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# Density in Relation to Patterns of Built-forms
## (Case Study: Addis Ababa, Ethiopia)

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**ABSTRACT:** Density[1] is a critical typology in determining sustainable urban built-form[2] patterns. Built-form refers to the assemblage and arrangement of the building masses in a city reflecting the spatial layout of spaces. The relationship between density and urban character is also based on at certain densities (thresholds). In a wider sense, sustainable cities are a matter of density. Recent debates about the creation of more sustainable urban form, compact cities have led to a renewed focus on issues of density. The argument is that high density high-rise with low ground coverage or compact city form can offer a high quality of life while minimizing crime, possibility to provide adequate amenities, green and open spaces, accessibility and space consumption. However, the relationships of density and patterns built-form are not reasonably well developed and integrated into the urban design-planning processes in developing countries cities like Addis Ababa. On the hand, not many studies have been undertaken with regard to density in relation to patterns of built-forms.
Therefore, this study aims to explore density in relation to patterns of built-form in the process of planning & design of urban spaces[3]. The analysis is based on the primary sources as well as secondary documents collected from the concerned agencies and related references. The findings illustrate that high density high-rise with low ground coverage patterns of built-forms can offer better possibilities for installing good spatial quality[4] of urban spaces. It concludes with an overview of emerging thinking/implications where further efforts are required in the future

**Keywords:** *Density, Ground coverage, Floor area ratio, Built-Forms, High-Density high-rise and low-rise, Spatial-Quality, Urban-spaces, built-environment, Addis-Ababa.*

## INTRODUCTION

The concept of 'density' in urbanism is frequently used to describe the relationship between a given area and the number of certain entities in that area (Van K. & Leduc, 2008,18). These entities might be people, built-forms, amenities, or floor space. However, the simple fact that 'density' is used in, for instance, design requirements, plan descriptions and communication between parties, does not mean that it is used correctly or to its full potential. There are very few efforts being applied by urban design & planning institutions or professionals and politicians to examine, evaluate and control densities like built-up /BAR, FAR/ and population density[5] along with different patterns of built-forms, and their impacts on 'spatial qualities' , especially in the developing country cities like 'Addis Ababa, Ethiopia.
It is evident that the city has two main facets, a large collection of buildings 'built-forms' linked by space, and a complex system of human activity linked by interaction. One of the pressing challenges in urban planning &design processes is controlling these linkages and interactions of the physical structures, spaces and human activities in a given area of built environment through proper application of "density". "Wisely used, density can be a valuable weapon in the planners' 'armoury', but indiscriminate use has revealed some limitations (Steven, 1960)." Indiscriminate application of density contributes to formation of high density low-rise with high ground coverage built-form pattern, which would negatively influence spatial quality elements including the provision of amenities, green and open spaces, outdoor spaces, cross ventilation, daylight access, circulation and accessibility, safety and security in the built-environment. Majority of built-environments in developing country cities including Addis Ababa are composed of single storey row and semi-detached houses known with overcrowdness and extreme high built-up area ratio/BAR/,

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which is being reflected by poor spatial quality. Similarly, high density high-rise with high ground coverage pattern of built-form7 would also negatively influence the provision of spatial quality elements as the result of indiscriminate use of 'density'.

Today high densities and the compact city are often seen as prerequisites for sustainable urbanisation and economic growth (Van K. & Leduc, 2008,18). However, density is a rich but unresolved concept in urban theory. Very few efforts are being applied by urban planning institutions or professionals and politicians to examine, evaluate and control building densities and their impacts on the spatial qualities to maintain sustainability in cities. But greatest obstacle is probably the lack of an adequate theory in relation to the issues of spatial quality and density paradox (Rådberg, 1996, 385). Therefore, it is strongly believed that urban planning is in a crisis particularly due to the absence of clear-cut theories of spatial quality and density of built environments, have on the other hand exerted impacts on the formation of sustainable built-forms. Designers, Planners and politicians over the world are aware of the urgent need for action plans to increase the spatial quality and sustainability in the large cities. It is also quite evident that the application of density has been misunderstood and not yet clearly addressed. It requires clear distinction in between the density used to describe built environment (Descriptive, has legal constraint and only to illustrate built environment as built-form comes first) and urban density used as a norm in the process of planning the city (prescriptive, normative and has legal status to design built environment as built-form comes latter) (Fig.1).

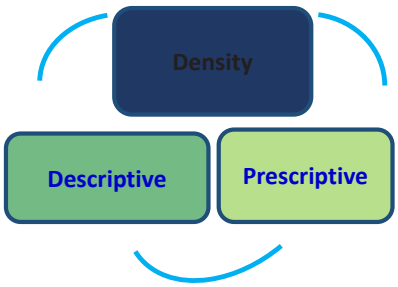


Fig. 1: Density in terms of Prescriptive and Descriptive

The issue of spatial quality, density and patterns of built-form is no less confused. The leading theorists of urban planning and design during the twentieth century (like, Le Corbusier; R. Unwin; L. Mumford; Jacobs, 1992, Lynch[1] 1994 and Alexander 1993 argue in favour of different ideal solutions. They argue for different urban models: some advocate high density high-rise buildings and large open spaces, others argue for traditional grid-iron plans, streets and compact blocks, still others argue for small-scale garden suburbs. There is evidently no consensus on the question of spatial quality, level of density and urban built-forms. Therefore, at certain densities (thresholds), the number of people within a given area is sufficient to generate the interactions needed to make certain urban functions or activities viable. Clearly, the greater the number and variety of urban activities, the richer the life of a community; thus, urbanity is based on 'density' (Lozano, 1990, 316).

The literatures reviewed reveal that there is a great confusion in the fields of spatial quality and sustainability in urban planning in the process of determining patterns of built-forms. Much of this confusion stems from the fact that the theories are formulated on a very general and abstract level. Author needs empirical facts, observations. Above all, a theoretical framework is needed for these empirical observations. The author also needs a systematic descriptive classification of the urban structure on the micro level in order to be able to process the accumulated information on existing housing settlement of built-environments. Accordingly, this study stresses on the issues of 'density' and 'patterns of built-forms' as well as their impacts on spatial quality in the housing settlements conceptually to come up with clear understandings.

Built-form includes the assemblage of buildings and the massing of low and high buildings, which influence the internal comfort conditions The built form1 in urban area changes with the population growth of an urban area with the change in massing, height etc. due to the changing intensity of land use. Massing influences the pattern of wind movement culminating in temperature changes in the surrounding area. It is also important to note that buildings are designed and constructed firstly for achieving the functional purpose (for which they are built) and secondly for achieving the conditions for comfort within them. The depth of buildings, height, orientation, design, site layout, landscape, and construction materials and techniques should be carefully considered in order to achieve the desired objective of providing lighting, outdoor spaces, green and open spaces, ventilation and adequate comfort conditions in the interiors and exteriors of buildings to result 'good spatial quality' of urban spaces. Consideration of climatic factors in design particularly for cities located hot and semi humid climates like Addis Ababa, Ethiopia i.e. needs for solar access, ventilation etc. imply selection of appropriate orientation for the building layouts that results 'sustainable patterns of built-forms'. 'Siting and orientation have important spatial quality implications since they can be used to gain advantage from microclimatic factors.

On the other hand, Franck & Pivo discusses patterns of built-form in relation to places. She says that there are three attributes of place types namely form, use and meaning (Franck & Pivo, 1994, 346). While form

attributes include all the material, spatial, structural and geometric properties, use attributes comprise all aspects of use which are sometimes referred to as function involving the performance of specific tasks that are housed by a particular type. Meaning attributes comprise the practical and symbolic messages that are conveyed by aspects of form and use or that are more loosely associated with that density and built-form (Franck & Pivo, 1994, 346-347).

