URBAN LIVING WITH NATURE: DESIGN FOR HUMAN-NATURE INTERACTIONS IN COMMUNAL GREEN SPACES AT RESIDENTIAL HIGH-RISES

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PhD

The Hong Kong Polytechnic University

2023

The Hong Kong Polytechnic University

School of Design

Urban Living with Nature: Design for Human-nature Interactions in Communal Green Spaces at Residential High-rises

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A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy

October 2020

CERTIFICATE OF ORIGINALITY

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it reproduces no material previously published or written, nor material that has been accepted for the award for any other degree or diploma, except where due acknowledgement has been cited in the text.

Ip Chung Man

Abstract

It is arguable that urban dwellers have been disconnecting from nature and witnessing an extinction of the human experience of wildlife. On the contrary, there are conflicts between the interfaces of humans and nature in a compact city. There is a research gap in human-nature interactions in urban living. Meanwhile, a new typology of sky gardens as multi-level communal green spaces has been driving the design of residential high-rises in the architectural practice.

This thesis aims to explore new biophilic designs for communal green spaces in high-density, high-rise contexts. The objectives are to investigate urban dwellers' interpretation, perception and experience of nature in urban living; analyse key substances of human-nature interactions and their inter-relationships; establish a conceptual design framework for human-nature interactions and principles of new biophilic design in high-density high-rise contexts; and examine design for human-nature interactions in communal green spaces at residential high-rises. Interpretative qualitative research methods are adopted. Photo-elicitation surveys are conducted to investigate whether urban dwellers appreciate the significance of human-nature interactions, how they interpret, perceive and experience nature in urban living, and whether their perception and experience are various from different ages in search of human-nature interactions for benefits of human and nature. Further to examining the key substances for human-nature interactions, their implications in terms of anthropocentrism, experience and space use are discussed. Case studies are carried out on the topics of co-existence with nature, urban interventions for human-nature interactions and a new typology of multi-level communal green spaces.

This thesis affirms that urban dwellers appreciate the significance of human-nature interactions in urban living. This thesis sets up the framework of human-nature interactions for the co-evolution of humans and nature in urban contexts. "Design for humans" utilises nature for the benefit of humans; "design for humans with nature" allows humans and the ecosystems to co-exist; and "design for nature" considers human intervention for the benefit of the ecosystems.

This thesis reveals the inter-relationships among nature-perceived settings, urban-nature elements and nature-based activities to facilitate human-nature interactions, and establishes the SOA (space, object and activity) model to present a new discourse on biophilic design for human-nature interactions in high-density, high-rise contexts.

This thesis contributes to architectural and urban design practice for planning urban settings, designing residential high-rises and revitalizing communal spaces with biophilic design. Purpose-led design of communal green spaces advocates socially-oriented, environmentally-driven and ecologically-friendly design considerations for different direct and indirect interactions and the co-evolution of humans and nature at residential high-rises. Further research on potential implications to the design process is suggested.

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Acknowledgements

I would like to express my sincere gratitude to my supervisors, Professor Peter Hadsell and Professor Timothy Joseph Jackna, and my family Ida Wong, Adrian Ip and Alden Ip.

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Chapter 1: Introduction

1.1   Introduction

With the rapid development of urbanisation, urban habitats have given way to the built environment, resulting in the decline of biodiversity and weakening the relationship between humans and nature. It is arguable that urban dwellers have been disconnecting from nature and witnessing an extinction of the human experience of wildlife. At present, a new design paradigm shifts the concept of sustainability from mitigating adverse impacts on the natural environment through low environmental impact design to regenerating the natural environment by fostering a positive impact with a biophilic design approach. It aims to promote biodiversity and nurture the innate human and nature connection. However, most theories and principles of biophilic design are developed in western countries, and there is a lack of theoretical guidance to the eastern culture and high-density, high-rise contexts.

High-rises have more feeble social networks and higher crime rates (Fowler, 2008).[1] Forty years ago, research on residents' behaviour in a high-rise apartment concluded that there was a high degree of anonymity and social isolation, including pervasive ignorance about neighbours and little inclination to establish friendly relations with them (Zito, 1974).[2] These phenomena are not uncommon in residential high-rises nowadays (Lau, 2010).[3]

Urban dwellers are characterised by a more affluent living style, exhibiting patterns of routine related to gaining affluence with few opportunities for unplanned chances of human-nature interactions, increasingly disconnected from the natural world, and witnessing an "extinction of experience" (Goddard et al., 2009),[4] that is critical for developing neighbourhoods and a sense of community, or chances of appreciation for the natural environment. These phenomena urge research on improving liveability in high-rise compact living.

Meanwhile, urbanisation is continuously extending to suburban and rural areas, and residential high-rises are not just in developed urban districts but in suburban areas. These towers become an interface between existing ecosystems on the fringes of rural environments and the growing urban condition. Within these towers, there is a new typology of multi-level communal green space (also known as a sky garden) aiming to reduce this gap. It is a new typology within urban high-rise architecture, aiming to improve the ventilation and thermal conditions of the microclimate and provide a recreational space to enhance social interaction and neighbourhood quality at the same

time. However, there is a lack of research on evaluating this communal green space at multi-levels and contributing to the larger question regarding human-nature interactions and urban living.

The Hong Kong government issued incentives for sky gardens, in domestic buildings in 2001, including exemption of gross floor area and relaxation of the allowable overall building height regarding the provision of sky gardens. Such incentives are conceived to encourage developers to incorporate greening measures in new residential high-rise buildings. But, can these sky gardens be the means of enhancing human-nature interactions?

1.2   Aims and Objectives

This thesis aims to study human-nature interactions in a compact high-rise city. Is urban development considered for the co-evolution of humans and nature? Do urban dwellers appreciate the significance of interaction with nature? What are their interpretations of nature in urban living? What are key substances to advocate human-nature interactions for the benefit of humans and nature? What are design opportunities for human-nature interactions in an urban environment? Are there implications for urban development and design practices?

This thesis examines the significance and design considerations of human-nature interactions in urban living environments for the benefit of humans and nature, particularly in high-density, high-rise contexts.

This thesis aims to identify nature-centric architectural design and investigate a new form of biophilia in high-density urban contexts. The hypothesis is that human-nature interactions are significant in urban living and communal green spaces facilitate these interactions at residential high-rises. A hypothetical model composed of space, object and activity is proposed to interpret direct and indirect human-nature interactions and establish a framework of biophilic design for multi-level communal green spaces in urban contexts.

1.3   Research Questions

There are three main research questions in this study as follows:

(i) What are the perceptions and experiences of urban dwellers to interacting with nature in urban living?

(ii) What is a new form of biophilic design to advocate human-nature interactions in high-density, high-rise contexts?

(iii) What are the design opportunities for human-nature interactions in communal green spaces at residential high-rises?

A series of sub-questions is developed as outlined below to guide and facilitate research studies systematically.

(i) What are the perceptions and experiences of urban dwellers to interacting with nature in urban living? The corresponding sub-questions are:

(a) What are the purposes and significance of urban dwellers interacting with nature?

(b) How do urban dwellers interpret nature in urban living?

(c) What kinds of direct and indirect interactions with nature do people consider significant?

(d) Are these perceptions and experiences varying among people of different ages?

(ii) What is a new form of biophilic design to advocate human-nature interactions in high-density, high-rise contexts? The corresponding sub-questions are:

(a) What kinds of space or urban settings that people associate with nature?

(b) What kinds of natural and artificial elements are associated with human-nature interactions?

(c) What kinds of activities are in relation to human-nature interactions?

(iii) What are the design opportunities for human-nature interactions in communal green spaces at residential high-rises? The corresponding sub-questions are:

(a) What is the significance of communal green spaces in high-density, high-rise contexts associated with nature?

(b) How do we design communal green spaces to facilitate human-nature interactions at residential high-rises?

(c) Are there implications to current design practices?

1.4   Significance of the Study

This research investigates human-nature interactions in a compact high-rise city and explores a new form of biophilia in high-density urban contexts. The findings aim to contribute to architectural and urban design practice for planning urban settings, designing residential high-rises and revitalizing communal spaces with biophilic design for the co-evolution of humans and nature in urban contexts.

Biophobia, which means having negative feelings such as fear, scary, disgusting and uncomfortable with nature, may be developed due to people's fear of living things and unexpectedness from nature.[5] Nature is not just a resource for human consumption but exists for its intrinsic value. Instead of sustaining nature for humanity's development, shall we nurture our positive attitude to nature and re-establish authentic human-nature connections for the co-existence of humans and nature?

Urbanisation is continuously extending to suburban and rural areas. As a result, residential high-rises are not just in developed urban districts but suburban areas. These towers become an interface between existing ecosystems in the fringes of rural environments and the growing urban condition. Within these towers, there is a new typology of communal green space aiming to reduce this gap. A multi-level communal green space (also known as a sky garden) is a covered or partially covered communal green space with natural ventilation at a high level. It is a new typology within urban high-rise architecture. It aims to improve the ventilation and thermal conditions of the microclimate and provide a recreational space to enhance social interaction and neighbourhood quality at the same time. However, there is a lack of research on evaluating this communal green space at multi-levels and contributing to the larger question regarding human-nature interactions and urban living.

I work as a practising architect and have been involved in several residential development projects in Hong Kong. The current typology of high-rise development has evolved to accommodate dense populations in a small building footprint. However, there is an urgent call from stakeholders to rethink the residential high-rise development of better quality of living by introducing design with nature.[6] I hope this study can shed light on my day-to-day work by designing sustainably with nature in the built environment.

1.5   Overview of the study

This thesis aims to study human-nature interactions in a compact high-rise city. The study of design for human-nature interactions is conceptualised in Fig. 1.1.

Anthropocentric

Design for Human

Human-Nature Interactions

Design for Human with Nature

Design for Nature

Non-anthropocentric
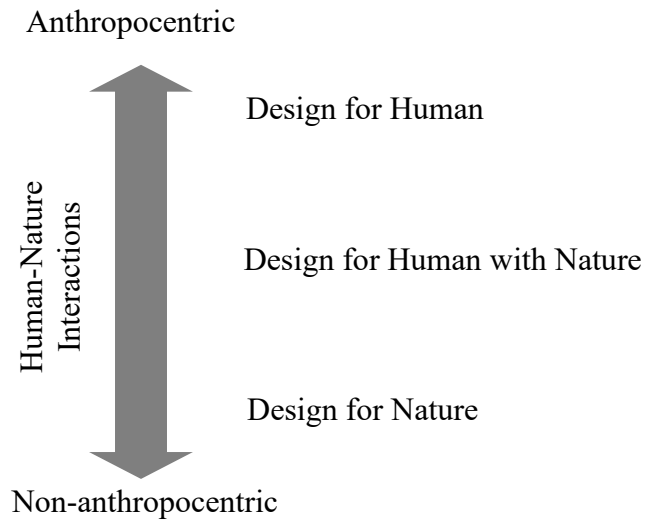
Fig. 1.1 - Design for human-nature interactions

Firstly, the significance of human-nature interactions in urban living is investigated. The multi-faceted definition of nature will then be explored in the literature review. This will include culture and civilisation that influence the interpretation of instrumental and intrinsic values of nature and respective human-nature relationships. Philosophies and theories of nature are discussed in the relationship between humans and nature. The literature review on human-nature interactions in urban living delineates benefits to humans in psychological, physiological, social and environmental aspects; meanwhile, benefits to nature in ecological aspects are considered on urban bio-diversity and humans' pro-environmental attitudes. A hypothetical model of space, object and activity is introduced to explore human-nature interactions in this study.

Secondly, opportunities for human-nature interactions in communal green spaces are outlined, in particular in communal green spaces at residential high-rises. The pull factors why communal green spaces are important to the physical, psychological and general well-being of high-density urban dwellers are identified. Key performance indicators on quantifying greenery and communal green spaces are introduced.

Thirdly, qualitative research methods are discussed to explore people's spatial and environmental experiences in the research methodology section. The photo-elicitation method favours collecting

data on people's expressions of intangible matters, followed by content analysis to depict key substances in human-nature interactions. Case studies and experimental engagement activities are carried out to explore and examine design opportunities for interacting with nature in urban contexts.

Fourthly, three sets of photo-elicitation surveys were conducted to investigate whether urban dwellers appreciate the significance of human-nature interactions, how they interpret, perceive and experience nature in urban living, and whether their perception and experience are various from different ages. These public engagement surveys provide insightful observations on urban dwellers' interactions with nature in different urban settings.

Fifthly, the fourth photo-elicitation survey was conducted in search of "Design for Human" and "Design for Nature" interactions in urban contexts. To further develop the discussion on the human-nature relationship, this series of findings express the perception of how humans rely on nature, co-exist with nature, and intervene in nature. A new possibility for biophilic design to advocate human-nature interactions in high-density, high-rise contexts is investigated through photo-elicitation surveys testing the anthropocentric scale when interpreting nature.

Sixthly, based on the interpreted urban-nature substances and corresponding implications, design opportunities for human-nature interactions in an urban living environment are explored. Case studies of strategies for human-nature interactions are carried out. Nature-centric designs for urban contexts are discussed.

Seventhly, whether the creation of communal green space at a high level (also known as a sky garden) can facilitate human-nature interactions at residential high-rises is discussed. Lastly, there are implications to intentions and practices on design for human-nature interactions in multi-level communal green spaces, and further research will be suggested.

Chapter 2: Human-Nature Interactions in Urban Living

2.1   Introduction

This chapter will establish the background of the thesis study. The literature review depicts the philosophical and pragmatic interpretations of nature. The significance of human-nature interactions is elaborated. Natural substances are identified in urban contexts. The overall framework of multi-dimensional human-nature interactions is formulated for the subsequent research works.

Definition of Nature

"Nature" has two distinctive meanings. First, "nature" means all the features, phenomena, and tangible and intangible things in the world that appear or exist independently of humans. Things that happen naturally without human interference or intervention are considered as nature. Second, "nature" means the type, status or characteristic of a thing.[7] The definition of "nature" mentioned and discussed in this thesis is primarily based on the former meaning.

2.2   Philosophy of Nature

Before examining human-nature interactions, discussing the various interpretations of nature is needed. However, this interpretation is based on a human-centric perspective and assumes that humans and nature are separate entities.
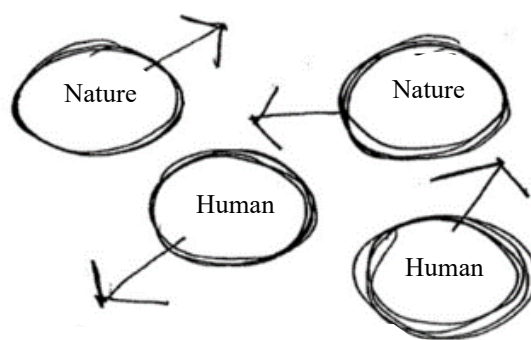
Fig. 2.1 – Nature is an independent entity / a living thing

Aristotle stated in his natural philosophy that motion, properties, change and growth result from the principle of nature.[8] If a movement of something or change will have an inner reason behind it from nature. Once the pre-account of nature is established, we can account for the whole process of movement and change. So, nature is interpreted as independent of other sources or external

causes. Aristotle also stated that art aims to represent not outward appearance but the inward significance.[9]

Nature lies in the mathematical fact. Galileo was the first to present nature in terms of mathematics and numeracy. He published the book "the Assayer" (1623), talking about astronomy and comets, and presented nature in terms of mathematics.[10,11] An example is water being a form of matter with floating bodies on rivers, which the proof came in terms of mathematics that proved this to be true.

Interpretation of nature is based on evidence. Descartes believed in the use of evidence, and philosophy was a thinking system that contained all knowledge.[12] He promoted the idea of methodological scepticism, where he would deny any points or arguments without concrete evidence and re-establish the theme to get a piece of better knowledge. In relation to architecture, he always modelled this as if taking the soil off the ground to build the building.
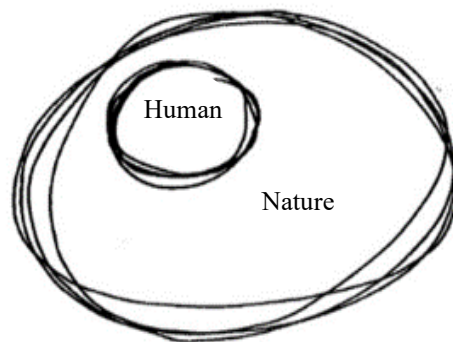
Fig. 2.2 – Nature is a scene / a huge organism, embracing humans

Nature is one huge organism. Plato believed that self-motion was external to nature.[13] His theory leads to later biological classification in the modern world, giving an excellent basis for the biologist to understand that species have characteristics that can classify them.[14]

Only one substance – God or nature exists. Spinoza's philosophies worked around the fact that all phenomena and events that happen on earth are related to God or nature.[15] He stated that all modifications and developments of nature are affected either by God or nature itself.

Nature cannot be interpreted in a definitive term due to human innocence. Romanticism is a theory that works on a basis with an emphasis on emotional self-awareness.[16] Romanticism was mainly

a legacy of scientific realisation and left comparatively less room for development in creativity with the human spirit. The analysis of romanticism breaks up reality into disconnected entities and looks at them with depth instead of shallow analysis from the outside. Hence, nature is not an experience and cannot be manipulated.[17] If one experiences nature, they will become in line regarding feelings with moral values.

Nature is interpreted by means of art rather than science. Goethe's major theories centred around the inner working of plants, and nature is not a simple task that humans could observe.[18] One of Goethe's ideas relies heavily on morphology and polarity. He contradicted Isaac Newton's philosophy of science.

Nature presents the central ontological role of processes. Evolution is the change in the properties of communities of organisms over the course of time or generations.[19] This includes slight changes in body proportions and different alignments from the previous organism. Darwin proposed that, due to the new circumstances, animals, plants and species would adapt to new environments with changes to their body caused by mutations and evolve to be suitable to live in a new location.[20] This theory supported many reasons for changes in characteristics of species around the world where they came from the same family as well as human evolution.
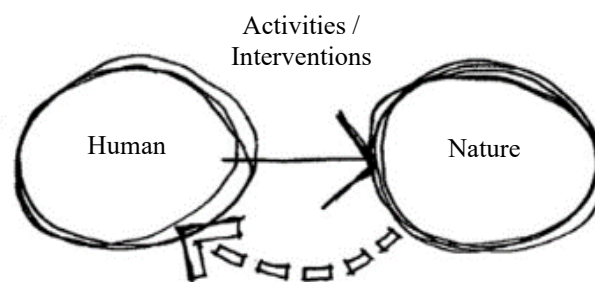
Fig. 2.3 – Nature exists with human interventions

Nature no longer exists without human intervention. Anthropocene is the geologic time referring to a major alteration of atmospheric, geological, hydrological, bio-spherical and other earth systems processes.[21] The term was first proposed by Paul Crutzen in 2000, he stated the start of the Anthropocene began when the industrial revolution began, yet some argue that the 1960s when the development of nuclear energy began.[22] This term brings great controversy about climate change and carbon dioxide volume in the atmosphere, whether it is a cause of human action or

caused by the Holocene epoch. It incurred more discussions on the ethics and righteousness of human interventions to nature.[23]

The philosophical exploration of the concept of nature has been discussed and summarised in Fig. 2.4.

Philosopher	Concept of Nature
Aristotle	Nature is the principle of non-static and ever-changing, and organisation that things have within themselves, independent of other sources or external causes.
Plato	Nature is one huge organism whose soul, principle or self-motion, was external.
Galileo	Nature lies in the mathematical fact, which is measurable, quantifiable, and justifiable under a unified mathematical theory.
Descartes	Interpretation of nature is based on evidence. Nature of mind and nature of material things are distinct substances.
Spinoza	Only one substance – God or Nature- exists, independent of all else. Mind and matter are merely different representations of this singular substance.
Goethe	Nature appears so hidden and inscrutable that humans cannot look at it properly. Nature is interpreted by means of art rather than science. Human appreciates nature through different senses.
Darwin	Nature signifies the central ontological role of processes. No matter whether it is animate or inanimate, its status and representation evolve from the perspective of enormously long sweeps of time.
Crutzen	Nature would no longer exist without human intervention. There is no natural environment on the globe without human influence, and we have reached an epoch of the Anthropocene.

Fig. 2.4 – A philosophical exploration of the concept of nature

To conceptualize the interpretations of nature in this thesis, three categorisations are proposed: (i) nature is a scene or a huge organism, embracing humans; (ii) nature is an independent entity or a living thing; and (iii) nature exists with human interventions. It establishes the basis of a hypothetical model of human-nature interactions in relation to "Space/Scene", "Object/Element", and "Activity", namely the SOA model, as shown in Fig. 2.5. The SOA model will work as a model of evaluation in the following sections.
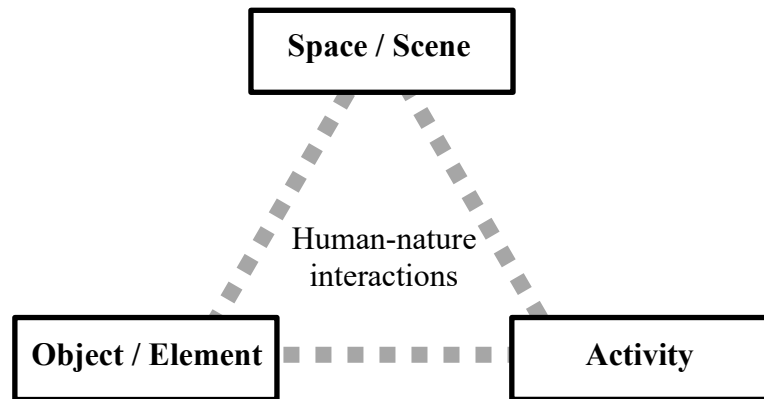
Fig. 2.5 – A hypothetical model of human-nature interactions "SOA" model

There is a paradigm shift from human-centric to nature-centric when interpreting the relationship and interface between humans and nature. The following paragraphs elaborate on the nature-centric philosophies and design theories that constitute new directions in terms of environmental ethics.

Environmental Ethics

Environmental ethics is a philosophy that studies the relationship of the morality between humans and the environment or non-human content, treating other species with the same level of respect that we apply to humans.[24] Nature has its "instrumental value" and "intrinsic value". Protecting the natural environment and conserving the ecosystems should not merely serve the sustainable development of human beings. Environmental ethics allows humans to rethink their damage to the ecosystem and think of plans to regenerate nature. Various theories are associated with environmental ethics, as summarised in Fig. 2.6.

