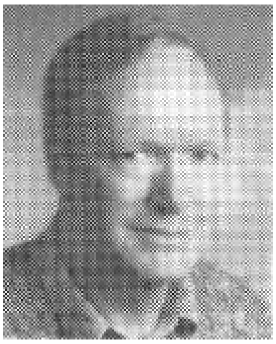
Density in Urban Development

Claudio Acioly Jr. and Forbes Davidson

The authors are with the Institute for Housing and Urban Development Studies (IHS), The Netherlands, and are involved with urban development issues through teaching and consultancies. They have worked at project level and have first hand experience both of the power of local traditions and of bureaucratic inertia when any changes are proposed to existing norms.

Claudio Acioly Jr. is an architect and urban planner with professional experience from Brazil, The Netherlands and Guinea-Bissau. He has written two books on self-help housing and neighbourhood upgrading. In 1992, he earned his Masters degree in Design, Planning and Management of Buildings and the Built Environment at the Faculty of Architecture, Delft University of Technology, The Netherlands.



Forbes Davidson is an urban planner specializing in the links between planning and urban management. He earned an honours degree in Geography at Glasgow University and did postgraduate work in Town Planning at Newcastle University. He has worked in the United Kingdom, Egypt, Indonesia, and India. His long involvement with the Ismailia Demonstration Project in Egypt led to the Urban Projects Manual, a practical guide to urban development. His recent work on urban upgrading in South Africa and resettlement in Bombay, India, underscores the importance of density issues. He is a member of the Royal Town Planning Institute, UK.

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Preface

When Swedish Development Aid was reorganized in 1995, a new Urban Development Division was established, acknowledging the importance of cities as centres of both dynamic growth and human hardship. It is responsible for setting policy, conducting programmes in infrastructure and housing, and advising the other sectors of Sida when they work in urban areas.

We are pleased to present four *Building Issues* as a Swedish contribution to the Second United Nations Conference on Human Settlements, Habitat II, Istanbul 1996. They address the themes of the conference: *adequate shelter for all and sustainable human settlement development in an urbanizing world*.

Claudio Acioly Jr. and Forbes Davidson have written one of these four *Building Issues*.

Göran Tannerfeldt

Head of the Division for
Urban Development and Environment
Sida

1 Introduction

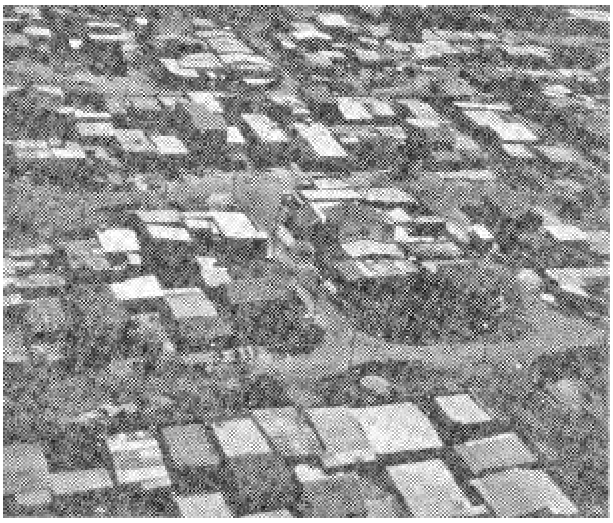
"What are the proper densities for city dwellings? The answer to this is something like the answer Lincoln gave to the question, 'How long should a man's legs be?' Long enough to reach the ground, Lincoln said. Just so, proper city dwelling densities are a matter of performance. They cannot be based on abstractions about the quantities of land that ideally should be allotted for so-and-so many people (living in some docile, imaginary society). Densities are too low, or too high, when they frustrate city diversity instead of abetting it. We ought to look at densities in much the same way as we look at calories and vitamins. Right amounts are right amounts because of how they perform. And what is right differs in specific instances."

Jane Jacobs, *The Death and Life of Great American Cities,*
Penguin Books, London, page 221.

Problem

The density of urban development is a controversial and sometimes confusing subject. Decisions made in this area can have significant impact on health, on urban environment, on the productivity of cities, and on human development as a whole. There is a wealth of experience and many relevant figures that, when compared to one another, can provide useful references for decision making in planning, design and management of human settlements. On one hand urban densities directly affect urban development processes both at the city and neighbourhood levels, but on the other hand they are also affected by land and housing policy shortcomings, inefficient urban management, planning and regulatory standards and urban design parameters.

A significant number of urban settlements in different countries are characterized by wide roads and excessive land reserved for public spaces. A quick analysis of their settlement layout will certainly reveal a waste of land



Low income incremental land development scheme, low rise, high density. Satellite city of Samambaia, Brasilia.

and costly infrastructure outcomes. Rather than being solely a consequence of inappropriate standards and regulations, it is more the result of design decisions which affect the urbanity and the overall population and building densities.

Because of all that, the sustainability of human settlements development will partly depend on how planners, urban designers, city managers and decision makers perceive and decide about the intrinsic benefits and disadvantages of densely occupied urban environments.

The objectives of the report are:

- to clarify the issues connected with density;
- to review experiences and cases where density assumes particular importance in urban development;
- to identify the most important variables linking density and performance;
- to provide reference points, tools and guidelines to help in making decisions concerning urban density, particularly for low income settlements.

The report is aimed at professionals involved in urban development who advise or make decisions regarding density, particularly those who design and choose alternatives concerning residential areas for low income groups. The report recognizes that perceptions of density vary widely between and within countries and cities. In other words, they are very much influenced by their cultural context. Comparison is complicated by the measuring instruments; population density, housing density and building density are all used and have inherent differences.

Method

A review of the authors' own professional experience helped to identify ways to deal with questions about urban densities in a variety of urban contexts. The analysis of more than 12 cases, some of which are summarized in the boxes, provided a basis for a comparative exercise. This was complemented by a literature survey. The importance of density in urban development is not reflected in the volume of work published in international journals. Some classic studies and a lot of unpublished reports were very useful, and some of them are named in the report. The authors chose to offer guidelines, references, a checklist and recommendations for decision making instead of providing ready solutions and ideal density figures.

Organization of the Report

Chapter 1 describes the problem and the aim of the report. Chapter 2 deals with the conceptualization of density, how it is understood and the main implications. Chapter 3 focuses on the planning and design processes in relation to density. The major elements that affect density are reviewed and a series of guidelines are suggested to improve performance of human settlements. Chapter 4 deals with the management and legal aspects of density, and highlights how regulations and enforcement have a potentially important role. The ability and willingness of the main urban actors from public and private sectors to enforce density related regulations is analysed.

The case studies of experiences with density are presented in boxes. These are used to reflect particular approaches or issues dealt with in the report. For example, one of the issues in design and planning is the optimization of infrastructure networks. The case of Curitiba is used to illustrate this.

2 General Considerations

Density is in the Mind of the Perceiver

Ask an Indian planner what he thinks about a 100 m^2 plot for low income groups and he will say that it is far too large and will be unaffordable. His colleague from East or Southern Africa, however will argue that this is far too small, and that it will never be accepted. The response may be, “We didn’t fight for independence to reduce our standards.” Even within one country different social groups will perceive density differently. What people see and feel depends on their own background, and to some extent on the layout, building form and use, and spatial use in an area. Figure 1 provides an overview of residential density figures of the largest cities by continent.[1]

What is common is that urban planners and designers, policy makers and decision makers are confronted with an increasing demand for efficiency of the urban environment. This means better use of land and natural resources, infrastructure, and human and financial resources. In this, the density of urban areas plays an important role.

A number of the key issues related to density are reviewed briefly below. Where the subjects can be influenced through design interventions, they are detailed in the section on planning and design implications.

Density as a Technical Issue

Density is one of the most important indicators and design parameters in the field of housing and human settlement planning. It is generally expressed as population per unit of land, or number of dwellings per unit of land. It serves as an instrument for urban planners, urban designers, architects and engineers to design and assess the performance and efficiency of subdivision plans. Inhabitants per hectare and dwellings per hectare are used to express specific qualities and development potentials of a site in relation to residential densities. It is common to find indicators expressed as net and gross densities. The former includes only the area allocated for residential use, and the latter refers to the whole settlement area including roads, public spaces and other uses (see glossary for definitions).

Density becomes a very important issue for the technical and financial assessment of the distribution and consumption of land, infrastructure and public services in residential areas. In principle, housing practitioners have assumed that the higher the density, the better the utilization of infrastructure and land.

The assumption is that high density assures the maximization of public investments including infrastructure, services and transportation, and allows efficient utilization of land. It may guarantee high rates of return and efficient revenue generation, assuming that there are benefits derived from a concentration of people and activities. However, one must look at this with caution, since high density settlement schemes can also overload infrastructure and services and put an extra pressure on land and residential spaces, producing crowded and unsuitable environments for human development. At the other extreme, low densities may increase per capita costs of land, infrastructure and services, affecting the sustainability of human settlements, and producing urban environments that constrain social interactions. These advantages and disadvantages are summarized in Figure 2.

Density of Plots and Dwellings

The size of the plot, the amount of plot which can be built up (plot coverage) and the height of the building (Floor Space Index or Floor Area Ratio) give the dimensions of the most visible aspect of density: the amount of

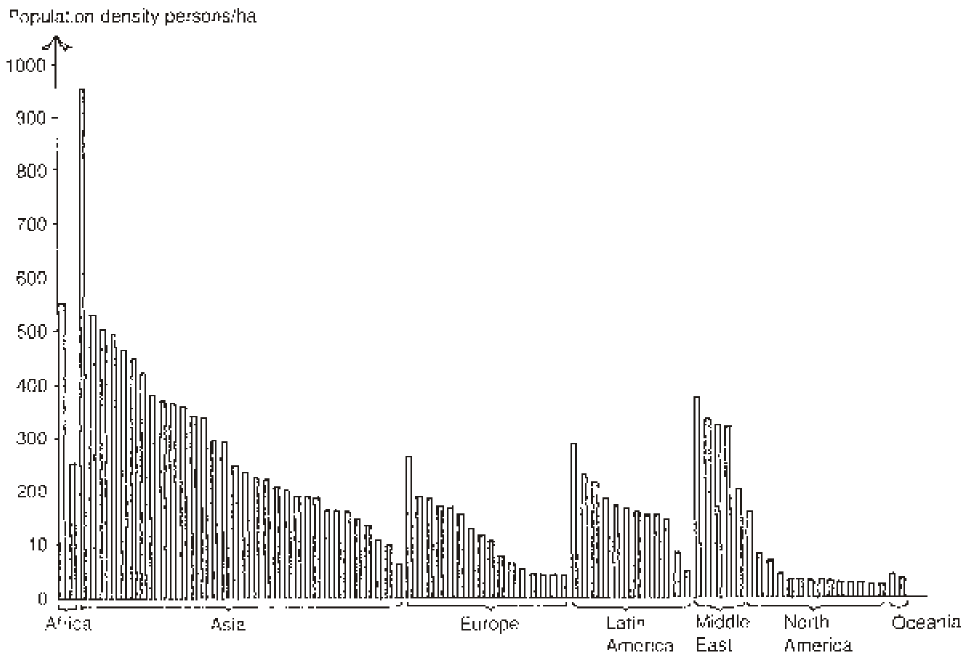


Fig. 1
Net Residential Densities in Large Cities.

