SLUMS IN INDIA: ADDRESSING THE HOUSING CRISIS

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ABSTRACT:
The objective of this paper was to understand the basic concept of slums and comprehend the multi-dimensional factors that affect the redevelopment of these settlements in India. This short exercise with a help of a detailed case study reveals a generic loophole of these numerous redevelopment programs; that is it ignores to fulfill the environmental aspects and comfort conditions of the occupants. This, in the longer run causes higher maintenance costs which the urban poor cannot afford. Therefore to begin with solving this issue, the paper tries to analyse the various spatial organization strategies for urban layouts that can contribute towards environmental comfort for developments with high population density (like slums).The analysis was done for hot and humid climate of Kolkata in India which has the second highest percentage of its urban population living in informal settlements.

Keywords: Slum upgrading; Hot–humid climate; Urban morphology; Massing; High density

1. INTRODUCTION:

In 2014, for the first time in history, more than half of the world's population (54%) lived in cities (UN/DESA, 2014).This rapid urbanization that can be seen in the developing countries come with its own side effects. As the infrastructure of the cities cannot cope with such rapid influx of people, it creates a housing crisis. Thus, a large section of the urban population who are unable to afford the high housing prices are forced to live in conditions which fit the classic definition of slums. With more than one-fourth of the urban population of the world living in slums. It can be said that slums are emerging as a dominant and distinct type of settlement in the developing world (UN-Habitat, 2014). It is therefore a pressing concern.

A lot of interventions have been carried out in the past few decades to overcome the problem of slums but only a handful of them have been successful after occupancy. A basic limitation that can be identified in these interventions is that they approach the problem only from a single dimension whereas slum improvement is multifaceted problem requiring a holistic approach.

This research paper intends to critically review case studies to understand as to what is required to carry out a successful slum intervention. The paper would further analyse various site layout strategies to achieve comfortable living conditions with respect to the local climate.

2. SLUMS IN INDIA:

The United Nations Human Settlements Program (UN-Habitat) defines a **slum** as "*a place of residence lacking one or more of the following: durable housing, sufficient living area, access to improved water, access to sanitation, and secure tenure*".

Although India's economy is the fastest growing with the GDP rate of 9.2% per annum and ranks third amongst nation regarding PPP, it is still a poor country. A large proportion of India's population is still poor and live in slums due to a number of factors including:

1. family poverty and a little education

2. regional inequities and urbanization
3. migration
4. a low-wage economy and unemployment
5. housing shortage

Slums typically begin at the outskirts of a city, located on least desirable public lands or lands with no clear land title. Over time, the city may expand past the original slums, enclosing the slums inside the urban perimeter. This makes the original slums valuable property, densely populated with many conveniences attractive to the urban poor. Slum is also a place where a lot of wealth is generated. Slum dwellers afford a lot of modern day equipments for their daily life and it is possible only because of their low cost living conditions in the slums (Bakshi, 2013).

2.1. Types of slum interventions:

1. **Slum removal:** Some city governments and state officials have simply sought to remove slums because they are illegally built on somebody else's land (wikipedia).But that does not solve the root social causes which create and maintain a slum.
2. **Slum relocation: :** Slum relocation strategies rely on removing the slums and relocating the slum poor to free semi-rural peripheries of cities, sometimes in free housing. This displaces the poor from opportunities to earn a livelihood generating economic insecurity. Therefore, causing the slum dwellers to sell off those properties and coming back to their original slum locations.
3. **Urban infrastructure development and urban housing:** Urban infrastructure such as reliable high speed mass transit system, motorways/interstates, and public housing projects have been cited (wikipedia) as responsible for the disappearance of major slums in the United States and Europe from the 1960s through 1970s. But in the developing countries, urban infrastructure doesn't seem to have effectively helped in mitigating the problem.
4. **Slum upgrading:** This approach was based on the idea (Turner, 1972) that seeks to upgrade the slum with basic infrastructure without having to worry about the derelict housing stock itself. But it can be argued as not a very holistics approach and had resulted in failures for example in the Kampungs of Indonesia. Inclusion of improvement of the housing has shown successful results in many cases. According to the 2006/2007 UN-HABITAT State of the World's Cities Report, the countries Thailand, mexico, Egypt and South Africa stand out in their efforts towards successful slum upgrading (UN-Habitat, 2006).

