Sustainable high-density environments

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Abstract

Density is a misunderstood metric in the discussion of cities. Using a case study of a widely acknowledged high-density city, Hong Kong, this paper examines aspects of density and concludes with a proposal for sustainable high-density development.

1 Introduction

The total area of Hong Kong amounts to only 1,096 square kilometres, with only 17 percent of the land being intensively developed. Most of the urban development is concentrated at the tip of the Kowloon Peninsula and along the northern shore of Hong Kong Island. The strip along Hong Kong Island is only 1.3 kilometres wide and 17 kilometres long, approximately 22.5 square kilometres in total. This small area of land, however, houses over one million inhabitants and provides over 700,000 jobs [1]. It is therefore, not surprising, that Hong Kong has one of the world highest densities in the world, after Macau and Monaco. And although high-densities are often associated with negative aspects, the attraction and success of Hong Kong is due, in part, to its high densities.

Squashed in between hills and a harbour, Hong Kong is one of the most distinctive places in the world. It is endowed with remarkable topology, combining the sky, the sea, and the land in a rich, three-dimensional mix that leaves you thinking about the fascinating juxtaposition of intense habitation and natural beauty. Population densities in Hong Kong are six times higher than those in European cities and thirty times higher than the densities of cities in the United States [2]. This extreme density has its problems, but surprisingly, it has several substantial positive outcomes. To reach these densities, the city form is more compact, with the result that facilities of all sorts are within easy reach of a huge proportion of the population. With many people being within their catchments areas, urban transportation systems are heavily used, helping to make
the bus and subway systems among the most profitable in the world [3]. The high-density contributes to the vitality of Hong Kong in less quantitative ways as well: it supports the astonishingly rich street life, a source of entertainment and relief to residents as well as being one of the most popular tourist attractions.

The topic of dense urban settlements is much debated. While it can be argued that Hong Kong is unique and not a subject for repetition, there are lessons about high-density to be learned by examining the city. In particular, the term “dense” can be examined from several perspectives. This paper will consider dense in terms of the interpretation of the term, notions of overcrowding and opportunities for diversity; the paper will conclude by proposing a working concept for density that is applicable broadly.

2 Defining density

Density is one of the most important aspects of urban design since, without sufficient population densities, an urban area will not be able to survive [4]. Commonly, we refer to the density of a location by using the metric of residential population per area of land, such as people per hectare. This measure, however, is inadequate.

The concept of density is well understood in the disciplines of chemistry or physics where it is defined as the ratio between a mass and its volume, often with reference to the relative density of water. In contrast, habitation density in urban settlements has no common meaning and can be interpreted in different ways by sociologists, geographers, and planners.

This is most common way of calculating population densities used above, however, is problematic, as Carnahan et al. [5] have recognized. As they note, population density is a composite of several different measures of land use and can be described by the following equation:

\[
P/A = (P/R) (R/D) (D/S) (S/N) (N/A)
\]

where:
- \(P\) = population
- \(A\) = area
- \(R\) = number of rooms
- \(D\) = number of dwellings
- \(S\) = number of residential structures
- \(N\) = net residential area

thus
- \(P/R\) = persons per room
- \(R/D\) = the average number of rooms per dwelling unit
- \(D/S\) = the average number of dwelling units per structure
- \(S/N\) = the number of structures per unit of land
- \(N/A\) = the proportion of the area used for residential purposes

Almost all research on population densities that has been carried out has treated all the above components separately [6]. As a result, we have no basis on
which to make comparisons between, for example, living in overcrowded conditions and living in isolation. Without a common definition, it is difficult to engage in discussions of cultural adaptations to density and of how adaptations to different levels of density may be effected.

Density only takes on a real meaning with reference to a scale [7]. For example, we can assume that three people doing clerical work in an office can work in reasonable comfort in a room of fifteen square meters with a common density of five square meters per person, but two hundred people in an auditorium or four people sleeping in one room may not feel that comfortable with the same common density. People in the auditorium may feel isolated and people sleeping in the same room may feel overcrowded [8]. Likewise, 40 people living one above the other on forty floors each with an area of 10 sq. m. will find it less dense that 40 people standing together in a field of 10 sq m.

