Is Our City Livable and Healthy in the Post-SARS Era? Re-designing Healthy Cities – a Lesson from Hong Kong

Lau, S. S. Y.

Research Group on Sustainable Cities, Center of Architecture and Urban Design for China and Hong Kong, The University of Hong Kong

Abstract

The paper draws an attention on the academic debate on the pros and cons of compact city, one that embraces a high-density and high-rise, mixed land-use urban form. The paper supports compact city as a candidate for sustainable urban form by reviewing and discussing recent new initiatives from Hong Kong in the post-SARS era that includes research and development efforts by academia and governments on the evaluation and derivation of guidelines for design implementation and building management operations at the urban design and building design levels. Similarly, innovative initiatives are also found in the collective efforts by statutory bodies, developers and professionals to improve the standard and quality of the habitable environment. The discussion is based on selected case studies from recently realized projects in the residential market; as well as applied research programs undertaken by universities and government. The summary is that recent efforts in Hong Kong show that there is confidence for a high density compact city to be a livable and healthy city. In the paper, the reference to 'health,' 'hygiene' or 'healthy buildings' is a causal usage. The three terms project a layperson's perception of the quality of the physical environment. In this way, the terms have no specific medical connections.

Keywords

Healthy City
Healthy Building
Sick Building
Evaluative Tools
Re-entrant

1. Background

1.1 Urban Context of Hong Kong

For ecologists and scientists who are concerned with the sustainability of the built and natural environment, one of the great achievements of the 21st century is unarguably an awakening that the incessant increase in human population and expansion of cities are the primary reasons for the ecological unbalance of our planet's life support system. A detrimental impact caused by population expansion is the irresistible temptation (economic benefits) from urbanization, characterized by a concentration of urban population, displacement of agricultural and farmland at a rapid pace since the last century [1], as well as the growth of infrastructure construction such as airports, container ports, highways and intercity fast speed trains. Hong Kong, one of the world's megacities [2], offers a unique model of a sustainable urban form via a mixed land-use and hyper-urbanization for most developing cities, notably those Asian cities. Hong Kong presented an alternative model for urban planners, managers and administrators, in terms of land resource, because of the hilly terrains, approximately 22% of Hong Kong's overall land area is urbanized and intensively developed, leaving remaining land area as designated country and marine parks, constituted by negligible agriculture, pastures, mountains, barren islands and waters. On the other hand, population growth for Hong Kong is driven by immigrants from the bordering Mainland China [3], which is responsible for a population increase of one million per decade until recently [4]. The challenge for Hong Kong is the fact that over half of its population lives and works in urban centers that intensify building and economic activities in the inner city; as a result, population density reaches around 46,000 people per square kilometers in the densest areas, contrasting with an overall average of nearly 5,000 people per square kilometers [5]. The continuous problem of land scarcity and increased population growth leave administrators and planners with little options but to embark on an unprecedented choice of urban form, that of a hyper-density city.

1.2 Challenges for Hyper-urbanized Cities: SARS and Built Environment

Recognized as a plausible and emerging alternative to urban sprawls, the high-density and high-rise urban experiment of Hong Kong is reckoned to be a positive contributor to the research on sustainable urban form [6]. Described as a Compact City, Hong Kong is experiencing an urban life rhythm shaped by convenience and efficiency because of proximity–living closely together. However, Hong Kong's approach for a dense, high-rise and massive built form yields potential threats to its overall environmental quality. In 2003, the World Health Organization (WHO) warned that, due to concentration of urban population, "traditional environmental risks such as high poverty incidence, malnutrition, dysentery, skin and eye infections, and other water-sanitation-related diseases are exacerbated by modern environmental risks such as exposure to hazardous and toxic substances, industrial water pollution, air pollution from industries and vehicles, noise, and stress due to lack of space and life style." Thus, the WHO remark on 'lack of space and lifestyle' coincides with the threats exemplified by an urban scenario such as Hong Kong's.

More significantly, the outbreak of Severe Acute Respiratory Syndrome (SARS) epidemic in March 2003 in Hong Kong and cities alike highlighted

a concern for urban health risk caused by fast spreading diseases promulgated by certain unfavorable features in the physical environment. For instance, field visits by the WHO confirmed that there is an inseparable relationship between physical environment and health hazards. The statement has subsequently prompted a shift in focus by local government, developers, professionals and researchers on improving the physical design of the urban environment, and jump-started a collective effort to reduce environment-related health hazards attributed by overcrowding and ultra density.