Nature-based	• Urban Biodiversity • Island Biogeography • Patch Dynamics, Sky Islands and Distance Decay
Nature-inspired	• Biophilia • Biomimicry
Nature-driven	• Restoration • Regeneration

Fig. 2.6 – Theories associated with Environmental Ethics

Catton and Dunlap (1978) explained that despite the creativity of humans, there are issues such as that human is reliant on other species in life.[25] The earth has a finite limit of resources, and one day it will run out, creating a physical restriction for humans. Schnaiberg (1980) created a model showing the exchange of materials between humans and the environment containing human processes and innovation.[26] Knight (2018) outlined four major areas of research on environmental sociology, which is a theory that covers the combination of the environment and society, including (i) the social causes of environmental problems; (ii) how the natural environment influences and impacts on society; (iii) the social reactions and responses to environmental threats and problems; and (iv) how the social processes and dynamics advance environmental reform and sustainability.[27]

Urban Biodiversity

Urban biodiversity refers to the diversity and variability of living organisms found in cities and their ecosystems. It is a comprehensive response to biogeography and human factors. Urban biodiversity looks at the urbanisation of towns and cities and how that influences the ecosystem and other species living within it.[28] People recognise that urban biodiversity is also affected by the social and cultural background in which it occurs.[29] What people think about biodiversity is essential. Harrison and Davies (2002) used the phrase "the biodiversity that matters" to describe the places that urban residents value because of social concerns associated with green spaces and semi-natural areas, such as access to green spaces, aesthetics, and opportunities for contact with nature.[30] These values shape the context in which people view different habitats and places in cities that are often ignored by ecologists (Nilon, 2010).[31]

Island Biogeography

Island biogeography was initially created by ecologist Robert MacArthur and biologist Edward O. Wilson. The theory describes an island as a landmass not connected to the significant landmass with sea and oceans in between, and species' existence may be different from the significant landmass.[32] The fragmentation of ecosystems due to the development of cities causes the loss of species within an area, causing a large extinction of species. The adaptation of the cities to become more "attractive" for species to return and to increase the immigration rate could rebalance the ecosystem and regain equilibrium (Fattorini, 2016).[33]

Patch Dynamics, Sky Islands and Distance Decay

Patch dynamics, sky islands and distance decay are all "ecosystem communities" theories. Firstly, patch dynamics is the theory linked to forests being divided into "patches" due to different vegetation, human influence, and water landscapes. Species tend to gather around the same area and territory.[34] The differentiation of these patches allows scientists to identify trends in an ecosystem's micro and macro levels. It allows us to see how disturbance and manipulation can affect the ecosystem, biodiversity conservation, and hierarchical patterns between species. Next, sky islands are areas with high elevations and extremely low elevation areas. Due to high elevation, the density of air and temperature decreases.[35] This promotes interesting species in these sky islands, increasing biodiversity. Lastly, distance decay refers to the similarity of species as distance increases. As distance increases, the species of similar types would decrease. The decrease can be modelled in a mathematical equation where the value of species would decrease in an inverse square magnitude.[36] All of these are theories that support the characterisation of ecosystems and the immigration of species.

Biophilia & Biophilic Design

Biophilia is a concept that human interaction links with nature and other life. Biophilic design is a deliberate attempt to transform the understanding of human affinity into a connection with natural systems and processes – known as biophilia (Wilson, 1984) – into the design of the built environment.[37] It has been incorporated into architecture and interior design to aid physiological and psychological health. It can vary from using natural sequences in the design of the building, adding water features and vegetation, creating a comfortable indoor climate, displaying natural art, optimizing natural lighting, and channelling airflow for natural ventilation.[38,39] These aspects mimic the outdoor natural environment to the built urban environment that urges humans and nature to interact.

Two basic dimensions of biophilia are:
1. Organic or naturalistic (shapes or forms in the built environment that directly, indirectly, or symbolically reflect the inherent human affinity for nature)
2. Place-based or vernacular (buildings and landscapes that connect to the culture and ecology of a locality or geographic area)

Patterns of biophilic design are summarized in Fig. 2.7.

Nature in the Space	Natural Analogues	Nature of the Space
• Visual Connection with Nature • Non-Visual Connection with Nature • Non-Rhythmic Sensory Stimuli • Access to Thermal & Airflow Variability • Presence of Water • Dynamic & Diffuse Light • Connection with Natural Systems	• Biomorphic Form & Patterns • Material Connection with Nature • Complexity & Order	• Prospect • Refuge • Mystery • Risk / Peril

Fig. 2.7 – Reference from Biophilic Design: The Theory, Science, and Practice of Bringing Buildings to Life (Kellert et al., 2008)[40]

Browning et al. (2014) further elaborated the biophilic design in a book, "14 Patterns of Biophilic Design", which signifies the importance of human connections with nature in the built environment through the 14 patterns of biophilic design in Fig. 2.3. Furthermore, it indicates that each pattern offers different kinds and levels of stress reduction, cognitive performance improvement, positive emotion, mood and preferences.[41] Some key notes of "14 Patterns of Biophilic Design" are extracted and summarized as follows.

A good biophilic design is crucial to create a space that is "inspirational, restorative, healthy, as well as integrative with the functionality of the place and the (urban) ecosystem to which it is applied. Above all, the biophilic design must nurture a love of place" (p. 13).

In terms of Nature in Space, a space with a good Visual Connection with Nature is "a view to elements of nature living systems and natural processes" (p. 24) that can reduce stress and increase positive emotional functioning, concentration and recovery rates by providing an environment that allows individuals to shift focus, relax eye muscles and mitigate cognitive temper fatigue. A space with a good Non-Visual Connection with Nature is "the auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes" (p. 26) that can reduce systolic blood pressure and stress hormones, increase cognitive performance and improve mental health. A space with good Non-Rhythmic Sensory Stimuli is "stochastic and ephemeral connections with nature that may be analysed statistically but may not be predicted precisely" (p. 28), which support physiological restoration. A space with good thermal & Airflow Variability is "subtle changes in air temperature, relative humidity, air flow across the skin, and surface temperatures that mimic natural environments" that "provides a feeling of both flexibility and a sense of control" (p. 30). A space with a good Presence of Water

is "a condition that enhances the experience of a place through seeing, hearing or touching water", which can calm individuals, reduce stress, heart rate and blood pressure, and increase concentration and memory restoration; a space with a good Dynamic & Diffuse Light "leverages varying intensities of light and shadow that change over time to create conditions that occur in nature" (p. 34) to increase productivity and help uphold circadian system functioning; a space with a good Connection with Natural Systems increase the "awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem" to create a relaxing, sentimental, enlightening experience.

In terms of Nature Analogues, a space with good Biomorphic Forms & Patterns creates comfortable and captivating "symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature," which can reduce stress and increase concentration (p. 38); a space with a good Material Connection with Nature creates rich, warm and authentic "materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place" (p. 40); a space with a good Complexity & Order is "rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature" (p. 42) that can reduce stress.

In terms of the Nature of the Space, a space with a good Prospect creates the feeling of open and freeing through "an unimpeded view over a distance, for surveillance and planning," which can reduce stress, boredom, irritation, fatigue and improve comfort and sense of safety (p. 44); a space with a good Refuge is "A place for withdrawal from environmental conditions or the main ow of activity, in which the individual is protected from behind and overhead" that can boost concentration, attention and perception of safety" (p. 46); a space with a good Mystery condition is "the promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment" can "result in strong dopamine or pleasure response (p. 12); a good Risk/Peril condition is "an identifiable threat coupled with a reliable safeguard" (p. 50).

Biomimicry and Biomimetic Design

Biomimicry is the concept of mimicry of natural species or phenomena.[42] Biomimicry uses examples and innovations already present in the natural world from millions of years of trial and error by nature. Biomimicry studies natural models and then imitates or draws inspiration from

these designs and processes to solve human problems.[43] Biomimetic design refers to human-made processes, substances, devices, or systems that imitate nature.[44] Shifting one's perspective from learning about nature to learning from nature is a way to solve human problems.[45]

Restorative design

Restorative design transforms a destroyed natural land that may be derelict by improving biodiversity and reducing carbon emissions and footprint, returning it to the natural world.[46] The restorative design has a basis for making urban cities more accessible, efficient, and friendly.[47] Restorative design refers to restoring social and ecological systems to a healthy state.[48]

Regenerative Design

Regenerative design is a theory that transforms old, derelict and unused developed areas for another use or life.[49] The concept includes designing community and ecology communities within a location and their interaction. The regenerative design uses the idea of the entire system to create a flexible and fair system that combines the needs of society with the integrity of nature.[50] It aims to maintain and evolve social and ecological systems in a healthy and sustainable way.[51] Co-evolution of humans and nature is advocated, as illustrated in Fig. 2.8.
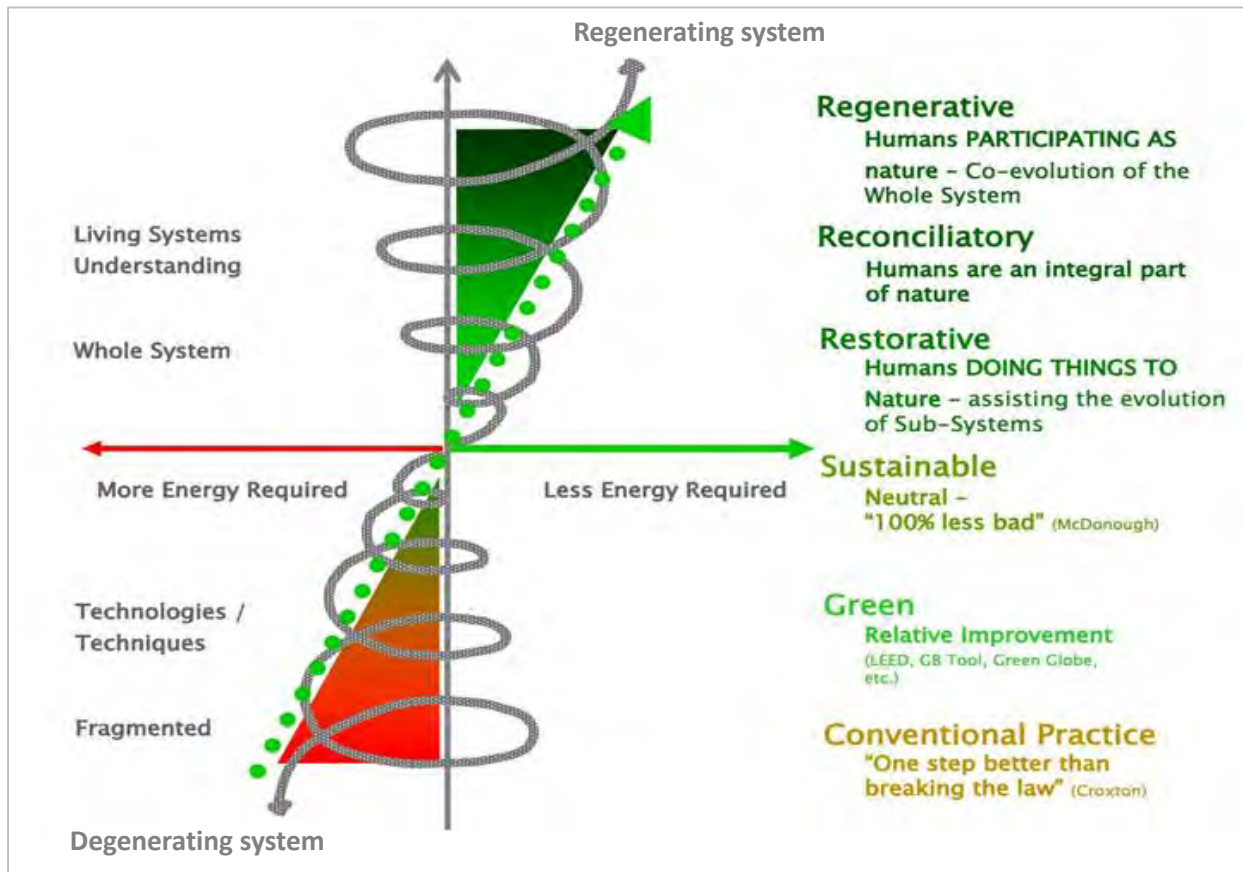
Fig. 2.8 – Trajectory of Environmentally Responsible Design (Reed, 2006)[52]

In the context of rapid urbanisation, conflicts with nature exist in developing and extending the built environment. This thesis hypothesises the significance of human-nature interactions in pursuing a biophilic built environment. The aforementioned environmental ethics and nature-centric theories on conserving the natural environment and ecosystems and respecting the co-existence of humans and nature underlie this thesis study and mode of inquiry in the subsequent sections.

2.3   Pragmatic Interpretations of Nature

The world's urban population has exceeded the rural population since 2008.[53] The population living in cities is still increasing continuously (United Nations, 2019).[54] P. Stevens's research paper (2010), *"Embedment in the environment: A new paradigm for wellbeing?"* discussed the widespread view that people were separable from the environment. Contrary to popular beliefs, health practitioners and policymakers were beginning to promote the idea that humans and nature were inseparable when discussing the ideas of embedment and embodiment.[55] We are connected

to nature through physical interactions; our surroundings shape that we are individually and collectively, providing us with a platform to enhance our well-being.[56]

Recent trends in property developments have incorporated different extents of greenery and sustainable design features, and even a concept of "nature" as the thematic design of the developments.[57] Their intentions may be due to satisfying the criteria of the government's incentives on additional gross floor areas, acting as a marketing strategy for property sale or committing to the quality of the built environment alongside the corporates' vision or corporate social responsibility. Two examples of the recent architectural design practice embraced ideas of human-nature interactions in urban contexts. Fig. 2.9 shows that a ceiling design of a ground floor entrance lobby, together with the adjoining covered outdoor space, has incorporated a massive coverage of hanging greenery, including an inverted tree, in a dramatic manner. It has demonstrated a new idea of greenery design in the built environment and attracted passers-by to perceive urban green with an iconic expression. However, the health condition and sustainable growth of the inverted tree and hanging greenery are doubted. Fig. 2.10 illustrates a covered communal green space at a high level, namely a sky garden, which aims to provide natural ventilation, greenery and recreational garden space for communal use and is claimed as a sustainable building design feature for residential high-rises. Its environmental, social and ecological performances require further studies.

Fig. 2.9 – Ceiling with hanging greenery
(Location: K11 Atelier, Hong Kong)
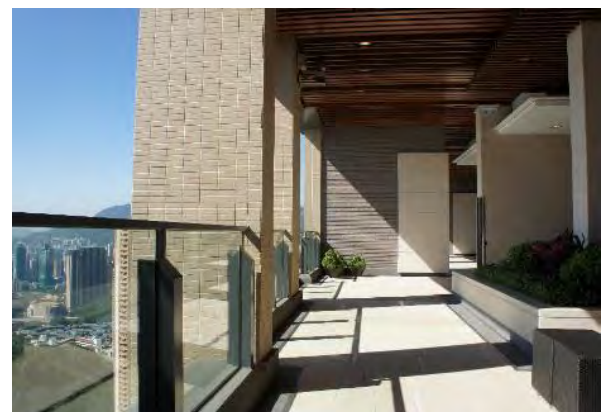
Fig. 2.10 – Sky garden at a residential high-rise
(Location: Aria, Hong Kong)

2.4   Psychological Aspect

Our psychological need to be around the life and life-like process is recognized that the direct experience of nature or nature-derived patterns can improve experience, mood and happiness.

(WELL, 2020).[58] The psychological effects of green spaces are explored by two prominent theories of stress-mitigating and restorative effects. The stress reduction theory explains that the natural environment facilitates positive emotional, attentional and physiological changes (Ulrich et al., 1991).[59] The attention restoration theory has substantiated that the natural environment alleviates recovery from mental fatigue caused by directed attention and stress (Kaplan, 1995).[60] Kaplan and Berman (2010) revealed that natural environments evoked "soft fascination" and improved performance in memory and learning tasks as well as self-regulation tasks, such as impulse control.[61]

Visual Connection with Nature

Erin Largo-Wright (2011) summarised the benefits of outdoor nature contact, indoor nature contact and indirect nature contact. Advocating for protecting pristine wilderness, incorporating wood parks and green spaces in communities and urban settings, cultivating grounds for viewing greenery, and maintaining healing gardens to promote gardening is essential to enhance outdoor nature contact.[62]

High school students with window views of trees and shrubbery, versus large empty lawns and built features like parking lots, had significantly fewer criminal behaviours and significantly higher graduation rates, merit awards, and student plans to attend college (Matsuoka, 2010).[63]

Kaplan (2001) reported psychological benefits from a view of nature from home. Views of gardens and flowers were important to feelings of satisfaction and effective functioning; meanwhile, views of trees were correlated with the sense of being restored and having one's directed attention intact.[64]

Non-visual Connection with Nature

Kamitsis and Francis (2013) informed that people positively impact mental health when they come into contact with nature through direct sensory contact and a sense of connection.[65]

Teenagers gave four main reasons for feeling tranquil and peaceful during and after gardening, including breathing fresh air outdoors, feeling connected with natural life systems, caring for creatures, and having time to reflect on themselves quietly (Louise et al., 2014).[66]

Laaksoharju (2012) examined the physical qualities of a garden environment and the behaviour they brought out in suburban children ages seven to nine. The results indicated that garden-based activities seemed to promote the development of children's proximal developmental areas. In addition, the environment's affordances could teach useful life lessons to a child, and knowledge that was attained by investigating the surroundings could be shared immediately in a group. The natural environment's numerous affordances, including spaces and materials, caught children's attention easily and made learning new things effortlessly.[67]

Proximity to Green Spaces

The results of research conducted by McCurdy et al. (2010) revealed that mental and physical health improvements could be associated with time spent exposed to green spaces.[68]

A walk in a park improved one's mood and performance in an attention task to a greater extent than a walk along an urban street (Johansson et al., 2011).[69] Tyrvainen et al. (2014) investigated the psychology (recovery of perception, subjective vitality, emotion, creativity) and physiology (concentration of cortisol in saliva) of short-term visits to the natural environment after normal work. It was suggested that even short-term visits to nature areas had more positive stress-reducing effects than the built-up environment. The large urban parks (more than 5ha) and large urban woodlands had positive effects on urban inhabitants, particularly healthy middle-aged women.[70]

A study of psychological restoration on the relative references for natural and urban environments (Hartig & Staats, 2006) investigated Swedish college students before a morning lecture (less fatigued condition) and after an afternoon lecture (more fatigued condition). It was found that the more fatigued participants gave more positive evaluations of attentional recovery and judged a greater likelihood of restoration when walking in the forest rather than in the urban centre.[71]

Collado et al. (2015) reiterated that contact with nature could cause negative emotions such as fear, fear, disgusting and uncomfortable urban children. The research found that children who grew up in urban areas are scared in the woods and feel sick with the filth outdoors.[72] Neighbourhood green spaces are crucial for children's healthy development, and there is a demand for contact with nature and greenery, even in an urban environment. Markevych et al. (2014) informed that risks of hyperactivity, inattention and peer relationship problems in ten-year-old children were associated with increasing distances to urban green spaces.[73]

Children's neighbourhood environment is essential in shaping their personality (Lee & Min, 2006).[74] Natural elements such as trees promote social interaction between neighbours, which can indirectly help monitor outdoor areas and supervise children in improvised urban communities (Kuo et al., 2002).[75]

Corraliza et al. (2012) revealed that the nearby natural environment reduced the negative effects of stressful events, and the health and well-being of children also depended on how these environments encouraged contact with the natural environment. Children who had more daily contact with nature cope better with adversity.[76] Flouri et al. (2014) suggested that neighbourhood green space could improve the emotional health of urban children in low-income families early in life (i.e., 3-5 years old). Among the children who frequently used parks and playgrounds, they were fewer behaviour problems and issues of hyperactivity.[77]

Quantity of Greenery
Compared with less green areas, people living in areas with more green areas had higher life satisfaction and lower levels of psychological distress (White et al., 2013).[78] Bagot et al. (2015) measured three potential contributors to the perceived restorative ability of children's playgrounds, which comprised the number of natural elements (i.e., trees, shrubs and grassy spaces), the presence of non-natural physical characteristics (e.g., play equipment and seating areas), and children's experiences at the playground (e.g., levels of physical exercises and social activities). It revealed that the volume of vegetation was the only significant measure of naturalness predicting the perceived restorativeness of children's school playgrounds with respect to attention restoration theory.[79]

Zhang et al. (2014) surveyed 1,119 children aged nine to ten in China and revealed that children's contact with nature fosters biophilic attitudes towards wildlife and enhances their willingness to support animal protection.[80]

These studies assert that green environments encourage physical activity and improve health; meanwhile, humans feel less psychological distress if they live in an area with more natural surroundings, as summarized in Fig. 2.11. Hence, proximity to and naturalness of green environments are critical factors to human-nature interactions in psychological aspects.