Similarly, Moudon argues that in order to characterize patterns of built forms, inventory on built forms should aim at observing

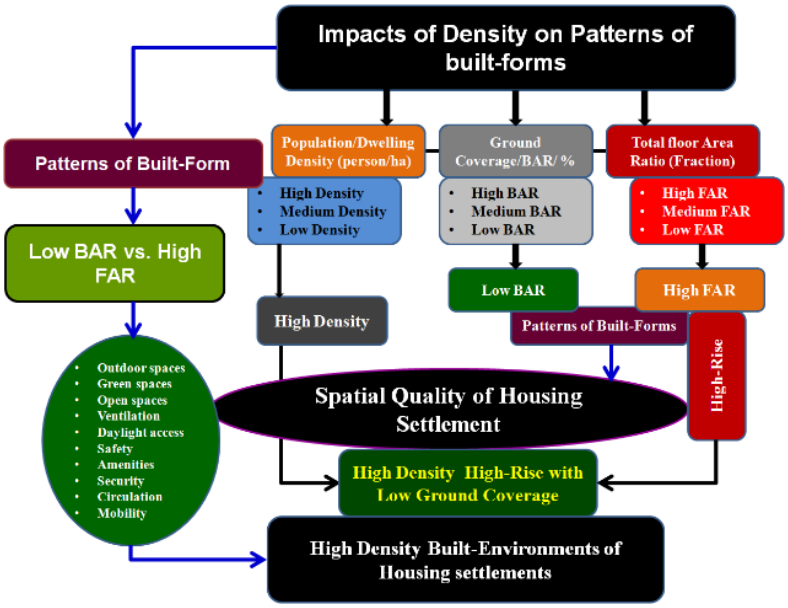


Fig. 2: Conceptual diagram showing the Density in relation to patterns of built-forms & their impact on spatial quality

and documenting dwelling types in terms of their shapes, the major building elements and where necessary their decorative elements (Moudon, 1994, 294). Formal characteristics also include whether houses are detached, semidetached, row, or high-rise buildings. The number of storeys, roof type, building materials, house sizes, and building uses are essential elements that characterize built forms. King denotes that the act of placing houses into either the same or different classes requires the selection of only those features that are seen as significant for making a distinction between them (King, 1994, 130).

However, the criteria used to classify and elaborate the degree of differentiation between them are obviously related to the purposes for which the categories are created. King, for example, provides taxonomy of built forms in England based on official government statistics as detached houses and bungalows, semidetached houses, terraced houses, flat and maisonettes and other accommodations (King, 1994,131). In this study, patterns of built forms are being considered not only as exemplars in the classification of dwelling-forms but also as analytic variables of the housing settlement. Pertinent questions that warrant investigation are: What are the dominant built forms prevailing in the housing settlements? How significant are built forms in defining built-environment? What socio-economic features have influenced the development of these built forms? What are the determinants of patterns of built forms in the residential neighborhoods? What are the implications of different patterns of built-forms on spatial quality of urban spaces?

Accordingly, pattern of built form is one of the determinants as illustrated in the conceptual diagram (Fig. 2), which would strongly influence spatial quality. It is also worth mentioning that by keeping population density fixed, one can design built environment with different patterns of built forms which might influence spatial quality of housing settlement like high density high rise with low ground coverage, high density low-rise with high ground coverage and medium density medium-rise with medium ground coverage patterns of built-forms (Fig. 3).

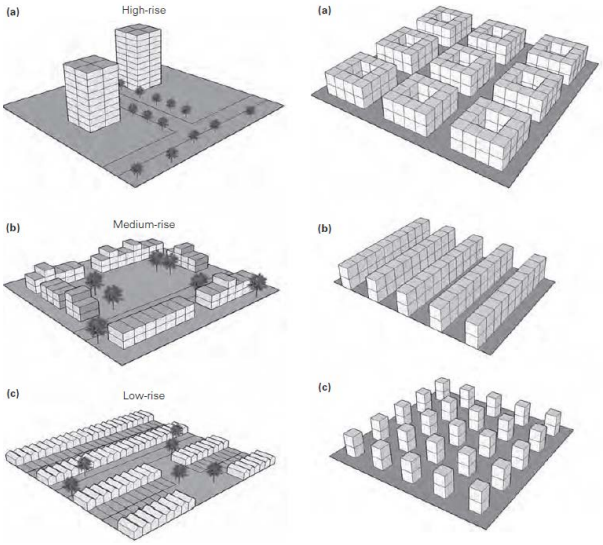


Fig. 3: Different patterns of built-forms with same dwelling density (Source: Cheng, 2010, 10)

However the level of spatial quality might be different for each built-form. For instance, high density high-rise with low ground converge would offer higher quality urban spaces by creating better possibilities for public amenities, green and open spaces, parking, visibility, ventilation, safety and security (many eyes on the street) and likes as illustrated above, whereas low rise with high ground coverage has occupied larger spaces by building structure leads to limited possibilities to offer important elements of spatial quality in the neighborhood for the residents at large. This is clear manifestations of how far different 'patterns of built-forms' with fixed population/ dwelling density are affecting spatial quality of the housing settlement. These are kinds of basic problems of understandings among designers, planners and architects who are supposed to design urban spaces and built-environment. Therefore, that is why pattern of built form is one of the determinants of spatial quality of urban spaces in the city. This has also unveiled that 'density' determines the categories of 'patterns of built-forms' on the other like high BAR vs. low FAR, low BAR vs. high FAR, high BAR vs. high FAR and low BAR vs. low FAR; where BAR is built-up area ratio or ground coverage and FAR is floor area ratio.

It is also important to note that there has been varying perceptions among scholars and authors to the concept 'density'. These perceptions stem from the varying fields of discipline from which density draws its meaning. Density has been studied extensively from many perspectives including – physical, psychological, social and environmental (Gómez Arenas, 2002). In the field of urban design & planning, a misunderstanding arises because of the several kinds of density used such as population /dwelling density, residential density, built-up density[b]/BAR, FAR/, net density, gross density etc. (Alexander, 1993). Another ambiguity arises from the use of the concept without clearly defining it. Mitrany & Churchman argue that in many studies, density has been referred to as "high" or "low", without a definition of what is a high or a low one. As a result these studies have not built up a sufficient body of knowledge or a comprehensive theory about the meaning of residential density (Mitrany & Churchman, 1998). This argument has been also raised by Correa who contends that:

…the old indicators of so many square metres of open space per 1000 persons are too simplistic and crude; we have got to desegregate these numbers, both qualitatively and quantitatively in order to anticipate their real usefulness. Estimating accurately the production costs of these various spaces involves examining the relation between building heights and overall densities, since the latter is the key determinant of 'built-forms' at the city scale. (Correa, 1985, 39)

High and low densities are relative measures. They differ between countries and communities, and they are dependent on which perspective density is being discussed. Comparison in density especially perceived density is complicated, since impressions and personal judgments are different. Ernest Alexander argues that there is no simple, clear definition of perceived density. Rather, it is a complex concept involving the interaction of perception with the concrete realities (Alexander, 1993, 183). But the central question in this study is how density can be used as an exemplar and as an analytic tool of urban built-form and spatial quality and a measure of optimal land utilization.