In this paper, we will develop the concept of density with reference to the three dimensional nature of spaces inhabited and will not consider the density as calculated on plan. Densities have been for far too long represented as two-dimensional data. In order to understand the true impact of density, density should be read in section, not in plan.

Whether section or plan, however, this definition of density is also inadequate. The density in the location is changing dramatically in the space of 24 hours. The density of a dormitory town can measured by the number of people who nominally sleep there, but the density will not be true when everyone goes to work. We can observe dramatic changes in pedestrian density during the office hours and during non-office hours in many city centres world over. Certainly we observe great differences in pedestrian densities in the new housing estates and new satellite towns in new developments in Hong Kong. In other sectors of Hong Kong, however, we notice that the density of the street does not vary tremendously during the day, the number of people is high for much of the day.

In conclusion, we suggest that density should be measured as a four dimensional metric, considering the number of people within a given volume of developable land and air space over a period of time. It may be desirable in some circumstances to consider diurnal variations while at other times a weekly or annual variation maybe more appropriate. Density can not, however, be meaningfully engaged if it is simply represented as a measure of number of people resident over night on a given patch of land.

3 Overcrowding

Density is commonly associated with overcrowding. A number of different measures are used to state how crowded a place is: people per room; people per apartment; apartments per buildings; and building per hectare and it has been identified [9] that the strongest relationship between the measure of people per room and indicators of social pathology, thus emphasizing the importance of interpersonal aspects of density. Thus, it can be concluded that a perception of overcrowding is not as much a problem of numbers but of distribution. We can
simplify this by saying that perception of a lack of space being available for given activity may lead to the feeling of overcrowding.

There are cultural factors as well. Individuals do not react in the same way to densities; their response depends on the circumstances [9]. More recently, research [10] has suggested that high-density living can lead to stress and anti-social behaviours and attitudes. These findings are numerous enough not to be ignored or dismissed, but there are also findings that refute these conclusions [11-13].

High-density and overcrowding are often confused and considered to be synonymous. Negative connotations of overcrowding are then transferred to high-density. A distinction must be made therefore and it must be clearly understood that high-density means a large number of people or dwellings per space/time measure while overcrowding implies too many people in a single unit of space for a particular activity. Density is thus a physical concept devoid of psychological implications; crowding is psychological state, a subjective and experiential process [14].

Crowding is an emotionally charged topic and has, by inference, emotionally charged discussions of density. Earlier work on density reported on the behaviour of rats living in crowded conditions. The outcomes were striking; behaviours observed included aggression, sexual deviations and cannibalism [15]. The results were soon begun to be extrapolated to speculation about human behaviour in similar conditions [16-18]. Popular sentiments were reinforced that cities were situations of overcrowding which led to unsocial behaviour and therefore the urban life was doomed [19].

In our consideration of high-density cities, however, we reiterate that crowding is not as much a problem of numbers but of distribution. If we consider crowding in purely physical terms, a lack of space will be the only important element. Perception of crowding always indicates a negative feeling rather than a report of density [20]. But whatever theory we decide to follow one thing is certain, that high-density may lead to overcrowding and therefore have a negative effect on environment. A body of research on high-density residential environments indicates, that lack of consistency or “fit” between architectural and behavioural systems can result in the experience of crowding, interpersonal avoidance, and social isolation [21]. When architectural design of high-density makes the formation and evolution of residential association patterns and social groups more difficult, it becomes hard to satisfy the residents [22]. Thus, high-density is achievable without overcrowding.

4 Diversity

It is commonly assumed that high-density settlements lead to diversity of habitation. The major influence, however, is not density but zoning. If diversity is defined by a concentration of people, this does not mean that a concentration of people will automatically be able to create diversity or activity at the street or podium level. The relationship between densities and the production of diversity is a very complex issue and cannot be treated as a simple mathematical equation.
It is possible that in order to achieve greater diversity, some dwellings in a district will need to be supplemented by other primary uses, like work, entertainment, or shopping, so people on the streets will be well spread out through the hours of the day. This will lead to a further intensification of the land and a further increase in diversity [2].