Spaces / Scenes

• Natural environment
(Ulrich et al., 1991; Kaplan, 1995; Kaplan & Berman, 2010; McCurdy et al., 2010)

• Communal green space & children playground
(Lee & Min, 2006; Flouri et al., 2014; Zhang et al., 2014; Bagot et al., 2015)

• Trees, flowers & garden
(Kaplan, 2001)

• Trees, shrubs, grassy spaces
(Bagot et al., 2015)

• Trees
(Kuo et al., 2002)

Positive impacts
on
psychological aspects

Objects

Activities

• Viewing of greenery
(Kaplan, 2001; Matsuoka, 2010; Erin Largo-Wright, 2011)

• A walk in green spaces
(Hartig & Staats, 2006; Tyrvainen et al., 2014)

• Daily / direct sensory contact with nature
(Corraliza et al., 2012; Johansson Kamitsis and Francis, 2013; White et al., 2013;

• Gardening / garden-based activities
(Erin Largo-Wright, 2011; Louise et al., 2014; Laaksoharju, 2012)

Fig. 2.11 – Positive impacts on psychological aspects from literature review

2.5 Physiological Aspect

From a physiological perspective, Caruana (2014) indicated that people in green spaces showed lower blood pressure, improved neuroendocrine and immune system function, and better brain wave patterns.[81] Koga and Iwasaki (2013) examined the psychological and physiological effects of touching plant foliage by measuring cerebral blood flow. It can be interpreted that fabric and natural pathos created a "soft" impression and pleasant feeling, while metal created a "hard" impression and evoked relatively unpleasant emotions. These results support the previous studies that plants, nature, and natural materials can bring relaxation to people and therefore, plants are an indispensable element of the human environment.[82]

Exercises in Green Spaces

Beute and de Kort (2014) reported positive effects of exposure to nature on stress, mood, and executive functioning. The beneficial effects of short-term exposure to nature included lower-order self-regulation, mood, and heart rate variability.[83] Song et al. (2014) conducted a field experiment on young males in Japan and verified that the heart rate was lower while walking in the urban park than in the city street during the springtime. Furthermore, compared with walking through city streets, walking in city parks was associated with higher parasympathetic activity and lower sympathetic activity.[84]

Barton and Pretty (2010) researched that five-minute daily activity in a green space achieved the most substantial positive effects on mood and self-esteem in the shortest duration, irrespective of activity intensity. It might be that a greener living environment offers more frequent opportunities to experience such benefits as people go about their everyday lives.[85]

Pretty et al. (2005) investigated whether there was a synergistic benefit in adopting green exercises or physical exercises in green spaces. Exercise alone reduced blood pressure, increased self-esteem, and significantly affected 4 of 6 mood measures. Both rural and urban pleasant scenes produced a greater positive effect on self-esteem than the exercise-only control.[86]

Van Den Berg and Custers (2011) reported that gardening promoted neuroendocrine and effective stress relief through a field experiment of outdoor gardening and indoor reading. It was discovered that gardening and reading decreased cortisol during the recovery period, but decreases were significantly larger in gardening. A positive mood was fully restored after gardening but further deteriorated during reading.[87]

Therapeutic Landscape

Environmental health promotion encourages healthy behaviours, activities, and environmental sustainability awareness. Focusing on the three forms of nature contact - outdoor, indoor, and indirect nature contact, E. Largo-Wight (2011) offered insights into the developing concept of public health promotion. The study revealed that a purposeful use of nature contact could cultivate healthy places indoors and outdoors in our everyday environment. Some examples included cultivating workplaces, hospitals, schools, and home grounds for viewing and advocating for the protection and preservation of pristine wilderness. It suggested a somewhat anthropocentric human-nature interaction, and healthy places and communities could be created through a

collaboration between public health and design professionals.[88]

The therapeutic landscape is constantly evolving and developing an idea of places that benefits health and well-being. The idea of a mentalising engagement with nature and developing emotional awareness is important for therapeutically engaging with the landscape. This correspondence and connection with the treatment environment, called psychoanalytic dynamics, will improve the patient's health and quality of life (Rose, 2012).[89] Therapeutic gardens are also designed to help people with dementia to retain memories, post-traumatic stress disorder, traumatic brain injuries and more (Burton, 2014).[90]

Conradson (2005) explored the idea of therapeutic landscapes and discussed the notion of place, self, and the relationship between the two. The multi-scale perspective on the constitution of a place was emphasised by the result of human, non-human, and material entities interacting with each other, while the idea of self emerged within and through its relations to other people and events.[91]

An evolving perception of the therapeutic landscape responds to ideas in new cultural geography (Gesler, 1992).[92] A humanistic approach was when the mind, body and spirit were brought together to interpret meanings that were exchanged with objects and relationships; it defined landscape as "a product of the human mind and material circumstances". Holistic medicine, the healing practices and beliefs outside of western scientific biomedicine, promoted the use of landscapes to maintain health and well-being in addition to its function for therapy and disease recovery (Williams, 1998).[93]

Doughty (2013) studied walkers' experiences in the therapeutic landscape and highlighted the benefits of a shared interaction with nature, that it could give a group of walkers a common orientation towards wellness. Though an individual interaction with the therapeutic landscape could enhance one's well-being, social interactions during the movement of a group walking together in the landscape were just as if not more beneficial. It created a sense of companionship, encouraged communication, and helped eliminate isolation and loneliness.[94]

These studies indicated that activities in green spaces achieve positive physiological effects, as summarized in Fig. 2.12. Therapeutic landscapes demonstrate the purposeful use of nature contact.
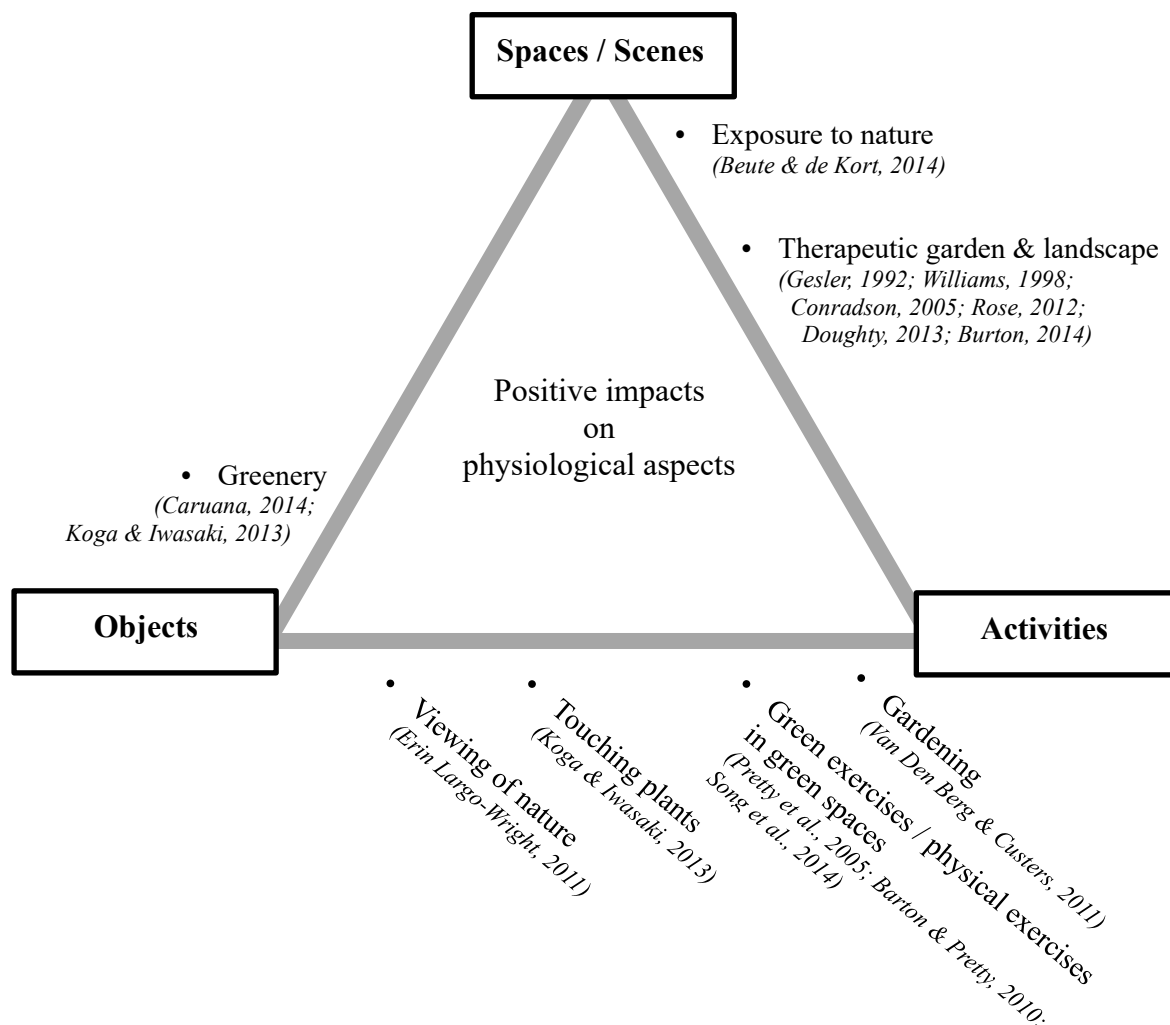
Fig. 2.12 – Positive impacts on physiological aspects from the literature review

2.6   Social Aspect

Fowler (2008) revealed that urban dwellers were often dissatisfied with densely compact living spaces, shortage of private outdoor spaces, lack of greenery, and unappealing outdoor communal spaces for social interaction and self-retreat, despite greatly enjoying the urban connectivity and convenience it came with.[95]

Casual Interactions – Everyday Lives

Peschardt et al. (2012) indicated that "socialising" and "rest and restitution" were the two main reasons why people preferred to visit Small Public Urban Green Spaces (SPUGS). Elderly men were found to be more likely to choose "rest and restitution", while women were the most likely

to experience "socialising". It is justified that SPUGS was deemed an important asset in citizens' everyday lives.[96]

Huang (2006) investigated high-rise residents" perception of outdoor interaction spaces. The hypothesis was that both space types and design elements had essential effects on social behaviour. The two space types, "circulation spaces" and "scenic & activity spaces", related to higher chances of social interaction. Design elements of visual focus, greenery, and spacious areas significantly facilitated social interaction.[97]

Purposeful Interactions - Community Gardening

Gardens provide the community with social cohesion, individuals with a place for self-retreat or escape from busy urban life, the elderly with community integration, and children with the means for improved psychological development. Amulya et al. (2009) elaborated that community gardens were a potentially useful strategy to improve individual health and strengthen neighbourhoods, where each community member had a duty to maintain and foster vegetation in the garden. It could enhance social connections, reciprocity, mutual trust, collective decision-making, civil engagement and community building through people's interactions with their neighbours to plant and care for vegetation.[98]

Diamant and Waterhouse (2010) discovered a relationship between the idea of belonging and social inclusion. By speaking to service users and observing their behaviour in an occupational therapy program, it was noted that they took individual and collective ownership of the garden through the interaction of the person, environment, and occupation. The richness and diversity of activities encouraged users to take responsibility for different garden areas, thus promoting a sense of belonging and social inclusion in the public park. On an individual level, he or she received affirmation from the group, and as a group, their work and efforts in the garden were appreciated by the public community.[99]

Urban spaces are the landscapes that shape the identities and cultures of communities. In Cape Town, economic and political segregation due to the apartheid still needed to be addressed, especially when the city underwent a social, political and economic transformation.[100] Though the two strands of research on southern urban agriculture and northern community gardening were independent, Battersby and Marshak (2013) developed a common framework for the rise in urban

agriculture in both areas. It was revealed that urban gardening benefited the individual by improving mental and physical well-being, and the community by bringing people together with a collective sense of purpose.

In a high-rise context, a survey on rooftop gardens in Singapore (Wong & Yuen, 2005) revealed a gap between people's awareness and usage of communal green spaces. People perceived benefits including aesthetic pleasure, areas for children to play, recreation and retreat. Accessibility, layout improvement and community involvement in garden planting were essential for designing better communal green spaces in an urban environment.[101]

Fowler (2008) revealed that children living in high-rises are either kept indoors because of parental over-protection or left relatively unsupervised outdoors far away from residences. They found difficulty in developing friendships in their living environment, resulting in more behavioural problems or poorer social skills. As a result, they may be more likely to commit crimes as they are secluded and develop poor social and motor skills.[102] Pleasant communal activity spaces and green areas could encourage social interaction among neighbours and are important to urban dwellers in high-rise residences.

Both Milligan et al. (2004) and Wang and MacMillan (2013) found that older adults enjoyed gardening and benefited from it. Allotment gardening activities increased a sense of achievement and aesthetic pleasure and prevented social isolation commonly found in the elderly. Longitudinal data on public gardening projected for participants' activities, health and well-being were collected in the form of diaries of older participants over 65 years of age and greater mobility. However, their age, physical limitations (such as ill health) and social friction (such as personality differences) prevented them from attaining the benefits of keeping a communal garden. This, in turn, leads to frustration or depression in the elderly. The study also found that communal gardening in the elderly encouraged them to work together, overcoming some physical limitations they may have had. Overall, there was a need for gardening programmes to be flexible and adaptable to the limitations experienced by the elderly.[103,104]

Delvin and Zaff (1998) found that older adults preferred garden apartments to high-rises and had a greater sense of community.[105] Kweon et al. (1998) revealed that common green spaces benefited older adults' social integration in the city centre. Such strong social integration among older adults

could indirectly lessen public expenditure on individual elderly services.[106]

These studies indicated that various human-nature interactions and interfaces positively impact social aspects, especially for children and older adults, as summarized in Fig. 2.13.
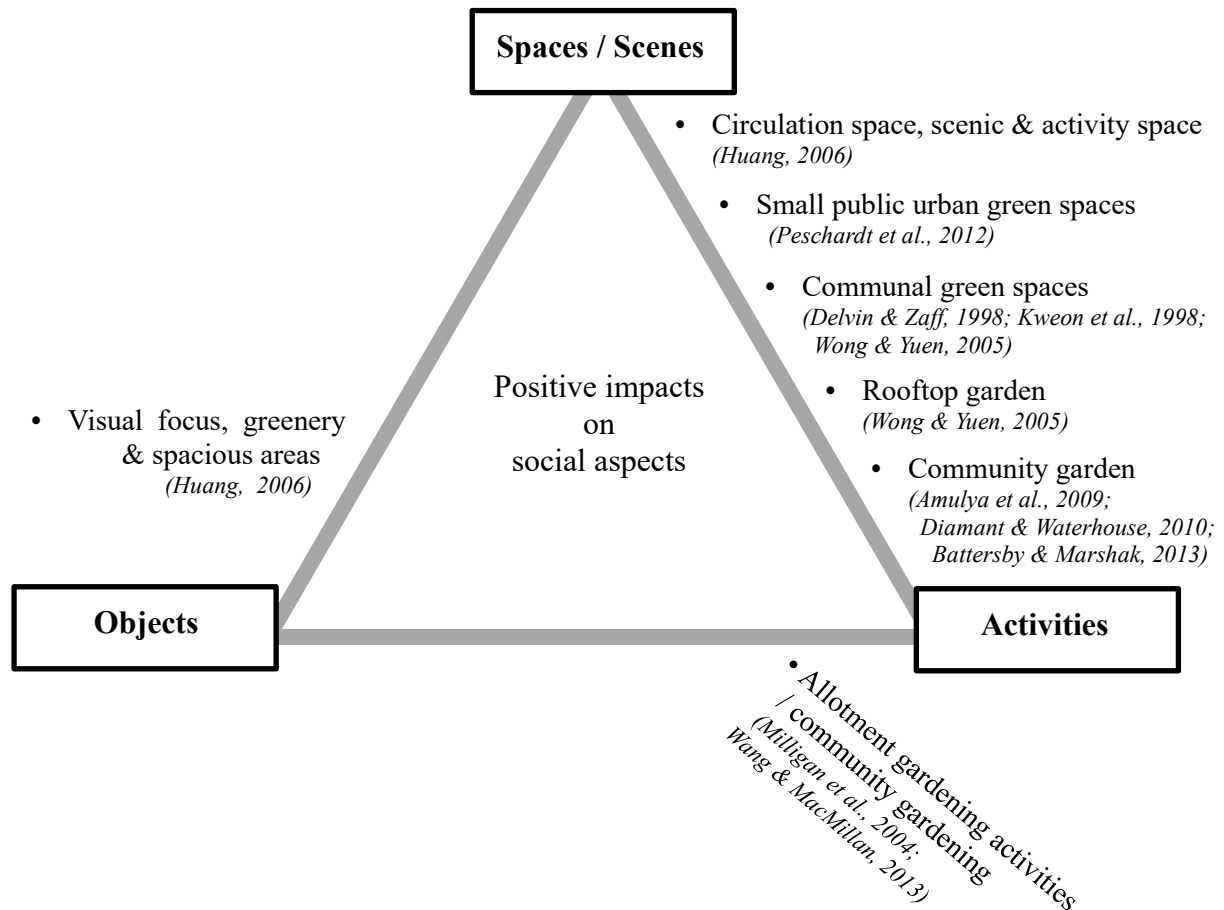
Fig. 2.13 – Positive impacts on social aspects from the literature review

2.7   Environmental Aspect

The following research identified that deliberate landscape design and greenery, directly and indirectly, benefit human thermal comfort and urban microclimatic condition.

Outdoor Thermal Comfort

Wind speed, solar radiation, relative humidity, air temperature and mean radiant temperature are key climatic factors that affect human thermal comfort.[107] Hoppe (1999) defined the physiological

equivalent temperature (PET) by considering human comfort level physiologically relevant under various conditions of direct sun, cloudy sky, tree canopy, translucent shade, opaque shade, and building shadow.[108] Givoni et al. (2003) developed the thermal sensation index (TSI) to present a range of thermally acceptable levels.[109]

HKGBC (2017) based on the high-density, high-rise urban contexts and outlined eight approaches to urban microclimate design strategies, as shown in Fig.2.14, regarding wind, thermal radiation, temperature and precipitation, which affect the outdoor human comfort level and usability of outdoor space.[110]

Wind	1. Increase ventilation with site planning
	2. Increase ventilation with building design
Thermal Radiation	3. Reduce direct solar radiation
	4. Reduce surface temperature
Temperature	5. Increase evaporative cooling
	6. Reduce heat accumulation
	7. Reduce heat release
Precipitation	8. Provide rain protection

Fig. 2.14 – Urban microclimate design strategies for outdoor human comfort (HKGBC, 2017)

Microclimate and High-rise Development

Levermore and Smith (2008) supported that improving urban microclimate by modifying its heat adsorption and emission could be improved through urban greening, the use of high-reflectivity materials, and increasing openness to allow cooling winds.[111]

An Urban Heat Island (UHI) is an urban area significantly warmer than the surrounding areas due to urban development.[112] Especially at night, under cloudless skies and light-wind conditions, the cooling rate in these urban areas is much slower than in rural areas. UHI affects the microclimate of a city. One major effect is higher regional temperature; other side effects include poor air quality.[113] According to Hong Kong Green Power (2004) research on the heat island effect, urban green spaces such as parks could reduce the surrounding temperature by 2.0°C to 3.2°C.[114]

Giridharan et al. (2008) identified that six independent factors affect UHI, including aspect ratio (height to width ratio), plan density ratio (footprint area to environmental area ratio), fabric density ratio (vertical surface area to environmental area ratio), green density ratio (green area to

environmental area ratio), thermal mass (specific heat capacity) and surface albedo (outgoing to incoming radiation ratio).[115]

On the other hand, stagnant air ventilation and pollution dispersal are critical issues.[116] Fung et al. (2009) investigated the air ventilation impact of the "wall effect" by aligning high-rise buildings in complex building clusters. Air ventilation was significantly reduced at 2m above ground with a 40% decrease in velocity ratio and an 80% increase in retention time of pollutants when high-rise buildings with four times the height of the street canyon were aligned as a "wall" upstream.[117] Buildings with higher permeability were encouraged.[118] The sustainable building guidelines in Hong Kong recommend that 20% building permeability should be achieved for a building of more than 60m in length.[119]

Chen (2010) analyzed that the percentage of the sky viable from the ground, defined as the sky view factor (SVF), affected the degree of night cooling. In high-density, high-rise urban areas, the high sky view factor contributed more heat transfer rate, implying the ground surface could be cooled down faster by the night cooling effect during the hot summer season.[120]

Microclimate and Urban Greenery
Brown and Gillespie (1995) investigated the effect of landscape design in creating thermal comfort and energy efficiency as the energy budget was mainly affected by humidity, air temperature, wind and radiation; the effects of landscape on thermal control related to how the design modified wind and radiation of the microclimate. Soft landscape elements could be adopted for terrestrial radiation modification. Consideration in the selection of trees commonly used in the landscape comprised solar transmissivity range in summer and winter, periods of foliation and defoliation, and maximum expected height.[121]

The benefits of urban trees included the direct effect on the shading of buildings and the indirect effect on ambient cooling, as explained by Akbari et al. (2001). Cool surfaces and urban trees lowered air temperature and hence, reduced the use of energy for cooling and smog in the research.[122] Furthermore, 20% of national cooling demand could be avoided through the large-scale implementation of UHI mitigation measures.

Alexandri (2008) researched that "direct cooling effects" significantly lowered air and surface

temperatures when walls and roofs were covered with vegetation. "Indirect radiative cooling effects" provided an additional effect on lowering air temperature by radiative cooling by green walls, apart from evapotranspiration and corrective cooling effects.[123] Picot's research (2004) showcased that vegetation was a real tool for controlling microclimatic conditions in external areas.[124]

Gaitani et al. (2007) discussed that using vegetation, water, and construction materials with high emissivity and reflecting values could effectively improve outdoor thermal comfort.[125] HKGBC (2017) suggested that horizontal greening (i.e., grass pavers, grassland, planters and green roof), vertical greening (i.e., green walls), trees, water features, permeable paving and shading (i.e., covers, tree canopies and building shade) contributed beneficial effects on human thermal comfort.[126]

According to research at the Sha Tin Sewage Treatment Works done by the Drainage Service Department and the University of Hong Kong, the green wall installed on the sludge storage facility reduced the building surface temperature by 7°C, while the green roof reduced the interior temperature by 2.3°C. Plant species were carefully selected, including Pyrostegia venusta, Bauhinia corymbose, and Campsis Grandiflora. Among them, the Pyrostegia venusta was the most effective one in cooling down the environment.[127]

Sponge City is a concept of conforming to nature with resilience to manage urban rain floods, acting as an eco-friendly flood prevention system in urban areas.[128] The soil on green roofs can absorb rainwater to alleviate the burden of the city's water canals and reduce flood risk.

Passive design is an approach in architectural design to facilitate the use of natural sources, including daylight and wind, to achieve comfortable environments without mechanical means. Passive design is climate-responsive; its design strategies vary between climatic zones and regions. The passive design intends to integrate the built environment with the ecosystems through adaptiveness and resilience. Adaptiveness maximises sunlight and wind for human comfort through natural heating, cooling and lighting. Resilience means the building's capability to avoid excessive heat gain, glare, and wind amplification, which may cause human discomfort. More importantly, consideration of passive design shall be from the end user's perspectives during operation, facilitating behaviour change for low carbon living and climatic adaptiveness.[129]

These studies indicated that natural substances are critical to positive impacts on the urban environment, as summarized in Fig. 2.15.
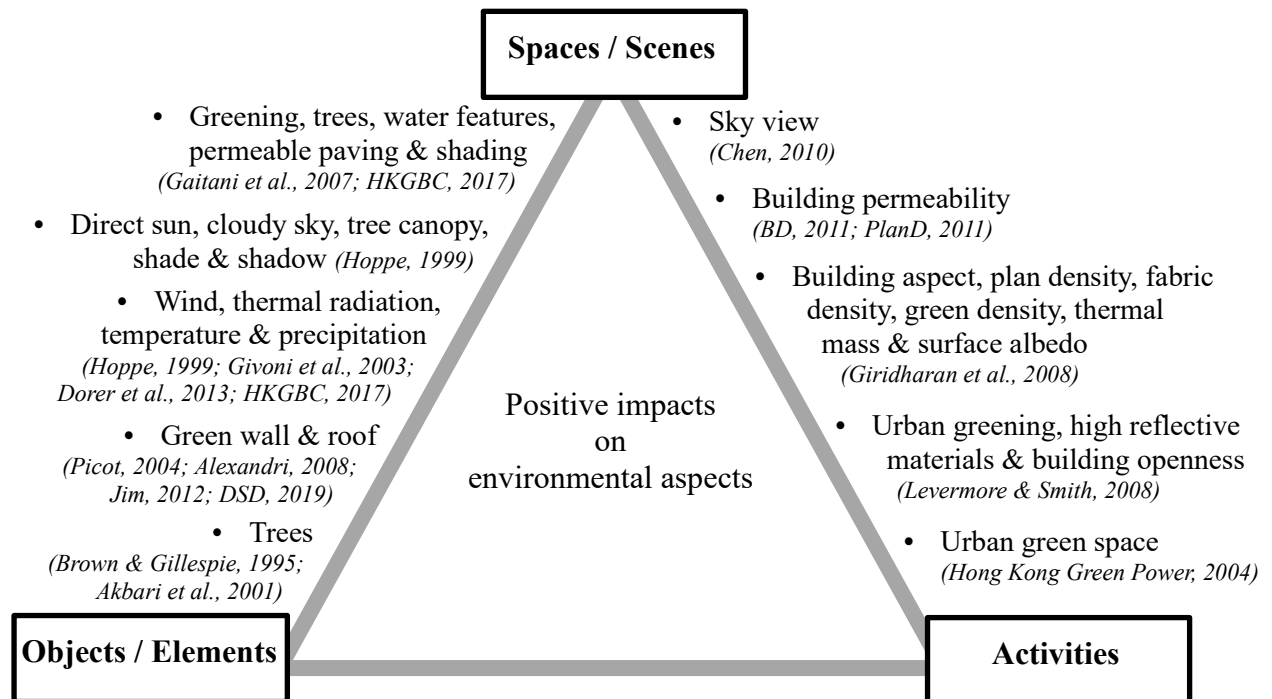
Fig. 2.15 – Positive impacts on environmental aspects from the literature review

2.8   Ecological Aspect

In 1992, the United Nations initiated the "Biodiversity Convention", signed by 194 countries and regions. China joined the convention in 1993, and Hong Kong was included within the scope of application of the convention in May 2011. In order to further create a harmonious future with nature, governments in October 2010, with the agreement of Japan, set the "2011-2020 Biodiversity Strategic Plan and Aichi Targets" as the basis to stop and ultimately reverse the loss of earth's biodiversity. The three goals included protecting biodiversity, the sustainable use of biodiversity, and the fair and equitable distribution of benefits from using genetic resources. Subsequently, the United Nations declared 2011-2020 as the "United Nations Decade of Biodiversity".[130]

Restorative and Regenerative Biodiverse Infrastructure

Urban dwellers are often unaware that urbanisation has indirectly or directly accelerated the natural extinction of many species by fifty to a hundred times.[131]

The City Habitat and Environment Committee of the City of Barcelona issued the "Green Infrastructure and Biodiversity Plan 2020 in Barcelona" in 2013, setting out the city government's goals and commitments to protect green infrastructure and biodiversity, a mutually beneficial model of conservation and urban development. Green infrastructure refers to a greening system that supports ecological, environmental, social, and economic development, including natural, cultivated, and landscaped areas and networks. According to this plan, Barcelona expected that by 2050, the city would have developed a mutually beneficial relationship with nature and re-naturalised the city.[132]

Fig. 2.16 – Photos of before and after naturalisation works at Passeig de Sant Joan, Barcelona

Naturalisation is afforestation and ecological corridor in the city connecting different types of green infrastructure and green belts of different sizes, allowing different organisms and ecology to co-exist in the city while encouraging people to carry out farming pro-natural activities in different green spaces. One successful example is Passeig de Sant Joan, as shown in Fig. 2.16. It is a central avenue in the city centre, successfully creating an urban ecological corridor that has allowed humans and various creatures such as birds, butterflies, and bees to move freely from the forest to the beach. The naturalisation plan mainly reorganised the pedestrian priority road network, connecting different green spaces and extending to the city park.[133] The project included widening the footpath and planting larger trees and multi-level, diversified native plants. The footpath was divided into leisure spaces; the road surface was covered with hydrophobic grass bricks or grass, additional seats, tables, children's play facilities, activities equipment for the elderly, and drinking

water dispensers. It was both a wide tree-lined avenue and a space in the park, allowing local people to enjoy life and make ecology sustainable.