Density has often been referred to as a degree or intensity of development or of occupancy. Conventionally, urban densities have been defined from two perspectives; of population and built-up density/BAR, FAR/. While population density has been referred to as the number of persons per unit ground area of development, built-up density (sometimes referred to as objective density) has been examined as land use ratios. In housing and urban design, density has been measured in terms of floor area ratios/FAR/ and ground coverage or built-up area ratio/BAR/ resulted patterns of built-form, and dwelling units per specified area (Alexander, 1993). Accommodation density in housing has been expressed as the number of inhabitants per unit of habitable space. Floor area ratio/FAR/ is a unit of density referring to the floor space in relation to plot or land area. Most of the space standards used for commercial or shopping areas, residential, institutional areas etc. are based on this unit and type of density. On the other hand, the correlation between density and patterns of built-form is quite strong that they would directly and indirectly influence spatial quality of housing settlements. Hence, density and patterns of built-form are sorts of determinants, which affect the quality of urban spaces as they can't exist in isolation to each other.

It is also very interesting to note that pattern of built-form is a product of the application of well or badly determined density as density and built-form are different faces of the same coin, which directly or indirectly exert impacts on spatial quality of housing settlements in the built-environment, however, built-form is an outcome of the application of density. Thus, they are parts of the major determinants, which affect the quality of urban spaces. It is obvious that density could be presented in terms of population density, ground coverage at different levels and total floor area ratio/FAR/ that might affect the patterns of built-form as changes in density characteristics changes the patterns of built-form. It is strongly believed that density and built-forms could also be demonstrated in various scenarios including high density low-rise, high density high-rise, medium density medium-rise, and medium density low-rise, low density low-rise with different levels of ground coverage or built-up area ratios/BAR/ in the built-environment as illustrated on Fig. 4 .

The illustration unveils that high density high-rise with low ground coverage built-form patterns would offer better spatial quality elements in the neighborhood than the other patterns of built-forms like high density high-rise and low-rise with high ground coverage, which have limitations to offer spaces for walking, standing, sitting and protection, because major spaces are occupied by building structures, failed to create possibilities to provide adequate spatial quality elements as stated above.

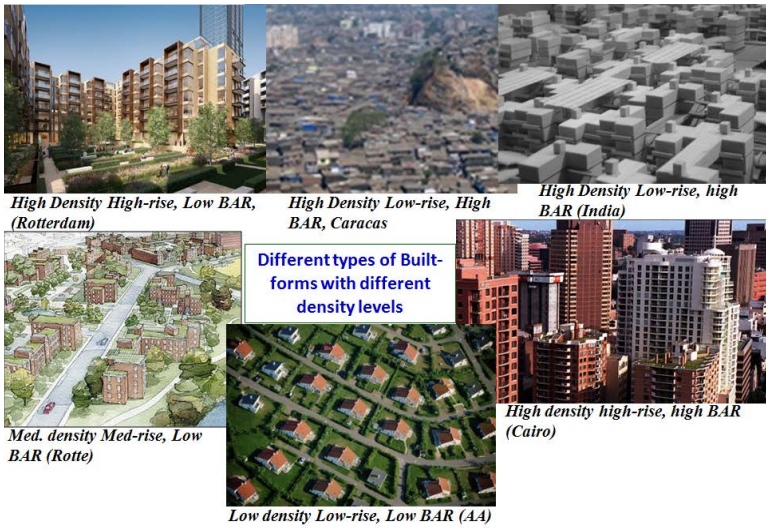


Fig. 4: Density and various patterns of Built-forms from various cities, in the World

On the other hand, the concept of ground coverage was frequently used throughout the 20th century to express the relationship between built and non-built land. Rowe & Koetter (1978) used the figure-ground analysis to visually represent coverage as the distribution of (built) mass and (un-built) open space. They used this representation to decode two opposite doctrines at the core of modern and traditional planning: the first accumulation of solids in an endless floating void, the other dominated by mass and cut through by voids showing different patterns of traditional & modernist patterns of urban space (Fig. 5).

It is also important to analyze the built-up density, regarding the efficiency of land uses; the cost effectiveness of infrastructure has a direct relationship to the intensity of building density. According to Acioly and Davidson, "The size of plot, the amount of plot which can be built up and the height of the building give the dimensions of the most visible aspect of density: the amount of space which is built" (Acioly & Davidson, 1996, 7).

Computations of ground coverage ratio and total floor area ratio of the neighborhoods have been done using the following equation: BAR=BA/PA, FAR=FA/PA and BH=FAR/BAR, where BA is ground coverage area, FA is Total Floor area, PA is plot/site area and BH is Building Height, BAR is ground coverage ratio/Built up area ratio/ and FAR represents total floor area ratio (Fig. 6). Spatial quality as dependent variable is based on the composition of density, patterns of built-forms and basic predictory variables stated above including green and open spaces, outdoor spaces, accessibility, circulation and mobility, ventilation, safety and security and the likes. Therefore the review underlines that appropriate application of density is a tool to design sustainable built-form and spatial quality.

Fig. 5: Figure-Ground diagram of Parma & Saint-Die (Source: Rowe & Koetter, 1978, 62-3)

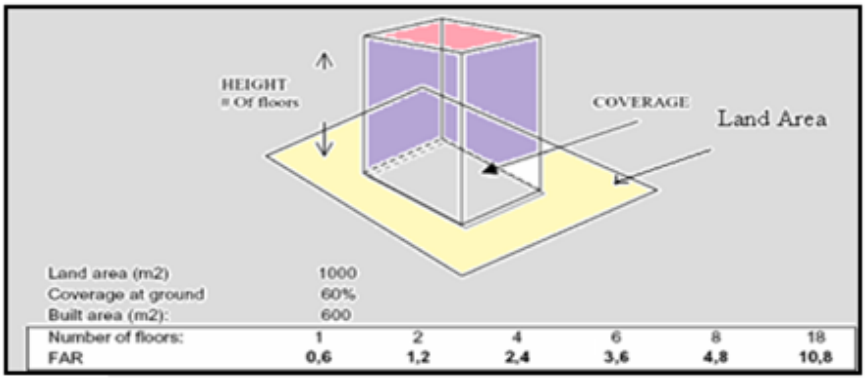


Fig. 6: Conceptual model of FAR values and percentage of ground coverage. (Source: Gren, 2006, 18).

## MATERIALS AND METHODS

This study has been employed the case study approach. The case study approach advocates the use of multiple sources of data and data collection methods, (Yin, 1981 in Kombe, 1995, 55). The approach to data collection and analysis in this study included both quantitative and qualitative sources and approaches, 'triangulation'.

The tools that were used under quantitative method include: household survey (questionnaire) at neighbourhood level, measurements along with support of (Google Earth, GIS/Line/ Nortek Maps), (up to 20% of plots and housing units were surveyed from each neighbourhood). Under qualititive method the main tools were visual survey, open ended interviews with local and city level authorities, key informants, and communities; and focus group discussion. The primary data have been augmented by secondary data obtained from documents from planning institutions and concerned agencies during analysis. Furthermore, related books, journals and websites have been consulted.

The study embraced the plots, blocks and neighborhoods from city center to suburb were studied. The area of each case study settlement ranges between 10.2-10.7 hectares with population density of 154 to 647inh/ha. Out of these areas of each case study about 20% of the built environments have been be surveyed. And hence, the study has been engaged four neighborhoods or settlements including; 2 from Inner city, 1 from intermediate zone and 1 from (sub-zone) of the city. The selection of case study areas was done on the basis of the criteria matrix as per the identified indicators and variables under study.

## RESULTS AND DISCUSSION

In this section, emerging issues from the four case studies analysis of the Settlements are compared. The results from these case studies analysis are interpreted and discussed so as to establish whether patterns of the issues discussed can be related to each other for all the cases or can be perceived different scenarios in the built-environments. For the purposes of consistency, the major themes used to analyze the four case study settlements with different densities and patterns of built-forms are maintained. These include the present built-form patterns, density and determinants of patterns of built-forms, the relationship between population density and built-forms, Impact of built up density and built-forms on spatial quality. Across the themes, density, issues of patterns of built-forms and impacts on spatial quality are discussed. The cross case analysis also explores from the selected case study locations in light of theories discussed in review and the four case analysis to fulfill the aims and purpose of this study.