Source
Figures from Bureau of the Census, US Dept. of Commerce quoted in The World Almanac® and Book of Facts 1994, Funk and Wagnalls Corporation. Figures are based on residential area of largest cities defined by urban area rather than administrative boundaries.

1 See also page 24 for comparative density figures for examples from different countries.

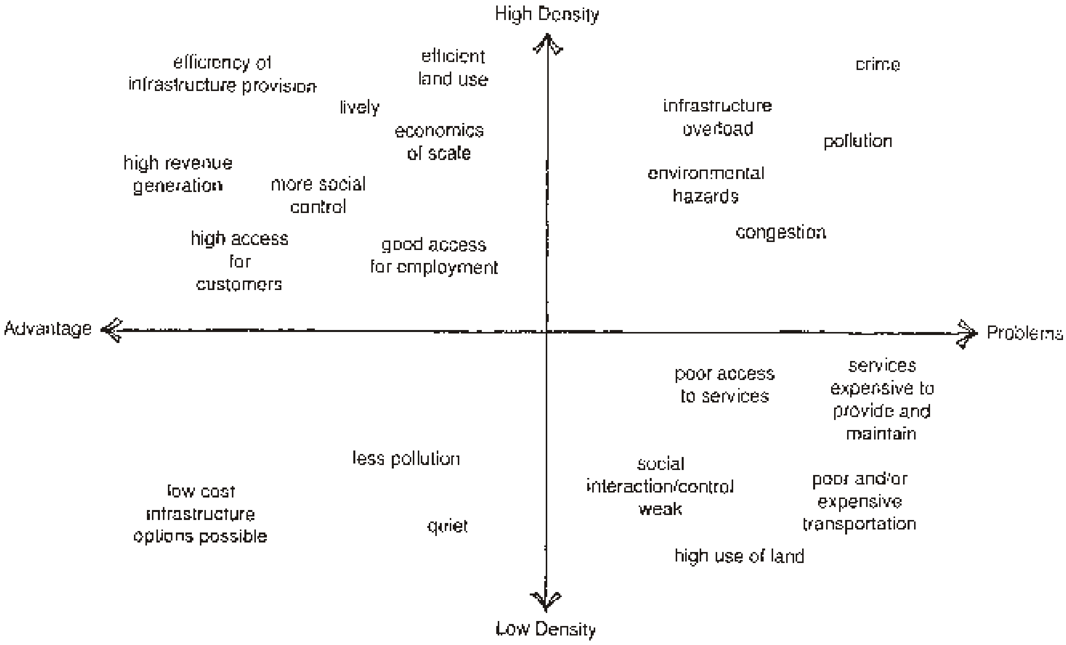


Fig. 2
Advantages and Disadvantages of High vs Low Density.

space which is built. This is what designers determine in the design phase, which officials can reinforce and control in planning and building permissions and in development control, but which does not necessarily guarantee success, since density is sensitive to external factors, such as land and housing policies, real estate market developments, etc.

Closely linked to density is the concept of crowding which implies that too many people live or work in a given neighbourhood, plot, dwelling or room. Recent studies in Guinea-Bissau (Box 1) for example reveal a strong correlation between high population densities (resulting in in-house crowding, crowding of beds) and ill health. The neighbourhoods of Bissau show extreme levels of density which seem to have parallels in many African countries. Overcrowding and densification of neighbourhoods have been one of the major negative effects of constrained land and housing markets, rather than being the result of direct planning decisions. The use of individual dwelling units is described in terms of persons per dwelling and square metres per person. Here we are dealing with issues of crowding within buildings, with implications of stress on social relations, and mental and physical health and epidemiological risks. Bissau and Hong Kong illustrate extreme figures of crowding which motivated a number of studies to assess the health impacts. We should emphasize that there is an important difference between housing density and crowding. It is possible to have a high density of housing without crowding.

Influences on Density

There are many factors influencing density, some of which can be dealt with directly, some indirectly and others over which there is very little possible action. In this report we focus on areas where effective action is possible, but it is important to understand the forces that influence dynamic changes in density. Figure 3 summarizes some of the most important influences.

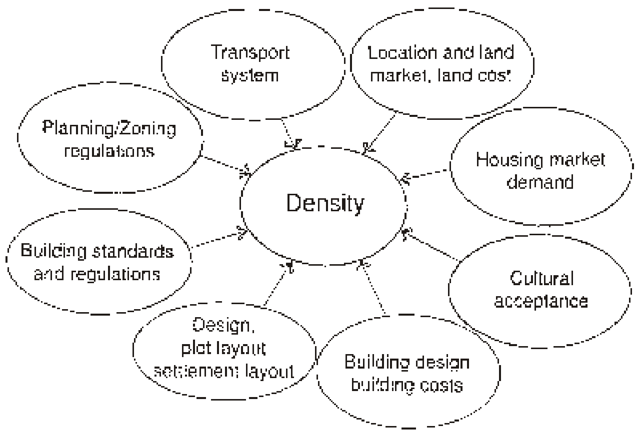


Fig. 3 Influences on Density.

New Developments vs Upgrading of Informal Settlements

The most common situation where density is considered is when new formal (legal) development is being planned. The decision may be direct when a government implements a programme, or indirect, when the development is promoted by the private sector. In the latter situation government influence will be a combination of regulations and negotiation.

The issue of the density of new development is seen as critical in a wide range of environments. The affordability of low density with expensive services, high maintenance and expensive transportation is an issue of debate in places as geographically and economically separated as South Africa, New Zealand and California. Low density suburbs have led to extensive and expensive land use resulting in a typical urban sprawl.

In the case of informal settlements, densities may be very high, with narrow streets, little open space and

Box 1 Crowding in Guinea Bissau

Densities are increasing rapidly in Bissau, the capital of Guinea-Bissau. The primate cities have very common urban growth patterns. The colonial core is usually surrounded by informal settlements that are characterized by poor housing conditions, inadequate infrastructure, poverty, informal market activities, renting and subletting of rooms and high densities and overcrowding.

Densification – in terms of population increase and spatial occupation – has been principally caused by an inefficient performance of the housing sector. Surveys in four neighbourhoods of Bissau revealed that population density varies in a range from 204 to 400 inhab/ha and housing density from 14 to 18 dwellings/ha. Apparently these figures are not exceptionally high but one must bear in mind that the houses are particularly large, reaching 180 m^2 or more, and are mostly overcrowded, the number of occupants varying from 10 to 22 persons per house. A large number of households live in one or two rooms of 16 m^2.

In the African context, densities are reaching alarming figures. The 52 country survey carried out by the UNCHS/World Bank-sponsored Housing Indicator Program reveals that Sub-Saharan Africa next to South Asia has the lowest mean floor area per person; the median useable living space per persons – which is 7.55 m^2/person. For South Asia this figure is 7.10 m^2/person (Angel et al., 1993). A recent survey in Bissau found 3.2 m^2/person as the floor area indicator for the city (Acioly, 1995) which is apparently a paradox when placed next to the size of the houses. This highlights external factors that create an acute form of density shown in the phenomenon of in-house crowding and expressed as in-bed crowding.

Recent surveys in three neighbourhoods of the city indicate that 67% of the houses had 3 to 4 persons per bed. This extreme form of density has serious social and health impacts for the population, specially vulnerable groups like children, pregnant women, elderly. The longitudinal study confirmed that continuous and long-term exposure to a crowded living environment is directly linked with increases in morbidity and mortality rates, transmission of communicable diseases, airborne and respiratory infections and specific chronic and infectious diseases.

probably no areas for common amenities. In this situation reblocking or restructuring of the existing layout will probably result in less land available for development, unless one opts for resettling some households to another site. This will relieve building and population densities and provide opportunities for better settlement management in case of fire, flood or natural disasters. However, one must be cautious with resettlement, since it has serious social and economic implications for the population, and is a difficult process to manage.

For this reason it is best to try to minimize resettlement, which in turn tends to increase pressure on existing land and buildings, resulting in higher densities. Depending on the location of the settlement, land prices may stimulate increases of floor area ratio and changes in density regulations, which may themselves result in the displacement of low income groups. The case of Bombay illustrates this issue (Box 8).

Fluctuating Densities and Urban Productivity

Inner city and Central Business District CBD areas may experience extremely high population densities, placing high pressure on urban services and on the urban fabric as a whole, while satellite/dormitory towns have extremely low densities during working hours. These variations affect drastically the consumption and management of public services and infrastructure. This has to do with mono-functional land uses which result in urban inefficiencies and urban congestion. São Paulo shows these problems very clearly. The concentration of activities and functions related to work and services in the inner city demands high investments in infrastructure, roads, traffic management and energy supply that are in fact all under-utilized, since they are unused during part of the day. Commuting, traffic congestion, high energy and fuel consumption, extensive land use and high population density are concentrated in time and space, a fact that challenges urban productivity. This phenomenon poses a question for proper management of densities and land uses which will increase the sustainability of urban environments.