There have been many examples of promoting urban biodiversity worldwide, such as the "Biodiversity Design-Technical Guidelines for New and Original Buildings" published by the British Institute of Architects in 2013, paying particular attention to some "species that depend on buildings for survival". These "building-reliant species" refer to the birds, bats, and invertebrates that have become accustomed to human living environments. The outer walls and roofs of buildings become their comfortable nests or temporary homes for the migratory birds that fly by.[134] The "Guidelines for Biodiverse Green Roof" in Toronto, Canada, provides architectural designs and reference examples that support these animals, such as herbs that provide food for migratory birds and wooden branches or small wooden boxes where they can rest.[135]

Ecologically Responsible Design Considerations

Because the facade design of modern buildings is mostly a large-area glass curtain wall, the phenomenon of bird impact frequently occurs. According to records, nearly 100 million to 1 billion birds die annually in the United States alone due to an impact on buildings.[136] The glass curtain wall with high reflectivity will form a mirror effect, reflecting the surrounding plants and green spaces and misleading birds. When the glass of the building curtain wall has a high transmittance, the plant image behind the building will also mislead the birds to fly. Visual signals shall be provided on glazing to prevent bird-window collisions.[137]

To this end, the American Bird Protection Association has proposed a number of measures to prevent birds from hitting buildings and design guidelines for bird-friendly buildings.[138] Among them, a bird-friendly glazing treatment can be a solution to prevent bird collision with windows. Most birds can detect ultraviolet (UV); thus, glass laced with UV reflective patterns would be visible for birds while remaining transparent for humans. Besides selecting glass, several solutions could prevent the bird's collision with buildings. These include using angled windows sloping at 20 to 40 degrees, frosted glass or adding a visual pattern with spacing not exceeding two by four inches.[139]

In 1995, the "Lights Out Program" was first launched in Chicago, requiring the public to switch off their interior and exterior decorative lighting at midnight during spring and autumn.[140] The

intention is to minimize disturbances to migratory birds. It was intended to prevent disrupting the birds' biological clock, affecting their rest and feeding time. Currently, more than twenty cities have supported the initiative.[141]

Fig. 2.17 – Bird-friendly glazing

Fig. 2.18 – Light-out program

Biodiverse Landscape and Roof

Goddard et al.'s (2009) research, "Scaling up from gardens – biodiversity conservation in urban environments", concluded that people living in cities were increasingly disconnected from the natural world, witnessing an "extinction of experience". Urban green spaces have considerable benefits that maximise the biodiversity of urban ecosystems and minimise the extinction of species and the extinction of the human experience of wildlife.[142]

Qiu et al. (2013) hypothesised that people could correctly perceive differences in biodiversity between urban green space and habitat types. However, high biodiversity did not relate positively to preference. On-site perception and preference were mainly triggered by specific features rather than the overall scenery and character of the setting. The findings were attributed to differences in attitude between experts and laypeople, suggesting that ecological knowledge could positively influence preference for certain aspects of biodiversity.[143]

Lee et al. (2014) studied people's preferences for living on green roofs with various vegetation characteristics, including manipulated plant life form, foliage colour, flowering, diversity and height. The most preferred restorative living roof had tall, green grass and flowering vegetation. Meanwhile, taller vegetation and increased diversity were associated with higher preference overall.[144]

Fernandez-Cañero et al. (2013) investigated people's preconceptions of green roofs and their visual preferences. Responders' socio-demographic and childhood environmental background influenced their preference toward different types of green roofs. It concluded that green roofs with more careful design, good maintenance, and a greater variety of vegetation structures and colours are preferred over more natural alternatives. Many misunderstandings and misconceptions about green roofs were found, which revealed the importance of environmental education to the public.[145]

Flowering vegetation with a wider variety of vegetation structures and colours, specific landscape features, and locations rich in species are preferred (Tinoco et al., 2018).[146] Meanwhile, bio-diverse and brown roofs favour urban ecology (Ishimatsu et al., 2013).[147] Grahn and Stigsdotter (2010) conducted surveys to explore the sensory perception of natural environments and human health. The essential factors that constituted the perceived sensory dimensions consisted of (i) "nature", which included nature quality and untouched, free-growing lawns; (ii) "rich in species", which referred to an abundance of natural animal populations and native plants; (iii) "refuge", which meant sufficient bushes, sandpits, tables, benches and play equipment; and (iv) "serene", which included an uncrowded, calm, clean, well-maintained area, and minimal traffic noise. Among these perceived sensory dimensions, people most preferred "serene" and considered "refuge", "nature", and "rich in species" to be the most strongly correlated with low-stress and restorative environments.[148]

Pro-Environmental Attitude

Goddard et al. (2009) revealed that people living in cities are increasingly disconnected from the natural world, witnessing an extinction of experience.[149] Urban green spaces have considerable benefits that maximise the biodiversity of urban ecosystems and the human experience of wildlife while minimising the extinction of different species. The importance of urban green spaces with natural structures maintains high ecological diversity (Sandstrom et al., 2006).[150]

Urban children spending more time in nature can enhance environmental attitudes and ecological behaviours. Activities with nature, such as picking fruits, planting seeds or caring for vegetables, improve children's environmental attitudes (Collado et al., 2015).[151] Garden activities should also be organised so children can freely use and shape the environment's affordances, and a well-designed children's garden was recommended (Laaksoharju, 2012).[152]

Zhang et al. (2014) surveyed 1,119 children aged nine to ten in China and verified that the children's contact with nature had a significant positive effect on nurturing biophilic attitudes toward wildlife and enhancing their willingness to support animal conservation.[153]

These studies indicated that natural substances and environments positively impact ecological aspects, as summarized in Fig. 2.19.
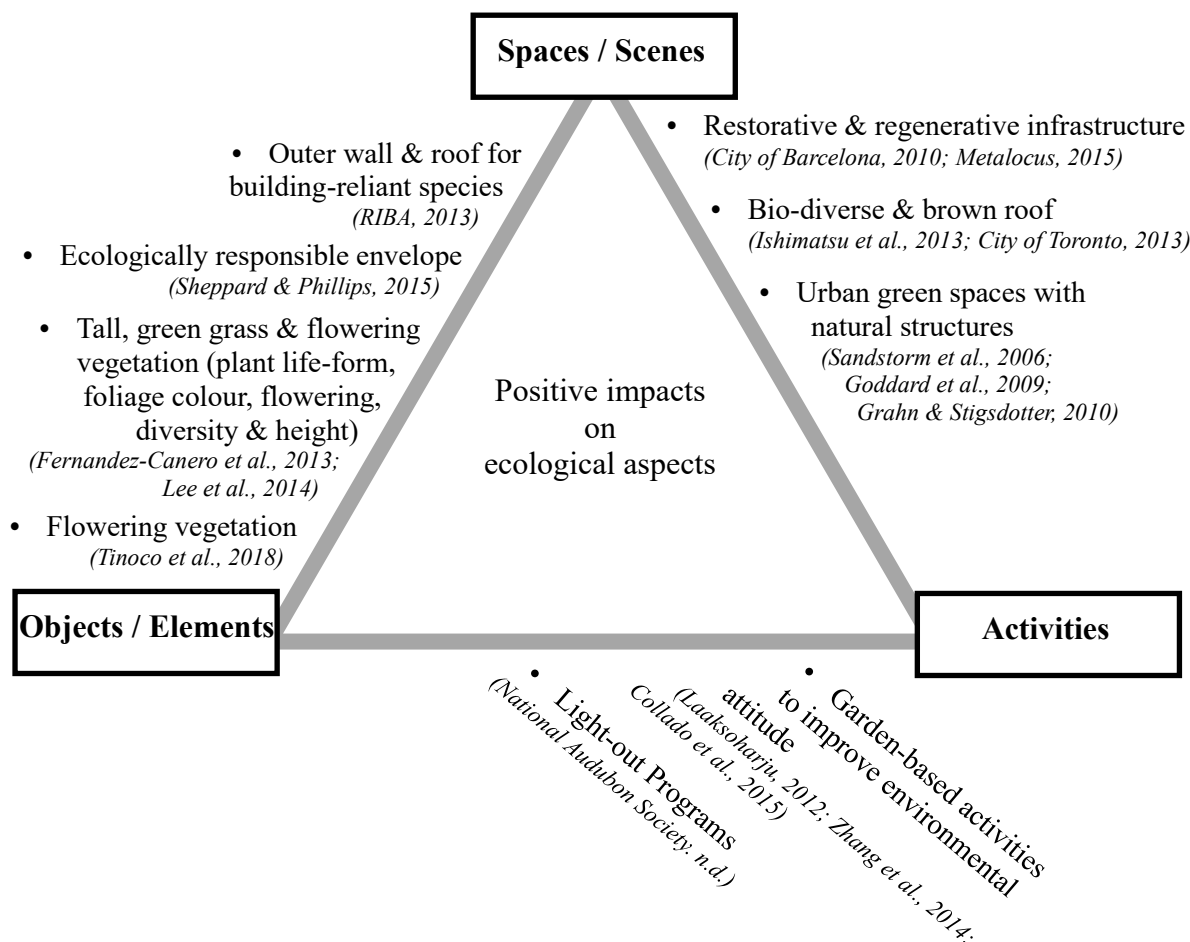
Fig. 2.19 – Positive impacts on ecological aspects from the literature review

2.9   Conflicts against Human-Nature Interactions in Urban Contexts

Although positive impacts are mentioned in the previous sections, the negativity of interaction with nature was also revealed from the literature review, as summarized in Fig. 2.20.

Psychological	• Patuano (2020) elaborated that some urban dwellers were biophobia and fear of more natural types of environments, which hindered positive impacts on psychological and physiological aspects due to human-nature interactions.[154]
Physiological	• Byers et al. (2020) and Cutts et al. (2017) indicated that there is a potential health risk for lead exposure in children and adults from consuming vegetables grown in urban soils due to contamination.[155,156]
Social	• Egerer, M. & Fairbairn, M. (2018), M. Estrada et al. (2020) and Wagner et al.(2019) researched social tensions in urban green spaces and community gardens and indicated that urban community gardens incurred community conflicts and restricted access and usage of public land by limited people who maintained the gardens; on the contrary, it marginalized individuals whom might not have the resources to participate the gardening programme. If the gardening programme has been commercialized or needs to charge to balance the setup, operation and maintainance expenses, it would futher deprive low-income individuals of using the public land. Appropriate citizen engagement methods are needed in recognition of existing community resources and different citizens' interests in urban green spaces.[157,158,159] • Milligan et al. (2004) revealed that owing to their age, physical limitations (such as ill-health) and social friction (such as personality differences) prevented them from attaining the said benefits of keeping a communal garden. This, in turn, leads to frustration or depression in the elderly. The study also found that communal gardening in the elderly encouraged them to work together, overcoming some physical limitations that they may have had personally. Overall, there was a need for gardening programmes to be flexible and adaptable to the limitations experienced by the elderly.[160]
Environmental	• Shafique et al. (2018) mentioned the main challenges of green roofs, including high construction and maintenance costs and roof leakage issues.[161] • Yin et al. (2021) and Tomasella et al. (2022) stated that the water consumption of plants in maintaining garden spaces was very high, and the selection of water-saving plants and substrates was critical for water saving.[162,163]
Ecological	• Sandstrom et al. (2006) delineated that semi-natural areas, such as layers of vegetation and deciduous trees, desired the biodiversity of birds; however, they imposed conflicts with urban dwellers. For instance, shrubs in urban green spaces may pose potentially dangerous places for women; and leaves, fruits and branches from trees may be slippery to passers-by, especially older adults. It resulted in favouring a simple vegetation structure. Kim et al. (2020) indicated that hornets and wasps gradually adapted to the urban environment in favour of urban biodiversity and ecosystem services; however, urban residents considered unsafe with them in green spaces.[164,165] • Hosaka, T., & Numata, S. (2016) identified the potential conflicts with wildlife in urban green spaces, such as more wasps and snakes for more urban green spaces, and recommended better green space management to minimize wildlife nuisances.[166]

Fig. 2.20 – Summary of negativity of interaction with nature from the literature review

Furthermore, there is a dilemma in the scope of human-nature interactions and how much we can interact with nature. Urbanites are hesitant to interact with nature, yet there is a need to increase exposure to develop an appreciation for the natural world. While we are afraid of the "disease-ridden" natural world, we are also taught to appreciate nature and animals, causing a contradiction between these two behaviours. This section will explore the various ways diseases navigate the natural world and, in turn, have an impact on humans, thus impacting how integrated human-nature interaction can be.

Vector-Borne Diseases (Dengue Fever)

Vector-Borne diseases have resurged in urban areas due to stagnant water bodies (Lindsay, 2017).[167] This may come from the high rainfall rate, air conditioner drippings and water containers present in urban cities.

Aedes aegypti lay their eggs in artificial water containers made by humans, a key component in the urban transmission cycle. Providing constant tap water reduces the need to store water in and around the house in containers because it is well-known that a container filled with water is an ideal habitat for Aedes aegypti (Gubler, 2011).[168] Houses can be designed to prevent adult mosquitoes from entering by sealed or screened openings. Reducing the spread of disease vectors can only be successful if combined with community participation to understand the diseases transmitted by these vectors and help control efforts. Most scrub typhus and spotted fever cases acquired the infection locally. These mosquitos are located in vegetated areas in Hong Kong, e.g. hiking areas, outdoor workplaces, vegetated areas near home or outdoor recreational areas, which are locations infected people have visited.[169]

Termite Damage

Termites can easily build nests in urban environments with high humidity, temperature, and suitable lighting conditions, increasing their destructive power. An essential aspect of why social insects in urban environments warrant control is when they threaten human life (Dimarco et al., 2017).[170]

Termites need cellulose for digestion. They destroy non-hard materials, timber formwork, waterproof membranes, roofing felt, structural timber, interior and window frames, wooden

baseboards, wooden floors and wooden furniture such as cabinets and cabinets. They also damage hard materials, plaster, PVC pipes and cables. Even certain soft metals, such as lead, copper, and aluminium, can be damaged by termites. Termite resistance material is concrete (Cheung et al., 2014).[171] Termite survey shall be conducted for the renovation of old buildings.

Diseases in Wildlife

Combined with the high densities of humans and domestic and companion animals, there is considerable opportunity for diseases to transmit from wildlife to humans or from wildlife to pets (Bradley & Altizer, 2007; Mackenstedt et al., 2015).[172,173] According to the World Health Organization (WHO), although the health of urban residents is generally better than that of rural residents, the risks are unevenly distributed, and most of the burden falls on vulnerable groups such as slum dwellers.[174]

There is evidence that, by changing the habitat structure and changing the availability of resources, urbanization has led to substantial changes in the structure of wildlife communities, characterized by low biodiversity and a proportional increase in the abundance of certain generalist species (Faeth, 2005).[175] Biotic homogenisation - with synanthropic species occurring at higher densities in urban and suburban environments. There is a likelihood of encounter and transmission between competent hosts, host abundance or density, and infected host mortality and recovery (Wood, 2014).[176] Increased synanthropic species population density can elevate contact rates (Evans, 2009).[177]

Ecotones – edges or transitional zones between adjacent ecosystems, biophysical factors, biological activity and ecology, evolutionary processes are concentrated and strengthened (Despommier, 2006).[178] Interspersing human landscapes such as farmland and settlements with natural landscapes, anthropogenic influences can alter pathogen niches by bringing together humans, vectors, and reservoir hosts (wildlife or domestic animals), thus increasing contact and the risk of transmission (Reisen, 2010).[179]

Livestock-keeping practice production systems and the movements of livestock and animal products in urban areas might be issues. The first cases of SARS reportedly occurred in individuals who handled these animals to prepare exotic food, and the virus is thought to have crossed over to their human host (Guan et al., 2003).[180]

Urbanization increases the density of people and livestock, creating conditions that can spread rather than reduce the spread of diseases (Enserink, 2008; Alirol et al., 2011).[181,182] As a result, further conflicts due can lead to disrupted human-nature living conditions.

Airborne transmissions spread more efficiently in urban settings.[183] Exposure to fine droplet nuclei exhaled by another person; these droplet nuclei can travel long distances. Zhang and Li (2012) suggested that the virus transmission was airborne. Once the aerosol is suspended in the air, it will be affected by the ventilation and airflow of the indoor space. Existing technologies used in modern buildings can help to improve ventilation and airflow to reduce transmission.[184]

The Monkeys and Boars venturing into urban areas

Due to the proximity between urban and natural areas in Hong Kong, wild animals often find themselves in developed urban areas, affecting citizens' quality of life with noise pollution and aggression from wildlife towards humans. Another reason for the increase in wildlife in urban areas is human behaviour. People often feed wildlife, encouraging them to exhibit aggressive behaviour to obtain food. Wildlife poses risks to the urban population, such as transmitting zoonotic diseases. Mackenstedt et al. (2015) revealed that wild animal species are attracted to suburban and urban habitats due to the ample food supply and structures to shelter in.[185] More urban-rural fringe habitats were created to expand urban areas in more rural and natural areas, posing a high disease hazard. According to the commission's report, synthetic wildlife is abundant and adaptive to cities; the number of trapped monkeys decreased by 59%, while no monkeys were trapped by 17 troops. Over the years, an increase in the monkey population has been a consequence of people feeding wildlife.[186] With the increase of high-rises built along the flanks of forest-covered mountains, the boars easily venture into hyper-urban environments, like in between apartment buildings or even inside malls.[187]

These are potential conflicts at the interfaces of humans and nature in urban contexts. Therefore, it informs that wildlife habitats shall be set away from urban areas, and some types of human-nature interactions, e.g. feeding wildlife, shall be avoided.

2.10   Conclusion

Multifaceted philosophical interpretations of nature are reviewed in Section 2.2. Nature is interpreted as a scene, a thing, a principle, a resource or a romantic appreciation from human perspectives. Environmental ethics poses a paradigm shift from the human-centric to the nature-centric interpretation of nature. Nature has its intrinsic value. Human activities have incurred that nature is no longer without human intervention. Humans are urged to treat other species with the same level of respect as applying for humans. Furthermore, human-nature interactions are from nature-based, nature-inspired and nature-driven theories. Nature-based theories envision human appreciation and respect for the existence of nature; nature-inspired theories take inspiration to solve human problems, and nature-driven theories intend to restore and enable the evolution of nature with human intervention.

Psychological	• Stress reduction (Ulrich et al., 1991; Johansson et al., 2011; White et al., 2013) • Attention restoration (Kaplan, 1995; Hartig & Staats, 2006; Johansson et al., 2011; Tyrvainen et al., 2014; Bagot et al., 2015) • Soft fascination (Kaplan & Berman, 2010) • Biophobia (Collado et al., 2015) • Cope better with adversity (Corraliza et al., 2012) • The emotional health of urban children (Flouri et al., 2014) • Catch children's attention (Laaksoharju, 2012)
Physiological	• Mood and heart rate variability (Barton & Pretty, 2010; Van Den Berg and Custers, 2011; Beute & de Kort, 2014; Song et al., 2014) • Blood flow and pressure (Pretty et al., 2005; K. Koga & Y. Iwasaki, 2013; Louise et al., 2014) • Horticulture therapy (Gesler, 1992; Williams, 1998; Conradson, 2005; Rose, 2012; Doughty, 2013; Burton, 2014)
Social	• Social interactions and inclusion (Wong & Yuen, 2005; Huang, 2006; Diamant & Waterhouse, 2010; Peschardt et al., 2012) • Community building (Amulya et al., 2009; Battersby & Marshak, 2013) • Elderly Neighbourhood (Delvin and Zaff, 1998; Kweon et al., 1998; Milligan et al., 2004; Wang & MacMillan, 2013)
Environmental	• Microclimate (Picot, 2004; Levermore & Smith, 2008, HKGBC, 2017) • Urban ventilation (Fung et al., 2009) • Outdoor thermal comfort (Brown & Gillespie, 1995; Hoppe, 1999; Givoni et al., 2003)
Ecological	• Urban biodiversity (Sandstrom et al., 2006; Goddard et al., 2009; Qiu et al., 2013; RIBA, 2013) • Humans' affinity to nature (Wilson 1984; Kellert & Wilson 1993; Fernandez-

| | Cañero et al., 2013; Lee et al., 2014) |
| | • Pro-environmental attitude (Collado et al., 2015; Laaksoharju, 2012; Zhang et al., 2014) |

Fig. 2.21 – Summary of the significance of interaction with nature from the literature review

The literature review has revealed the significance of human-nature interactions, as summarised in Fig. 2.21. As discussed in Sections 2.3 to 2.5, recent studies have demonstrated that human-nature interactions positively affect physical, psychological and physiological health. These interactions can consist of just short exposure to nature, viewing greenery, walking in an urban park, physical exercises in green spaces or cultivating vegetation. Green spaces facilitate urban dwellers, including children and older adults, stress mitigating, attention restorative and soft fascinating. Meanwhile, nature-based or garden-based activities contribute to a positive mood, lowering heart rate, engaging with nature, and developing emotional awareness.