### Determinants of Built-Form Patterns and Impacts on Spatial Quality Building Height

With the exception of Lideta-Firdbet and Gerji-Sunshine, the majority of the houses in Wube-Bereha and Yeka-Ayat are single storey houses (Fig. 7). Yet, within Lideta-Firdbet where redevelopment into multi-storey houses is more pronounced, single storey houses are fewer than multi-storey houses. Out of 26 houses that were studied in Lideta-Firdbet, all 26 were multi-storey detached and semidetached condominium buildings (Fig.7 and Fig.11). The condominium building is rather unique with its 5-8 storeys providing office accommodation to business activities in addition residential uses in the ground floors those buildings laid at the street sides, the apartment owners and a number of other offices rented to private and public institutions.

In Gerji-Sunshine study neighborhood, out of a total of 26 houses, 26 houses were multi-storey, 15 four to five storeys and 11 six storeys (Fig. 7 and Fig. 16). However, Wube-Bereha and Yeka-Ayat are predominantly low-rise housing area (Fig.13 and Fig. 15 respectively). Out of 26 houses in Yeka-Ayat, only 4 were two to three storeys and the remaining houses are single storey (Fig. 7 and Fig. 15). In Wube-Bereha, only three were multi-

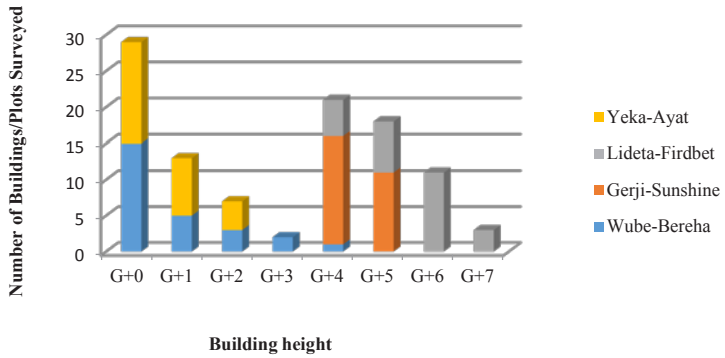


Fig. 7: Building height in four case study settlements.

storey houses as the remaining were single storeys. Variations in building heights for the four case study settlements have been summarized in (Fig. 7). Hence, Lideta-Firdbet and Gerji-Sunshine are high density high-rise built structures with different patterns of built-forms and had direct impact on spatial qualities. The built-form pattern in Lideta-Firdbet is low ground coverage and high floor area ratio/high FAR/, where as built-form pattern in Gerji-Sunshine is high ground coverage and high floor area ratio/high FAR/ as shown in (Fig. 11 and Fig. 12) below.

The Redevelopment of high-rise buildings in Lideta-Firdbet has to be linked with the building uses and new demands that arise in the settlement. Since Lideta-Firdbet is part of the city centre, new demands for commercial, office and residential spaces have prompted property developers to buy and redevelop single storey Addis Traditional houses into high rise blocks of condominium and apartments. The fact that former owners of the old houses in Lideta-Firdbet do not have the financial capacity to redevelop their houses, the market forces is replacing these owners through 'redevelopment' process.

The emerging high-rise buildings in Lideta-Firdbet are largely a result of the redevelopment process and initiatives by government who want to subsidize by responding to these new demands. However, the question that remains is how to balance market forces on land and housing development and ensure acceptable spatial and environmental qualities. Perhaps it is easy to argue given marginal role local authorities are playing to co-ordinate housing in Lideta-Firdbet and have got good result that good spatial quality has been installed in the settlement. The reverse is true for multi-story development in Gerji-Sunshine settlement due to high building coverage which leads to lose of spaces for public amenities, outdoor spaces, and green and open spaces, ventilation and access to daylight and other related quality elements.

This is however a thorny issue that ought to be resolved before extreme negative consequences is going to be experienced in Gerji-Sunshine housing settlement. On the other hand the analysis result indicates that High-rise building structures with low BAR like Lideta F. facilitates possibilities to protect the neighborhood by creating more pedestrian movements as 'many eyes on the street' to install natural surveillances to minimize incidence of crime and fear of crime as well. So, it could also be considered as determinants of built-form patterns and spatial quality.

## Plot Characteristics

A plot characteristic is one of the determinants, which influence the patterns of built-forms in the built environments in various aspects. Plot configuration, that is the size and the shape, influence the built-form of houses and its impacts on the spatial quality. From the four main variables, plot exposure is being discussed to characterize plot configuration from case study areas. These variables are plot size, plot ratio or plot dimension, plot exposure and plot boundary definition, however this article has been focused on the plot exposure and analysed its impacts on patterns of built-forms and spatial quality in particular.

Since, the underlying assumption in the analysis of exposure is that the more the number of exposures, the more likely that comfort living characteristics are ensured. Empirical observations from the four cases show that in both formal and informal settlements, many plots have no exposure or have limited exposure to only one side. In Wube-Bereha, for example, out of 26 plots, 11 plots have no exposures and 10 plots had only 1 exposure, 3 had two exposures and only 2 had three exposures as Wube Bereha was characterised by high density low-rise with high ground coverage patterns of built-form (Fig. 9). The basic reason for the absence of exposures in this neighborhood was due to occupation of plots by housing structures dominantly. In Gerji-Sunshine is another neighborhood characterised by high density high-rise with high ground coverage patterns of built-form (Fig. 9), out of a total 26 plots, 20 plots had two exposure, 6 plots had three exposures. Despite the compact layout of Gerji-sunshine, at least each plot has two exposures. The number of exposures in Gerji-Sunshine is due to the fact that at least each house is facing an access street a bit better than Wube-Bereha's

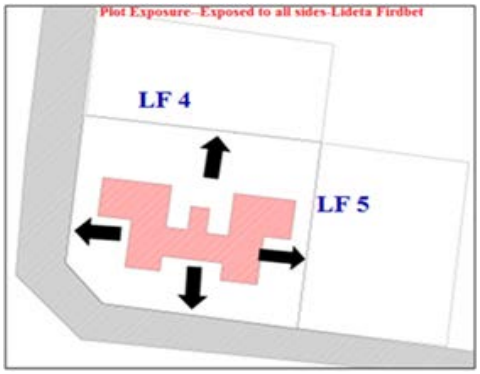


Fig. 8: Plot Exposures in All directions (Lideta-Firdbet) facilitates for better ventilation

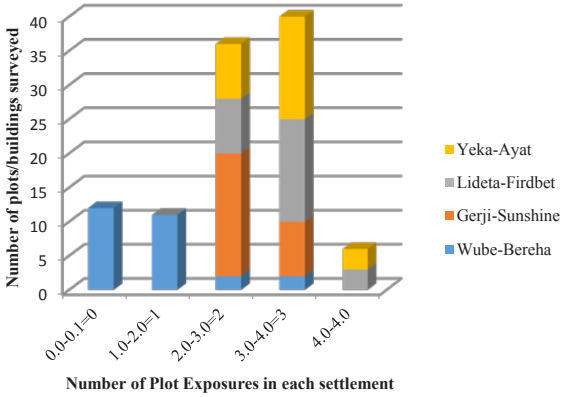


Fig. 9: Plot Exposure in four case study settlements.

existing situation. Two views can be discussed with regard to plot exposure in Wube-Bereha. First, since Wube-Bereha is too consolidated with compact layout of buildings, the limited exposures for more than half of the plots has made living in this settlement uncomfortable due to the lack of cross ventilation and to some extent inadequate light into the rooms. Second, often views have been blocked due to congested buildings. The overall situation is that amenity within Wube-Bereha settlement is rather poor when plot exposure is compared across cases (Fig. 9).