Density is significant for the economic performance of a city. High population density means a high level of access for business both to employees and to markets. This is generally seen as positive. Higher accessibility for workers and enterprises means more competition and productivity with less energy and time consumption. The city of Curitiba (Box 3) illustrates the benefits of this approach. However, in the very common situation where increase in density is unplanned, or badly managed, it can also mean an overstressing or overload of infrastructure with resulting poor functioning and inefficiencies. For example, irregular water supply in Hyderabad, India, means that businesses and homes have to invest in water storage and pumps. Unreliable electricity means that businesses have to invest in generators, also causing increased pollution.

Density, the Real Estate Market and the Efficient Provision of Services

In the absence of good urban management, density will tend to increase in locations with a high level of accessibility – particularly to employment, services and high standards of infrastructure where land prices will be consequently high. In the absence of alternatives for land

and housing, there will be a natural tendency to increase population density by means of informal increases of either built density – increases in plot density and plot coverage through new building expansions – or increases in the occupancy rates of existing buildings. Market distortions, legal frameworks and private sector mobilization in the real estate market will dictate the degree to which this phenomenon will occur.

Governments can stimulate and reinforce this mechanism by playing an enabling role while providing high levels of profit to private developers, allowing high occupancy rates of plots and buildings and carefully monitoring real estate development, as is the case in Hong Kong (Lai, 1993).

The efficient use of land as a limited resource, and whether the state or the market should control this, is perceived differently in different countries. There are particularly big differences between market and planned economies. In market economies there are normally some regulation and control, but it is the market that influences density. The disadvantage is that the broader social costs, such as poor access to schools, shopping or health facilities and loss of agricultural land, are not taken into account. Planned economies traditionally used density as a key element in planning, with square metres per inhabitant as a determinant in planning dwelling environments. This had the disadvantage of being inflexible and often of producing undesirable urban forms.

A very important indicator of efficiency of land use is the ratio between public and private space, which is commonly included in planning legislation. The recommendations deal more specifically about increases in infrastructure and maintenance costs in relation to this ratio and density outcomes.

One of the main arguments for encouraging higher densities is the efficient provision and maintenance of infrastructure. The arguments are simple: low density means long infrastructure runs and thus higher cost per consumer both for installation and for operation, as shown by the cases of Ismailia and São Paulo (Box 5 and Box 9). Since the provision of public services such as health and education are based on the number of people to be served within a specified radial distance, low density housing areas also impose longer journeys on children and mothers. Schools and health clinics become more difficult to reach. For example, the scattered settlements with large plots and individual free-standing houses surrounding many African towns mean that many people live without municipal services or are obliged to cover long distances to reach them. This is partly because the municipalities do not function well, and partly because these areas are very expensive to service. The large plots and often unplanned forms of land occupation result in inefficient urban configurations.

At the other end of the density spectrum, higher than planned density creates problems of congestion, overloaded infrastructure and urban inefficiencies. Traffic, drainage, water and sanitation systems are usually the most affected. On-site sanitation systems become overloaded, “grey water” cannot be efficiently evacuated though drainage systems and heavy rain cannot be absorbed adequately.

Health, Water Supply and Sanitation

High density generally allows for more efficient provision of infrastructure as the network lengths per unit served decrease and more people have access to public services. The low income settlements in Natal, Brazil, show that an efficient network layout combined with certain sanitation technologies and high population density accomplish substantial gains in lowering the overall cost of the system per household[2].

At the other extreme, low density can allow the use of on-plot water supply and sanitation which can provide a flexible and cost effective means of upgrading over time. In public health terms, low densities allow the use of low cost on-site sanitation systems and reduce health hazards.

There is little doubt that extremely high densities result in poor health conditions, although it is difficult to separate what is caused by density and what is caused by the poverty which is associated (Box 1 Guinea-Bissau and Box 2 Natal, Brazil).

Fire Protection, Accessibility and Transportation

High density informal developments, especially in Asia and Africa, have had a bad history of fire, property loss

Box 2 Density and sewerage costs in Brazil

Experiences with shallow sewerage in Northeast Brazil show relationships between population density and optimal costs in the cost of sewerage networks. In two squatter settlements (Rocas and Santos Reis) in the city of Natal density averaged 350 persons/ha. Since conventional sewerage was unaffordable, the population agreed to have an alternative sewerage network, locally called condominial sewage, passing through the backyard of the plots. Total capital costs were US$ 350 per household, and the system was so effective that it was replicated in other site and service and settlement upgrading sites in the city and elsewhere in Brazil.

The efficiency of the system was not only a result of technological innovation but also the layout of the system – passing through backyards of plots and optimizing network length with system coverage. Evaluations of the system showed a noticeable reduction in costs per household as density increased. It also showed that at a given density, it could be more economical than on-site sanitation systems. At densities above 160 persons/ha, annual cost per household falls below US$ 48.

Source Sinnatamby in Hardoy et al., 1990.

2 For further discussion of this see Caminos and Goethert (1978), Davidson and Payne (1983), Cotton (1991) and Bazant (1978).

Box 3 Density issues in Curitiba, Brazil

In Curitiba, a city of 1.6 million in Brazil, the concept of density was the backbone of urban transformation after the approval of the master plan in 1966. The plan had two main concerns: to decongest the inner city and revitalize the urban and architectural heritage in this area and to shift the concentric radial growth of the city into a linear pattern by introducing a north-south of traffic and transportation axis tangential to the inner city, called the "structural axis."

Zoning was based on use – commercial, residential, industrial and mixed use – and the desired population density. The strategy was to encourage new commercial developments to move out of the inner city, pairing high density residential areas with commercial activities and linking them by public transport. The principle was that the sites must be well served by public transport, and the density coefficient would decrease as the distance to the public transport network increased. Development permits could only be issued by the local government if the request were accompanied by a careful analysis and information about traffic generation and the requirements for infrastructure and parking.

The structural axis is formed by a three part system. The central lane of the main road is exclusively for buses, a solution that accomplishes performances equal to those of metro systems, while two parallel roads serve local traffic within the same road profile. The system is completed by two other roads, usually situated one block further from the central road, for the continuous one way traffic towards and from the inner city. The area situated in-between these two one way traffic roads is called the structural sector and is zoned as a high density area, accommodating commercial and residential uses, and reaching densities up to 600 inhab/ha. In the structural sector, buildings can reach a total floor area equal to 6 times the plot size.

According to municipal policy, land was acquired during and before the implementation of the transport network, so that the local government could guarantee the maximization of infrastructure and services and the desired densification along the structural axis. The municipality applied a creative special appropriation mechanism for buildings of historical value in the inner city. This allowed the transfer of development rights or building potentials (principle of "solo criado") from the existing sites to elsewhere in the city, if the infrastructure and services could cope with the increased built up area and higher density. The owners would pass the title of these buildings to the municipality in exchange of more floor space in another area. The municipality thus safeguards the building heritage and uses the buildings as museums, foundations, training centres, etc. It also increases densities elsewhere in the city and provides a good trade-off for the private sector. An automated property register and a land information system established at the beginning of the 1980s allows the Municipality to provide any resident with information about building coefficient, densities and development potentials of every single plot in the city.

The concept of density, interpreted in Curitiba as an increase in plot occupancy and coefficients in relation to plot areas, measured in inhabitants per hectare, was applied in a very balanced way. It defined a clear profile and skyline of the city. The areas situated between the structural axis have middle and low population and building densities. Middle densities are the areas where multi-family housing is predominant, reaching a density up to 180 inhab/ha. The low density areas are characterized by low rise single family housing with densities up to 70 inhab/ha.

The urban planning solutions applied in Curitiba aim to recover and consolidate the urbanity of the traditional city, to allow the residents to identify themselves with their urban environment and to interact socially with their fellow citizens. It advocates the mixture of functions, incomes and densities, brings the green areas into the urban environment, maximizes the existing roads and infrastructure and links them all through simple but extremely efficient public transport. The reinforcement of high densities throughout the public transport axis provides not only the maximization of public investments, but helps Curitiba to save 25% in fuel consumption and to achieve a significant reduction of dioxide emissions. This gives the plan, and the use of density, a significant impact on the sustainability of development.

and even human losses. Temporary materials, unsafe power connections, careless use of wood fuel for cooking and sometimes pressure tactics by local land owners or criminal elements in densely occupied settlements have provoked fire disasters of large proportions. Narrow streets and high building densities (high plot coverage) facilitated the spread of fires and impeded fire services to reach sites in time. The rationale for upgrading and sometimes decreasing the building density of low income squatter areas is often linked to improving accessibility for emergency services such as ambulances and fire brigades. The fault is not density alone, but a combination of building density, building materials and the dimensions of streets and other open spaces. In large settlements, accessibility to public transport is one of the reasons to widen existing roads.

But accessibility alone is not enough. Efficient public transport requires medium to high densities to be able to provide frequent and efficient services. For this reason, density of urban development, including residential development, has become an important issue relating to sustainable urban development. Residential densities influence the number and types of trips and modes of travel used. The total number of trips per person by private car decreases as cities or neighbourhoods become more dense. The case of Curitiba (Box 3) emphasises this aspect.

Social Implications

Socially, low densities are connected with high incomes and a low degree of casual social contact. High densities are associated often with low income, with liveliness and social contact, but also with conflict. The impacts of density are also influenced by the quality of design of layout, how buildings and spaces are designed and linked.

Low densities are associated with clean air, space for recreation. Much low density development was a reaction against the overcrowding of inner city areas. However they also have problems; the New Towns with low to medium densities and plenty of recreation space were also the home of "New Town Blues." This was a common description of the dissatisfaction with the social life expressed by families who moved from large cities such as London and Glasgow to newly created, relatively low density towns.