Pleasant communal activity spaces and green areas encourage social interaction among neighbours, as reviewed in Section 2.6. Communal gardens facilitate causal and incidental social interactions, allowing a children-friendly living environment and an elderly-integrated neighbourhood. Community gardening enhances social connections, reciprocity, mutual trust, collective decision-making, civil engagement and community building through people's interactions with their neighbours to plant and care for vegetation.

Urban green spaces promote human experience with wildlife, enhance ecological knowledge and nurture eco-conscious attitudes and behaviour, as elaborated in Section 2.8. In particular, urban children spending more time in nature garden-based activities could enhance environmental attitudes. Besides, it is revealed in Section 2.7 that an effective landscape design creates thermal comfort and energy efficiency. However, there are conflicts against human-nature interactions in urban contexts, as discussed in Section 2.9.

Urban green spaces have direct and indirect benefits to humans and nature. A summary of contributing factors to positive impacts on human-nature interactions is tabulated in Fig. 2.22, which serves as an overall framework of multi-dimensional human-nature interactions for the subsequent research works.

Psychological	S	•	Natural environment
		•	Communal green space & children's playground
	O	•	Trees, shrubs, flowers, grassy spaces
	A	•	Viewing of greenery
		•	A walk in green spaces
		•	Daily / direct sensory contact with nature
		•	Gardening / garden-based activities
Physiological	S	•	Exposure to nature
		•	Therapeutic garden & landscape
	O	•	Greenery
	A	•	Viewing of nature
		•	Green exercises / physical exercises in green spaces
		•	Gardening
Social	S	•	Circulation space, scenic & activity space
		•	Communal green spaces & Small public urban green spaces
		•	Community garden
	O	•	Visual focus, greenery & spacious areas
	A	•	Allotment gardening activities/community gardening
Environmental	S	•	Building permeability, configuration & surface materials
		•	Communal green space & sky view
	O	•	Greenery
		•	Sky, sunlight & wind
Ecological	S	•	Restorative & regenerative infrastructure
		•	Bio-diverse & brown roof
		•	Urban green spaces with natural structures
	O	•	Ecologically responsible envelope/design for building-reliant species
		•	Greenery & flowering vegetation
	A	•	Garden-based activities to improve environmental attitude
		•	Light-out Programs

Fig. 2.22 – Summary of contributing factors ("S" – Spaces/Scenes; "O" – Objects/Elements; "A" – Activities) to positive impacts on human-nature interactions

Chapter 3: Communal Spaces and Communal Green Spaces in Urban Contexts

3.1 Introduction

This chapter will identify the pull factors why communal green spaces are important to the physical, psychological and general well-being of high-density urban dwellers. The chapter will recentre the need for urban-nature connections through communal green spaces and introduce the methods of how to accomplish this through the different typologies of communal green spaces.

3.2 Urban-Nature Connections in Urban Contexts

Urban dwellers tend to be more biophobic and socially isolated as they lack exposure to nature (Collado et al., 2015).[188]

High-rises have more feeble social networks and higher crime rates (Fowler, 2008).[189] Forty years ago, research on residents' behaviour in a high-rise apartment concluded that there was a high degree of anonymity and social isolation, including pervasive ignorance about neighbours and little inclination to establish friendly relations with them (Zito, 1974).[190] These phenomena are not uncommon in residential high-rises nowadays. Robert (2007) suggested six types of fears found in high-rise residences.[191] A fire in the high-rise housing Grenfell Tower in London caused multiple deaths. After the incident, many public housing residents doubted the safety of the design in high-rises.[192] High-rise buildings are prone to more outbreaks of diseases due to their density.

Another tragic example is Amoy Gardens in Hong Kong. Due to the dense quality of high-rise buildings, it was an incubation ground for the virus. Hence, there was a high infection rate and death rate in that estate in Hong Kong during the outbreak of severe acute respiratory syndrome (SARS) in 2003.[193]

On the other hand, residents of high-rises strongly hope to have a pleasant communal green space, which can encourage social interaction and community activities between neighbours under appropriate circumstances.[194] Communal green spaces allow families to expand into these spaces such that their tiny apartments do not restrict them. In addition, communal green spaces placed at high levels help to mitigate urban heat effects; reduce carbon emissions; provide shade and remove heat from surrounding air through evapotranspiration; prevent excessive heat absorption by the floors below, leading to reduced energy consumption; and allow rainwater collection systems

(Chan et al., 2019).

Communal Green Spaces in Hong Kong

Although Hong Kong has a high-density ratio, two-thirds of the land is a natural landscape, including a mixture of woodland, shrubland, grassland and wetland. In addition, over 40% are country parks and nature reserves, and less than 25% are developable lands.[195]

In Hong Kong, there is about 66m^2 of green space per capita; however, this is only 2.5m^2 of green space per capita in urban areas if country parks are excluded. The twenty-four country parks are accessible by public transportation via mass transit railway, buses and mini-buses. According to the government record, "spending a day in a country park" was regarded by many as one of the best recreational choices. Country Park has received more than 11 million visitors annually in the last decade.[196]

Although Hong Kong has plentiful country parks, this section is interested in the communal green spaces in urban areas. Hong Kong Planning Standards and Guidelines (HKPSG) indicate how many park areas people should have per capita and what functions of greening should be in urban areas. For instance, the following statement is extracted from chapter four of the HKPSG depicting the benefits of urban greenery.[197]

"Functions of greening include offering visual and psychological comfort and relief, adding aesthetic quality and human dimensions, increasing permeability of space, delineating vistas of interesting view corridors, providing a sense of seasonal changes, improving microclimate by providing sunshades and windbreaks, breaking down noxious gas emitted from vehicles, mitigating traffic noise, acting as hydrological balancing reservoir by retaining runoff and helping moderating soil erosion and enhancing slope stability, being of indigenous species providing food and shelter for wildlife, and reducing visual monotony and enhance the quality of the road environment."

This statement suggests the importance of communal green spaces in urban areas by cultivating microclimates. This provides a recluse from the current living environment for the majority of Hong Kong. Furthermore, it states that urban greenery also serves wildlife and natural habitats.

Typically, due to the small living space in Hong Kong, high-rises result in the growing importance of communal green spaces in urban contexts. The average living area per person in Hong Kong is about two-thirds of the area in the U.K.[198] The tiny living space signifies the importance of communal and outdoor recreational areas. The research by Chan et al. (2008) elaborated that home buyers in Hong Kong had a higher willingness to purchase homes due to the positive impacts of parks and clubhouses on buyers' willingness as the essential elements of good quality living spaces.[199] Chan and Lee (2009) stated the importance of environmental design criteria indicators, which comprise the sense of community, green design features and open spaces.[200] However, most of the population live in dense urban districts and have fewer chances to interact with the natural environment in their daily life due to physical urban settings and cultural and social living patterns.

Tan et al. (2019) revealed more social interactions among older adults in green areas in public housing in Hong Kong than in street resting gardens. There was also a preference and appreciation for colourful flowers as a part of the aesthetic design in urban green spaces (UGSs), which could be related to cultural factors of bright-coloured flowers being linked to the perception of vitality. The study suggested a 400m walking distance for easy accessibility of UGSs for older adults. There was popularity in small-scale UGSs in high-density areas, which older adults preferred. In terms of design for nature and design for humans with nature, including a colourful and bio-diverse range of flowers and plants could facilitate a better appreciation of nature of the elderly and introduce plant biodiversity.[201]

Communal green spaces in urban contexts have the potential to preserve the local natural and cultural heritage by providing habitats for a diversity of urban wildlife and conserving a diversity of urban ecosystems (Van Leeuwen et al., 2010).[202] Urban communal green spaces exist at various city locations, serving different functions to urban dwellers and wildlife alike. Nevertheless, in the Hong Kong context, Lau (2014) found that small public urban open spaces are of poor quality in Hong Kong and mainly act as social hubs and living spaces for older adults, compensating for the lack of private space. In a comparative study, "Use of Small Public Urban Green Spaces (SPUGS)", to Copenhagen, SPUGS did not act as a natural meeting point for people of all age groups in Hong Kong because of the poor design and lack of facilities.[203] However, communal green spaces on a smaller scale could be designed to be easily accessible to commuters in urban areas.

There are conflicts against human-nature interaction in green communal spaces. Tam and Bonebrake (2016) found a diverse population of butterfly species in Hong Kong urban parks, where vegetation provided a nectar resource and acted as a habitat. However, the maintenance of urban parks, such as using insecticide and the regular pruning and clearance of vegetation, might decrease butterfly populations. A suggested solution to improve butterfly populations was to plant more native plants to mimic their natural habitats, such as native nectar plants and host plants for breeding. The study also recognised the value of communal green spaces in urban contexts to bridge natural forest habitats, i.e., butterflies, to more urban green spaces and improve habitat connectivity. There was an evident dilemma between the demand for better maintenance of urban parks and the possible destruction of species' natural habitats in Hong Kong.[204] This is an example of conflicts between human-nature interaction in urban green spaces that can be mediated by suggesting a careful study of species and matching the fauna to needs. These conflicts against human-nature interactions in urban contexts will be further discussed later.

3.3   Communal Green Spaces at High Levels in Urban Developments in Hong Kong

In the high-density urban environment, the scarcity of land squeezes the development of high-rise greenery away from the ground level. In Hong Kong, a typical residential development comprises several domestic towers sitting on a 2-4 storey podium with car parks and retail. By regulations, the podium within the 15m height limit from the street is allowed to be 100% site coverage, while the towers cover 25-33% of site areas according to different site classifications. There are different types of communal green spaces in residential high-rises. The types are usually emerging from their locations and connectivity to the community. Podium gardens are green spaces on top of the podium, sky gardens are scattered at various levels of the towers, and roof gardens are situated on the roof of the towers. Fig. 3.1 illustrates a typical high-rise residential development where podium and sky gardens are for communal use, and roof gardens are within the private premises of duplex units at the uppermost storeys.

A sky garden is a communal green space in a building at a high level. In 2001, the Hong Kong government implemented green feature incentives on gross floor area (GFA) and site coverage (SC) exemption.[205] The sky garden is one of the promoted green features. Other features comprise a balcony, a utility platform, a precast façade and wing walls. Fig. 3.2 lists milestones in sky garden development in Hong Kong.

Fig. 3.1 – Communal green spaces at multi-levels in residential development in Hong Kong

However, the public raised concerns about the provision of these features, which enlarged building bulks, causing wall effects and detriments to urban micro-climate and street environments and requested the government to review the policy of green feature incentives.

In 2005, the government issued a report "A First Sustainable Development Strategy for Hong Kong" and promoted sustainable urban planning and building design practices.[206] In addition, it laid down the blueprint for subsequent departmental actions for improving pedestrian and living environments. In 2006, the government commenced a consultancy study on building design that supports sustainable urban living space, which targeted to formulate building design guidelines on facilitating better urban air ventilation, mitigating the urban heat island effect, enhancing the environmental quality of pedestrians and public spaces and providing more greenery.[207]

In 2009, the Council on Sustainable Development (CSD) conducted a public consultation to gather the public, professionals' and developers' views on fostering a better quality of the living environment and GFA concessions for green features, recreational amenities and auxiliary

facilities under the existing policies.[208] In 2010, CSD issued the final report to the government and recommended statutory requirements for building set-back and the introduction of green area ratio while GFA / SC concessions for some green feature provisions should be restrained. In addition, the report supported the sky garden as one of the sustainable design strategies in high-rise developments.[209] As a result, in 2011, the Buildings Department issued the practice note "Building Design to Foster a Quality and Sustainable Built Environment" to introduce sustainable building design guidelines and the overall cap of 10% of the total GFA of the development for green feature provisions. In this practice note, sky gardens were further promoted that the provision of sky gardens could exclude from GFA calculation not subject to the overall cap.[210]

Year	Milestones
2001	Hong Kong (HK) government issued "green incentives" for promoting green building features. Sky garden is one of the green features and also a new building feature to HK people at that moment. Practice note "Green and Innovative Buildings" was issued that communal sky gardens for residential buildings were excluded from GFA calculation.
2005	HK government issued a report "A First Sustainable Development Strategy for HK".
2006-2009	Consultancy study on building design that supported sustainable urban living space in HK and targeted to formulate design guidelines on urban air ventilation, environmental quality of pedestrian level and public spaces and urban greenery.
2009	The Council on Sustainable Development (CSD) reviewed the sustainable design and conducted a public consultation.
2010	CSD issued a report to recommend the revision of green incentives and new legislation on green building design.
2011	The practice note "Building Design to Foster a Quality and Sustainable Built Environment" was issued in 2011. Sky gardens that improve the permeability of a development to its neighbourhood could exempt GFA not subject to the overall cap of 10% of the total GFA of the development.

Fig. 3.2 - Milestones on sky garden development in Hong Kong

The terminology of sky gardens is not well defined in the academic field. For this thesis, the term sky garden will be replaced by communal green space at a high level.

Local Case Studies

The two local cases are selected to overview the provisions of communal green spaces at high levels in residential high-rises. Detailed case studies will be presented in Chapter 8.

Fig. 3.3 – Residential development, The Orchard, in Hong Kong

The Orchard is one of the earliest private residential developments with the provision of communal green spaces at high levels after the implementation of government incentives in Hong Kong. It was built in 2003. Two 38-storey residential high-rises accommodate 442 units. Two communal green spaces are located on the 17th and 32nd floors, which also serve as refuge floors. Japanese Garden and British Garden are themes of these two gardens, respectively, as shown in Fig. 3.3.[211] Sitting area, strolling paths, sculptures and plants are provided. It is a typical case of adaptive use of refuge floors as communal green spaces and limited spaces for greenery and recreational activities.

Fig. 3.4 – Residential development, Indi Home, in Hong Kong

Indi Home is another residential development with communal green spaces at a high level. A 50-storey residential high-rise with 960 units was built in 2006. A communal green space of 1,000m^2 is located on the 45th floor and serves as a refuge floor. With discrete structural walls and columns, segmented spaces are found to accommodate basic amenities for children's play, sitting, strolling and fitness. Fig. 3.4 illustrates the spatial quality with 4.5m headroom but narrow activity spaces.[212]

International Case Studies

The two international cases are selected to reveal the possibility of communal space and greenery at high levels and exemplify how interactions with nature could be facilitated in residential high-rises.
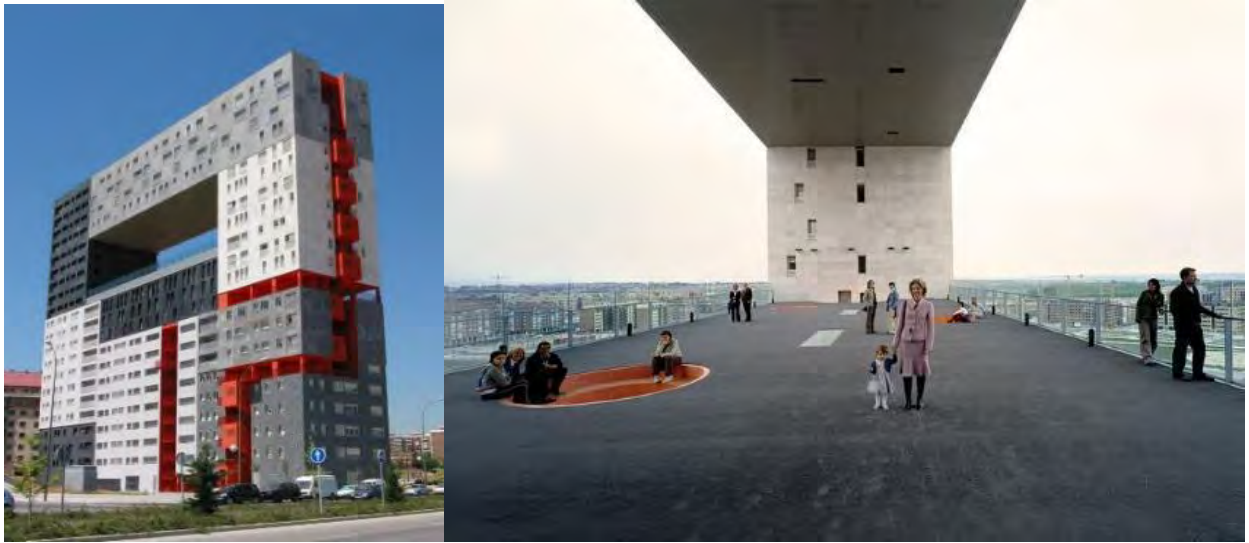
Fig. 3.5 – Residential development, Mirador, in Madrid

One of the pioneering projects with a new typology of communal space at a high level is Mirador in Madrid, Spain. A residential building with 156 apartments was built in 2005. 40m above the ground, a large lookout space offers residents and neighbours a community garden and an outdoor interaction space to contemplate the skyline. The courtyard concept is converted to a vertical communal space at a high level.[213]

Fig. 3.6 – Residential development, Vertical Forest, in Milan

Another project demonstrates a new typology of residential high-rises with extensive green coverage at high levels. These two 27-storey green vertical residential towers were built in Milan, Italy, in 2014. Over 900 trees, 5,000 bushes and 11,000 plants are provided throughout the tower balconies, as shown in Fig. 3.6. The design concept was to adopt lush vegetation to balance the microclimate, filter out dust particles, and shade sunlight in the urban environment. The diversity and characteristics of the selected plants produce humidity, absorb carbon dioxide and dust particles, produce oxygen and protect the buildings from radiation and acoustic pollution.[214]

The differences in spatial quality and provisions of greenery amongst the local and international case studies pose an inquiry on what kinds of communal green spaces we shall advocate at residential high-rises, in particular to the contexts of Hong Kong.

3.4   Evolution of Communal Spaces at High Levels in Hong Kong

Before communal green spaces were developed in the urban areas of Hong Kong, there were existing forms of communal spaces which were usually found in the various public housing estates of Hong Kong. The communal spaces include corridors, lift lobbies, staircase landings, rooftops and shared balconies. Even if these spaces are typically not allocated for greenery, the potential for transformation is possible. These spaces are often used for amenities, shared communal facilities and more.
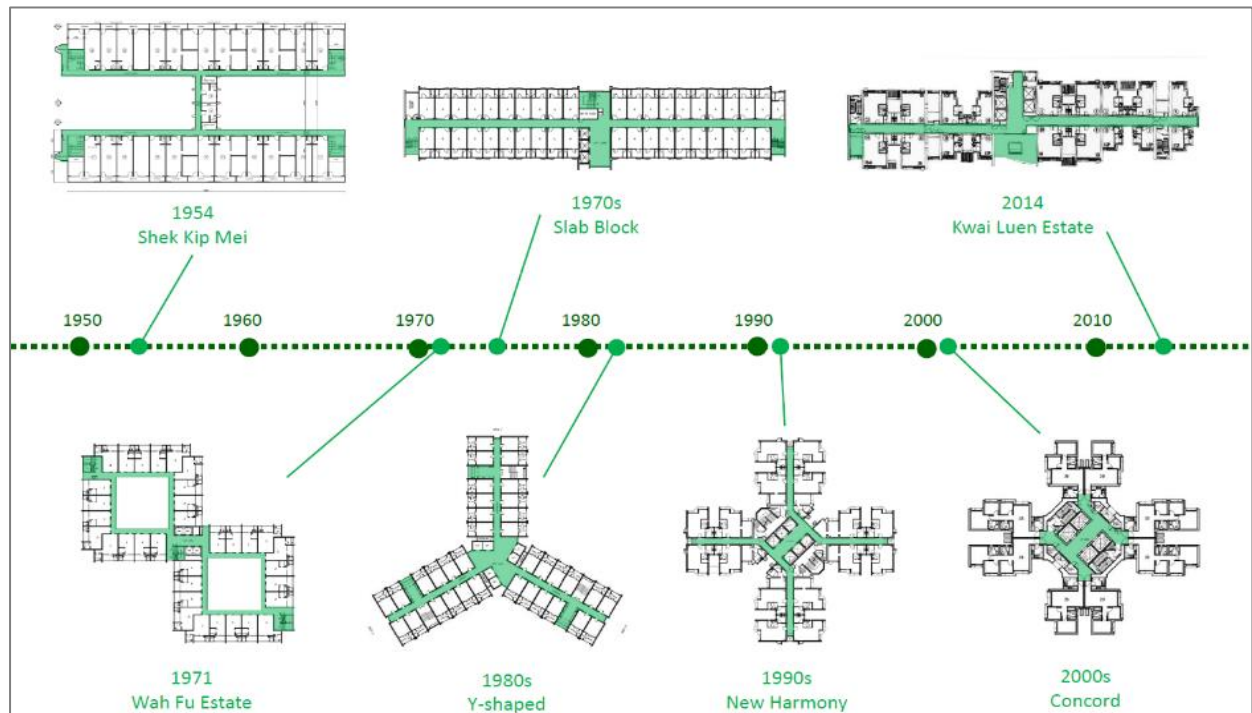
Fig. 3.7 – Timeline of communal spaces at high levels in public housing development in Hong Kong

Shek Kip Mei - Mark I

Shek Kip Mei Estate was the first public housing estate to relocate families from the squatter settlement slums area in 1954.[215] Due to the low-rise typology of residential blocks, the centre of the H on the ground floor acted as a courtyard where communities could come together. Each floor of the two linear blocks (residential wings) was connected by two staircases at two ends, with a central connecting block (communal facilities) connecting the two linear blocks.[216] Open balcony corridors facing the courtyard provided access to flats. A rooftop school was accommodated into the housing, implying the emphasis on creating a neighbourhood within the housing complex.[217]

Wah Fu Estate - Twin Tower

Wah Fu Estate was the first public housing estate planned as a self-contained community. A central courtyard was enclosed but still with open-air above. The balcony-like corridors of each floor facilitated causal interactions among neighbours, and the flats could be seen from opposite sides.[218]

Slab Block

Slab housing was the second stage of public housing. In addition to providing accommodation, public housing was also moving towards a better living environment. There were five significant

designs to the slab block series: the rectangular shape, the Link I series, the 90-degrees twist, the 120-degrees twist, and the 135-degree twist. The design of the arrangement eliminated the open-air courtyard in the building. The communal spaces, as a result, are minimised. There were neighbours on the opposite side of the corridor or landing of each floor. Of which it was more of a cramped space. However, the lift lobby of each floor was much larger compared to the twin tower. It offered a small communal space and interconnected the two wings of the building.[219]

Y-Shaped (Trident Design)

Trident style was three identical arms from one central lift core. Housing blocks were generally 35 storeys in height and had a unique "Y" shape, with three independent wings connected by a central elevator lobby.[220] The flats of different blocks no longer directly faced each other and gave higher privacy to the occupants. The apartment sizes were increased; however, community spaces were minimised.[221] Natural light could only be imported from the ends of the wings.