Overcrowding and ultra density is a common feature of many emergent and expanding cities in Asia. Again, taking Hong Kong as an example, since the 1970s, Hong Kong residents have assimilated with a compact way of life. In Hong Kong, a common housing form is a private residential estate, which typically includes ten or more number of towers each as tall as 40 stories or more and housed up to eight family units per story. These multifamily residential towers, for convenience sake, are often built on the roof of a shopping mall which is also a giant elevated garage for private cars with its ground serviced by Hong Kong's well known and efficient public transportation network. Despite the crowdedness and ultra density, the so-called compact city and unchecked concentration of population resulted from a mixed land-use planning approach produces a dynamic lifestyle that attracts tourists and field researchers to appreciate the workings and advantages of a compact city form such as Hong Kong's for the vibrancy, vitality and excitement found in a lifestyle that is comparable to Soho, New York or London [7]. However, housing conditions in Hong Kong compared to other cities are very poor. Housing size in Hong Kong is smaller in relation to other cities or countries, with a smaller internal floor area per person. For example, according to a research on housing standard of private dwellings, carried out by the Research and Library Services Division of the Legislative Council Secretariat in 1999, Hong Kong's private housing standard was very low: it is estimated that average saleable area of 15.6 square meters per person is lower than the minimum space standards of 21.34 square meters and 18 square meters per person in the UK and Japan respectively [8].

But the SARS episode shows that there is a negative side to the dynamic and lively otherwise desirable compact city. Typically, as many as 10,000 or so residents are found to inhabit a housing development (estate), equivalent to one or two townships by European standard. The residents live closely to each other while enduring the claim that there is hardly any privacy, open space, sufficient daylight or natural ventilation by world standard such as the American Society of Heating, Refrigerating and Air conditioning Engineering ASHRAE or Chartered Institution of Building Services Engineers CIBSE. For instance, the author coordinated a series of field measurements during the year 2003 to 2005 that measured as low as 30 lux as an average daylight level or 0.3 percent daylight factor in a kitchen on the lowest floor of a 30–to–40-story apartment building falls short of the world's norm of 1 to 2 per cent daylight factor [9]. The deprived environmental qualities of the high-rise apartment towers could be attributed by a planning policy that advocates a high-density approach; the permissible plot ratio is as much as 8 or 800 per cent floor-area ratio for residential development. As a result, virtually all residential sites in Hong Kong adopt a stacked up and packed design concept resulting in many high-rise apartment towers.

Because of the local building regulations that require externally faced windows for every room in a family unit in the high-rise towers, bedrooms and living rooms are customarily and preferably planned to face outwards for access to daylight, ventilation, views and so on. All seems fine except their kitchens and bathrooms are typically grouped together to have their windows facing onto an open shaft or a light well technically known as a 're-entrant [10]' in the bye-laws. The rationale is to hide the utilities, laundry, air conditioner systems, and kitchen exhausts for the sake of aesthetics. On closer inspection, the SARS outbreak was associated with the poor qualities of daylight, ventilation, and maintenance of exhaust fans, plumbing, drainage pipes and condensers of air conditioning units in these 're-entrants.' The re-entrants are a prime suspect for the spread of SARS in a number of poorly maintained housing developments. In this way, the re-entrant has become a culprit identified for further study of a remedy to the health concerns of built environment. The association of SARS disease with the depletion of the outdoor physical environment in a compact city design prompted the search for a 'sustainable and healthy urban building form' to pave the way forward for those densely populated cities.

2. Shifting the Attention from Building to Outdoor Built Environment

Relatively recent, researchers [11] have highlighted the significance of an integrative approach incorporating urban external factors. There is a need for researchers and designers, especially urban designers to work with climatology and related specialists to devise means to design effective urban morphology [12]. Although there is a fair amount of research work on the 'health issues' of building at an individual basis, (there have been) very few researches on the impact of man-made factors... especially at urban scale [13]. Clearly, this view coincides with the WHO observation that there is strong interplay between buildings and their immediate surrounding as demonstrated by the SARS incident. Soon after the SARS attack in Hong Kong, practitioners and research investigators became interested in urban experiments in order to diagnose the interactions between urban and building design variables from an environmental and health point of concern, trying hard to find a quick fix.