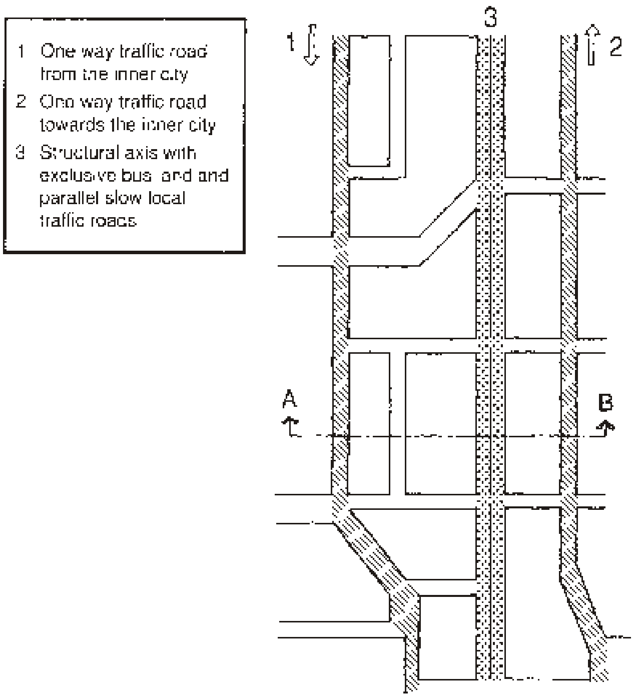


*Fig. 4 Curitiba structural axis.
Density = 600 inhab/ha. FAR = 6.*

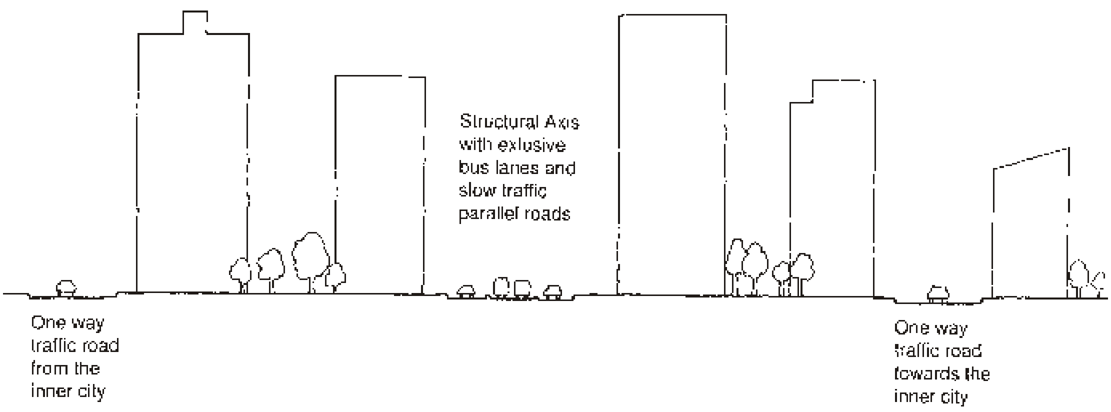


Fig. 5 Curitiba structural axis – section A – B.

Concerns about security are tending to promote higher densities. Large gardens in low density neighbourhoods may be seen as a danger rather than an advantage. New middle class development in cities such as Nairobi and Johannesburg promote compact "town houses" crouching behind barbed wire topped walls.

Environment and Sustainability of Urban Development

The relation between density and the environment is complex. Dense development with little open space can increase run-off, but also reduces the amount of land taken for urban development. Low density, green urban development takes enormous areas of land. In Hong Kong there is a controversy over Government's intention to decrease densities, because it implies a shift from the typical high rise, high density approach towards low rise, lower density schemes that will promote the horizontal growth of the city over its limited countryside. Not only are private developers concerned about the decrease in saleable floor area and profit, but environmentalists are concerned about the environmental impact.

3 Recommendations

Planning and Design Implications

Sustainable housing development calls for special attention to the improvement of physical planning outcomes in which densities occupy a pertinent position. Particularly, during the process of paradigm changing in the 1990s in which cities are recognized to be the engines of development, and their performance and productivity a question to be approached through effective management. Not only the management of the urban environment assumes importance but also the actual spatial planning, the design of the urban environment and the way cities are built gain relevance in the present agenda of discussion. The sustainable city as a concept appears to be linked to better designs of the urban environment. Efficiency in the design and spatial planning of human settlements is a key area of concern which certainly must deal with the problem of density within a broader perspective. This implies a rediscovery of the economics of space and the value of the end product of planning and design processes. Density outcomes must be economically efficient and reinforce sustainable human development but must be culturally acceptable as well.

Density should be the result of a design process through which the designer must deal dynamically with standards, plot and dwelling sizes, housing typology, spatial planning, cultural acceptability and environmental suitability. It should not be the unilateral result of a cost analysis and financial exercise aiming at the optimization of infrastructure, services and land. Though, since dwelling occupancy is very dynamic it becomes very hard to stipulate or control population density once a plan is executed.

For the purpose of planning a subdivision, it is much more pertinent to work with housing and building densities. These are more controllable figures and give more possibilities to assess the trade-offs in relation to land occupation and the costs of infrastructure and services. The number of dwellings in relation to the provision of services and infrastructure may remain as originally planned, but increase of building occupancy, sub-division and overcrowding may occur if land and housing delivery is constrained. See Figure 6.

Models of Development at City Level

The assumed benefits gained from economy of scale and concentration of population which have influenced the densification and verticalization of towns and promoted the compact city model are now once more the order of the day. This movement is also stimulated by the fact that local governments lack resources and means to cope with increasing public expenditures, including the demand for investments necessary to foster sustainable urban development. Resources need to be utilized efficiently. The use and occupation of available space and vacant land should be rationalized. Public utilities must be efficiently managed. Municipal services must be financially sustainable and housing projects must fit into available land and be economically and environmentally sound.

The advocates of the compact city argue that the garden city movement and the International Congress of Modern Architecture CIAM did widespread damage with a city model based on low densities, social and spatial stratification and satellite developments which is perverse for the urbanity of cities. Peripheral developments and unbalanced weights between green and unoccupied spaces and the built up area created other levels of economic problems related to population mobility, transportation and commuting, energy consumption and disruption of the daily urban systems. A compact city with higher densities, mixed land uses and a balanced relationship between private and public domains would recover urbanity and sustain the economic recovery of the inner city.

The amount of space allocated for private and public domains will not only influence density indicators but

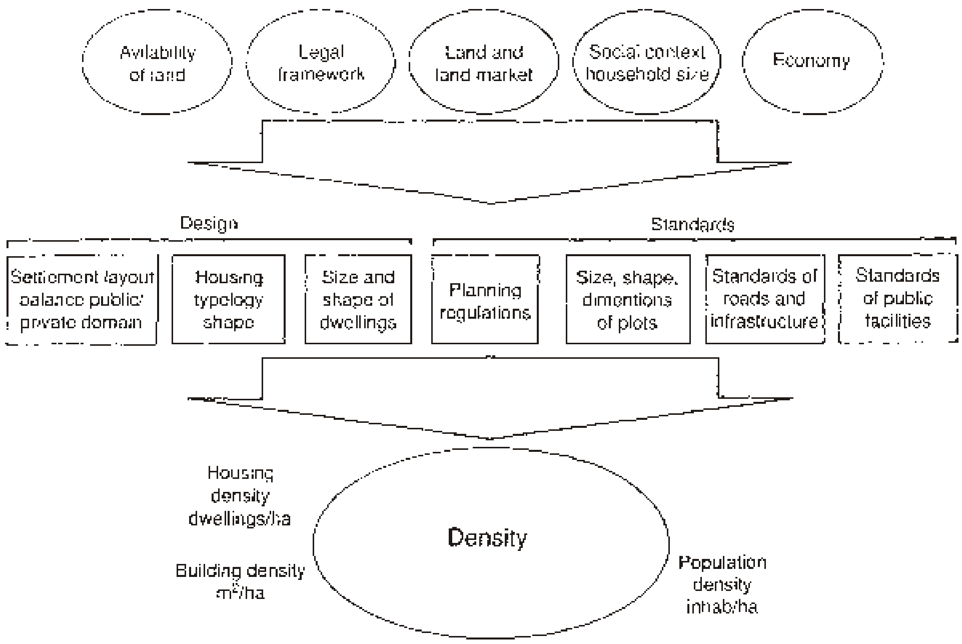


Fig. 6
Design and Standard Issues Affecting Density

will also define certain morphological characteristics and specific qualities, as the box on Karachi shows. While certain settlements have a major part of their areas allocated to public use – green areas, vehicular traffic and pedestrian circulation and complementary public services – providing a certain feeling of space and confined social contacts, others have most of the space allocated to private use, such as residential, mixed residential-commercial or solely commercial-industrial uses.

Density influences social interaction, but Hillier[3] showed that in the case of high density inner city high rise housing in London the configuration – or the layout and design of buildings and spaces – can have more impact than the density itself. Hillier argues that regardless of the density of the housing estate, if the spatial layout of the settlement constrains natural movement then there will be never sufficient people to generate the sense that the space is well used.

Guidelines for Urban Designers

There is a merit to looking at housing layout efficiency in relation to densities, considering that sustainable housing development partly depends on the degree the layout solution provides optimal land utilization and infrastructure distribution.

Since design decisions are taken at a very early stage of the development process, it is important to provide quick references and call attention to specific outcomes when certain choices are made at the design phase. Table 1 shows population and housing densities for a new neighbourhood for 5,000 people and the land needed to provide housing according to a predefined percentage allocated to residential use for both low-rise and high-rise housing.

Box 4 Density variations in Karachi, Pakistan

Examples from Karachi show that different types of urban layouts in residential developments produce totally different density outcomes. A *katchi abadi* – squatter settlement – with an irregular configuration, densely occupied and only 25% of the land used for open spaces and circulation, presents a density of 650 persons/ha for plots of 75 m^2. An inner-city residential area, with a gridiron layout based on narrow and small plots of 90 m^2 and only 25% of land used for circulation and open space presents a high density equal to 625 persons/ha. In north-east Karachi, a gridiron planned residential site based on plots of 150 m^2 and 40% of the land used for circulation and open space presents a medium density of 260 persons/ha. In North Karachi, a planned residential area based on plots of 350 m^2 and having a substantial part of the land utilized for open space and circulation (45%) presents a low density equal to 102 persons/ha.

Source Dowall and Clarke, 1991.

The costs of infrastructure and public utilities will depend on the optimization of the layout solution and the percentage of land allocated for residential use, public space (traffic, streets, pedestrian pathways, parking areas), and semi-public spaces (schools, playgrounds, public facilities, recreational spaces) and the level and standard of services. If the solution reserves substantial land for public use, then it is logical that there will be less for other purposes; a higher burden on public and community sectors in terms of maintenance costs, taxation, etc.; longer distances to be covered by on foot journeys and infrastructure networks; and higher costs to serve it with public utilities. The layout must enhance an efficient and balanced trade-off between the private and public domains.