New Harmony

New Harmony was the most predominant public housing design in the 1990s, like four identical arms from one central lift core.[222] The benefit of this design was openings at both ends of their lift lobby, allowing cross ventilation. Communal space was lesser compared to the trident designs. The sense of the community was lost within this design residents were no longer connected to neighbours on residential floors. Instead, community facilities were provided in separate blocks or ground and podium levels.[223]

Concorde

The last generation of public housing – the concord block – was a zig-zag form, firstly introduced in 1997. The concord design was more spacious, with eight apartments on a typical floor providing greater privacy than the 16 to 18 on a typical Harmony floor.[224] From a construction point of view, the concord block aimed to promote a more simplified formwork system in the production process. Meanwhile, it reduced the communal space, and the distance from the lift lobby to each family's doorstep was not farther than a few steps away.

Kwai Luen Estate – Sky Gardens

Kwai Luen Estate was built in 2011, representing one of the latest public housing developments.[225] Public housing has adopted site-specific and non-standardised designs since 2010. It was an

elongated rectangle design. Alongside every three floors, there were sky gardens where residents could gather.[226] It started to consider a balance between spatial efficiency and the quality of communal spaces on residential floors.

Public housing shares a similar architectural language for each decade and iteration. Private housing, however, is a different matter. When space is capital, communal space is limited and displaced to different estate parts. Therefore, maximising saleable areas and spatial efficiency is the main objective in designing private residential properties. Some examples are listed below:
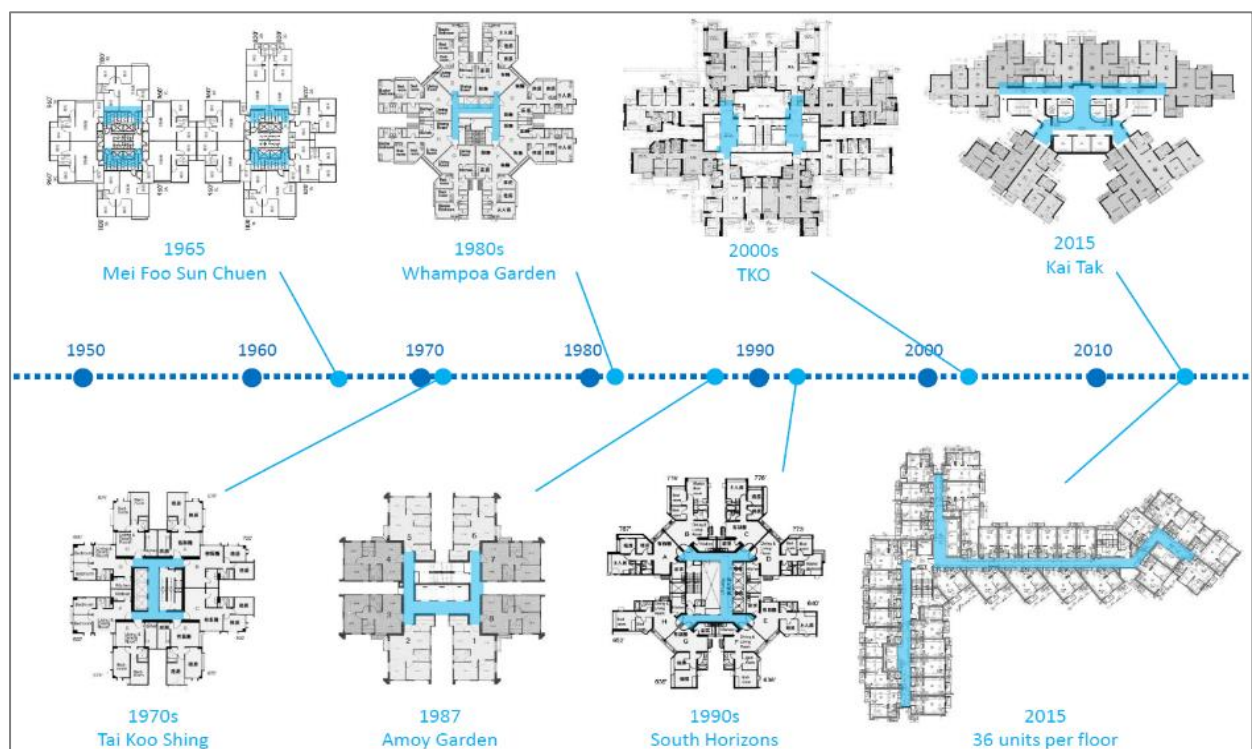
Fig. 3.8 – Timeline of communal spaces at high levels in private residential development in Hong Kong

Mei Foo Sun Chuen

Mei Foo Sun Chuen was a pioneering private housing development for Hong Kong regarding its scale, scope, and planning concepts. It was then the world's largest residential estate and Hong Kong's first self-contained residential community in which accommodation and complete services, including shops, open space and recreational facilities, were stitched together via an elevated podium.[227] Mei Foo Sun Chuen adopted the cruciform style floor plans, which show bedrooms, kitchens, stairwells, and each housing block's relationship with the linked podiums. It enhances the opportunity for residents to use the podium and raises the interaction between inhabitants. On

the contrary, communal spaces on each floor are squeezed to the nominal, merely aiming to satisfy means of escape requirements.

Taikoo Shing, Whampoa Gardens, Amoy Gardens, South Horizons, Tseung Kwan O
Taikoo Shing, Whampoa Gardens, South Horizon, Amoy Gardens and Tseung Kwan O represent large-scale private residential developments in the late 20th century from the early seventies to finishing in the change of the century. As communal spaces on residential floors are counted for gross floor areas under regulations, their provisions serve for circulation and fire escape and must be minimal.

36 Units Per Floor – Upper Ease in Hung Hom
The layout plan of 36 units per floor is the Upper Ease in Hung Hom, a 32-storey residential building.[228] Assuming three to four family members live in each unit, almost a hundred residents are on each floor. However, there are just long corridors connecting them without considering communal spaces for a hundred people neighbourhood.

Kai Tak New District Development
Meanwhile, on the contrary, there has been a new typology of residential high-rises with sustainable design features in the last two decades. It is mainly due to the government incentives on additional gross floor areas for these features and implanting sustainable building design ideas to the outline zoning plans and land leases of newly developed areas.[229,230] Kai Tak New District is an example. New development projects have incorporated ideas of wider and naturally ventilated corridors and lobbies, sky gardens and rooftop gardens to provide more pleasant communal spaces for residents.

3.5   Quantifying Communal Green Spaces for Human-Nature Interactions

There are many forms of indicators for communal green spaces. This section will explore quantitative techniques, such as salivary biomarkers and sustainable building design guidelines. Nevertheless, what is most important is understanding the definition of "green space" and another associated keyword used to describe such spaces.

Since green space has a multidisciplinary nature in medicine, urban design, ecology and social

sciences, green space is a general term used in conjunction with this discipline. However, it is essential to have a clear definition to avoid relying on personal interpretations of the characteristics of broad terms and avoid subjective interpretations by readers. For example, green infrastructure means providing a network of green spaces for urban residents in the city or the entire landscape (Tzoulas et al., 2007).[231] Associated open spaces, urban vegetation, parks, remnant patches, residential gardens or yards, road verges or streetscapes. These terms and definitions all assume human interaction or an urban context. Furthermore, these terms are applied at multiple scales (e.g., landscape, city, neighbourhood, or parcel), not all include vegetation (e.g., open spaces or residential yards may be paved), and the accessibility can vary (e.g., streetscapes might be public or, in the case of streets on private property, private).

There were six types of definitions identified from the literature review (Taylor & Hochuli, 2017):[232]

(i)   The definition acknowledged the range of definitions "of what could be considered "green space".

(ii)   The definition was provided by examples "illustrate what is meant by green space"'

(iii)   Green areas are referred to "green and natural areas without further explanation".

(iv)   Land uses were generic land uses described as "green space".

(v)   Vegetated areas feature vegetation.

Most green space definitions were considered in an urban context. However, there are also two broad interpretations of green space:

(i)   Green space as nature / natural areas; and

(ii)   Green space is an urban vegetated space.

Thus, green space should be clearly defined based on measurable criteria within the context of the study or field.

One way to measure the impact of green spaces is a scientific one by exploring biomarkers. Hunter et al. (2019) used salivary biomarkers to indicate stress with variation in the day, duration, and place of nature experience of urban dwellers. The salivary biomarkers are cortisol, the primary stress hormone, and salivary amylase, a marker investigating the stress response to physical and mental stressors. It was found that the effects of natural pills that used common sense and the

explanations of published studies to stimulate patients to take natural rest were found to be most effective when urban residents had 20-minute and 30-minute natural experiences. The period continued to occur at a reduced rate. It also showed that activity type did not influence cortisol response (i.e. activity type did not influence stress levels).[233] This could suggest that communal green spaces can be designed for shorter experiences to maximise the efficiency of the psychological benefits of green space.

How do the current architectural practices measure green in Hong Kong? As per the Sustainable Building Design Guidelines under PNAP APP-152 issued in 2011 by the HKSAR government, site coverage of greenery measures the percentage of the area comprised of greenery. Sites are required to achieve a minimum greenery requirement. Multiple levels of greenery, even vertical greening, can be considered under some circumstances.[234] However, this greenery requirement merely considers green coverage regardless of qualitative indicators on ecological and functional values.

Micro-level

Some researchers suggest adopting the Leaf Area Index (LAI), which is related to a range of ecological processes like photosynthesis, transpiration and metabolism, reflecting the values of urban greenery more effectively. LAI is defined as the single side leaf area per unit ground area in biological science. Different types of greenery have various LAI. For instance, the LAI of trees is around 2.5-4.0, turf around 2.0, and an intensive green roof can achieve an LAI of 3.5-4.5.

There are two methods to measure LAI. Firstly, the direct harvest is based on collecting all leaf materials within a specific area and measuring the area of each leaf. Secondly, indirect measurements refer to digital hemispheric photography by measuring the leaf area within the photograph; radiation transmittance/reflection by using the amount of light energy transmitted or reflected by a plant canopy; remote sensing by using satellite images to find LAI based on the linear relationship between normalised difference vegetation index (NDVI) and LAI (Ong, 2003).[235]

Fig. 3.9 – Leaf Area Index (LAI)

LAI drives the within and the below canopy microclimate and determines and controls canopy water interception, radiation extinction, and water and carbon gas exchange. Thus, it is accurate to determine specific parameters and benchmarks (Breda, 2003).[236] LAI provides a method to measure a particular place's leaf area and land area ratio, thus becoming an indicator of green space. However, the multitude of methodologies presents a varied LAI, affecting its precision and accuracy when comparing LAI from two different measurement methods.

Based on the Leaf Area Index, as mentioned, Green Plot Ratio (GPR) is defined as the average LAI of the greenery on site. Combining the concept of building plot ratio and LAI, GPR measures the total single-side leaf area of the planted landscape to the plot area.

GPR can more reasonably indicate the greening effect on the site because it is directly related to the number of active photosynthetic leaves. In addition, it provides designers with greater flexibility in terms of design options because it is a targeted degree of green composition specified instead of land cover, which is consistent with current practices of measuring the ecological health of urban areas.

GPR provides a more general and applicable ratio to green space design, but it is held back by the limitations of LAI in indicating other factors, such as the ecological and social benefits of the plant.

Low-growing plants have higher LAI values because of the need to capture more light if they survive under a canopy; thus, designers may use low-growing plants, which is undesirable due to the lack of suitable conditions to provide biodiversity (Ong et al., 2012).[237]

Another indicator is the Biotope Area Ratio (BAR). BAR represents the ecologically effective surface area in proportion to the total land area. It is a comprehensive urban environmental indicator as it is not only taken into account greenery extent but also an ecologically effective surface area in terms of microclimate regulation, air filtering, groundwater recharge, rainwater drainage, cultural services in terms of residential and living conditions, and on habitat for flora and fauna and biodiversity (Lakes & Kim, 2012).[238]

BAR is based on extracting land-use features from high-resolution aerial images and ranking land-use features using the BAR index value (Peroni et al., 2019). It is the effective ecological area ratio to the total land area. When determining the total BAR of a site, different types of surface areas have different weight ratios. In addition, the weight ratio of BAR varies from city to city to adapt to different local environments.[239]

BAR is interpreted as adaptable measurement, management, and assessment of urban ecosystem services. Considering the permeability of surfaces allows a more well-rounded and context-specific assessment of the urban ecosystem services. However, cultural and ecological benchmarks are not considered in BAR, which could affect the measurement of the quality of green space if BAR is used as the only indicator of effective surface area.

Macro-level

On a macro scale, the Urban Neighbourhood Green Index (UNGI) is an indicator assessing the spatial distribution of Urban Green Space (UGS) in the vicinity of the urban environment. UNGI consists of two parts based on neighbourhood characteristics: urban vegetation and urban building features. The urban vegetation includes the amount of green and the type of green, while the urban building feature is composed of proximity to green, height and density of the building feature (Gupta et al., 2012).[240]

UGS has a significant impact on neighbours, which is the basis of the social inequality provided by UGS and provides a wealth of information for urban planning and decision-making. UNGI can

discover the built environment's impact and accessibility to UGS quality, so it performs better in UGS planning (Zhu et al., 2019).[241]

UNGI has considered the characteristics of urban built-up and the characteristics of urban vegetation. As a result, it would be a more accurate representation of urban green space than the green index, land cover, and other two-dimensional measurements of green space.

Effective Green Equivalent (EGE) is another indicator to measure public green spaces for cities regarding quality and accessibility. EGE considers green space measurement from a more practical standpoint. EGE is defined as an area of green space multiplied by corrected coefficients of quality and accessibility. The variables include the least road distances to urban green spaces, green patch areas, the quality of green patches determined by the Normalised Difference Vegetation Index (NDVI) and resident population. An average EGE relates to a city-level indicator to measure the average EGE of all residents within the city boundaries. An Inequality Coefficient (IC) measures the inequality of EGE distribution across the urban area. The higher the city's IC value is, the more unequal the public green space distribution is among urban residents (Yao et al., 2014).[242]

Although UNGI and EGE are on a macro scale and may not be applicable to a building scale in a vertical dimension, their considering factors of proximity to green and quality and accessibility of green spaces are good references to quantify communal green spaces at multi-levels. These factors are not considered in the current architectural practices in Hong Kong.

3.6   Knowledge Gaps in Research and Practice

Based on the literature review and desktop study in Chapters 2 and 3, the knowledge gaps in research and practice on the topic of urban living with nature in a compact city are revealed as follows.

Urban dwellers consider disconnecting from nature (Fowler, 2008, Goddard et al., 2009, Markevych et al., 2014 and Collado et al., 2015).[243,244,245,246] On the contrary, conflicts on the interfaces between humans and nature in urban contexts, e.g. wild bird feeding, monkeys and wild boars venturing into urban areas. In particular, urbanisation is continuously extending to suburban and rural areas, and residential high-rises are not just in developed urban districts but in suburban

areas. These towers become an interface between existing ecosystems on the fringes of rural environments and the growing urban condition.

The new design paradigm shifts the concept of sustainability from mitigating adverse impacts on the natural environment through low environmental impact design to regenerating the natural environment by fostering a positive impact with a biophilic design approach. It aims to promote biodiversity and nurture the innate human and nature connection. However, most theories and principles of biophilic design are developed in western countries, and there is a lack of theoretical guidance to the eastern culture and high-density, high-rise contexts. Whether regenerative, biophilia (Wilson, 1984), and biophilic design (Kellert et al., 2008 and Browning et al., 2014) are applicable in a compact city.[247,248,249]

Communal green space has positive impacts, but most of the findings are not based on high-density, high-rise contexts (especially for psychological, physiological, social and ecological aspects). In architectural design practice, there is a new typology of multi-level communal green space (also known as a sky garden) aiming to reduce this gap. It is a new typology within urban high-rise architecture, aiming to improve the ventilation and thermal conditions of the microclimate and provide a recreational space to enhance social interaction and neighbourhood quality at the same time. However, there is a lack of research on evaluating this communal green space at multi-levels and contributing to the larger question regarding human-nature interactions and urban living.

3.7   Conclusion

In this section, the characteristics of high-density, high-rise contexts are discussed. Opportunities for human-nature interactions in communal green spaces are outlined, particularly communal green spaces at residential high-rises. Key performance indicators for quantifying greenery and communal green spaces are identified. Knowledge gaps in research and practice are revealed.

In high-density, high-rise contexts, urban dwellers lack social interactions with neighbours and exposure to nature in their daily lives. Deficiencies in high-rise compact living include a high degree of anonymity and social isolation, a sense of insecurity, a chance of outbreaks of diseases and a high infection rate and hurdles for children's healthy development. The tiny living space in apartments further signifies the importance of communal and outdoor recreational areas.

Urban communal green spaces exist at various city locations, both in horizontal and vertical dimensions, serving different functions to urban dwellers. Given concerns on high-rise urban development's environmental and social performance, quality communal green spaces at multi-levels, i.e., sky gardens, have been advocated to contribute to the urban micro-climate, greenery, recreational use, and environmental quality high-rise living environment. Further analyses will be carried out in Chapter 7.

Overall, there is a shift to integrating natural substances from greening to naturalisation in the built environment. As concluded in Section 3.5, it is not just to calculate what form of greening can be included as green coverage but also to look further and focus on choosing the appropriate variety, connecting adjacent green infrastructure, and practising nature-centric design. From a macro point of view, if we consider the urban and rural development and architectural design from multiple perspectives and understand that the green building liveable community is not just humans but the entire natural ecology and living organisms, whether human beings, other living things and natural ecology will coexist and evolve sustainably.

There is a dilemma in the scope of human-nature interactions and how much we can interact with nature. Urban dwellers are hesitant to interact with nature, yet there is a need to increase exposure to develop an appreciation for the natural world. There is a need to study human-nature interactions in a compact high-rise city and investigate a new form of biophilic design in high-density urban contexts.

Chapter 4: Research Methodologies

4.1   Introduction

This chapter will discuss and evaluate appropriate methods in the thesis study. This thesis examines the significance and design considerations of human-nature interactions in urban living environments for the benefit of humans and nature, particularly in high-density, high-rise contexts. In this inquiry, two key types of stakeholders are urban dwellers who interpret, interact and intervene in nature and persons who legitimate, design and operate the architectural and urban settings to facilitate interactions with nature. Qualitative research methods are discussed and evaluated to formulate this thesis's overall framework of research methodologies.

4.2   Research Questions

There are three main research questions in this study, as follows:

(i)   What are the perceptions and experiences of urban dwellers to interacting with nature in urban living?

(ii)   What is a new form of biophilic design to advocate human-nature interactions in high-density, high-rise contexts?

(iii)   What are the design opportunities for human-nature interactions in communal green spaces at residential high-rises?

These research questions have their significance and priority in the study process. The first question intends to establish the main body of knowledge, followed by the second question of analysing essential elements from it. The third question examines and relates the findings to specific architectural settings and urban contexts. A series of sub-questions are developed to systematically guide and facilitate research studies, as outlined below.

(i) What are the perceptions and experiences of urban dwellers to interacting with nature in urban living? The corresponding sub-questions are:

(a) What are the purposes and significance of urban dwellers interacting with nature?

(b) How do urban dwellers interpret nature in urban living?

(c) What kinds of direct and indirect interactions with nature do people consider significant?

(d) Are these perceptions and experiences varying among people of different ages?

(ii) What is a new form of biophilic design to advocate human-nature interactions in high-density, high-rise contexts? The corresponding sub-questions are:

(a) What kinds of space or urban settings that people associate with nature?

(b) What kinds of natural and artificial elements are associated with human-nature interactions?

(c) What kinds of activities are in relation to human-nature interactions?

(iii) What are the design opportunities for human-nature interactions in communal green spaces at residential high-rises? The corresponding sub-questions are:

(a) What is the significance of communal green spaces in high-density, high-rise contexts associated with nature?

(b) How do we design communal green spaces to facilitate human-nature interactions at residential high-rises?

(c) Are there implications for current design practices?

4.3 Qualitative Research Methods

As discussed in the previous chapters, from the literature review, interactions with nature bring various direct and indirect benefits on psychological, physiological, social, environmental and ecological aspects, and potential conflicts with nature exist in urban living. While designs for both anthropocentric and non-anthropocentric interactions can improve wellbeing, each of these may yield better results for different types of situations. Qualitative research methods will be used to ask the questions of communal green space integration in high-rise urban contexts in Hong Kong.

The study aims to have an in-depth understanding of people's preferences and enjoyment in environmental settings. Furthermore, it investigates what attributes attract people to stay and enjoy there every day.

Qualitative research methods are preferred to explore people's spatial experience and environmental experiences from diverse perspectives. Spatial components and their inter-relationships are various in a vast spectrum. For instance, two gardens of similar size accommodate the same provisions of vegetation and amenities, but their setting and spatial arrangements can be entirely different. So, it would be insufficient to understand by quantifying

or surveying merely what kinds of spatial elements and features are in communal green spaces.

4.3.1   Case Study

A case study is defined as an empirical inquiry to reveal an in-depth understanding of a phenomenon, event, activity or process within real-life contexts, especially for investigating a complex setting with multiple pertinent variables (Merriam 1998, Creswell 2002, Yin 2003).[250,251,252]

VanWynsberghe et al. (2007) depicted a prototypical case study composed of seven common features - small sample size, contextual detail, natural settings, boundedness, working hypotheses and lessons learned, multiple data sources, and extendibility. It is a trans-paradigmatic and trans-disciplinary heuristic technique that carefully delineates the phenomena for which evidence is being collected. Three approaches to case study research are distinguished. Case studies in the postpositivist paradigm generate and test hypotheses about the natural world with the cases. Case studies in the critical theory paradigm generalise across a more extensive set of units through an intensive study of a single unit. Case studies in the interpretive paradigm constitute a meaning of social action in a given reality via an iterative process.[253]

Arguably, the case study may not contribute to scientific development as it cannot be generalised based on an individual case. Also, the case study may contain a bias toward verification, which confirms the researcher's preconceived notions. In Flyvbjerg's research (2006) of "five misunderstandings about case-study research", the aforementioned arguments are negated as follows.[254]

(i)   The case study generates the type of context-dependent knowledge in the study of human affairs.

(ii)   Comparative and case studies act as an alternative means to end testing theories. A critical case is considered. The strategic choice of case is governed mainly by arbitrary or practical. Falsification of propositions is well suited.

(iii)   The strategic selection of cases increases the generalizability of case studies. Information-oriented selection, based on expectations about the information content, comprises extreme/deviant cases, maximum variation cases, critical cases, and paradigmatic cases.

(iv)   The case study contains no more significant bias towards verifying the researcher's preconceived notions than other methods of inquiry.

(v)   Good case studies should be read as narratives in their entirety.

On the contrary, a case study aims to examine the detailed contextual analysis of several events or situations regarding their similarities, differences and inter-relationships. Thus, this research method involves an in-depth qualitative inquiry into a specific and complex phenomenon within its real-life context. In terms of types of case studies as qualitative inquiry, Thomas (2011) compiled a summary in Fig. 4.1.