Therefore it can be deduced that the first two interventions of removal and relocation don't work but slum upgrading does have a better success rate and coupling it with long term urban infrastructure development can be the ideal solution to this problem.
Therefore to pinpoint the factors responsible for a successful slum upgrade two case studies will be critically reviewed.

3. CASE STUDIES:

3.1 Yerwada slum project: It was initiated by Mahila Milan in collaboration with SPARC, JNNURM and BSUP. It was an "in-situ upgrading scheme which has been done as a pilot project in Yerwada slum in Pune. This scheme means that the settlement keeps its current structure. And intends to allow districts to improve organically without uprooting the communities (figure 1).

3.1.1. The Architectural dimension: The footprint for each household is kept the same (an average of $24m^2$) and the upgrading takes place on exactly the current site. By upgrading, means to double the existing footprint by creating another floor so that the extended families can live comfortably together. This enables the slum dwellers to stay in their community but still get access to better housing and infrastructure (figure 1).

3.1.2. The urban dimension: In addition to reconstructing the homes, Mahila Milan worked hard in Yerwada to re-align the structures, minor widening of pathways and making space for municipal water, sewerage and electricity connections (figure 1).

Figure 1: shows the different housing typologies designed for the project, where each storey of the building develops organically when the need arises. The image on the right shows a part of the master plan, elaborating how the original footprints were maintained to carve out more spaces for pathways.
Source: (fairs, 2009)

Figure 2: shows a part of the overall masterplan of the Yerwada area and supporting photographs of the dingy access lanes.
Source: (after Fyhr, 2012)

3.1.3. Lessons learnt from the project:

1. Public participation: Active participation of the local body (in this case, the women's group Mahila Milan) act as a key player in almost every aspect of the project. Such local representative body can offer with local knowledge and connections as well as act as a collection point for advocacy on behalf of slum residents.
2. Mapping the existing layout to have an informed master plan taking into account the uses of important elements like existing streets and semi-open spaces (if any).
3. Retaining as much as possible of the existing neighborhood by only removing substandard shelter and housing and replacing them with sturdier construction.

4. Redevelopment occurs vertically instead of expanding horizontally to provide more common open spaces and to accommodate larger densities.
5. Using slums residents who are already skilled in this industry as the major construction labour for the project. This help reduce overall project cost.
6. Encouraging the slum residents to invest a small portion towards the construction of the project. Like the Yerwada residents along with the help of a number of beneficiaries had contributed about 10% of the construction costs while the rest 90% was sanctioned by the government. This helps boost the pride and ownership of the residents and they are more dedicated towards making such slum upgrade projects a success.

3.1.4 Drawback of the Project:

1. The residents were involved in every step of the design process which resulted the project team to stick with the existing footprint of the slum.
2. Sticking to the existing footprint meant there was no or little urban design improvements done like widening of streets, creating open spaces etc required for a good standard of community living (fig 2).
3. The buildings have no setbacks therefore has only one side open. This would result in poor ventilation which would thereby cause overheating and poor indoor air quality.
4. Simple passive strategies on urban scale and buiding scale could have helped the economically challenged residents of Yerwada with more energy savings and better living conditions.

Therefore to overcome these drawbacks it is very essential to understand the urban strategies of massing and layout specific to the local climate to be able to mitigate the poor living conditions that are still prevalent in these examples of slum upgrades.

4. CLIMATE ANALYSIS OF THE STUDY AREA:

Kolkata has the second highest slum population in India and has been chosen as the study area for the research paper. The city is located at 22.5ºN and 88.3ºE, 4 meters above sea level, with annual average temperature is 26.5ºC with monthly mean temperatures range from 18.9 °C to 30.4 °C (figure 3). Kolkata sits within the lower Ganges Delta of eastern India surrounded by the east Kolkata wetlands which influences its climate resulting in such high humidity of 73% which can reach to a maximum of 83%.the average wind speed is 2.1 m/s. Thus, it is classified as Tropical wet-and-dry climate "Aw" by Köppen-Geiger classification.