Can density be a parameter for decisions taken at this level? Urban designers routinely use population density as a reference, usually gross population density. The table on page 14 gives some implications of design decisions.

With a plot size of 125 m^2 and a net population density of 400 inhabitants/ha, varying the percentage of land allocated to residential use does not change the net housing density (80 dwellings/ha) or the total land for residential use (12.5 ha), since the plot size is the same. As the percentage of land allocated for residential use increases (up to 65%), the total land needed to accommodate this population decreases and the gross population density increases up to 260 inhabitants/ha. Thus increasing density should lead to an optimal use of essential development inputs – land and infrastructure. The decision on the trade-off between public and private domains has been made; it is acceptable that 60 to 65% of land allocated for residential use should lead to efficiency. However the urban standards will be also relevant, whether there will be wide roads or not, if local green areas and recreational spaces are concentrated or spread. Final costs will also depend on whether services are incrementally executed or ready-made.

If we decide to predefine 60% of land allocated for residential use as the criteria to accomplish settlement layout efficiency, but vary the plot size (from 250 to 90 m^2) to accommodate the same population (5,000 inhabitants), both housing and population densities increase, and there is a substantial decrease in the total residential land and the total land needed. Decreasing the plot size at a ratio of 2.7 all densities will be increased at the same ratio. Thus the plot size determines most of outcomes. The smaller the plot the higher the density and less land required to accommodate the same population. The question now is whether the plot size is culturally acceptable and financially marketable, and again whether the urban standards respond to efficiency requirements.

If high rise housing alternatives are applied, then the situation changes completely. Using a four storey building with 20 flats of 50 m^2 per floor and increasing the percentage of land allocated for residential use, net population and housing densities remain unchanged but

3 Hillier, B. et al. (1988). "The Other Side of the Tracks: the Kings Cross railway site and its urban context", University College, London, 23 pp., mimeo.

Table 1 Relation Between Housing Type and Density

Population					*Land*		*High Rise Housing*					*Low Rise Housing*				*Settlement*
Total Population	Persons per Household	Total Households	Gross Density (persons/ha)	Net Density (persons/ha)	Residential Land %	Individual Plot Size (m²)	*Flat size (m²)*	*Number of floors*	*Flats per floor*	*Number of blocks*	*Block size (m²)*	Housing Density	Net Housing Density	Total Residential Land (ha)	Total Land Needed (ha)	Settlement Type
5,000	5	1,000	140	400	35	125						28	80	12.5	35.7	Low rise – 1 dwelling/plot
5,000	5	1,000	200	400	50	125						40	80	12.5	25.0	Low rise – 1 dwelling/plot
5,000	5	1,000	260	400	65	125						52	80	12.5	19.2	Low rise – 1 dwelling/plot
5,000	5	1,000	120	200	60	250						24	40	25.0	41.7	Low rise – 1 dwelling/plot
5,000	5	1,000	250	417	60	120						50	83	12.0	20.0	Low rise – 1 dwelling/plot
5,000	5	1,000	333	556	60	90						67	111	9.0	15.0	Low rise – 1 dwelling/plot
5,000	5	1,000	1,167	3,333	35		*50*	*4*	*20*	*12.5*	*1,200*	233	667	1.5	4.3	High rise – 80 flats/block
5,000	5	1,000	1,667	3,333	50		*50*	*4*	*20*	*12.5*	*1,200*	333	667	1.5	3.0	High rise – 80 flats/block
5,000	5	1,000	2,167	3,333	65		*50*	*4*	*20*	*12.5*	*1,200*	433	667	1.5	2.3	High rise – 80 flats/block
5,000	5	1,000	2,000	3,333	60		*50*	*4*	*20*	*12.5*	*1,200*	400	667	1.5	2.5	High rise – 80 flats/block
5,000	5	1,000	2,500	4,167	60		*50*	*5*	*20*	*10.0*	*1,200*	500	833	1.2	2.0	High rise – 100 flats/block
5,000	5	1,000	3,250	5,000	65		*50*	*6*	*20*	*8.3*	*1,200*	650	1,000	1.0	1.5	High rise – 120 flats/block

gross densities increase dramatically (from 1,167 to 2,167 inhab/ha). In comparison to the low-rise solution, this alternative consumes far less land, but all infrastructure and services will be extremely concentrated. The case of Hong Kong shows this very well. The urbanized area occupies only 10% of the territory, as a result of government policy towards high-rise, high density developments that accommodate more than 5,000 persons per hectare. The settlement layout will be decisive in the definition of the trade-offs: public-private domains, the amount of green areas, distance between buildings, parking places and the availability of infrastructure.

Higher densities in this case imply an extensive use of the available land on one hand and, on the other hand, it places a heavy occasional load on existing infrastructure such as electricity supply, drainage, sewage and parking.

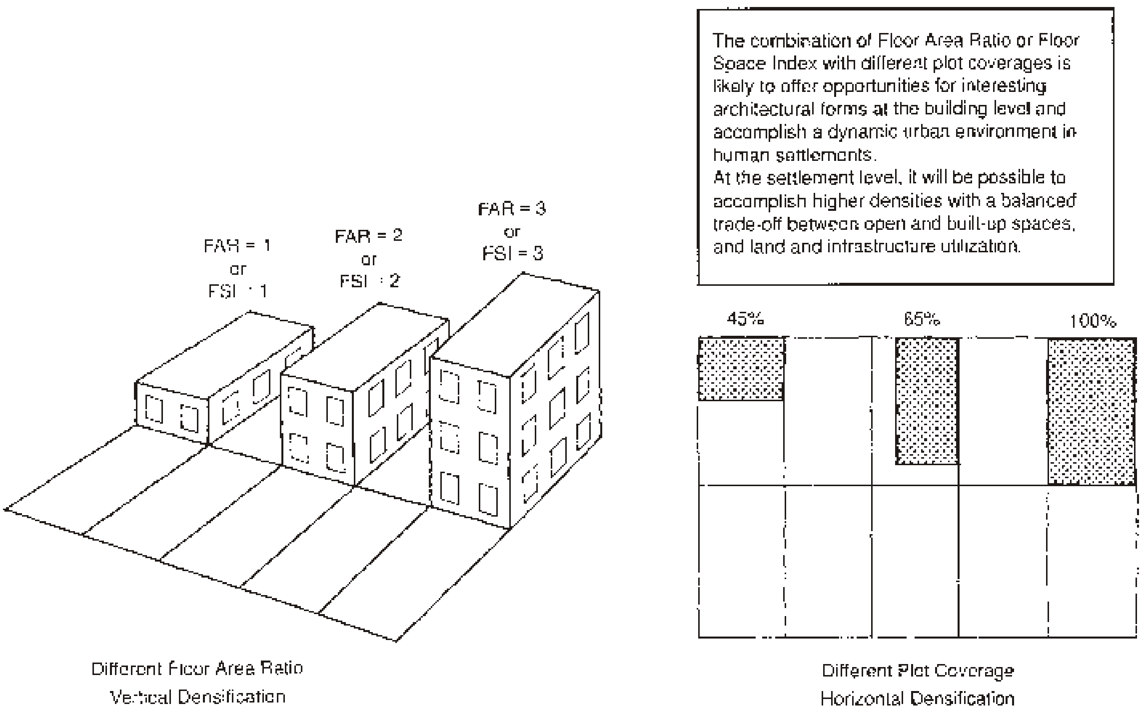


Fig. 7 Relation between Floor Area Ratio and Plot Coverage.

Box 5 Plot development in Ismailia, Egypt

Background

The Ismailia Demonstration Projects commenced in Egypt in 1978 aimed to develop a model for urban development which would be accessible to low income groups and which would echo the pattern of development in Egyptian cities.

Housing in Egypt is normally developed incrementally, depending on income and demand. This poses a particular challenge in how to plan for layouts and infrastructure that can accommodate these changes. In broad terms the challenge was to design a system affordable to middle and low income families starting with one storey development, but assuming that average development would extend to two storeys within a 10 – 20 year period. In other words, density would at least double and over time could reach 4 or more times the original level.

Practical approaches for design for densification included:

Aspect	Plot size	Plot shape	Water supply	Drainage	Schools
Response	Plot sizes were kept at an average of 100 m^2 which allowed more options for economic vertical expansion, rather than keeping them very small which would have maximized initial affordability.	Plot width was designed to be sufficient to allow stairs. Wider plots can be more efficient as two flats can be constructed on each floor sharing stair access.	Design was related to the first threshold of density, with the possibility of doubling later.	This was initially designed for on-plot sanitation, with upgrading to water borne possible later.	School sites and buildings were designed with potential of vertical expansion. Multi shift use was also common in Egypt.

Flexibility also extended to use of small construction contracts and strong local decision making which allowed implementation to be responsive.

More can be less

The process of development of the design involved a lot of discussion with trade-off between smaller plots giving greater affordability, or larger plots with greater flexibility over time. This debate was mainly between design professionals. Later, in the implementation phase, the response of local people to the plots that were being developed was that they were too narrow – the frontage was 6 metres, designed to be economical for infrastructure provision. People complained, rightly, that if the plots were wider – 7.5 or 9 m, they could develop with two flats on each floor sharing the same stair – and thus be more efficient. In this case the paradoxical result was that the approach which initially aimed at greater densities, in the end would have resulted in lower density.

Lessons

Lessons from the experience in Ismailia are:

- Do not plan for a “static” situation, rather bear in mind that settlement is a process.
- Thus it is possible to plan for densification.
- Whatever you plan to start with, something else is likely to occur!

During the project design phase, densities are controllable variables, but one should never forget that the real figures are subject to influences from external factors such as housing shortage, location, constrained land supply, accessibility to public transport and services. For example, if there is an acute housing shortage and the plot size allows housing extensions, experience shows that there is a natural densification of settlements – thus an increase of plot occupancy and decrease of floor area ratio per person – usually related to informal rented housing, specially if the area is well situated in relation to employment opportunities and services. The cases of Bissau and Brasilia illustrate this. This means that external conditions may transform density values that might even oppose existing land use legislation. Changes in the zoning regulations that allow increases in plot coverage or floor area ratio may affect density outcomes as well through vertical or horizontal building expansion.