2.1 New Initiatives from Hong Kong

2.1.1 Daylight and Building Design

Examples of one such experiment is the review of daylight – quantity and quality of the so-called 're-entrant' as a built form descriptor – Figures 1a and b: daylight study from a physical and psychological health point of views. Researchers led by the author investigated the ways to improve the provision of daylight for habitable rooms such as bedrooms, living rooms, dinning rooms, kitchens and bathrooms under various high-rise scenarios. The study researched on the improved daylight performance by means of modifying the physical design of kitchen. The modification suggestion comes from the re-examining of the interactions of window, size, area, configuration (internally reflected component) and usage of kitchen including size and shape of the adjacent re-entrant (externally reflected component) that controls, to a large extent, daylight passage. More significantly, the outcome suggests that most local kitchens are suffering from a too small usable area and more importantly

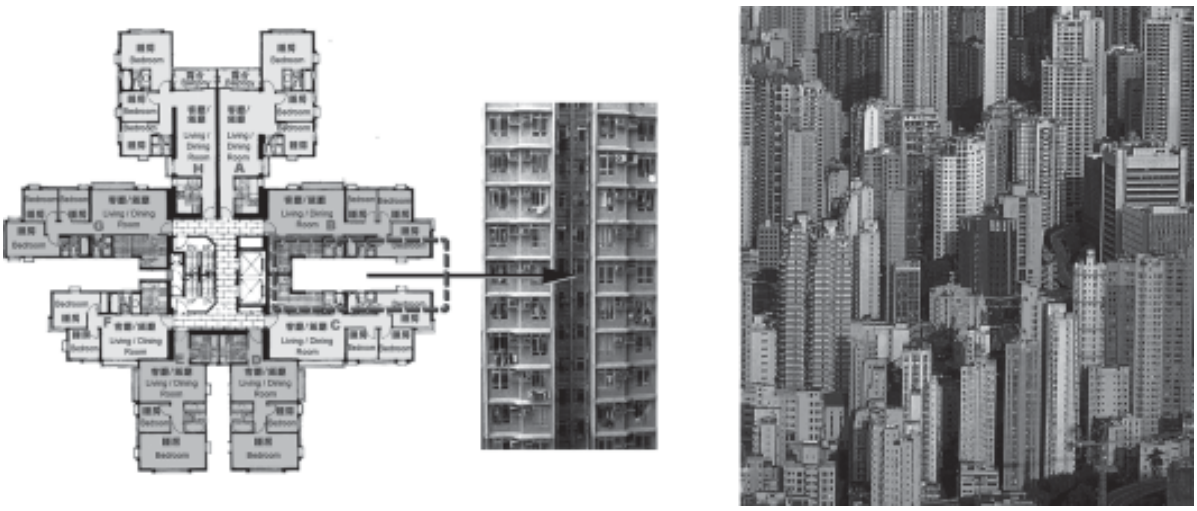

Figure 1a & b Typical floor plan showing the 're-entrant' in the elevation, and a distant view of mixed land-use (office and multifamily apartment buildings in the urban center) in Hong Kong

unacceptable room configurations and shapes because poor aspect ratios diminish drastically daylight quantity and quality. The research also pinpointed that there should be a guideline for the preferred configuration, shape, positioning and size of window. As for the review of the re-entrant, a number of innovative developers experimented an enhanced design of the re-entrant to improve daylight passage, and tried to separate those contaminants (foul air from kitchen exhausts and rejected heat from air conditioning condensers) from windows so as to reduce health threats of re-entrants (Figure 2). Other developers favor the abandonment of the re-entrant by repositioning the kitchen to the externally facing perimeter of the building (Figure 3). This relocation strategy, however, compromises building frontage for daylight, air and view privileges of all other habitable rooms – for example, a counter-argument may be constructed according to a recent lifestyle survey coordinated by the author in Shanghai involving 650 young working couples who indicate that after all, their usage of kitchen has drastically relinquished to an absolute minimal as the new generation workers prefer eating out for most meals in order to cope with the contemporary urban lifestyle [14]. From this perspective, the merit in improving daylight for kitchens by the relocation theory and abandoning the use of re-entrant raises a doubt.

Besides daylighting, there are also the emerging efforts on the study of microclimatic impacts on the overall environmental performance of urban developments as discussed in the beginning of Section 2. In the recent past years, efforts from local universities and government have targeted the values of breeze corridor, street level ventilation, heat island, green space, and topics which are related to thermal comfort, health issues (heat stress) and energy consumption (summer cooling) of the city as a whole. These efforts are seen in the increasing commissioning of contract research on the review of relevant building or planning codes, as well as the setting up of design guidelines and methodologies. The following case study pinpoints the research on urban heat island due to a compact city phenomenon – urban canyon.