Analyst	Types of Case Studies
George and Bennett (2005)	Theory testing, atheoretical/configurative idiographic, disciplined configurative, heuristic, plausibility probes, building block studies
Merriam (1988)	Descriptive, interpretative, evaluative
Stake (1995)	Intrinsic, instrumental, single / collective
Bassey (1999)	Theory seeking, theory testing, storytelling, picture drawing, evaluative
de Vaus (2001)	Descriptive / explanatory, theory testing / theory building, single / multiple case, holistic / embedded, parallel / sequential, retrospective / prospective
Mitchell (2006)	Illustrative, social analytic, extended over time, configurative idiographic, disciplined configurative, heuristic plausibility probes
Yin (2009)	Critical, extreme/unique, longitudinal, representative, revelatory

Fig. 4.1 – Typology of case studies (Thomas, 2011)[255]

There are two classifications of case studies. First, the purposes of case studies are referred to, which include intrinsic, instrumental, evaluative and explanatory, as depicted in Merriam (1988) and Stake's (1995) researches.[256,257]   Second, the approaches of case studies concerned consist of theory testing, theory building, illustrative, descriptive, retrospective/prospective, critical, extreme/unique, longitudinal, representative and revelatory, as elaborated in George and Bennett (2005), Bassey (1999), de Vaus (2001), Mitchell (2006) and Yin (2009) studies.[258,259,260,261,262]

Thomas (2011) further delineated the typology of a case study involving three layers of considerations (i) subject and object, (ii) purpose and (iii) approach and process, as illustrated in Fig. 4.2 below. Thus, it facilitates the consideration of theoretical or illustrative approaches,

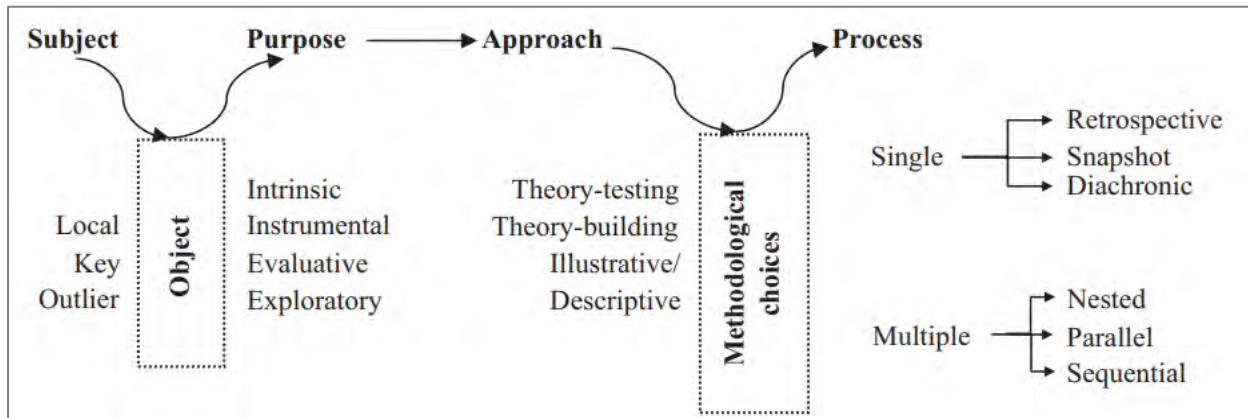methodological decisions, and decisions about the process of research design.

Fig. 4.2 – A typology of case study (Thomas, 2011)[263]

This framework helps to clarify the purpose of the study and identify the likely analytical approach to be pursued and the likely process to be followed.

For this thesis, the case studies will be conducted by examining how communal green spaces at high levels in residential high-rises facilitate interaction with nature and foster neighbourhood is the research object. The subject is the set of selected communal green spaces at high levels in compact high-rise cities, i.e. Hong Kong and Singapore. A case study of intrinsic interest with defining elements involves multiple studies possessing both subject and object, and the aim is to explain interactions with nature and neighbours through theory building in environmental, social and ecological aspects. Furthermore, another case study is considered in response to the research questions of this thesis. It is a single snapshot case study to identify nature-centric architectural design and its design considerations in local urban contexts, and its approach is illustrative and descriptive.

4.3.2 Go-along Interview

The walking interview is one of the novel qualitative research approaches. It acts as a hybrid of qualitative interviewing and field observations. The researcher walks with interviewees on their daily routes and asks them questions along the way. Quantitative data concerning the routes are taken; meanwhile, qualitative data are derived from the conservation exchange (Evans et al., 2011).[264]

A go-along interview is a kind of walking interview. Interviewees are supposed to be familiar with

the subject area and decide the routes and durations of the walking interviews. This interview setting is conducive to interviewees' openness, and frankness and dynamic conversation are envisaged (Garcia et al., 2012).[265] There are five thematic areas in favour of this research method, including environmental perception, spatial practices, biographies, social architecture, and the social realm (Kusenbach, 2003).[266]

The researcher has to pay more attention to logistics, possible safety concerns, required time investments, susceptibility to weather and other outside factors. Also, ethical issues concerning unintentional photo and audio records of non-participants are adequately considered.

The following table, Fig. 4.3, delineates three studies' research questions and objectives by adopting go-along interviews.

Topic	**Social networks in the lives of older adults ageing in place**	**College students' perceptions of sexual health resources**	**People's associations with a place**
Author	Gardner, 2011	Carcia et al., 2012	Evans & Jones, 2011
Research Questions	Explore the public life of older people ageing in place to understand how neighbourhoods, as important physical and social places of ageing, contribute to the well-being of older people.	Explore students' perspectives regarding how services could be offered or expanded to address their sexual health needs better is a critical step toward making necessary information.	Explore personal connections to the area, histories, and specific locations of interest/significance.
Research Objectives	Examine neighbourhood perceptions, experiences and interactions.	Identify the sexual health resources as perceived by undergraduate students in a college campus setting.	Examine people's experiences of the place.
Research Methods	Go-along interviews: Interviewees made all of the decisions related to location, activity and mode of travel. Visual, textual and auditory data were collected using a hidden recorder, a simple 'point and shoot' digital camera and extensive field note-taking.	Go-along interviews: Interviewees chose routes and the amount of movement that took place within the interview. Audio-recorded with a discrete lapel microphone was adopted. The interview guide comprised four primary questions for the go-along interview	Go-along interviews: The interviewee led a tour in terms of routes and time. Free interpretation of the place. Largely unstructured with minimal questioning with a global positioning system (GPS) to record the geographical tracks of walked interviews alongside an audio recording

Fig. 4.3 – Case studies on go-along interviews[267,268,269]

People's perceptions, experiences and attachments to physical and social places are investigated in these studies, which are good references to the research topics on urban living with communal green spaces.

4.3.3   Photo-Elicitation Survey

A photo-elicitation interview is a participatory action research method. Participants are asked to take a number of photos of a place or a thing they consider necessary to tell their stories under research themes.

Photo-elicitation was named in the mid-1950s by an American anthropological researcher, John Collier (Collier, 1957). He aimed to explore participants' feelings towards his work through photography stimuli by providing a selected series of images of industrial locations.[270] Photography stimuli have developed into two main categories: research-generated and participants-generated. Photo-elicitation is widely adopted by researchers in various fields as an alternate data collection method to understand participants' points of view through a visual medium. It has various names, such as volunteer-employed photography (VEP), participant-driven-photo-elicitation (PDPE) and content identifying methodology (CIM), which varies according to the research background and methodology. It is generally defined as the participatory qualitative methodology to reflect on research subjects' preferences, and experiences and encourage in-depth consideration of personal views under specified themes or questions through visuals and words (Richard & Lahman, 2015; Hao et al., 2016; Burton et al., 2017; Justesen et al., 2014; Nejad and Ali, 2015). Photo-elicitation will be referred to as the methodology throughout this paper. The merits and usefulness of photo-elicitation have been studied and examined by various researchers and are summarised into four main factors as shown below (Richard & Lahman, 2015; Hao et al., 2016; Burton et al., 2017; Justesen et al., 2014; Nejad and Ali, 2015; Stedman et al., 2004).[271,272,273,274,275,276]

Participatory Research Method
Photo-elicitation is a collaboration between researchers and participants, which is participant-driven. As a result, participants have more involvement throughout the research process, increasing their willingness, engagement, and self-awareness. Furthermore, participants are allowed to explore their values, beliefs, attitudes and first-hand experiences in the process, so the

photos taken will be fundamentally reflexive to express unobservable ideas or feelings. The horizons of both participants and researchers could then be considered.

Sharpening of Participants' Observation

The photo reveals the person's way of knowing. Under the limited vision of the camera lens, participants are encouraged to analyse their surroundings carefully in advance of shooting. The restricted frame will remind participants to focus on and reconsider which visual content elements should be included or omitted. Participants are then empowered to naturally clarify and explain their thoughts and choices with reasonings behind them. Thus, photography enhanced participants' self-reflection ability and hermeneutic sense-making.

Conveying Multi-layered Meanings

Images are contested and complex. They are interactive experiences of participants across time and space. It can imply participants' thoughts and understanding of the world, such as their feelings, thoughts and intentions, as photography has been identified by Collier (1957) and Becker (1998) as a medium for emotional and cognitive information. It can also examine participants' social and cultural understanding. The richness of information inherited in the photos is not comparable with traditional representation, i.e. non-visual technique.[277]

Graphic Representation of Metaphoric and Inherent Meanings

Graphic representation illustrates the visual dimension of participants' understanding with the combination of participants' languages to establish common grounds for sharing between researchers and participants. Furthermore, it conveys hardly verbalised or written findings, thus adding the level of transferability. Moreover, the problem of illiteracy is dealt with through a visual representation.

Furthermore, photo-elicitation has been widely adopted in the field of landscape representation. Various researchers and scholars have utilised it to indicate the public's preference for the landscape, outdoor experience, and community planning. Nejad and Ali (2015) have confirmed that photography is a reliable substitution for actual scenes when the actual environment is hardly accessible by researchers and participants simultaneously. Furthermore, it is readily comparable to ease the research and analysis process.[278]

Case Studies on Photo-Elicitation Survey Method

These photos contain the richness of qualitative data and construct a theory of each participant. The participants may take many photos and deliberately shortlist the most representatives. They can illustrate the actual setting and specific spatial perception supplemented by their wordings. Some directive questions can be asked to the participants in the interviews, such as which pictures are the most accurate delineation of the neighbourhood and human-nature interaction.

It also allows participants to take photos at their convenient time. They may not be embarrassed about taking photos when their neighbours are present or capture other people in photos. The photo-taking process induces the participants to think about the importance and positive impact of the research topic. However, some people may try to tally their responses to meet the researcher or audience's expectations instead of authentic reflection.

Three samples of research studies using photo-elicitation interviews are delineated with research questions and objectives as follows.

Topic	Photo-elicitation and the agricultural landscape: 'seeing' and 'telling' about farming, community and place	The mind's eye: a photographic method for understanding meaning in people's lives	Rethinking Children's public health: the development of an assets model
Author	Belin, 2005	Steger et al., 2013	Whiting et al., 2013
Research Questions	Explore that farming practice changes are linked to farmers' relationship to the landscape, conservationists and contemporary production systems.	Explore a person's answers to the question of his or her personal meaning in life.	Explore asset-based strategies for the enhancement of children's public health.
Research Objectives	Examine farmers' values and understandings about their lives and work in the deteriorating agricultural landscape.	Examine individuals' experiences with meaning in life from visual expressions of abstract or symbolic things.	Actively engage with children to facilitate the mapping of their internal and external assets.
Research Methods	Photo elicitation: Farmers were given a disposable camera in the first interview and were asked to take 12 photos of their significant landscapes. Farmers depicted their photos in the second interview. A day-long farm tour to the sites of the photos was followed.	Photo elicitation: Participants were asked to take photos of abstract or symbolic things which make their life feel meaningful. Interviews were scheduled after one week that participants submitted photos. Participants ranked each photo and completed a survey in the interviews.	Photo elicitation: Children were asked to take photos of any activities they enjoyed. Children were interviewed at their homes and gave their reflections on their photos.

Fig. 4.4 – Case studies on photo-elicitation interviews[279,280,281]

These studies illustrate the photo-elicitation method in favour of collecting data on people's expressions of intangible matters. Afterwards, a constant comparative analysis based on the grounded theory is carried out, and the data are coded and categorised to develop a theory.

The go-along and photo-elicitation interviews gather audio records, field notes, location maps, photos and narratives from semi-structured interviews. In addition, the researcher may get further contact with residents as happened to and introduced by the participants during the walking interview. Limitations, difficulties and similarities of the two methods are tabulated as follows.

	Go-along Interview	Photo Elucidation Interview
Limitations / difficulties	• Weather • Safety • Noise (public area) • Confidentiality • Ethics for non-participants • Logistics • Technical problems • Complexity related to observation and narratives	• More time commitments by interviewees • Possible interviewees' embarrassment from taking photos in front of neighbours • Interviewees may forget reasons why taking photos at those spots • Researchers should be more familiar with the subject place
Similarities	• Participatory • In-depth understanding of physical areas where researchers are unfamiliar • Observation of participants' nonverbal expression	

Fig. 4.5 – Comparison between go-along interview and photo elucidation interview

In view of the research questions, comparisons amongst three qualitative research methods of sedentary interview, photo-elicitation interview and go-along interview are summarized in the table below, and their relevant research issues are indicated.

Research issues		Sedentary Interview	Photo Elicitation Interview	Go-along Interview
Tangible	How often do people interact with nature?	Applicable	Applicable	Applicable
	What are the attractive features?			
Intangible	Spatial experiences	Less applicable	More applicable	More applicable
	Environmental perceptions			
	Neighbourhood interactions			
	Human-nature interactions			
Personal attachments		Less applicable	More applicable	Less applicable
Interpretative	Environmentally driven attributes	Less applicable	Less applicable	More applicable
	Socially oriented attributes			
	Ecologically beneficial attributes			
Pragmatic	Connectivity / accessibility	Applicable	Applicable	Applicable
	Maintenance			
	Safety / Security			

Fig. 4.6 – Comparison amongst sedentary, go-along and photo-elicitation interviews

The go-along and photo-elicitation interviews are qualitative research methods to collect more extensive and in-depth data than traditional sedentary interviews. In addition, the photo-elicitation method offers interviewees alternative ways to express or enrich their narratives. As a result, the researchers can better understand participants' narratives, especially for depicting environmental perception and spatial experiences.

4.4   Chosen Framework of Research Methodology

Given the above discussion, interpretative qualitative research methods are adopted to explore people's spatial experience and environmental experiences in this thesis study.

The photo-elicitation method favours collecting data on people's expressions of intangible matters, followed by content analysis to depict key substances in human-nature interactions. Furthermore, the photo-elicitation method is suitable for this research topic in understanding the natural elements around participants' daily living, as the researcher is not effective and possible to follow and record every place that participants found associated with nature.

A series of photo-elicitation studies will be conducted to understand how urban dwellers consider or associate nature in daily life. Urban dwellers would be asked to express their interpretations of nature in their everyday urban life by taking photos and writing. The photos illustrate framing or representations of nature from urban dwellers' perspectives. Their narratives can imply diverse spiritual or physical connections to nature.

A case study method can reveal an in-depth understanding of a phenomenon, event, activity or process within real-life contexts. Case studies, together with experiential engagement activities, are carried out to explore and examine design opportunities for interacting with nature in urban contexts, in which the empirical inquiries reveal an in-depth understanding of a phenomenon, event, activity or process within real-life contexts, especially for investigating a complex setting with multiple pertinent variables of human-nature interactions. As illustrated in Fig. 4.7, the research methodology is developed.
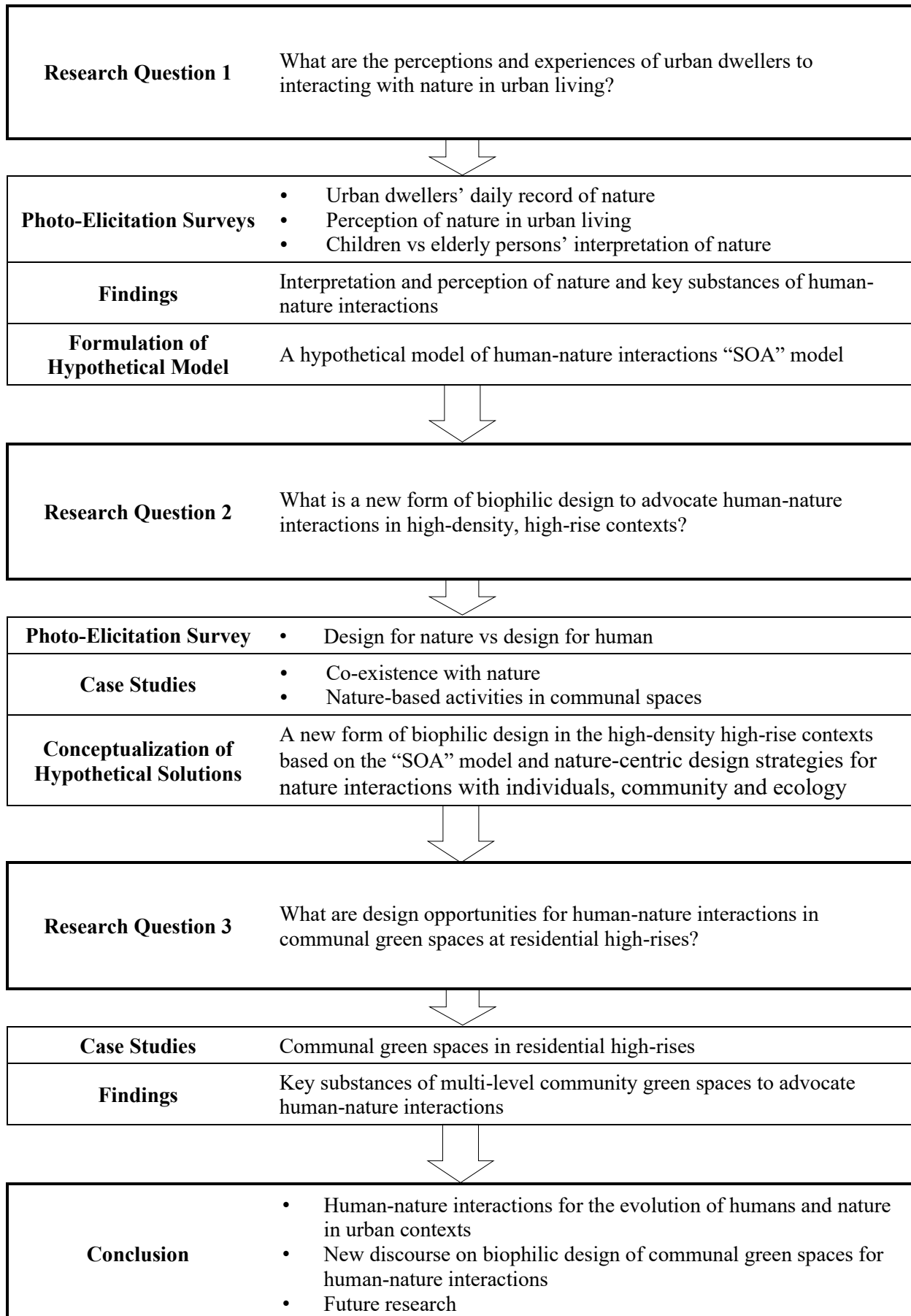
Research Question 1	What are the perceptions and experiences of urban dwellers to interacting with nature in urban living?

Photo-Elicitation Surveys	• Urban dwellers' daily record of nature • Perception of nature in urban living • Children vs elderly persons' interpretation of nature
Findings	Interpretation and perception of nature and key substances of human-nature interactions
Formulation of Hypothetical Model	A hypothetical model of human-nature interactions "SOA" model

Research Question 2	What is a new form of biophilic design to advocate human-nature interactions in high-density, high-rise contexts?

Photo-Elicitation Survey	• Design for nature vs design for human
Case Studies	• Co-existence with nature • Nature-based activities in communal spaces
Conceptualization of Hypothetical Solutions	A new form of biophilic design in the high-density high-rise contexts based on the "SOA" model and nature-centric design strategies for nature interactions with individuals, community and ecology

Research Question 3	What are design opportunities for human-nature interactions in communal green spaces at residential high-rises?

Case Studies	Communal green spaces in residential high-rises
Findings	Key substances of multi-level community green spaces to advocate human-nature interactions

Conclusion	• Human-nature interactions for the evolution of humans and nature in urban contexts • New discourse on biophilic design of communal green spaces for human-nature interactions • Future research

Fig. 4.7 – The chosen research methodology

The research study is divided into two parts in a conceptual framework. The first part intends to establish the main body of knowledge of urban dwellers' interactions with nature in compact high-rise contexts (as analysed in Chapters 2 and 3), followed by analysing essential elements attributed to these interactions. The second part examines and relates the findings to specific architectural settings and urban contexts.

Regarding the Research Question 1, a series of photo-elicitation surveys are conducted to understand urban dwellers' daily record of nature, perception of nature in urban living, and children vs elderly persons' interpretation of nature. Findings of interpretation and perception of nature and key substances of human-nature interactions have resulted. Furthermore, potential design implications in terms of anthropocentrism, experience and space use are expected to be identified. This formulates a hypothetical model of human-nature interactions "SOA" (space, object and activity) model.

Regarding the Research Question 2, another set of photo-elicitation surveys and case studies are carried out. This comes up with the conceptualization of hypothetical solutions for the new form of biophilic design in the high-density, high-rise contexts based on the SOA model; and nature-centric design strategies for nature interactions with individuals, communities and ecology.

That puts forward to answering the Research Question 3, together with case studies on communal green spaces in residential high-rises. The current designs of communal green spaces are reviewed. Policies and incentives for the design of communal green spaces and green building criteria on communal green spaces in residential buildings in Hong Kong and Singapore are studied, followed by case studies in both cities. Discussions on multi-level communal green spaces in response to the psychological, physiological, social, environmental, and ecological aspects are carried out. Key substances and design directions of multi-level community green spaces to advocate human-nature interactions are proposed.

Conclusions include human-nature interactions for the evolution of humans and nature in urban contexts and a new discourse on the biophilic design of communal green spaces for human-nature interactions, followed by suggested future research.

Chapter 5: Perception and Experience of Urban Dwellers to Interact with Nature in Urban Living

5.1   Introduction

Regarding the Research Question 1, a series of photo-elicitation surveys were conducted to understand urban dwellers' daily record of nature, perception of nature in urban living, and children vs elderly persons' interpretation of nature.

This chapter will describe the findings from the data collection process and analyse the current-day relationship between urban dwellers' interactions with nature in the urban context. The analysis will reveal multi-faceted definitions of nature from the perspectives of urban dwellers through three sets of photo-elicitation surveys. The topics investigated will include how urban dwellers identify natural environments, whether they can appreciate the significance of human-nature interactions, how they interpret, perceive and experience nature in urban living, and whether their perceptions and experience vary from different ages.

5.2   Photo-Elicitation Survey – Urban Dwellers' Daily Record of Nature

Photo elicitation surveys were conducted to explore how urban dwellers consider or associate nature in their daily life through their records of urban nature. Urban dwellers were mainly solicited from Hong Kong and surrounding Asian cities such as Singapore and Taiwan and were asked to express their interpretations of nature in their urban living by photo taking. In addition, they were asked to provide a photo with writing that can associate with or allow them to interact with nature in their cities. Photos were then compared and analysed to find out the more figurative elements to represent nature in the urban context, i.e. elements that appeared most frequently. All elements were also classified into seven types based on their nature.