Again while designing for this type of hot and humid climate, with low diurnal temperature change it will be critical to provide good ventilation and shading strategies.

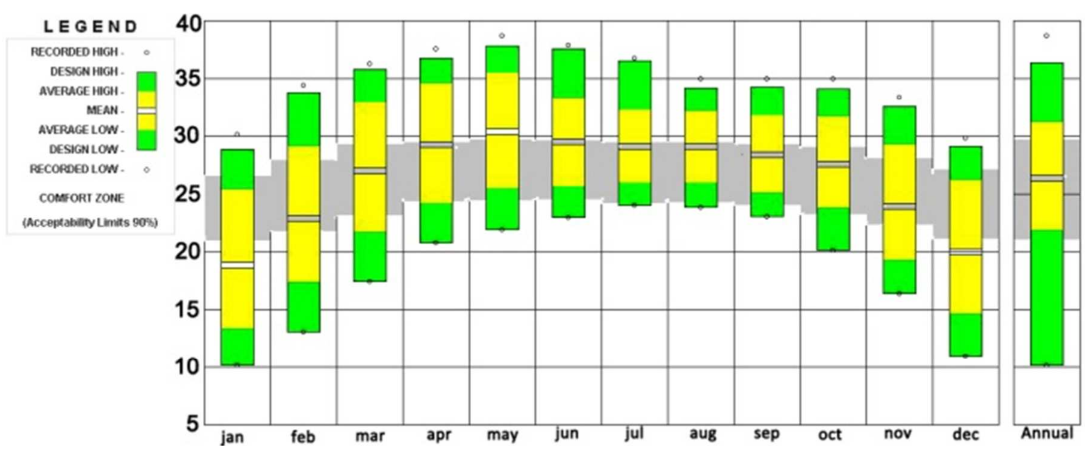

Figure 3: monthly temperature of Kolkata (source: after climate consultant 6.0).

5. ANALYSIS OF URBAN DESIGN STRATEGIES FOR SLUM UPGRADES IN KOLKATA.

Design strategies for building groups in a dense residential area (like slums), not only require to accommodate their density on the plot ratio and site coverage, but also calls for a passive design approach to control and manipulate the amount of sun, wind and light to achieve minimal energy loads. The form and placement of a group of buildings with respect to streets help achieve variable open spaces between buildings and create distinct microclimates surrounding the buildings.

5.1. Morphological factors: Therefore to begin with, certain criteria as follows are fixed:

5.1.1. Urban population density: the average population density in Kolkata slums are 0.44 persons/m^2 (herz, rahbaran, & zhou, 2008). So, if a **plot area of 1 hectare is considered** for the study, it would thereby accommodate 4400 people in that area. Again, learning from various precedents (favela redevelopments in Brazil and Yerwada slum, India) an average unit size of 40m^2 is fixed. Again according to the Kolkata municipality guidelines a maximum plot ratio of 3 and building coverage of upto 60% is allowed. Therefore, in order to accommodate atleast 90% of the existing population the constants assumed for further analysis is as follows:

1. **Plot ratio = 3**
2. **building coverage = 50%**

5.1.2. Orientation: Since the sun is mostly overhead in Kolkata (figure 4) coupled with strong incident solar radiation. Overhead protection is very important. However, the optimum building orientation is to have the long facades of the building facing north-south with shorter side aligned east-west to avoid that intense solar gains from the west. For this study, the building block will be facing 10^o E from south, in order to catch the prevailing winds from the Southeast for better urban ventilation throughout the site.

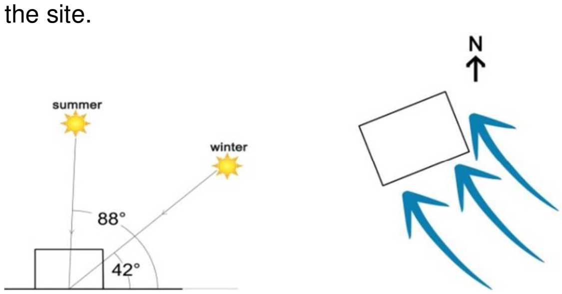

Figure 4: Shows the solar altitudes and plan orientation facing SE to take advantage of the SE prevailing winds.