The relationship between density and infrastructure costs seems to be even more complex. While studying the design and implementation of low income settlements in Brasilia, Brandão argues that per capita costs of infrastructure decreases spectacularly when the population density is increased from 50 to 200 inhabitants/ha[4]. From 200 to 300 inhabitants/ha, per capita costs decrease but not significantly and tend to remain at the lowest values for 300 to 600 inhabitants/ha.

This is also confirmed by Mascaró who studied the cost of urban infrastructure networks in relation to densities (Mascaró, 1987). When assessing the share of each network in the total network cost, he shows that as population density increases, the share of pavement, drainage, sewage and public lighting is increased while the share of water, gas and electricity supplies is decreased. This means that for some networks higher densities lead to optimal or maximization of use. The pavement of roads seems to be the most costly component followed by sewage and drainage. The overall cost of the networks per dwelling decreases drastically from US$ 2,500 per dwelling for a density of 75 inhabitants/ha to US$ 750 per dwelling for a density of 300 inhabitants/ha. Evidence from Northeast Brazil (Box 2 Density and Sewer-

4 Brandão, A.B. (1975). “Urbanismo, Infraestrutura e Arquitetura dos Projetos PLANAP”, Brasilia, Brazil, 35 pp. Mimeo.

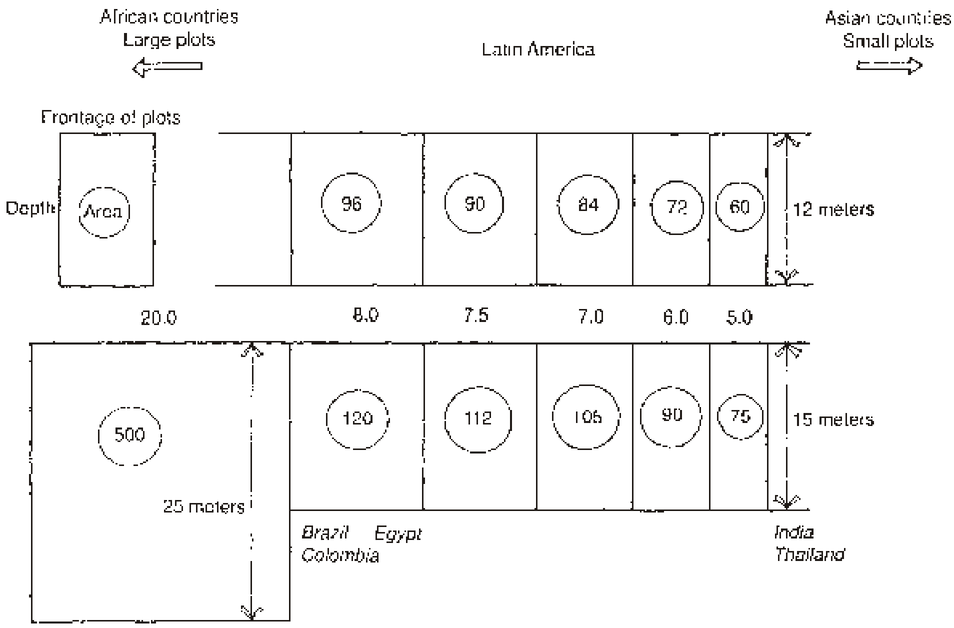


Fig. 8
Plot Sizes and Shapes by Region

age Costs in Natal, Brazil) also confirms these statements.

Settlement Layout

The layout of a planned residential area is the result of a design action that subdivides available land for development and defines the public and private domains. That is why the gross density in housing is greatly affected by its urban configuration. The density equation embraces some important practical conditions beyond the urban configuration that must be culturally and environmentally appropriate. These include:

- the total number of occupants per dwelling,
- the total area of the dwellings,
- the legislation regulating the plot coverage: the proportion of the plot that is allowed to be covered by the building,
- the floor space index (FSI) or floor area ratio (FAR): the ratio between the plot area and the total built up area allowed to be constructed,
- the total space allocated for vehicles: the standards defining the width of roads and pedestrian pathways.

The degree to which the above regulations and standards are respected will largely define the density outcome of the urban environment. Independent of deliberate actions or of vernacular or spontaneous/collective processes, every human settlement carries a spatial configuration that has some inherent qualities and constraints.

Design for Efficiency

Whether land is squandered or efficiently occupied will basically depend on the standards used for roads and plots. The size, the width, length or depth and shapes of plots, plot coverage regulation and dimensions of roads will significantly affect ultimate density.

For example, the square metres of road per house in a typical Malaysian land subdivision is up to four times greater than in comparable North American or Western European projects. When compared with commonly accepted international practices, about 25% of the land set aside in the typical subdivision could be assessed as being wasted. The streets are too wide, the set-backs too great, and land is set aside for redundant community facilities. (Dowal and Clarke, 1991).

Plot size is culturally bound and varies from country to country. In Delhi, the Rohini sites and services project offers plots from 26 to 90 m^2 in which two storey buildings can be constructed, permitting plot coverage up to 75% and allowing two dwelling units for plots of 48, 60 and 90 m^2. In Brasilia, the Candangolândia and Itamaracá projects were based on the 120 m^2 plot but the national legislation for low income projects establishes a minimum plot of 126 m^2. In Guinea-Bissau, urban plots are conventionally defined as 20 by 25 m, covering an area of 500 m^2. These differences in plot size make it very difficult to compare densities and reinforce the observation that density figures are strongly related to the cultures of the cities concerned. However, whatever the cultural acceptance, low density implies either low standard of infrastructure or high costs which are very difficult to afford and which also have high environmental costs. Many American cities face serious dilemmas due to earlier choices made in favour of suburban developments, low density and individual private transport based dwelling environments.

The discussion of settlement layout efficiency developed by Caminos and Goethert (1976) defines three classes of land:

- Public land including the area occupied by roads and public open spaces, the cost of which has to be borne by the residents.
- Semi-public land including schools and other specialized institutions, the cost of which is normally borne by the institution concerned.
- Private land including all individual plots for housing, commerce and other uses, the cost of which is normally borne by the occupants.

Box 6 Density and efficiency of layouts in Mexico

A survey in 12 settlements in Mexico city provides comprehensive and detailed information about the performance of the sites in relation to densities and utilization of land and infrastructure. Nine of them are low income settlements. The lowest density was 166 persons/ha in Netzahualcóyotl, a settlement based on low-rise and one house (80 – 100 m^2) per plot, situated 9 km from the city centre and built in 1963; the site is characterized by a regular gridiron layout with large amounts of land allocated for public use and wide roads. There are 137,000 plots of 150 m^2 covering 4,000 ha. The clusters are 200 by 50 meters with 45 plots per cluster and with a gross density of 110 persons/ha (1970). The highest density of 1,442 persons/ha was found in Tepito (La Florida), a settlement based on medium-rise housing with a high percentage of land for residential-private use, with extensive plot coverage – most of the private area is covered – and a low percentage for roads and footpaths. Gross density in the study area reached 900 persons/ha. Tepito is a centrally located and consolidated neighbourhood, the result of land subdivisions, where more than 40,000 people live. The building stock is flats and houses (26 m^2), one or two storeys high, the majority tenements (vecindades and tugurios). Most plots are regular in form and size.

The study assumes that acceptable and desirable densities for residential areas should range between 300 and 600 persons/ha, and that the housing typology should vary between 1 and 3 storeys, with an average residential floor area per person of 10 – 20 m^2 and a plot coverage of 30 – 35%. The study also presumed an optimal trade-off in land allocation: 20 – 30% for pubic areas, 3 – 13% for semi-public and 39 – 77% for private use. Only few settlements fell within this density range, and those satisfying the density requirement did not satisfy the land utilization criteria. A great deal of the settlements were squandering land and others creating congestion by allocating excessive land for residential use.

In terms of layout efficiency, six settlements were graded inefficient, half of which met the density criteria and the other half had low population density. The layout efficiency of the other six settlements was not measured. It is worth to mention the outcomes of a high-rise and high density (711 persons/ha) and public sponsored settlement (115 ha) implemented in 1966. Half of the buildings are 4 and 5 storeys high and the rest 7, 8, 14 and 22 storeys with flats measuring 74 m^2. Only 15% of the land is for residential use, 27% for roads, footpaths and parking and 49% – almost half – for green and recreational spaces. Since high-rise buildings demand special care for norms related to setbacks, distance between buildings, spaces for parking and recreation, and community services, all in a compact, concentrated site, this alternative does not always achieve a balanced trade-off even when population densities reflect a potential increase of beneficiaries.

Recommendation

Caminos and Goethert recommend from analysis of various cases (some mentioned in the table on p. 24) that efficient percentages in each category are:

Public land	*20 – 25%*
Semi-public land	*15 – 18%*
Private land	*55 – 62%*

These figures will be affected by large public institutions and by the local cultural context, but are useful as a reference point. The study in Mexico (Box 6) also confirms that these figures tend to result in optimal settlement layouts.

Plot Frontage

The narrower the plots the more that will fit in a particular cluster pattern, which is often pre-defined by urban design regulations. However, narrow plots impose limitations to housing design and usually imply very narrow houses, narrow rooms with a housing expansion pattern towards the backyard, especially if minimal setbacks to allow circulation, ventilation, light and rainwater catchment are respected. It also encourages the implementation of row houses to optimize the use of land (Box 5 Ismailia).

The trade-off in terms of infrastructure costs offered by narrow plots is high, because it means a greater number of dwellings and thus more families can be served per length of networks. There is indeed an optimization of the infrastructure network.

However, in terms of land market, narrow plots may be unattractive for potential buyers due to restrictions or difficulties in developing the land. Narrow plots, however, tend to maximize the profit per plot for the settlement developer whether this is government or a private developer.

Recommendation

Narrow plots should only be used when necessary, in extreme situations, because of climatic impacts and cultural acceptance. Narrow plots should be linked to row housing development schemes, high plot coverage in case of short depth and vertical developments.

Road Width

Wider roads tend to increase the costs of plots when the trade-offs are made between the available land that was subdivided for private use and the total area for services and infrastructure. The traffic system, streets and main roads, is the most costly component in a project, especially if they are paved or surfaced.