It is evident that the basic characteristics of housing forms in Addis Ababa and most African cities are well known with the limitation of plot or building exposure, which can offer access to ventilation and daylight within and around the building. Two of the case studies have limitations of exposure; especially Wube-Bereha is mainly with the problem of Exposure (Fig.11 and Fig. 12). On the other hand, Lideta-Firdbet (Fig. 8 and Fig. 9) and Yeka Ayat have sufficient exposures allowing ventilation and daylight access as good indicator of spatial quality as shown in the (Fig. 9). And hence, Plot or building exposure is one of the important characteristic that has direct impact on the patterns of built form and spatial quality of housing settlements.

This situation is mainly attributed to extensive development of houses and with buildings covering almost the entire plots that have barely left space for alleyways or streets and amenities. Since development in this settlement takes place informally, individual tendencies towards high plot coverage does not take into consideration the need for plot exposure. Apart from narrow footpaths that cannot provide adequate space for exposure, which is quite indispensible for cross ventilation and access to daylight adequately , the remaining unbuilt spaces within the settlement are too few to guarantee adequate cross ventilation to many of the blocked houses. The lack of streets in the inner parts of the settlements further limits the number of exposures. For example, more than half of all sampled houses in Wube-Bereha, that is 22 out of 26 houses, do not have vehicular accessibility. Coupled with congested houses, liveability qualities within Wube-Bereha are relatively poor when compared to other case study areas (Fig. 9). On the other this situation also lays base for increasing rate of the incidence of crime in the neighborhood as well as highly inaccessible to protect fire accidents if it happens.

## Density Characteristics in Relation Patterns of Built-forms

### Ground Coverage and Floor Area Ratio

When ground coverage was calculated across the cases, Wube-Bereha reveals a relatively higher coverage ranging from 85% to about 110% and floor area ratio from 0.84-1.15 (Fig. 11) clearly illustrating high overcrowdness in the built-environment.

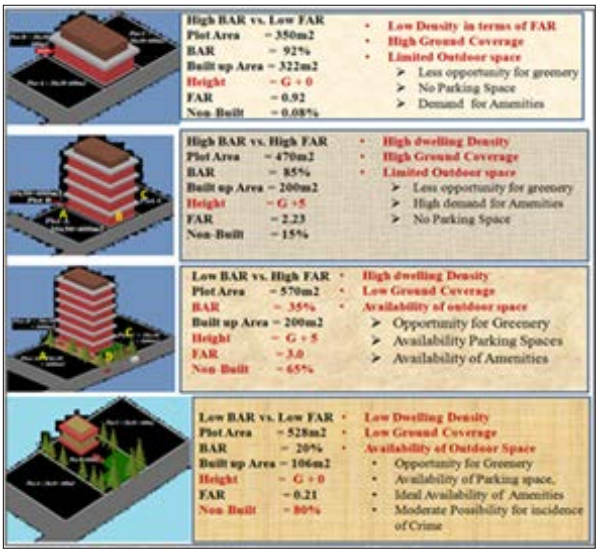


Fig. 10: Built-up Density with different patterns of built-forms at plot level and different ground coverage

Plot coverage for Yeka-Ayat is very low (21%-35%) (Fig. 11). Plot coverage in Gerji-Sunshine spreads across the range that is between 75% and 85% (Fig. 11). Low plot coverage is also notable in Lideta-Firdbet, which is within the standards of the city Administration (Fig. 11). While Yeka-Ayat was designed as a low-density area, whereas higher plot coverage in Wube-Bereha and Gerji-Sunshine were a result of market forces to maximise profit from rental accommodation by individual developers.

Both Floor area ratio and ground coverage of the plots are the basic characteristics of density, which have direct impact on the patterns of built forms and spatial quality of housing settlements. It is strongly believed that both high ground coverage with low floor area ratio and high ground coverage with high floor area ratio as built-forms would highly threaten possibilities for the provision of public amenities like recreational spaces, greeneries, open spaces, walking and sitting spaces as well as affect the ventilation and circulation of air within buildings severely. Whereas low ground coverage with high floor area ratio can render the possibilities for the provision of public amenities in the built-environment sufficiently. The figure illustrates the density characteristics in four case study settlements with different patterns of built-forms (Fig. 10), which influence the spatial quality positively or negatively in the built-environment.

The (Fig. 11 and Fig. 14) also illustrates that Lideta-Firdbet high density high rise with low ground coverage has better quality urban spaces than Gerji-sunshine high density high-rise with high ground coverage rations/BAR/ because most of the spaces were occupied by building structures (Fig. 11 and Fig.16). Similarly Wube-Bereha high density low-rise with high ground coverage (Fig. 11 and Fig.13) has poor quality urban spaces than low density low-rise with low ground coverage, however in Yeka-Ayat low density low-rise with extreme low ground coverage built-form there were very loose interaction and security problem (Fig. 11 and Fig. 15). When floor area ratios at plot level are considered, the result is generally low ratios ranging between 0.35 & 0.98, Wube-Bereha has ratios ranging from 0.5 to 1.15 (Fig. 12 and Fig.13). Both settlements are low-rise housing forms with different density characteristics that Wube-Bereha is high density low-rise characterised by overcrowdness and Yeka-Ayat is low density low-rise with sparse spatial layout (Fig. 12 and Fig. 15).

It is indicative that the general pattern in floor area ratios at plot level across the cases is generally low, medium and high with significant variations. This observation can be attributed to the single storey character of buildings particularly in the Wube-Bereha consolidated informal and formal settlements and relatively larger plot sizes in Yeka-Ayat, even though there are houses with two to three storeys in Yeka-Ayat, actually vary in number. Therefore, the analysis result unveils that high ground coverage and low floor area ratio have been influenced the patterns of built-forms and spatial quality of urban spaces by limiting possibilities for the provision of adequate public amenities, outdoor spaces, ventilation, green and open spaces, lees possibilities to combat incidence of crime, weak accessibility