5.1.3. Building geometry: Two types of building geometries are considered:

Type A (square), L1:L2 = 1

Type B (rectangle), L1:L2 = 2

It has been previously studied that there is no significant difference Type A and Type B, both in inducing wind speed or affecting the level comfort perception, but the greater number of buildings with less building coverage within the site, the greater the change of wind speed will increase (paramita & fukuda, 2013). Therefore, out of the two, Type A is considered for analysis. (figure 5

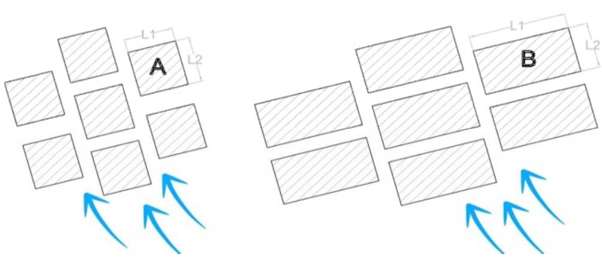

Figure 5: shows a cluster of type A and Type B unit blocks.

5.1.4. Canyon geometry: The canyon geometry plays and important role on manipulating the amount of sun, wind and light entering the site and building geometry. Therefore, four different height/width ratio (figure 6) are considered as shown in table 1:

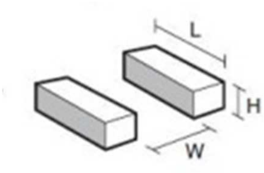

Figure 6: Height and width considered for the canyon geometry.

Table 1: Shows the 4 different types of canyon geometry that will be analysed.

Type	No. of floors (floor height=3m)	Width between buildings	Height/width ratio (H/W)	Constants
1	3 (9 m)	5 m	1.8	B.C=50% P.R= 3 $L_1/L_2 = 1$
2	6 (18 m)	5 m	3.6	
3	3 (9 m)	10 m	.9	
4	Varies(2-6), (6-18 m)	5 m	varies	

5.1.5. Spatial organization of building blocks: There are a no. of ways by which a group of buildings can be spatially organized. In this paper, four typical styles will be studied, which are commonly seen in indian cities as shown in figure 7:

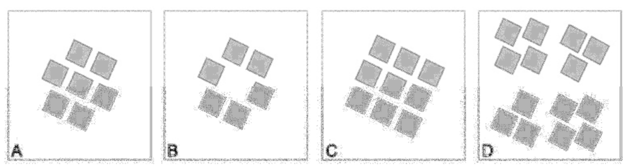

Figure 7: The four types of spatial organization of blocks to be analysed.

Type A is a compact form found in hot climates to avoid solar access. Type B is a courtyard form where an open space is surrounded by building blocks. Type C is another compact form with a rectangular grid layout, very common in planned developments. And finally type D, which is an interspersed form, which can be planned or unplanned.

5.2. Effects of sun and wind on different layout strategies

The previously defined 4 different types of canyon geometry (height/width ratio) are now applied to the 4 types of spatial layouts of building blocks therefore, resulting in 16 different cases. The cases are represented as A1, A2, B3, C4, and so on, where "A/B/C/D" represents the spatial organization (figure 7) and "1/2/3/4" represents the height to width ratio (table 1). Furthermore, solar and wind analysis were carried out to understand the environmental performance of these various cases.

5.2.2 Effect of Sun: Since Kolkata experiences a dry and mild winter with temperatures within the comfort band it was only logical to simulate the effect of sun on the different spatial configurations for the summer season. As presented in figure 8, it can be inferred that cases B2 and D2 with H/W=3.6 have lower amount of sunlight hours. This means with appropriate ventilation, thermal comfort can be achieved at pedestrian level. But A2 and C2 (which also have low solar access) might not be favourable because of its compact nature. Since it is situated in hot and humid climate, such compactness might inhibit evaporation due to shading and low wind velocity and thereby causing discomfort. Again all the type D cases, on an average show lower solar access on ground level which might prove to be comfortable with adequate urban ventilation. Type 4 cases also show a balanced solar access on street level.