Wider roads have a direct impact in the cost of plots. The standard of road and their dimensions also have a major impact on the costs of land development.

Wider roads increase the percentage of land allocated for public use and diminishes opportunities for land subdivision for private use. However, on the positive side, they may offer more long term flexibility as road space can have multiple uses such as transportation, parking, play area, work area and social meeting space. Brasilia provides a negative example, and India a positive case.

Recommendation
Planners must always minimize the impact of the costs of the road net in the total project cost. A combination of pedestrian routes, exclusive access for local traffic and main vehicle roads must be linked with an efficient settlement layout. The width of roads must reflect the estimated density of pedestrian, private vehicle and public transport traffic.

Density and Plot Layout
We have seen that the plot dimensions (length and width), infrastructure standards (road width, infrastructure networks, regulations) and settlement layout are important variables to define density outcomes and to achieve efficient utilization of land and infrastructure. Dowall and Clarke argue that plot frontages of 4 – 4.25 m and plot areas of 35 m^2 are the most profitable figures for residential areas in Asia. This may be true from the economic point of view, but will certainly fail to be culturally acceptable in many other contexts since it automatically forces the design of row houses and induces vertical housing extensions. The urban densities derived from these plot areas and housing typology will bring residential densities to very high levels which may not suit all countries.

The size of residential plots in many African countries exceeds 250 m^2, a factor that differs greatly from other parts of the world and influences density outcomes. Certain traditions affect these outcomes such as the need for private open spaces in the vicinity of the houses, large houses and plots and the traditional use of these spaces. Assumptions that these standards are unchangeable are questioned by an examination of what is happening in African cities. In Harare, there is a densification process through informal occupation of gardens of formal subdivisions. In Nairobi, there is a transformation of single storey developments into multi storey buildings.

Recommendation
Before deciding upon a specific plot size and shape for new developments or land regularization, settlement planners and urban designers must consider both local housing affordability limits and land prices stipulated by the real estate market. This decision should be balanced with cultural practices and local values. In new developments, it is recommended to establish different plot sizes according to the profiles of the target groups provided that the layout achieves the most desirable economic efficiency.

Density and Optimization of Land Use
Studies carried out in urban centres in India indicate that present urban growth rates are putting an explosive pressure on available land. There is a decrease of per capita land available and therefore a need for a more intensive utilization of land. One of the prime concerns expressed by HUDCO's study is to achieve higher levels of density[5]. It is argued that there is a multiplying effect from this: an optimal use of land, a reduction of shelter costs per unit and stabilization of land costs. There is a need to assess possible shifts from low rise, one storey, one family housing development to high rise, multi-storey, multi-family housing (See Box 8 Bombay).

Experimental designs based on a minimum dwelling unit of up to 30 m^2 used cluster layouts to provide density outcomes of 280 dwellings/ha with two storey dwellings, up to 600 dwellings/ha with 5 storey walk-up multifamily buildings. It is difficult to assess whether these are realistic and culturally acceptable for the Indian context, but the shortage of urban land and housing requires an urgent and sustainable approach to the planning and design of housing.

Recommendation
High density schemes require special attention to commercial spaces and the balance between open and occupied spaces. Designers must carefully assess all possibilities and trade-offs to reach optimal use of available land and infrastructure while producing pleasant and sustainable urban environments.

Density and Land Market
Some studies and examples from Seoul show that restrictions in the land delivery system and by-laws and planning control on densities of residential development greatly affect land costs (Dowall and Clarke, 1991). Specific regulations on zoning, urban standards, plot layouts and building setbacks can severely reduce available space for residential development, but the ultimate im-

Box 7 Density in Dodoma, Tanzania

In the new town of Dodoma, the Capital Development Authority recommends desirable residential densities between 12.5 and 35 dwellings/ha. The CDA advocates compact communities where most effective use of roads, infrastructure and land can be accomplished provided that next to efficiency and economy, the housing schemes should offer privacy, pleasant living environment and recreation facilities. The CDA set the conditions and criteria for urban development standards in the city which is based on plot sizes, minimum plot widths, setbacks, maximum densities and plot ratio coverage (CDA, 1980). It is interesting to note the contrast with densities recommended by HUDCO for India. The settled part of Dodoma had a gross density of 4.2 housing units/ha in 1974, a net density of 9.2 and population density of 88 persons/ha. In its attempt to control housing developments, the CDA established a density of 26 units/ha in row housing developments with a minimum plot of 225 m^2. Densities can vary from 7.5 units/ha for detached houses built in 1,000 m^2 plots to 16.5 units/ha for semi-detached houses built in 425 m^2 plots.

5 HUDCO-Housing and Urban Development Corporation, (undated). "Optimising the Density in Residential Settlements – An analysis of physical parameters", New Delhi, Design and Research Series no. 7.

Box 8 Bombay, slum rehabilitation programme

Greater Bombay has a population of about 12 million. Downtown land values are reputed to be the highest in the world. Densities are high and any unused land tends to be occupied by informal development. Pressures are increased as the centre of Bombay is an island. This means that there is both high pressure for development and very limited options in terms of space. One major innovation was to promote a very large scale development at New Bombay. However, New Bombay is far from existing sources of employment, and the opportunities developing there are formal sector and of limited use to the poor who are crammed in high density shacks along railway lines, on sites reserved for government projects or sleeping in the streets. An approach with considerable potential, but not without risks of its own, is now attracting a lot of interest.

The programme aims to re-house squatters in or close to their present location in accommodation built by the private sector. The motor of the scheme is the offer of increased allowable Floor Space Index (FSI) from the normal 1 to 2.5. This can be used on another site within limits set by government. The additional value of the permission is sufficient to make it worth building the new units, though they are small and there are doubts about their suitability for all families affected.

The high land market and potential profit from the programme seem to be attracting considerable interest – though detailed figures were not available. Developers express satisfaction and the intention to carry out further projects. The advantage of private developers or "builders" is that they bring in capital and are able to arrange permissions quickly. On the other hand there does need to be an effective mechanism to ensure quality in design, layout and construction – as is likely that there will be considerable pressure to minimize on these.

pacts will greatly depend on controls and constraints related to high density developments. The process of deregulation of building codes and regulations in Bogotá resulted in increasing building densities. Bangkok experiences greatly rising densities as the house types change from small town houses to 4 to 5 storey multifamily buildings. Because prices of residential plots have gone up, housing supply moves to peripheral locations; project sites areas have decreased by more than half and consequently are more dense, reaching 56 dwellings/ha in comparison to 35 dwellings/ha. These cases show that there is a strong ralationship between the land market and residential densities, which can be seen in other cities, such as Hong Kong.

Recommendation

In the absence of sufficient developed and serviced land, planners should search for alternatives within the city where increases in population and in the built-up area are environmentally, economically and culturally acceptable. Urban designers should search for appropriate architectural and urbanistic solutions, combining vertical and horizontal densification with diverse land uses, that can alleviate the impact of increased building densities.

4 Management and Legal Implications

The effectiveness of development guidelines and regulations is limited by the degree to which governments can enforce or influence the enforcement of decisions. There are four main stages in development, each of which has a different degree to which government has a control.

Subdivision
Government normally has control through laws and regulations unless development is informal.

On-plot development
Forms of control include on-site inspections, penalties, licences and taxation. Experience shows that even when these mechanisms and regulations exist, some individuals and private developers find ways to get around them.

Building use
This is the most problematic area to control. In most situations this cannot be controlled, as urban development needs and priorities are subject to rapid change. Many slums, particularly in Europe, United States and Latin America were a result of internal subdivision of individual, often large, houses and the emergence of multifamily occupancy.

Change of existing buildings and use
Government may wish to influence existing density patterns. This may be stimulated by what is considered over or under use of certain areas. Where controls are enforced, then regulations relating to, for example, increase in allowable building through increased Floor Space Index, can be very powerful. Bombay and São Paulo are examples of this situation.

For these reasons it is very difficult to control population densities. Building densities are easier to control and manage than population densities, but either would have to be supported by political will if they are to be enforced. In cases where the housing market is restricted it will normally not be possible to enforce.

Guidance of density may be more effective than control. The closer to market forces a development plan is, the better the chance of implementation. For example, encouraging high density near high volume public transport is likely to work, as the interests of all main actors tend to coincide. A similar pattern can work in Brazil, in Holland and in Egypt. Partnerships between government and private sector provide an opportunity for government to influence density through negotiation.

Checklist of Tools to Influence Density

This is a list of legal and management tools that can be used to influence density.

Tool	*Advantages*	*Disadvantages*
Building regulations	Regulations can stimulate optimal use of private space and public infrastructure. There are normally existing systems of building regulation; changes can make significant difference. Makes density more manageable.	Conservatism in system may cause overcrowding if it creates barriers for developers. It may constrain development if it does not adequately reflect the dynamics of urban development. May be open to abuse.
Floor Space Index or Floor Area Ratio – increase	Relatively easy to manage. Has major influence. Can be used as a trade-off against other development objectives.	Its high value in the context of high land values make it susceptible to corrupt practices. It may overload infrastructure and public services if not carefully monitored. Does not work where land values are low.
Guided land development	Gives potential of some degree of control without high entry costs. Development standards can be easier adapted to the needs and resources of inhabitants. Easy to manage density increases in relation to infrastructure needs and demands.	Difficult to implement where land market is active as it goes against land developer interests. There may also be resistance from conventional planners. It demands a close and intensive monitoring of the development process.
Legalization of existing informal areas	Allows problems of excessive density to be ameliorated. The degree of overcrowding can be reduced. Increases proportion of land formally developed.	Requires some resettlement. High costs are involved through acquisition of appropriate alternative land, provision of infrastructure and ensuring access to employment. High density areas may be consolidated and put higher pressure on services and infrastructure.
Land sharing – or partnership in land development	Can encourage good balance between residential and other uses. It can be used as an instrument of urban equity and redistribution of wealth in cities. Can help to manage densification through development.	If not implemented under supervision of government it might cause undesirable land occupation/ use. If not carefully implemented it may cause overload of the existing infrastructure and public services.
Land taxation	If realistically related to the value of the location, land taxation tends to encourage high density in high access locations, but should be limited by zoning and land use regulations. Taxing vacant land can also encourage use and alleviate pressure on the existing building stock.	Requires political will. Where there is not clear accountability and transparency this can be a source of corruption.
Land use regulations	Define development parameters and provide guidelines for development. Provide clarity in the market and allow proper management of densities.	Tend to be inflexible and restrain development. May stratify the city and constrain access of low income groups to housing. May disrupt population and building densities in different parts of the city.
Partnerships in urban development projects	Density objectives can be balanced with private sector objectives. Optimal use of land, services, infrastructure and resources can be accomplished.	Partnerships may exclude community interests. Specific interest groups may highjack important areas of the city.
Property taxation	If up to date and implemented, taxation can be used to stimulate more intensive uses including use of vacant land. May stimulate higher densities and optimal use of land, buildings, infrastructure and financial resources.	Difficult instrument to use flexibly. Seldom popular politically
Public transport management and planning	Investment in public transport both allows and requires densification to be able to operate efficiently.	May require subsidy in interim stages.
Upgrading of infrastructure	Allows densification. Provides opportunities for improved health conditions in densely occupied areas. Allows environmental improvement. If linked with improved management and financing, this can increase sustainability of urban environments.	Can lead to increased prices of property which can go against affordability objectives. Can consume a lot of resources of local governments if not done under strict supervision and criterion.