2.1.2 Urban Heat Island and Outdoor Environment

In the 1970s and 1980s, many studies have come to appreciate the environmental and energy

Figure 2 A modified floor plan showing two enlarged re-entrants

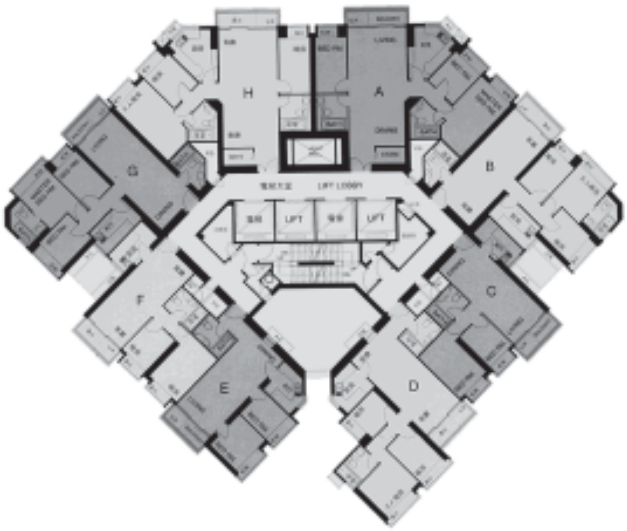

Figure 3 A latest trend in the typical floor plan for high-rise residential tower – where the kitchen is moved away from a re-entrant and shares the same view, orientation with the rest of the rooms/spaces of the same family unit

impacts caused by noticeable climate change within the cities in comparison with the rural areas. The index, known as Urban Heat Island (UHI) is in essence the consequence of a number of anthropogenic and physical factors (Figure 4). The physical factors include heat absorption, heat production, pollution, impervious surfaces, reduced ventilation and lack of vegetation in the urbanized areas. Recently, researches have shown that the geometry of urban form also has a significant contribution to the forming of UHI. Urban form descriptors include density, height to floor ratio and sky view factors of buildings that fit well with the agenda for a healthy city. For hot climate geographic zones, UHI is an undesirable phenomenon that would not only pump up energy consumption of air conditioning due to excessive heat built-up in the evenings but would also cause thermal discomfort for users of outdoor spaces. Indicated by a number of site measurements by local researchers (Figure 5), lowering of UHI will increase the human adaptability to harsh environments and reduces the dependence on high-use of air conditioning as well as promotes the use of outdoor public spaces [15].

The Hong Kong urban fabric is dominated by tall residential blocks unlike in the Northern American or European cities where most high density residential blocks cater for the under-privileged, residential buildings in Hong Kong cover both inexpensive public housing units built by the government and privately owned luxury apartments for mid to high income families. In such high-density living conditions, the provision of open space at neighborhood level would yield vital benefits, environmental and social, to the residents. The lesson from the SARS attack is that when designing open spaces, architects and planners need to consider how the overall built forms, fabric and surface materials affect the microclimate conditions of these spaces. Only when the conditions allow for human comfort is right would these spaces serve their purposes properly. After the SARS outbreak,