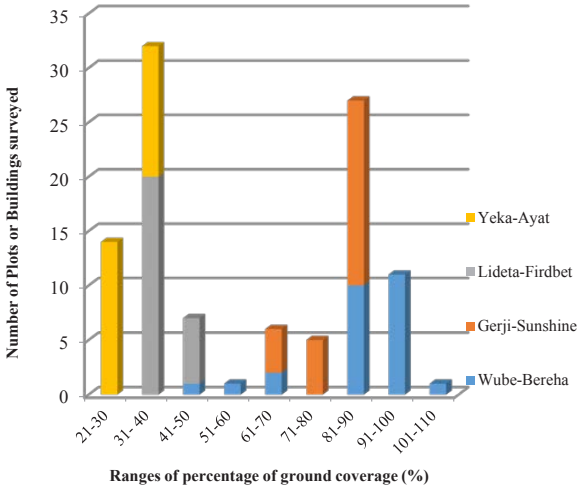


Fig. 11: Ground coverage in percentage in each settlement

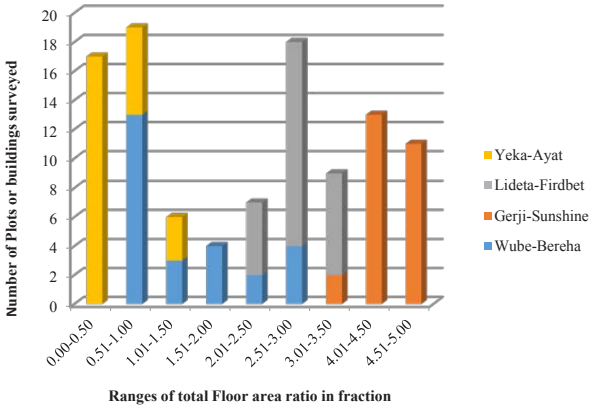


Fig. 12: Total Floor area Ration in four cas study Settlements in Fraction

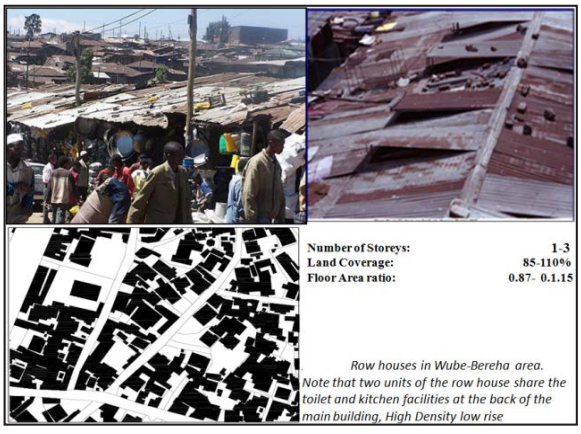


Fig. 13: High density low-rise with high BAR built-form, crowded and poor spatial quality, ventilation by penetrating roofs. No space for circulation

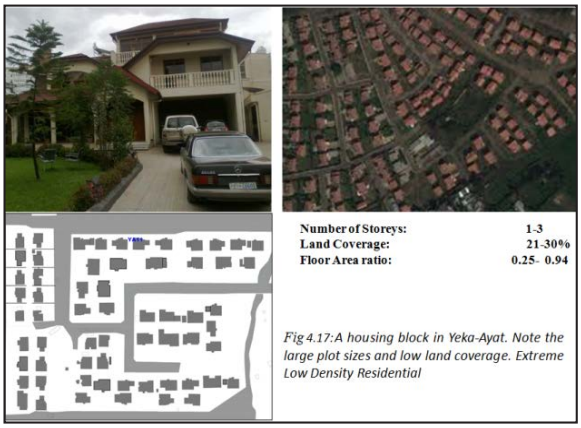


Fig. 14: High Density high-rise with low BAR built-form pattern, comprises better spatial quality elements, morphologically good space layout

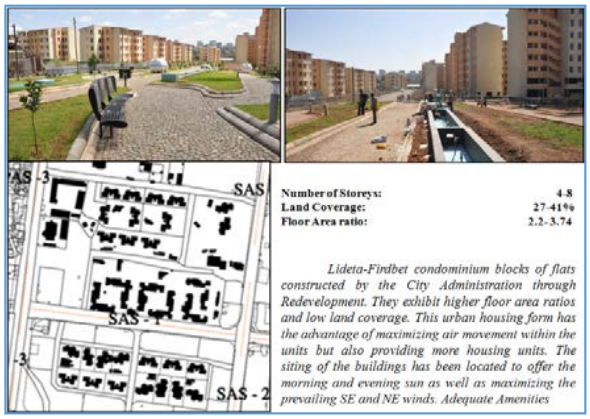


Fig. 15: Low Density Low-rise with extreme low BAR, very sparsely settled and residents suffering from incidence of crime, frequent robbery and burglary


Fig. 16: High de nsity high-rise with High BAR built-form pattern, no adequate spaces for amenities, parking etc. (Gerji-sunshine)

and circulation in the built environment. From the above cross case analysis, Lideta-Firdbet characterised by high density low-rise with relatively low ground coverage pattern of built-form has been offered better spatial quality urban spaces than the other three case study neighborhoods in building the above stated spatial quality elements.

## The Effects of Total Floor Area Ratio and Ground Coverage at Block & Neighborhood Level

Density is expressed as number of houses per hectare, occupancy characteristics, and plot coverage and plot floor area ratio provide an explicit magnitude of intensity of development of spatial quality and their impacts on the patterns of built-forms especially where there are houses with more than one storey as the case is for Gerji-Sunshine. The number of houses per hectare is therefore misleading if parameters of built forms are not defined and vividly identified. For example, there are buildings with more than 6 storeys in Gerji-Sunshine, but when a housing unit per hectare is used to calculate density, and a house with several floors is counted as one, this will be misleading.

It is the floor area ratio at a block and neighborhood level that provides the dimension of intensity of development of an urban built-form. To unveil density variation in the case study areas, two variables of land coverage and floor area ratios at block level are examined. Density at block level includes those facilities that are usually part of the daily requirements of urban settlement. Together with developments on plots, it includes half the width of the surrounding roads and services such as shops, incidental open spaces at cluster or block level. On the other hand, the patterns of built form at unit level have direct impacts on the neighbourhood and block level. For instance, High BAR vs. high FAR and high BAR vs. Low FAR illustrate the effect on spatial quality of urban spaces on the (Fig. 13, Fig.16 and Fig.17). It is strongly believed that the effect of built form at plot level is being reflected on the neighbourhood scale as illustrated on the sketches.

When blocks are employed as units of analysis, land coverage and floor area ratios in the four case study areas show variations within and between cases as illustrated in (Fig. 12). It is apparent that while Wube-Bereha reveals higher land coverage than the other three cases (Fig.12 and Fig.13) but also with variations within the case, it has low floor area ratios compared to Gerji-Sunshine and Lideta-Firdbet. Variation in coverage is related to the amount of open land that is either yet to be built or presently existing as informal squares or un-built courtyards, and streets within the settlement. Little variations in terms of land coverage and floor area ratio can be noted in Gerji-Sunshine and Yeka-Ayat. Wube-Bereha and Gerji-Sunshine show negligible variation in land coverage (Fig. 16 and Fig. 17). If horizontal extension and land coverage are taken into consideration, then Wube-Bereha portray rather horizontally densified urban settlement whose negative consequences have

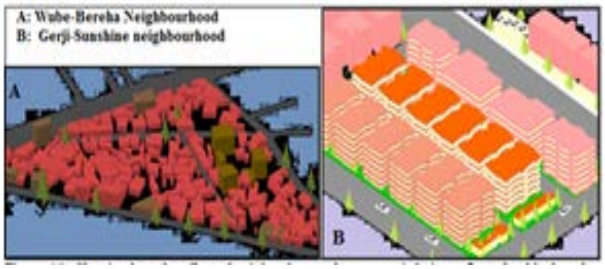


Fig. 17: The effect of built-form patterns at plot level is being reflected at neighborhood level, or high BAR at plot level can reflected at neighborhood scale

been more apparent than in Lideta-Firdbet and Yeka-Ayat. When vertical densification and increase in floor area ratio is considered, Lideta-Firdbet and Gerji-Sunshine prominently depict a vertically densified urban settlement that optimizes land but Gerji-Sunshine with high percentage of ground coverage depicting negative externalities associated with unregulated vertical densification that has been clearly affecting patterns of built-form and spatial quality of housing settlement.

## The Impact of Built-Up Densities on Patterns of Built -form and Spatial Quality

As it has been introduced so far, one of the objectives of this study was to analyze the built-up densities in terms of floor area ratio/FAR/ and percentage of ground coverage by buildings and its impacts on spatial quality. According to Rådberg, the parameters that can be used to measure urban physical density are: residential density, building height and percentage of built up area (Rådberg, 1996,390). The residential density which means FAR and the percentage of land coverage by building are being considered in this study to measure the built-up densities. FAR is the ratio between total floor area by number of floors and the land and plot area. The total floor area means the area of total floors occupied by all the buildings available in the block. The land area includes the total land area covered by block with half of its surrounding roads width. Percentage of ground coverage/BAR/ is the percentage of total land covered by buildings inside the block and the total land area of block with half of its surrounding roads.