Box 9 Density management in São Paulo, Brazil

With a population of about 9.4 million (1991) living in an area of 149,300 ha and a density of 63 inhabitants/ ha, São Paulo is one of the largest cities in the world. Greater São Paulo, with 38 municipalities, is expected to reach 25 million inhabitants in the beginning of the next century. In the period 1989 – 92, the city experienced an innovative planning process related to density. The increase of building densities in residential and non-residential areas was one of the backbones of a strategic urban development plan based on the argument that there are strong relations between the production of built-up space, densification and demand for infrastructure. A careful analysis and inventory of the different zones of the city was carried out to detect where the existing infrastructure and services could cope with increased density of land use. A series of indicators were developed to establish the relationship between the accepted capacity of the available infrastructure and services, and the built-up area. The existing spare capacity must be translated into potential square meters of built-up space. This densification potential was called “stock of space”.

Transport, road, water, drainage, electricity and sewage networks were systematically assessed. Transport deserved special attention since the location of origins and destinations of journeys are simultaneously affected by any change in land use. The road system of the city centre was congested and almost saturated with traffic towards the inner city, up to 2000 vehicles during the peak hour of the morning. Many passengers commuted: 30,000 passengers during the morning peak. The drainage system showed an indirect relationship with density. Increasing building densities made the urban surface impermeable, bringing flood risks. The water, sewage and electricity systems were assessed through their three subsystems: production (capture, treatment, generation), main distribution (primary network, collectors, substations) and local networks.

The plan utilized the same concept of floor area ratio used in Curitiba, Rio de Janeiro and Bombay, called locally coefficient of use/maximization – CAU (Coeficiente de Aproveitamento Unico). The plan adopted CAU = 1 for the whole urban area of the city as a unique floor area ratio. This means that the building might reach a built up area equal to the area of the plot. The CAU index relates the built-up area to the plot size and determines the area for which the building right is free of charge. The CAU was used as a starting point to define the zones possible to have increases in density (CAU 1) and those which do not fulfil the criteria. The guiding principle for densification was the availability of infrastructure and their capacity to absorb consumption increases. In general, the urban areas with poor water supply, lacking sewage, and with insufficient roads and inadequate public transport were defined as areas where it was not possible to increase densities. In an area where the limit of the infrastructure was almost reached, the plan would stimulate diversification of land use and guide the land occupation-densification. The zone presenting a low density of power, roads, public transport and a high stock of development space was defined as an area for potential densification.

The crucial innovation of the plan was the management of the stock of the space. An information system was established to monitor the registration, processing and periodic dissemination of changes in use, density and occupation throughout the 15 densification zones. The municipality would act as a bank. The stock of space would correspond to credit in infrastructure, and the consumption of space in the form of built-up area would represent the debts of the client, individuals and private developers. The local government linked this potential for increasing building densities with mechanisms to foster housing production. Density – the concept of densification – was used in a very creative way, extrapolating its pure physical planning character to create an instrument to stimulate social housing production. More recently, it amended legislation to stimulate social housing production through partnership-based urban operations called interlinked and social interest operations, very similar to the floor area ratio (solo criado) used in Curitiba. A municipal housing fund FUNAPS was linked to these operations and became an urban management tool to promote the most desirable physical and functional organization of the city. The operations are used when private land or public land has been occupied by unauthorized settlements. In both cases, the owner requests a change of the CAU of the plot where the settlement is situated or of another plot he owns elsewhere in the city. The land is carefully valued before and after interventions are carried out. Infrastructure and building costs are implemented by the owner who pays with housing units to the local government and receives in exchange densification possibilities or development rights on the plot where the project takes place or in another plot he owns.

Appendices

Glossary

Word/ concept	*Definition*
1 acre = 0.405 ha	
1 sq ft = 0.093 m^2	
Crowding	Degree to which the number of people in an area exceeds an accepted level of occupancy. "Accepted" is, of course, a relative concept depending on cultural background and socio-economic status.
Density, population	Number of persons living in an area.
Density, residential	Number of persons per unit area in residential areas.
Gross	Number of persons living in an area divided by the total area. This includes schools, public open space, roads, green areas and other facilities.
Net	Number of persons living in an area divided by the net residential area. This is the area developed with dwellings and gardens. In places with UK influence on regulation this includes local circulation including half width of surrounding roads and small public spaces.
Density, perceived	The level of density which people feel an area has. This is dependent on the individual and his/her background culture and also on the nature of the built up area.
Dwelling	Number of dwelling units per hectare.
Dwellings/ha	A housing unit originally designed to house one family.
Floor area ratio (FAR)	The ratio between the total floor area, including thickness of walls, and the total area of a plot (same as FSI).
Floor space index (FSI)	The ratio between the total floor area, including thickness of walls, and the total area of a plot (same as FAR).
Gross area	Total area including all land uses without any deduction.
Formal development	Development which is according to zoning and building regulations.
Habitable room/area	A room normally used for prolonged everyday activities e.g. living, sleeping, working.
Habitable space	Floor area in a dwelling excluding service/utility spaces (kitchen, WC, bathroom, storage, hallways).
Inhabitants/ha	Number of persons per hectare – (either gross or net).
Informal development	Development which is not according to zoning and building regulations. Normally refers to spontaneous housing and related commercial development. May account for up to 50% of development in some major cities.
Net area	Area of land or building after deduction of certain uses, such as non residential areas.
Occupancy rate	Ratio of occupants to the number of habitable rooms.
Plot coverage	Proportion of total plot area occupied by buildings.
Space per person	Habitable space available per person in a dwelling.
Sprawl	Situation where land uses occupy more land than is required.

Reference Figures Relating to Density

Continent	Country	Location/Project	Housing Typology	Gross Population Density (inhab/ha)	Net Population Density (inhab/ha)	Gross Housing Density dwellings/ha	Plot/ Dwelling Size	Dwelling Size	m^2/ person	Total Housing Units	Total Area (ha)	Total Population
Africa	Egypt	Ismaila Hai el Salaam	Walk-up flats				100					
Africa	Guinea Bissau	Guinea Bissau	Single storey detached				500					
Africa	Kenya	Nairobi				476				40		
Africa	Kenya	Nairobi				937				62		
Africa	Kenya	Nairobi, Uhuru Phase4	Row house/2 floors	312	78		71					
Africa	Kenya	Nairobi, Mathare Valley	Tenements	1600	3333		3					
Africa	Liberia	Monrovia	Site & services	174	305	25.2	163			593	23	
Africa	Tanzania	Dodoma 1974			88	9.2						
Africa	Tanzania	Dodoma recom.	Row			26	225					
Africa	Tanzania	Dodoma recom.	Single			16.5	425					
Africa	Togo	Lome	Sites & services	124	230	27	217			540	20	
Asia	Hong Kong	Hong Kong	Emergency High Rise						4			
Asia	India	Experimental-HUDCO	5 storey			600		30				
Asia	India	Rohini, Delhi	2 storey				26	20				
Asia	India	Rohini, Delhi	5 storey				26	20				
Europe	Netherlands	Amsterdam, Osdorp	Flats 4 floors			80				347		
Europe	Netherlands	Den Haag, Turfmarkt	Flats 5–6 floors			260				336		
Europe	Netherlands	Enschede, Transburg	Flats 5 floors			90				370		
Europe	Netherlands	Rotterdam, Spaanse Kade	Flats 5–11 floors			200				268		
Europe		Minimum standard	Minimum						15.8			
General	Kenya	Nairobi Mathare	Detached			270						
General		Efficient plots (Dowal)					35/					
General		Residential Density High		400		666						
General		Residential Density Low		100		166						
General		Residential Density Medium		200		333						
General		Residential Density Very High		600		1000						
Latin America	Brazil	Brasilia-Itamaraca	Detached core house	215	441	40	120	36		452	11.1	2,400
Latin America	Brazil	Brasilia-Candangolandia	Semi-detached core			36	120–250	42		2236	62.2	11,200
Latin America	Brazil	Curitiba		37								
Latin America	Brazil	Sao Paulo		63	160							
Latin America	Brazil	Brazil Official Minimum					126					
Latin America	Colombia	Medellin	Grouped house	279	574		96/43					
Latin America	Jamaica	Montego Bay	Site & services	229	468	44.2	100/			828	18.7	
Latin America	Mexico	Iztacalco	High-rise flats	405	433	77		80		5690	74	30,000
Latin America	Mexico	San Juan Aragon	Detached house	338	178		190/32.5	64		9900	193	65,340
Latin America	Peru	Lima El Agustino	Flat/row house	525	664	36/36						
Latin America	Peru	Piura	Flats	408	1949	137	76			170	1.2	
Latin America	Venezuela	Cuidad Guayana	Detached house	124	186		300/65					
North America	United States	Boston	Flat, high rise			1449						
North America	United States	Boston	Flat, row			480						
North America	United States	Boston, Cambridge Post	Walk-up flats	112	148		319/114					
North America	United States	Boston, Columbia Point	Flats, 7 floors	747	1449		78					
North America		Minimum standard	Minimum						31.6			

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