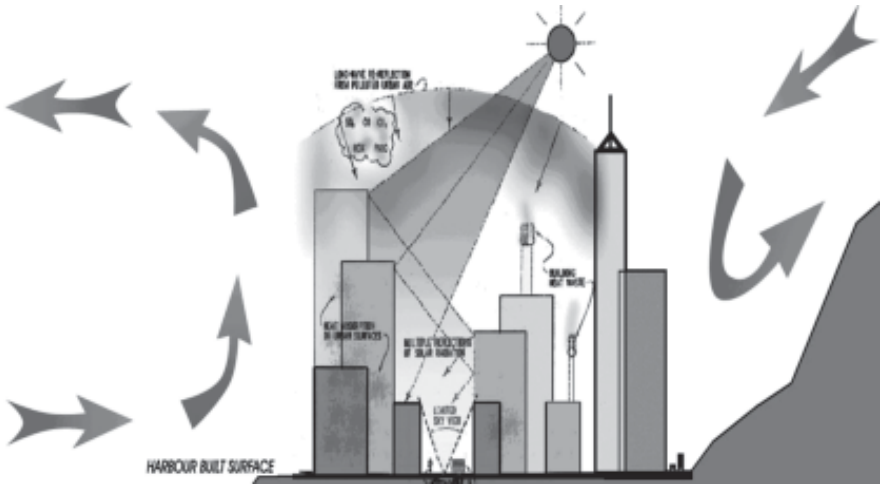

Figure 4 Urban heat island found in the urban canyon in Hong Kong

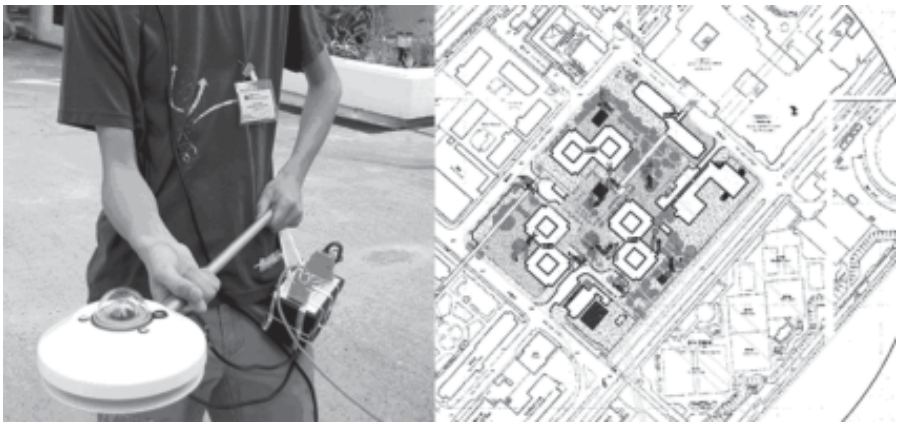

Figure 5 Measurement kits for heat island in a residential housing estate

researchers in Hong Kong have attempted to develop guidelines for better living conditions in residential areas. Research team in HKU has already started to look into built-form fabric, climatic conditions, land-use descriptor and locational aspects of housing in order to look for better design standards for a 'healthy' city. The work so far has identified 12 urban design variables, such as wind velocity in the canyon, solar radiation, sky view factor, plot ratio, location quotient and so on, as critical for a better and healthy living environment. The study by Giridharan and teams [16] indicated that a significant part of the differences in outdoor temperatures within and between residential developments can be explained by the impact of design-related variables on the overall residential environment. The work paved the way for an environmentally conscious urban design process for new housing design in Hong Kong.

2.1.3 Research and Development of Assessing Environmental Performance of Buildings and the Built Environment, the Hong Kong Story– HK-BEAM & CEPAS

Recent years saw tremendous achievements in the developing of tools that facilitate

integrated appraisals of healthy design/planning by means of an environmental based design audit process. At a macro level, there is an array of assessment frameworks for analyzing healthy buildings and environments, such as Environmental Impact Assessment (EIA), Environmental Health Impact Assessment (EHIA), Risk Assessment (RA), Environment and Natural Resources Accounting (ENRA), and Strategic Environmental Assessment (SEA). In the field of architecture, for instance, there are assessment tools such as the Green Building Tool developed by the consortium of international researchers under the auspices of the International Initiative of Sustainable Built Environment (i.i.S.B.E.) based in Canada. The tool aims at six main environmental issues, covering 'resource consumption,' 'loadings,' 'indoor environmental quality,' 'quality of service,' 'economics,' and 'pre-operation management.' Other well known tools that adopt similar criteria are the LEED program of North America and the BREEAM framework of the UK, plus many similar evaluative tools in the Scandinavian and Central European countries.

As early as 1996, Hong Kong has introduced a set of Hong Kong Building Environmental Evaluation Assessment Method (HK-BEAM) which was originally developed upon the BREEAM framework. Up to date, HK-BEAM has undergone several major revisions and updates by local researchers to cope with the dynamic changes in the complex requirements and concerns in the local real estate market. Despite continual promotion and operation of the voluntary evaluation system, there are about 120 new and old buildings that have been assessed over a decade, a figure that is somewhat inproportional to the immense volume of activities in the building industry over the same period. In 2003, the government in its support for sustainable development of the building industry initiated a consultancy study to bring home a brand new assessment system known as the Comprehensive Environmental Performance Assessment Method (CEPAS). The coexistence of two evaluation tools for a single and monotonic market sparked off domestic debates for duplication, in efforts, marginality merits and seeks justifications. Meanwhile, the unexpected outbreak of SARS 2003 prolonged the scope and extent of the consultancy study and delayed the full-scale implementation of CEPAS as a design and evaluative tool up to this date.

In essence, these tools referred to in the preceding paragraph deploy a multi-criterion evaluative approach based on international, regional, and local parameters, and most significantly engage a wide body of stake holder right from the beginning of the research and development stage to develop the relative weighting for benchmarking. As far as the dispute of the parallel existence of two evaluation tools for a relatively small market, the author sees that the real problem lies in a struggle to introduce a mandatory tool versus a voluntary tool, as recently in force by the Japanese Government for certain sizes of developments [17].