The analysis of FAR and percentage of land covered by buildings/ BAR/ have been done according to the theory of Rådberg which is about the classification of patterns of built-forms. The FAR values which have been found from the measurements for the settlements show that the settlements containing very low FAR values where as the percentage of ground coverage by houses inside the blocks are very high. On the other hand the Lideta-Firdbet settlement containing FAR values ranging from approximately 2.1 to 3.7 which can be considered as a medium to high where the percentage of land coverage is ranging from 21% to 41% (Fig. 11 and Fig.14). The characteristics, in terms of built-up densities and spatial qualities of the most housing settlements in Addis Ababa city are similar. But there is a variation in terms of Built forms due to significant variation in plots. The built-up densities, spatial qualities and built forms of Lideta-Firdbet are different to the most of the settlements in Addis Ababa city where the condominium houses are made by concrete materials with adequate amenities, good ventilation, safety and security, adequate communal outdoor spaces, Moderate transport accessibility relatively with other three case study neighborhoods.

On the other hand, the houses in Wube-Bereha are made by earth materials and tin's roof, mud and wattle. It is based on this that the two different settlements were selected as a case. The first case of the informal settlements is Wube-Bereha where FAR value is ranging from 0.81 to 0.1.15 can be treated as a very low dense, in terms of FAR value (Fig. 12 and Fig. 18). Almost all of the houses in this settlement are 1 storey. The percentage of land coverage by houses are very high like 85-110%.The second case settlement is Gerji-Sunshine where FAR value is high, for instance maximum 3.5-4.78. In this case ground coverage by buildings is maximum 79%-85% which is also very high for any residential area next to Wube-Bereha (Fig. 17 and Fig. 18). All of the houses are multi-story in this settlement. In both cases the percentage of ground coverage by houses is very high which means that there is a shortage of space inside the block to provide amenities, private and communal outdoor spaces so as to maintain good spatial qualities and liveability. The FAR value is very low for Wube-Bereha as well; however, the FAR value is high for Gerji-Sunshine, so the FAR value can be increased to increase the efficiency of space, if the ground coverage would be kept optimum. And hence, In order to have good spatial quality, high FAR value should be supported by low BAR/ground coverage in the built-environment.

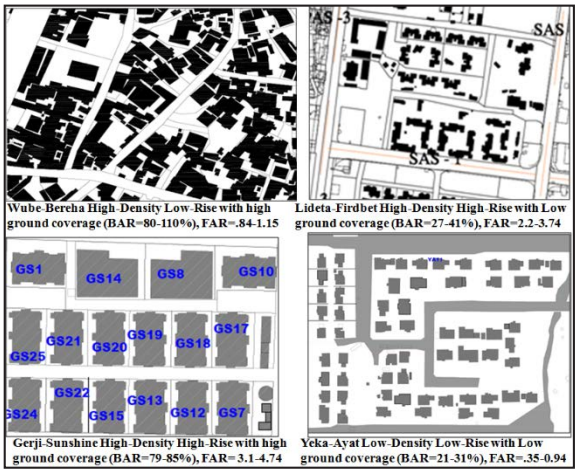


Fig. 18: Morphology of the four case study settlements with their respective BAR & FAR, showing each case study areas pattern of built-forms

On the other hand the FAR and percentage of ground coverage by buildings varies from block to block in the settlements. Those depend on the income level of the residents providing the justification for selecting the blocks according to the income levels of the residents. Lideta-Firdbet, the first redeveloped condominium residential area in Addis Ababa city that the FAR value of 2.1-3.74, where the percentage of ground coverage by buildings is approximately 21 to 45%, (Fig. 12, Fig.14 and Fig.18). The building height of this block is ranging from 5 to 8 storeys where the FAR value is high and percentage of ground coverage is low. In this settlement the open space is sufficiently provided for the children to play, adults to relax and recreate in the neighborhood. The second formal settlement is Yeka-Ayat high middle and high income inhabitants where the approximate FAR value is 0.35-0.98, which is extremely low and the land coverage is approximately 21-31% (Fig. 12, Fig.15 and Fig.18). Here the height of building is ranging from 1 to 3 storeys. The FAR value is low due to the extreme low land coverage by buildings. In this settlement there is a sufficient private outdoor space in individual compounds and it has no problem of ventilation and access to daylight, however, there is high problem of security as the residents witnessed during interview that there is high rate of incidence of crime and burglary. Even frequent killings have been committed in this neighborhood, which could be taken as indicator of poor spatial quality of urban spaces.

## The Relationship between Population Density and Built-Form Patterns

Built-up density in terms of floor area ratio/FAR/ has a direct relationship with the number of inhabitants residing per unit area or hectare of land (see figure 18 & 19). It is crystal clear that FAR value is a ratio between the plot or land size and the number of times that any one is permitted to cover built-up area as ground coverage is the footprint of that covered area. On the other hand, Floor area ratio can directly determine population density in the built-environment. The higher the number of total floor area ratio, the higher the population number like Lideta and Gerji-Sunshine where high density high rise housing settlements with different scenarios of built-form patterns respectively (Fig. 18 and Fig. 19).

As analyzed above, the built-form pattern of Lideta-Firdbet is low ground coverage with high floor area ratio /low BARS vs. high FAR/ where as Gerji-sunshine is high ground coverage with high floor area ratio /high BAR vs. high FAR/ respectively. But in Gerji-Sunshine it evident that due to high ground coverage there were high demand of amenities and services as opposite to Lideta-Firdbet. However, one can also perceive high population density in the built-form of extreme low floor area ratio as different scenarios like Wube-Bereha. This is clear manifestation of high rate of room occupancy in the housing settlement that means many people living in single room or above the recommend minimum 2 persons per room/22m2. This is different from population density of the housing settlement. Population Density is a number of people per unit area or hectare of land, whereas Overcrowdness is the number of people per room or per dwellings exceeding the recommended minimum capacity. The case of Wube-Bereha is typical example of Overcrowdness that the population density is 625 per hectare within extreme low floor area ratio in the built-environment (Fig. 11, Fig.12, Fig.13 and Fig. 18). As analyzed above, the percentage of ground coverage is very high but total floor area ratio is too low, which is clearly showing high dense in terms of ground coverage and low dense in terms of floor area ratio. High ground coverage means the close distance between housing structures that highly threatens the spatial quality by narrowing down the possibilities for outdoor spaces, greenery and open spaces, ventilation and daylight access, visibility, safety & security. The opposite is true for Lideta-Firdbet in terms of spatial quality (Fig. 11, Fig.13 and Fig. 18).

Therefore, built-up density in terms of floor area ratio has been addressed explicitly above as one of the density characteristics that would have determined population density in the built-environment and hence floor area ratio/FAR/ value is directly correlated with population density. According to the analysis result, population density might be high with low floor area ratio lead to Overcrowdness and high population density with high floor area ratio, means much number of people living in multi-storied building structures per hectare. As planner/designer we should have to distinguish Overcrowdness and density. Architects and planners should have to prescribe the density thresholds for built environment to maintain spatial quality to create possibilities for adequate outdoor spaces, green and open spaces, ventilation & daylight, safety and security & the likes as variables of spatial quality elements.