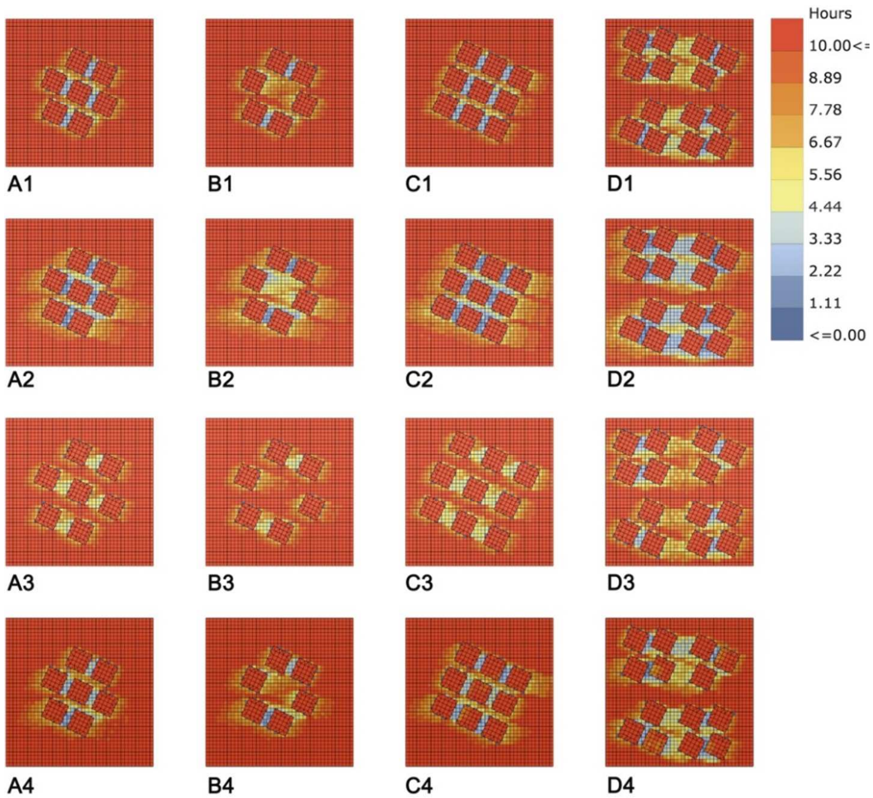

Figure 8: Average sun hours analysis of all the cases for summer. (source: rhino,ladybug)

