserve energy. The third idea is that all services – at household (water, electricity and sanitation) and community (education, health and transport) levels – can be decentralised to provide basic needs. And the fourth is that labour-cells not only provide renewable energy to the city but they also minimise the environmental impact of energy consumption.

Taken together, the concept of labour-cells yields principles of *labour-use* planning for sustainable cities, which constitutes a completely different perspective from 'land-use' planning. Not enough theoretical work has been done on the subject, especially in the institutions of higher learning which are engaged in the debate on urban governance. The 'vulnerability' of the VRU is a product of social relations because the labour that the VRU creates has to be harnessed to the engine of the city to produce the profits that investors demand. Land-use planning imbues value to land and profit and not to labour. Hence, these

¹⁸ Based on Carbon Footprint by Country 2023, World Population Review, <https://worldpopulationreview.com/country-rankings/carbon-footprint-by-country>

¹⁹ Roy, Dunu, A Subaltern View of Climate Change, Economic & Political Weekly, Vol. i. No. 31, August 2015

pro-investor models need to be empirically and theoretically questioned on behalf of VRUs. Curiously though, if VRUs possess a 'hard' core of resilience and survival beneath their theorised 'soft' exterior, would they not also be able to speak on their own behalf? I think that is a question that DM would have embraced as a provocation to his many admirers and acolytes.

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