It is also worth mentioning that by keeping population density fixed, one can design urban-space with different patterns of built forms which might influence spatial quality of housing settlement like High rise with low ground coverage, low-rise with high ground coverage and medium-rise with medium ground coverage categories of dwelling forms in built-environment (Fig.19). Therefore, with different scenarios of built-forms, population density can be remaining the same; however the level of spatial quality is different for each built-form pattern. For instance, high density high-rise with low ground converge built-form can offer better quality urban spaces than high density low-rise and high-rise with high ground coverage built-form by creating better possibilities for public amenities, green and open spaces, visibility, ventilation, safety and security and likes as illustrated in (fig. 19). These figures clearly demonstrate the same dwelling density with different built-forms as stated above. Each built-form patterns has different characteristics and implications like high density high-rise with low ground coverage has offered possibilities to provide better spatial quality elements in the neighborhood, whereas in low rise with high ground coverage occupied larger spaces by building structure, which has been limited possibilities to offer important elements of spatial quality in the neighborhoods for the residents at large. This is clear manifestations of how far different patterns of built-form

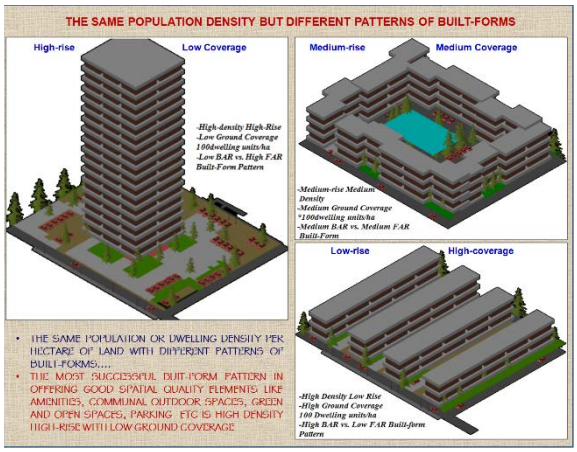


Fig. 19: Different patterns of Built-forms with the same population density, but high-density high-rise low BAR or 1st built-form would offer better amenities and spatial quality elements (compiled by author, 2014) from Analysis & review

with the same population/dwelling density are affecting spatial quality of the settlement. Therefore, that is why pattern of built form is one of the determinants, which influence the spatial quality of urban spaces in the city.

## CONCLUSION

This study strongly addressed that density is a critical typology and integral component of urban design and planning in determining sustainable 'patterns of built-forms' and 'spatial quality' of urban spaces. Therefore, the relationship between density and urban character is also based on the concept of viable thresholds (BAR: 30-50% on the basis of floor area ratio/ FAR<2.5/): at certain densities (thresholds) (>625 inh/ha), the number of people within a given area becomes sufficient to generate the interactions needed to make urban functions or activities viable. And hence, this study concludes in a wider sense, sustainable cities are a matter of 'density'. Density should be used as prescriptive and norms to design built-environment rather than describing built-environment.

The study concludes that Patterns of Built-Forms are the outcomes or product of density in the built-environment that would influence spatial quality of housing settlements. High ground coverage versus high and low floor area ratio is the basic density characteristics of developing countries cities including Addis Ababa that leads to less possibility of outdoor spaces, less access to mobility and circulation spaces, create possibilities for incidence of crime, less opportunity to green and public urban spaces in the city. So, this pattern of the built-form highly threatened the spatial quality of urban spaces. It is evident that the effect of built-form patterns at plot level can be reflected at neighborhood level, or high BAR at plot level is being reflected at neighborhood scale with negative externalities.

And hence the study also concludes, high density low rise with high ground coverage and high density high rise with high ground coverage are kinds of patterns of built-forms and density characteristics, which have been highly threatened spatial quality elements, because most of the space is occupied by building structures. The key finding of this study is that high density high rise with Low ground Coverage built-form pattern would facilitate higher possibility in building better spatial quality of urban spaces in the housing settlements, like space for circulation, green and open spaces, parking, ventilation and air circulation within building structures, security due to 'many eyes on the street', green and open spaces around the buildings, access day light, possibility to use private and communal outdoor spaces. FAR Values and BAR should be integrated, harmonized and go hand in hand while design urban spaces in the housing settlements in order to allow possibilities to provide the above stated spatial quality elements. So, (low BAR vs. High FAR) built form pattern is the most successful category in allowing possibilities to deign better urban spaces than (high BAR vs. low FAR), (high BAR vs. high FAR), and (low BAR vs. low FAR) built-form patterns as per the analysis results and findings. It is also important to note that the study also identified plot, building and density characteristics as the basic determinants of patterns of built-forms that would influence spatial quality of urban spaces in the settlement.

Therefore, on the basis of the analysis results and review, the Author can also conclude that little attention has been given to density and patterns of built-forms as basic prerequisites of sustainability of urban built-environment as well as integral part urban planning and design in the process of installing good quality urban spaces. And hence, this study underlined that "Start Planning and Design of Built Environment with proper density thresholds" that is being used as the best strategy in the process of planning and design of built-environment to build sustainable patterns of built-form to make sure quality urban spaces. Thus, urban spaces design in the housing settlements should be considered as critical policy element in Addis Ababa city administration and in the urban areas of the country as the whole. "Start Planning and Design of urban environment, which are supposed for housing settlement with prescription of 'density thresholds' (BAR: 30-50%, FAR>2.5, Popn Density >625) to offer quality urban spaces in the city".

Finally, recent debates about the creation of more sustainable urban built-form, compact cities have led to a renewed focus on issues of density, especially dwelling & built-up density. The argument is that compact cities form or high density urban built form can offer a better quality urban space in the built environment through un-indiscriminate application of 'density'.

## ACKNOWLEDGEMENT

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## ENDNOTES

1. 'Density' determines the categories of 'patterns of built-forms' including high BAR vs. low FAR, low BAR vs. high FAR, high BAR vs. high FAR and low BAR vs. low FAR; where BAR is built-up area ratio or ground coverage and FAR is floor area ratio, where High BAR=high built-up area ratio/ high percentage of ground coverage, low BAR is low built-up area ratio, high FAR is high floor area ratio and vice versa. Ground Coverage = Land coverage = Building Coverage = Built-up area ratio/BAR/.

2. Built form includes the assemblage of buildings and the massing of low and high buildings, which influence the internal external comfort conditions. The built form in urban area changes with the population growth of an urban area with the change in massing, height etc. due to the changing intensity of land use.

3. Urban spaces defined as formal spaces which are the products of cities and usually moulded by building facades and the city floor.

4. Spatial quality refers the effectiveness and capacity of urban spaces to function the communities properly in built environment with higher performance efficiency of space usage that fulfils the human needs together with spatial justices through effective planning processes like un-indiscriminate application of density in the built-environment. Therefore, spatial quality of urban space is the extent to which that space satisfies the expectations of a community. In relation to the spatial quality of urban space, density of built environment has direct or indirect influences on it.

5. 'Population density' has been referred to as the number of persons per unit ground area of development, built-up density (sometimes referred to as objective density) has been examined as land use ratios. In housing and urban design, density has been measured in terms of floor area ratios/FAR/ and ground coverage or built-up area ratio/BAR/ resulted patterns of built-form.

6. Built-up density refers to floor area ratio/FAR/ and built-up area ratio/BAR/) or ground coverage and is determined by the space between buildings, building width, building configuration and building height. Gross residential density refers to the number of dwelling units divided by the total site area, while net residential density as explained above refers to the number of dwelling units divided by the area of the site taken up by residential use only. it can be used to differentiate between urban forms in a more efficient way.

7. Pattern of built-form is a product of the application of well or badly determined density as density and built-form are different faces of the same coin, which directly or indirectly exert impacts on spatial quality of housing settlements

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