The need to engage the wide spectrum of stakeholders for mutual benefits (public and private sector) was echoed by a WHO's reminder in 1996: "What is more important for health as well as for environment is not the speed with which cities are growing but the extent to which effective local responses are developed from all sectors and possible resources." Reports by WHO point out that "One of the most important mechanisms for integrated planning and implementation is that of networking across sectors, groups, cities and even countries." Internationally, such networking has

already started. Environmental NGOs, for example, have established national coalitions as well as regional and global networks. City-city linkages such as CITYNET, the Intercity Network for Sustainable Development and the International Cooperation Network of Asian Cities, as well as the International Initiatives on Sustainable Built Environment iiSBE have been organized. For Hong Kong, there is a simultaneous proliferation of NGOs over the years whose main concerns have been connected with sustainability; for instance, the Hong Kong Professional Green Building Council (PGBC), the Conservancy Association and the Green Council that cover broadly the three respective groups of stake holders – the professional consultants, the community interest group, and last but not the least, the building industry interest group.

3. The Relationship between Healthy City & Healthy Building

Levin [18] highlighted the scientific view that it is more than likely that with good design, construction, and operational practices, buildings can provide healthy indoor air quality with far less outdoor air ventilation than is commonly recommended and even required. But in order to protect people in the buildings suffering from adverse pollutant sources and in buildings where design, construction, or operational practices are of poor quality, buildings are recommended to be provided with more ventilation than might otherwise be necessary.

3.1 Declarations on Health and the Built Environment

About a decade ago, health and the built environment have been identified to be one of the key concerns for the livability of human settlements. The 1992 Rio Declaration states that "human beings are at the center of concerns for sustainable development... they are entitled to a *healthy* and productive life in harmony with nature." In the "Istanbul Declaration on Human Settlements [19]," similar emphasis are found in the UN Global Plan of Action. In the Global Plan's statement on "Environmentally Sustainable, Healthy and Livable Human Settlements," one could draw reference to the following proposed UN actions. Four of the eight actions connect health and the built environment in one way or another.

a. Improve the health and well-being of all people throughout their life-span, particularly people living in poverty.
b. Improve environmental conditions, and reduce industrial and domestic waste, and other forms of health risks in human settlements.
c. Recognize the need for *an integrated approach to the provision of those environmental services* and policies that are essential for human life.
d. Promote a *healthy environment* that will continue to support adequate shelter for all and sustainable settlements for current and future generations.
e. Secure for all reliable supply of safe drinking water and meeting the competing demands of industry and agriculture.
f. Improve the *livability* of human settlements.
g. Develop further international legal mechanisms.
h. Develop mechanisms for assessing the environmental impact of proposed activities.

3.2 Healthy Building

As statistical data shows that people spend up to 80% of their time in buildings for varieties of activities, [20, 21]; indoor environment is increasingly a topic of concern and investigation by stakeholders that include scientists, professionals, health experts, building owners and user occupants. As an example, literature reviews associate the renewed interests on the health study of building with specific building-related health symptoms, and recommends the topic of 'Indoor Environment' [22] as an indicator for the 'health performance' of buildings. Interestingly, the extent of the indicator for 'Indoor Environment' covers two main themes – physically measurable quantities, and aesthetic factors, with 11 sub-themes altogether. The two themes are proposed out of an intention to balance quantitative and mathematical based evaluation and non-quantitative or mathematical based evaluations. While the former deals with the objective, quantitative, or measurable, the later deals with the subjective, non-quantitative, or non-measurable. The reality is that the second theme proves extremely difficult to be evaluated, as they often involve subjective evaluation by the occupant or user. Group behavior towards the usage of buildings is influenced by social and cultural idiosyncrasies and considerations [23].

3.2.1. Syndromes, Causes and Design Guidelines for Sick Building

The unsatisfactory performance of a healthy building is termed 'unhealthy,' or 'sick' building, otherwise known as Sick Building Syndrome (SBS). Building scientists have divided the constituents of SBS by means of a checklist for use in a building design process to ensure healthy conditions for occupants. Generally speaking, SBS is associated with the various unhealthy symptoms such as, dryness of the eyes, blocked or stuffed nose, dry throat, headache, difficulty in breathing, itching or watering of the eyes, runny nose, lethargy and/or tiredness, flu-like feelings and tightness of the chest [24]. Sick buildings can have various communicable diseases such as chicken-flu, bird-flu and SARS. In an unhealthy buildings/ environment with smaller open space, poor air circulation and air stagnation, it is easy to spread these epidemics human to human. This has led necessarily to rethink of the design standards of the city.