Our cities much too often fall victim to zoning laws which encourage sprawl and segregation of the home, shops, and the workplace. There are laws forbidding us to put apartments above stores, or mix factories and office blocks together, although we all know that mixing stores, homes, and offices creates a more diverse and stable human realm where the spheres of life are not geographically separated and fragmented. In reaction to the sterility of simple zoned cities, complexity is proposed as one of the most important goals of urban planners, together with flexibility and identity [23]. Flexibility could further be described as one of the conditions that facilitate urban life and progress. Complexity, on the other hand, is a mixture of functions, densities, and changeability, and the capacity to alter the course of time. As a result, it is possible to add new layers to existing urban structures [23].

Density and economic success are often associated. Quigley [24] emphasizes the role of diversity in enhancing economic efficiency. The advantages of urban diversity, which are frequently called “urbanization economies,” are found in the writings of Jacobs [25]. In her work, Jacobs describes a few examples where diversity facilitated innovation through the borrowing of processes from other sectors. The same ideas are found in the work of Glaeser et al. [26]. Kelly and Helper [27] show how diversity can encourage innovation in cities, and how narrow specialization can hinder it. However, surprisingly, there is no appropriate theoretical framework for urbanization economies. As a result, there is no framework in which to compare the relative advantages and disadvantages of urban diversity and specialization, and to study their role in shaping urban systems [28]. Duranton argues that in some instances, diversity is more important, while in others, specialization matters more. He also points out that the large body of empirical literature on diversity and specialization in cities reaches seemingly contradictory conclusions [26, 29, 30].

One reason why the old parts of Hong Kong function so well is found in their mix-use development [31]. In these parts of town, shops and restaurants can be found not only on the ground floor but also frequently on the upper levels of buildings. Some of the new developments follow the same principle. For example, in Times Square, shops, restaurants, and fast-food outlets are located on two underground levels, then follow a further ten stories of shops with four levels of restaurants above these shops, and then some office blocks are above the restaurants. In the older parts of town, nearly all residential buildings have shops, offices, or restaurants located at their lower levels, and residential apartments above. This kind of development helps the city to retain its vitality and excitement throughout the day and sometimes through the night. Places that have nightclubs, karaoke bars, and such like, offer a twenty-four-hour cycle of activity. Residents in these older parts are usually content with the environment, which offers them all the necessary facilities within walking distance and a
thriving community life [31]. Many live and work within the district and some very rarely leave it.

5 Effective land use

Traditional oversight of land development has relied on controls such as zoning and plot ratio. These systems have not been effective when creating high-density environments as they remain focussed on singular parcels of land and do not provide a systemic control. Typical of a development situation is the example of Central Plaza in Wanchai, Hong Kong where the goal of producing a remarkably tall building (included in the world’s ten tallest buildings when built) was achieved by assigning a significant portion of the parcel to public pen space and thus pushing the permissible lot ration higher to achieve the final height. This public open space is bleak, adjacent as it is to a very tall isolated structure. As a result, the space is little used and the city inhabitants do not benefit from an area that is notionally for their use. This type of the development is increasingly common in Hong Kong and it has very little to do with traditional Hong Kong urban structure.

Layering, superimposition, co-existence of unlike parts, and collage are long-standing features of Hong Kong’s environment. They are very different from Western rationalism, which is becoming increasingly irrelevant in the chaotic and fast-changing Hong Kong of today. Layers are constantly added on top of layers of the urban structure of Hong Kong to accommodate activities, interwoven with one another and justified by the way they involve people, are a common characteristic of Hong Kong’s urban form [32]. When describing Hong Kong, one cannot help being reminded of Christopher Alexander’s essay “A city is not a tree.” In this essay, Alexander argues that Western modern cities lack “a level of complexity necessary to sustain a legitimate urbanity” [33]. He believes that this is due to the hierarchical organization and configuration of the city, which he calls “a tree.” Alexander analyzed a number of modern city designs including the Greater London Plan (Abercrombie), Mesa City (Soleri), the Tokyo Plan (Tange), Chandigarth (Le Corbusier), and Brasilia (Costa) and concluded that closed urban systems, such as those mentioned above, limit urban choices by imposing a strict hierarchical order of spines and roots. Alexander believed that hierarchy, prescription, and exclusion are disturbing effects of modern urbanism. In his opinion, cities are more like semi-lattice structures that can be understood as a set of landscapes.