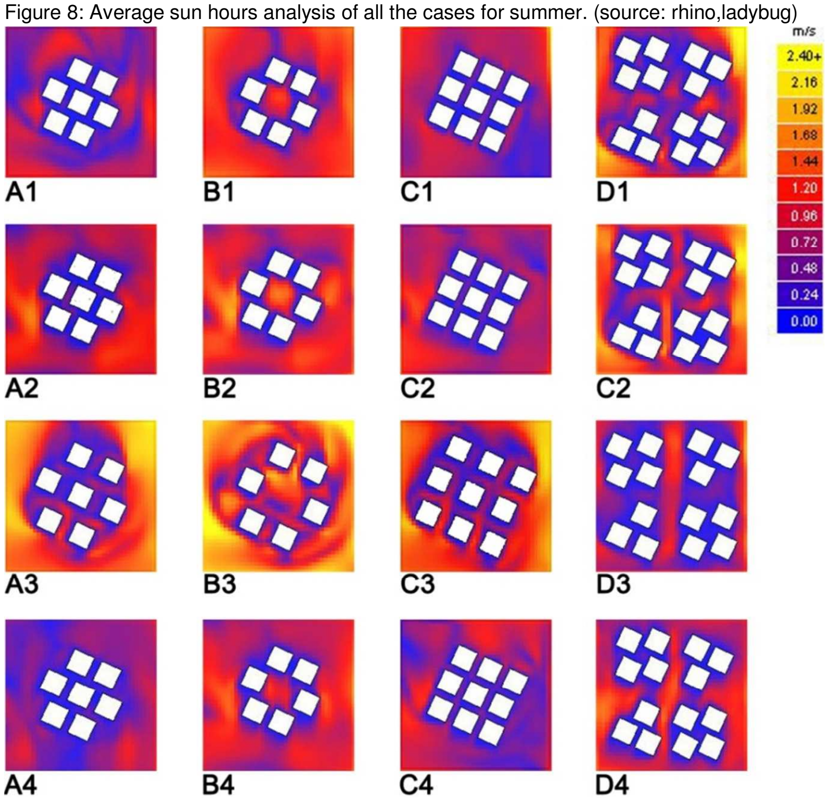

Figure 9: wind analysis for all the cases. (Source: ecotect, winair).

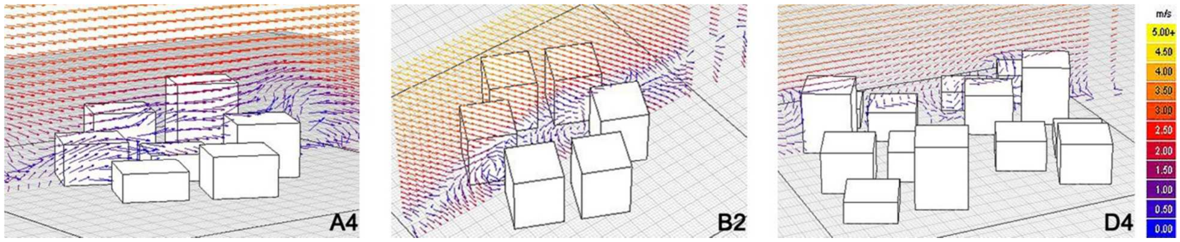

Figure 10: Shows the wind flow vectors in cases which were able to facilitate urban ventilation. Wind flow speed ranging from .5 to 1.5 m/s near ground level. (Source: ecotect, winair)

5.2.2 Effect of Wind: As presented in figure 9, it can be inferred that cases A3, B3 and D3 all have increased ventilation rates because of the low height/width ratio. But this aspect ratio of type 3 units might not be feasible in slum developments as it might fail to accomodate the original population density in and efficient manner. Another interesting fact to be noted is, even after having a constant street width of 5 metres like type 1 and 2. Type 4 layout (Clusters with varying heights) had much better ventilation rates than its other counterparts. Again, as anticipated, the compact typology (type C) fails to facilitate urban ventilation.

Therefore it can be deduced that urban spatial layouts like courtyard and interspersed block plans with varying building heights (figure 10) help facilitate urban ventilation and therefore works well in hot and humid climate.

5.3. Limitations of the analysis:

Since the Mean radiant temperature of the urban forms and PET (Physiological Equivalent Temperature) was not calculated, the solar and wind analysis for the different urban morphologies are only indicative.

5.4. Conclusions: The analysis can be summarized as follows:

1. Since, the sun is almost overhead in this location, roof protections by creating pergolas or green roofs if recommended to avoid absorption of excess sola radiation.
2. For the same reason, a lot of shading with the help of overhangs is required. Protection from the low angled solar radiation from the east and west is also required.
3. Spatial layouts like the courtyard and the interspersed form where quite successful in providing a balanced solar access to the streetscape and well as created better urban ventilation throughout the site layout which is critical for comfort in hot and humid climate.
4. The open areas in courtyard forms as well as in interspersed form can have canopy like vegetation to reduce the solar impact without majorly affecting the wind flow.
5. The compact form typology does not work well in hot and humid climates.
6. The typology with the lowest height to width ratio (h/w = 0.9) is a good option because it facilitate adequate window throughout the layout but might not be able to cope with high population density and therefore would require careful consideration.
7. It was very interesting to find that buildings with varying heights (type 4) worked better than building with same heights for hot and humid climates. This is because it provided much better urban ventilation than spatial layouts with same building height.
8. Interspersed urban layout with varying building heights turned out to be the best case scenario. This urban form can be manipulated more to achieve optimum results for ventilation and population density.

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