Physically measurable quantities	Aesthetic factors
temperature, draughts ventilation air flow rates, noise, air quality, light	layout, light, colors, space, materials, other subjective elements

Table 1 Elements of healthy building [25]

The causes of sick building are categorized under three categories: physical factors, chemical pollutants, and micro-organism. Physical factors include uncomfortable temperatures, low humidity, low air movement and ventilation rates, poor lighting quality and surface colouring, poor seating, noise, and no control over surrounding environment. Chemical pollutants include factors such as cigarette smoke, formaldehyde vapours from insulation and furniture, VOCs from adhesives, paint and cleaners and ozone from photocopiers, printers and HV sources, whilst micro-organism can include spores and micro-toxins from moulds in ventilation system and wall surfaces, dust mites and micro-organisms in carpets, fabrics and plants and organisms in drinking water and vending machines. These causes can be used as design guidance to help planners, designers and building services consultants to guarantee a certain standard or quality of indoor environment [26].

4. Conclusion

Because of SARS, the study of health and built environment has become a significant aspect of research agenda for the building design and construction industry in densely populated cities. The paper advocates by the Hong Kong examples, the shift in emphases from an entirely indoor design and assessment to a combined indoor–outdoor (built environment) assessment.

The discussion above in achieving a healthy city is a process, and can be in two ways.

a. Awakening process for government and private sectors to consider opinions and ideas about health matters in the design realm by the design professionals.

b. This must be an ongoing process in various aspects: (i) government and private sector bodies should be aware and closely follow the programs initiated by bodies like the UN to achieve the 'healthy city' program successfully. The author believes that the spirit of the 'healthy city' program should be readdressed accordingly; (ii) initiation of building design and development to change some aspects of the building that is mostly sensitive to healthy environment, such as light well sizing (re-entrant) etc.; (iii) research institution such as universities should have the initiation to evaluate the program by using green building evaluation tools – Hong Kong Government has already taken steps to study the international evaluation tools and R&D in order to improve its local tools, for examples HK-BEAM and CEPAS; (iv) university research teams have taken other initiatives such as to address the heat island effects that would help to generate guidelines for the planning and design of housing estates to result in a health-friendly urban environment. The author believes these are positive measures and attitudes that would lead to making the environment more livable and healthy.

Notes

Healthy Cities Program

In 1986, the WHO European Regional Office launched the **Healthy Cities** program with the purpose to "develop health-enhancing public policies that create physical and social environments that would support health and strengthen community action for health, as well as to emphasize the principles of health promotion to develop new styles of enabling, facilitating, mediating, advocating and building new partnerships and coalitions for health."

It is recorded that over 100 countries have been involved in this program. Initially implemented in the Asia-Pacific region of Australia, Japan and New Zealand, the program recruited Bangladesh, Cambodia, China, Fiji, India, Indonesia, Laos PDR, Malaysia, Mongolia, Myanmar, Thailand, Nepal, Papua New Guinea, Philippines, Republic of Korea, Sri Lanka, and Vietnam [27].

December 1993 marked the first global conference on Healthy City in California, USA with participants from over 50 countries. After the event, an International Healthy City Foundation was established with the purpose to developing evaluating tools, training, publications and conferences.

In December 2003, an international conference is planned in Northern Ireland to celebrate 15 years of the healthy cities movement in Europe and globally; to shape goals, strategies and visions for the future.

Comments made by WHO on the Healthy Cities Program show that there is no single method applicable to all countries towards healthy city in the light of local political, economic and social considerations. However, a general framework and common steps are developed based on studies in the Western Pacific region. It is recommended that the general framework would be modified after an in-depth study of local contexts.

The main approach of the Healthy City movement is to organize citizens of diverse disciplines "from business, government and other sectors of society who recognize their interconnection can be used to impact the well-being of the entire community [28]." One important distinction is that these healthy city projects that are launched around the world integrate people from different interest groups to work as one.

As mentioned, the most fundamental task is to achieve integration. People contributes to the program should involve as many sectors as possible, WHO summarizes a list of key players in the Healthy City to be: community members; local, provincial/state and national politicians; government service providers from a variety of sectors (e.g. health, welfare, transport, police, public housing authority); community service providers; non-governmental organizations; community-based organizations; private enterprise interests; consumer groups; local government authorities; provincial/state government authorities; relevant national government authorities; ethnic groups; community media; and educational institutions.

Acknowledgement

The discussion in section 2.1 on the works done on enhancing daylight access and re-entrant improvement is the product of a Hong Kong Research Grants Council 2002-5 project: Research on building and window design–an empirical study to enhance daylight qualities in high-rise residential apartment buildings in Hong Kong (project no. HKU 7205/02H), to which proper acknowledgement is expressed here.