We find a similar theory in Kurokawa [34] where a comparison is drawn between a tree and a rhizome structure. A tree is a structure with an artery and sub-branches; if the major artery is cut, then none of the sub-branches will be able to survive. The possibility of connection between the branches also does not exist. Small branches cannot grow straight from the trunk; growth occurs in a highly ordered manner. By comparison, a rhizome has no hierarchy, either horizontally or vertically, and there are always possibilities for connection between any parts of the system. A rhizome is an interwoven complex of heterogeneous parts that exist without a centre. It is forever changing and is able
to extend in any direction. It is possible that Kurokawa is drawing upon the work of Deleuze and Guattari [35] where “theory has been aborted in favor of the shifting layers and boundless interconnectivities of the rhizome”.

Our cities, however, do not develop in a linear process and therefore cannot be designed in a linear way. Hong Kong older parts are incomprehensible within Western frameworks with their complexity, artificial landscapes, movement corridors, and an interwoven complex of heterogeneous parts. The ever changing, and forever reconfiguring features of this urban landscape come close to Kurokawa’s ‘rhizome’. In other fields, the hierarchical approach is rigid, inflexible and susceptible to systemic failure. By contrast, rhizomic structures have been found to be a robust form, for example in computer networks and social systems [36].

In planning, the hierarchical approach encourages environmental determinism which fails to support rapidly evolving uses and leads to inefficiencies. Effective land use can only be achieved with the elimination of land wastage and the use land for more than one activity. Stacking up various functions on top of each other may answer the problem but we can develop it further by trying to design not for one specific activity but for few that can take place in the same space over different times of the day. This type of the development may lead to space production instead of space consumption.

What is needed is a different mode of urbanism, less designated, less designed, and less regulated; instead we need a system that facilitates adaptability, temporality, and reconfigurability, in summary, more habitable. It is a system that allows extreme mixes of programs leading to the creation of complexity and diversity similar to those found in the older parts of Hong Kong, unlike that applied in developments built in recent years; a system that facilitates provision for higher densities and much higher land intensification.

6 Sustainable density

High density can only be effective when it is developed on the understanding of density outlined above as a four-dimensional metric. Sustainability is only possible when the density is predicated on economic effectiveness, and that in turn based on diversity of function.

Density without doubt is the most important aspect of urban design, for without sufficient density a city, or an urban area will find it difficult to survive. The high concentration of people in the small area is a very nature of urbanity. However, when we talk about densities we must remember that densities have four dimensions not two. Densities need to be understood not only in term of number per unit of space, but also as an area available per person and as a number within 24 hours cycle. When talking about densities we must not confuse high-density with overcrowding. Overcrowding is not a problem of numbers but of distribution. If overcrowding is perceived in purely physical terms, the lack of space is the only crucial element. Over-provision can also have a negative impact. When we design for high density we need to remember that diversity is one of the most important and necessary element for city to flourish, but high-
density does not lead to high-diversity. No concentration of residents is sufficient if diversity is suppressed or thwarted. If complexity and diversity is one of the main goals, then flexibility has to be designed as one of the conditions which will help urban life and progress. As a result, it will be possible to add new layers to existing urban structures. The multi-use and multi-layered city could be the answer to the problem since mixture of functions and densities, able to alter over time, can produce a lively and exciting urban environment.

Koolhaas [37] has described the architecture of Manhattan as “the paradigm of the exploitation of density. The culture of congestion is the culture of twentieth century.” I am sure that the culture of density will become the culture of 21st century. Increasingly, few places can afford wastage of any land, a situation Hong Kong arrived at many years ago. Beyond the demand for land, however, we need to think about how we can produce more space, especially public space and space for recreation, through development. We need to consider development opportunities as an opportunity to balance land use and, through appropriate balance, achieve greater intensification of land use.

References