The discussion in section 2.2 on the works done on the study of microclimate, urban heat island and housing planning is the product of an ongoing Hong Kong Research Grants Council 2003–6 project: Urban design approach to lower apace conditions energy in residential development in Hong Kong (project no. HKU 7309/03H), to which proper acknowledgement is also expressed here.

Acknowledgement is also due to the HKU SARS research team members that include Chau,

Kwong Wing; Ho, Daniel Chi-wing; Wong, S. K., and Wong, W. S. for sharing their knowledge and inputs in the building health index and building regulations, and R. Giridharan for sharing his expertise in urban climatic design variables.

The author would like to thank the following: Lam, Woo Hei for his professional guidance; Leung, K. C.; Chan; Peter. S. K.; Ip, Y. K.; and Au, K. M., for their unfailing support towards the research on daylighting.

Last but not the least, Mr. Li Fuk Ming, Miss Xu Ziping and W. M. Jayantha for their assistance in the graphics and research on this paper.

References

[1] Bugliarello, G. (1994). Technology and the city. In Fuchs, R. J., et al. (Eds.), Mega-city Growth and the Future. Tokyo: United Nations University Press.

[2] United Nations. (2002). Statistics year book. Retrieved from http://www.unstats.un.org/unsd.

[3] As a special economic zone, the physical territory of Hong Kong is barbed off by means of a river and fences from the rest of the Mainland China. The mainlanders require a special visa to enter Hong Kong.

[4] Hong Kong Government. (2001). Census and Statistics Department. Retrieved from http://www.info.gov.hk/censtatd/.

[5] Ibid.

[6] Burgess, R. (2000). The compact city debate: A global perspective. In Jenks, M., et al. (Eds.), Compact Cities: Sustainable urban forms for developing countries. London: Spon Press.

[7] Lau, S. S. Y. (2005). A report on the survey of urban lifestyle for young office workers in the urban centers Shanghai. Unpublished report. Shanghai: China.

[8] Hui, E., Lam, M., & Ho, V. (2004). Land use policy and patterns in Hong Kong. In ENHR Conference. Cambridge, UK.

[9] Lau, S. S. Y., et al. (2006). Reconsidering daylighting design paradigms for tall buildings in a densely built city. Architectural Science Review, 49, 285-294.

[10] 'Re-entrant' is actually the official name used in the building regulations of Hong Kong. It refers to vertical light walls for pipes, exhaust fans for ventilation and daylight. It is a semi or totally enclosed configuration.

[11] Swaid, H., & Hoffman, M. E. (1990). Climatic impacts of urban design features for high and mid-latitude cities. Energy and Building, 14, 325–336.

[12] Golany, G. S. (1995). Urban design morphology and thermal performance. Atmospheric Environment, 30, 455–465.

[13] Givoni, B. (1998). Climate considerations in building and urban design. USA: John Wiley & Sons.

[14] Reference [7].

[15] Giridharan, R., Tai, J., & Lau, S. S. Y. (2005). A study of microclimate conditions in outdoor spaces of high-rise residential developments. In International Conference on Sustainable Buildings. Tokyo.

[16] Ibid.

[17] IBEC (2004). CASBEE for new construction. Tokyo: Institute for Building Environment and Energy Conservation (IBEC).

[18] Levin, H. (2000). Design and construct of healthy and sustainable buildings. Proceeding of Healthy Buildings. Helsinki, 13–22.

[19] UNCHS (1996). Istanbul declaration on human settlements. Retrieved from United Nations Center for Human Settlement Web site: http://www.unchs.org.

[20] Steri, J., et al. (2000). New target values for IAQ and climate in Finland. Proceeding of Healthy Buildings. Helsinki, 531–536.

[21] Follin, T. (2000). A method to create environmentally friendly and healthy buildings. Proceeding of Healthy Buildings. Helsinki, 569–574.

[22] HK–BEAM Society. (2004). HK–BEAM 4/04 'New Buildings': An environmental assessment for new buildings, version 4/04. Hong Kong: Author.

[23] Reference [7].

[24] Jones, P. J., Vaughan, N. D., & Grajewski, T. (1997). New guidelines for the design of healthy office Environment. In BEPAC + EPSRC Conference. Abington, England.

[25] Reference [22].

[26] Samuelsson, I. (2000). Quality assurance of the indoor environment in schools, offices and dwellings Proceeding of Healthy Buildings. Helsinki, 555–560.

[27] Takano, T. (1998). What is a healthy city?. WHO–C.C.H.C.U.P.R. Monograph, 1. Tokyo: WHO Collaborating Center for Healthy Cities and Urban Policy Research.

[28] IHCF. (1994). International Healthy City Foundation. Retrieved from www.healthycities.org.