This survey focuses on how urban dwellers consider or associate nature in daily life. Participants were asked to do a simple exercise for a week. Details of the exercise are as follows:

Title: Photo-survey on "human-nature interactions"

Duration: One week

Action:

1.   Take a photo of anything or any place that the participant considers or associates it related to "nature". It is the participant's interpretation of the meaning of "nature".

2. Describe why the photo is taken in one sentence.

3. Submit the photo with a description via "WhatsApp" instantly or at the participant's convenience by the end of each day.

4. Expect at least one photo each day of the week. Indeed, there is no maximum number of photo submissions per day.

Thirty participants submitted their photos and returned the questionnaires. Two hundred sixty-two photos were received. Details of participants' profiles and responses are in Appendix 2.

5.2.1   Findings

The interpretation of nature is broad. Participants of this study consider that urban dwellers easily forget to appreciate and enjoy "nature" in their working and living environment. Participants' interpretations of nature are summarized and discussed in the following paragraphs. Their responses are interpreted based on various philosophies of nature, as tabulated below.

Participants' Interpretation of Nature *(Percentage of participants' interpretation)*	Philosophy of Nature
Nature and humans are separate entities *(2%)*	Aristotle: Nature is independent of other sources or external causes.
Nature is a living thing *(18%)*	Descartes: Interpretation of nature is based on evidence.
Nature is a resource *(7%)*	
Nature is a scene *(30%)*	Plato: Nature is one huge organism.
Nature is a natural occurrence *(13%)*	Darwin: Nature presents the central ontological role of processes.
Nature is science *(1%)*	Galileo: Nature lies in the mathematical fact.
Nature is from human's romantic appreciation *(15%)*	Romantics: Nature represents the return to our original innocence.
Nature is various from a different culture *(2%)*	Goethe: Nature is interpreted by means of art rather than science.
	Spinoza: Only one substance – God or Nature exists.
Nature is fighting with human intervention *(3%)*	Crutzen: Nature is no longer without human intervention
Nature exists with human intervention *(7%)*	
Nature is disappearing due to human intervention *(2%)*	

Fig. 5.1 – Participants' interpretations of nature relate to the philosophy of nature

5.2.2   Analysis

The first photo-elicitation survey indicated the 30 participants' daily records of their association with nature in daily living for seven days. Since they were required to take a photo each day, their photos were more related to their daily life and taken from their living or working environments or the ways towards the office or home. The convenience of the place they took the photo was also a key consideration. It involved their interactions with nature or their reflections on nature in the built environment. The photos were taken instantly, and the narratives were expressive at the moment of photo-taking. The first survey findings revealed participants' association with nature in their daily living environment. These daily records could directly reflect the participants' outreach areas from their homes or workplaces. Therefore, more instant reflections were received. It is relatively effective to acquire the participants' data on daily urban living and causal interactions with nature.

In the following paragraphs, the numbers inside the bracket stand for *(the number of the participant, the number of the participant's response)*, and their exact statements are in *Italic* font type.

Nature and humans are separate entities

Human is centric, and nature is identified as another. Human co-exists with nature but is not integrated as part of nature. *"Nature is always around us, but we are seldom aware of" (1.1). "Nature is the last thing to be remembered in human development" (1.4). "Mankind works hard to co-exist well with Nature as much as possible" (13.9). "Man likes to be in control when coming in front of nature. Can we succeed?" (13.12).*

Fig. 5.2 – Nature and humans are separate entities – participants' photos

Nature is a living thing

Most people consider that tree represents nature or symbolises nature in Hong Kong *(24.5, 25.9, 29.5)*. People also consider other living things, including animals – fish *(9.17)*, tortoise *(8.3)*, cat *(9.31, 25.4)*, dog *(9.33)*, bird *(9.4, 9.5, 9.23, 9.24, 18.1, 18.2, 25.8)*, monkey *(14.2)*; plant – trees *(3.2, 9.1, 9.24, 15.3, 17.5, 30.3)*, flowers *(9.27, 18.8, 25.2, 25.13)*, fruit *(26.1)*, bamboo *(17.4)*, even little plant in planter boxes or pots on roadside *(9.14, 9.15, 9.16)*; insect - ants *(25.10)*; habitat - bird nest *(25.7)*.

A human being is a living thing that is interpreted as nature. *(6.6)* "A baby yearned for his mommy and his food, and he got them!" *(21.6)*.

Fig. 5.3 – Nature is a living thing – participants' photos

Nature is a scene

The most prominent scene representing nature is the sky *(10.6, 11.2, 13.3, 17.1, 26.6, 24.8, 30.4, 30.7)*. A scene can have different compositions of natural elements, such as moon *(6.7, 9.30, 18.5, 30.6)*, sunrise *(18.7)*, sunset *(5.1, 9.37, 26.7)*, sunshine *(25.12)* and beach *(4.3)*. Nature is green, a palette of lush vegetation *(2.4, 6.5, 8.7, 11.3, 13.1)*, or a place of plenty of greenery – playground *(9.10)*, park *(9.28, 9.29, 12.4, 18.3)*, country park *(10.5)* and others *(9.3, 16.5)*.
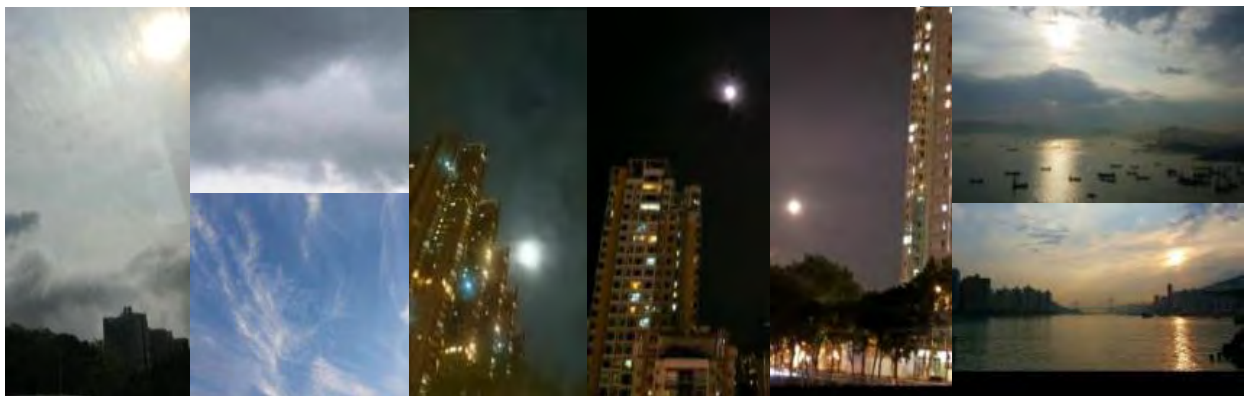
Fig. 5.4 – Nature is a scene – participants' photos

Furthermore, nature acts as the background of the city. *"This pavement is surrounded by big trees, inside the city. People can also feel the natural environment: big trees, tree shade, and slowly falling leaves." (4.2)*. Images depict this interpretation with "nature" or composition of natural elements as a backdrop comprising sea or harbour *(9.32, 9.34, 17.6, 18.6, 22.1)*, skyscrapers under the sky *(21.7)*, mountains *(8.4, 9.35, 12.1, 17.7, 26.5)*, green slopes behind buildings *(8.5, 29.2)*, street or roadside greenery *(4.2, 9.2, 9.9, 9.11, 9.18, 9.19, 9.22, 10.7, 15.1)* and trees *(10.1, 12.2, 12.3)*.

Fig. 5.5 – Nature acts as a background of the city – participants' photos

Nature is a natural occurrence

Things happen unintentionally, unexpectedly or recurrently. People consider rainstorms *(3.3, 3.6, 27.3, 28.4, 29.6)*, sunshine *(2.5)*, and sunrise and sunset *(14.7)* as nature. Symbols directly or indirectly demonstrating the process of growth and death also represent nature, such as *"withered flower" (28.5, 29.7)*, *"fallen leaves" (30.1)*, *"growing leaves" (30.2)*, *"blossom" (25.5)*, *"rain" (9.7, 10.4, 12.7, 25.3)*, *"sunshine after rain" (25.11)*, *"fallen leaves" (24.1)*, *"the heat and humidity. Summer is approaching" (21.5)*, *"in several rainy days; new lives are brought up" (19.1)*, *"all things and creatures find their way to grow and outgrow in nature" (13.6)*, *"Cleaner is cleaning up dead leaves from the ground. Despite the nice scenery around, nature requires us to pay some effort in cleaning up" (11.8)*, and *"the power of natural growth" (4.4)*.

Weather is naturally happening and influences our daily life and mood. People prepare for nature or think that they can prepare for it. *"Always thinking of bringing an umbrella today....." (27.4)*; *"on a dull rainy day, I saw a bird getting lost in the concrete jungle. It seems that our moods are disturbed by the poor weather." (20.6)*; and *"learning to expect the unexpected, rapid changing nature" (7.2)*.

Fig. 5.6 – Nature is a natural occurrence – participants' photos

Nature is from human's romantic appreciation

This signifies our innate affinity to nature and the beauty of nature. Their narratives exemplify interpretations of nature with imagination, diversity and difference. In a sense, there is a clear separation between the natural elements and the participants. *"Nature is a natural painter of any masterpieces in the world"(1.3). "Everything in nature is a gift"(1.5). "The aesthetic beauty of nature heals us"(1.6). "Nature should be something that we respect, we appreciate, and we fear"(1.7). "The mango tree at the front door cheers for me every morning when I leave home"(2.2). "On my way to work, I see the long-awaited sunshine, getting energized"(2.5). "The beautiful gift from nature brings hope and happiness to life"(4.5). "Under a big tree, a human is insignificant"(3.1). "It was very refreshing after a rainstorm! Mirror effect"(3.3). "Talk like these two women in the picture; enjoy this serenity"(4.6). "When I stare at the sky, the shadow of trees makes me feel peaceful"(4.7). "Nature is something vibrant to me"(7.1). "Simply a few trees with different colours can become a beautiful picture. Life can be just that simple"(9.20). "We feel so small and humble in front of Nature"(13.7). "Nature not just includes what is on earth, but also what is beneath it"(13.10). "To me, nature cannot state without sunshine. So, a rainy scene cannot fully represent the beauty of nature. I need the sun"(16.6). "Looking up, not for high-rises, but the birds' heaven"(18.1). "What is better than sitting at the seashore, enjoying the music of the waved after a week of hard work?"(21.4). "Hi, good day, baby leaf! You going to stay strong and healthy, just like your siblings do"(22.3). "Stay inside and watch outside is the perfect activity on a rainy day. Time to get oneself poetic and romantic"(22.5). "Hi, Mr Sunshine. You are back finally!"(22.6). "Lime in coke and floating ice kinda remind of the melting ice caused by damaging human nature"(24.2). "Yellow flags" describe trees with yellow leaves (26.2). "The beauty of sunshine ornamented the beauty of architecture"(28.1). "Every bit of green represents the courage of living and encourages people who are facing challenges"(28.2). "The alarm clock in nature is*

tender"(28.3). "A kind of quietness can be witnessed with eyes"(28.6). "Striving hard is an attitude!"(28.7).

Fig. 5.7 – Nature is from human's romantic appreciation – participants' photos

Nature is science

It follows a logical and biological explanation. *"Palm trees on the street at night near Austin road. Daytime they do. Photosynthesis and giving out oxygen, while at night it becomes completely different, and the nature was amazing"(9.12). "The force of nature"* delineates how strong the wind is, and trees are blown to distortion *(13.2).*

Fig. 5.8 – Nature is science – participants' photos

Nature is fighting with human intervention

Nature is in confrontation against human intervention, and vice versa. Participants found this tension in the built environment. Trees on retaining walls show strong vitality in a harsh growing environment *(29.3).* A tree truck has embraced a portion of a steel balustrade *(20.5).* Small

vegetation grows from gaps in paving blocks or between walls and pavement *(15.2). "Natural green roof! The plant finds its way to survive" (8.7).*

On the other hand, people twist nature into a form they want *(5.3)*. People consider nature (a living thing) an optional item. *"We are so lazy that we do not even plant the trees"(5.4).*

Fig. 5.9 – Nature is fighting with human intervention – participants' photos

Nature exists with human intervention

Nature is in harmony with human intervention. *"Orientation of humans and animals is very similar. So, they have to respect each other in order to live together"(19.7).* For instance, this signifier consists of green walls *(15.4)*; previous concrete pavement with some gaps between pavers to put grass onto *(15.5, 27.1)*; ponds at the park *(30.4)*; and "artificial home... but it works", which describes an image of swarms living in an artificial lake peacefully *(26.6)*. *"Pigeons are living at the old Central market building" (9.23)*; and *"birds no longer have to find any forest to take shelter from rain",* which shows birds build their nests under the eaves of buildings *(19.3)*. Gardens and landscaped areas are good demonstrations *(21.3)*. *"This little garden is a combination of natural and artificial scenery. It allows people to feel nature in the geometrical and symmetrical garden planning"(4.1).* Vegetation climbs up and embraces walls, structures and buildings *(11.1, 11.2, 15.7, 19.4)*.
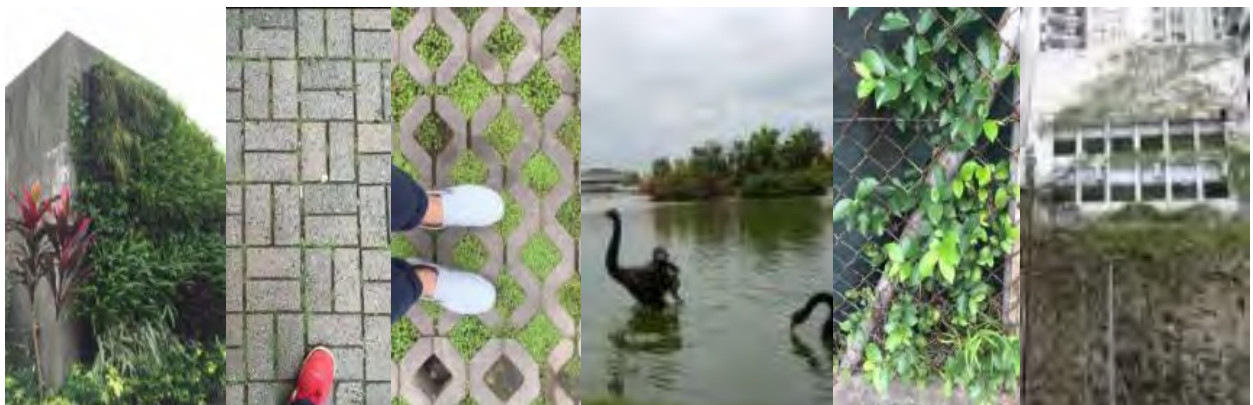
Fig. 5.10 – Nature exists with human intervention – participants' photos

Nature is various from different perspectives

Human appreciates nature through photos and drawings. It depicts the beauty of nature or the natural environment for people's enjoyment *(27.2)*. Humans associate with nature through commodities. Dress-up with earth tone colour and simple cutting makes people feel *"nature" (27.5)*. Custom extends the interpretation of human nature interaction apart from human life and physical entity. *"Ancestry returns to nature"(14.4). "We will be back to earth"(30.5).*

Fig. 5.11 – Nature is various from different cultures – participants' photos

Nature is disappearing due to human intervention

Human expresses their reflection on urbanisation and treasure existing natural elements or the environment in the city. *"Nature has gradually submerged in the buildings. Fish ponds and homelands are gone"(3.7). "ReClaim Da Street - this is how nature ends under human habitation" (26.4). "I will not consider this nature in any sense, but I do not foresee seeing anything more natural than this today other than repeating what I sent yesterday. Weekdays are pretty mundane"*, and the image shows a night view of roadside greenery *(17.2). "The pigeons were standing at the lamp next to the MTR construction site. The site was previously a small green area which was also the pigeon's home"(9.6).*

Fig. 5.12 – Nature is disappearing due to human intervention – participants' photos

Nature is resource

Human consumes nature. *"Do not take for granted everything that nature gives you"(1.2).* *"Healthy food is from nature"(6.4).* Resources include edible consumables such as vegetables *(13.4)*, fruit *(6.4, 24.3)*, fish *(14.3)*, and energy and electricity generation for artificial lighting *(24.7)*. Natural elements are for utilitarian considerations. *"Bamboo poles for laundry and scaffolding are wholly taken from another nature"(15.7).* The grass is cultivated for soccer fields *(12.2)*. Nature provides shelter to humans. Tree canopy offers sunshades *(23.2)*. *"A man is taking rest under the old tree"(9.25).* Tall trees add privacy in see-through spaces *(11.3)*. Natural elements are for commercial purposes. *"'Apple shop cannot find real apple, but you can see some real trees outside"(9.21).* *"Walk past a restaurant with flower decoration"(18.9).*

Fig. 5.13 – Nature is a resource – participants' photos

5.2.3   Discussion

The associated human-nature relationships are conceptually illustrated in Fig. 5.14.

N = Nature
H = Human

1. Nature & Human are separate entities

2. Nature is a living thing

3. Nature is resource

4. Nature is a scene / natural occurrence

5. Nature is from human's romantic appreciation

N_1 + N_2 = N_3

6. Nature is science

C = Culture

7. Nature is various from different cultures

N/God

8. Only one substance – God or nature

9. Nature is for human sustainable development

10. Anthropocene

Fig. 5.14 – Illustration of concepts of various human-nature relationships

The participants' photos and narratives indicate that there is a clear distinction between humans and nature. Although humans are natural beings, much of the responses from the participants

identify a separation, either by impact or observation. The findings from the photo-elicitation survey illustrate that the interpretations of nature vary, distinctive and even conflicting, such as nature as object vs scene, static vs ever-changing, and scientific vs romantic, closely related to the philosophical review in Fig. 5.1 and discussed in the literature review. It is revealed that the meanings of nature by urban dwellers are multi-faceted and relate to their own experiences and perception. Furthermore, more participants expressed romantic appreciation of nature with their narratives of nature with imagination, diversity and difference, which reflect personal attachment and affinity to nature in their living environment.

On the other hand, participants were aware of human interventions and conflicts with nature in urban development. They expressed their sympathy and reflection on environmental ethics in urbanisation. Nature has its intrinsic value in both natural and human-built environments.

The next step is to investigate direct and indirect interactions in daily urban life. The following paragraphs relate the findings to the direct and indirect interactions with nature in daily urban life.

Living

People desire to live with nature. *"Nature should be around the corner, should be touchable, should be a shelter to people, but not artificial"(3.4). "The neighbour sits quietly outside his / her home and enjoys the music and refreshing air from nature. Such kind of living is yearning"(20.1). "Cycling to work helps reduce air pollution, but it seems to be mission impossible in the urban area! Honestly, breathing in the fresh air instead of travelling on an air-conditioned bus"(20.3). "Can we be composed of just nature? Full of body, entire life, nothing artificial. It is a matter of balance"(16.4.) "After seven days, I found that nature is far away but close. It always surrounds us but not enough. How can we build a better world with nature? There is always a hint in our daily life. Although it seems to be a long way to go, the better world awaits us there"(16.7). "Weekend is a good time to return to nature" (7.7, 20.7).*

Fig. 5.15 – People desire living with nature – participants' photos

People enjoy connecting with nature through resting, waiting, walking, jogging and running. *"In the weekend that is not too hot, I enjoy walking along this shady trail instead of taking any vehicle"(2.3). "It would be nice to have a walk every day in this park"(8.2).* People spend their leisure time with nature. *"Jogging under red flowers and green leaves"(25.1). "Pleasant after-meal walk with trees and shrubs in the refreshing breeze"(22.2). "We have minimal time to get in touch with nature on working days. We could only walk around the park near our home after dinner"(20.2). "Night run along the seafront"(18.6). "Run with nature. Fresh air is filled in the body throughout the day"(16.3). "Choice for waiting for a bus: looking up or mobile addiction"(16.2). "It is cool to wait for the bus under a tree, always can hear the bird's singing"(6.2). "Trees surround a resting place. It is also a quiet area of nature"(4.5).*

Fig. 5.16 – People enjoy connecting nature – participants' photos

Memory

People associate nature with personal memories or attachments. *"King George V Memorial Park, Kowloon. This is the first park I went to with my parents when I was still a baby 40 years ago. Full of a good memory and glad it is still there"(9.8). "St. John's Cathedral is a quiet place with trees around and a grass plot. I often came when I felt upset as it was just next to the office. This*

place helped me to relax and passed through a lot of tough moments"(9.26). "I walk past this path every day, witnessing it from green to leafless, and now it becomes 'lively' again!"(8.1).

Fig. 5.17 – People associate nature with memories or attachments – participants' photos

Planting

People plant their own indoor plants at office *(2.1, 7.3, 9.36, 14.5, 14.6, 21.1, 27.6)*, at home *(2.7, 6.1, 7.6)* or somewhere else *(11.7, 17.3, 18.4, 29.1)*.
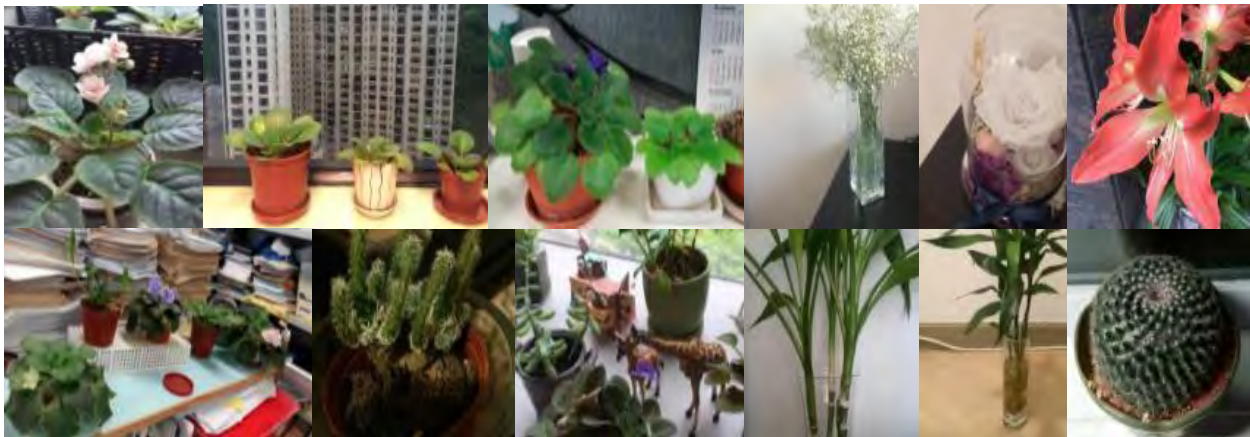
Fig. 5.18 – People plant their plants at an office or home – participants' photos

View

Having a view out to the natural green, people desire to look for a piece of greenery from windows at the office *(2.6, 20.4)* and at home *(16.1, 29.2)*. *"Feel so comfortable to look out the window and see nature"(14.1). "While being accompanied by the blue-ray computer at the office, I gaze at the splash of green outside, wishing to walk through it"(2.6).*
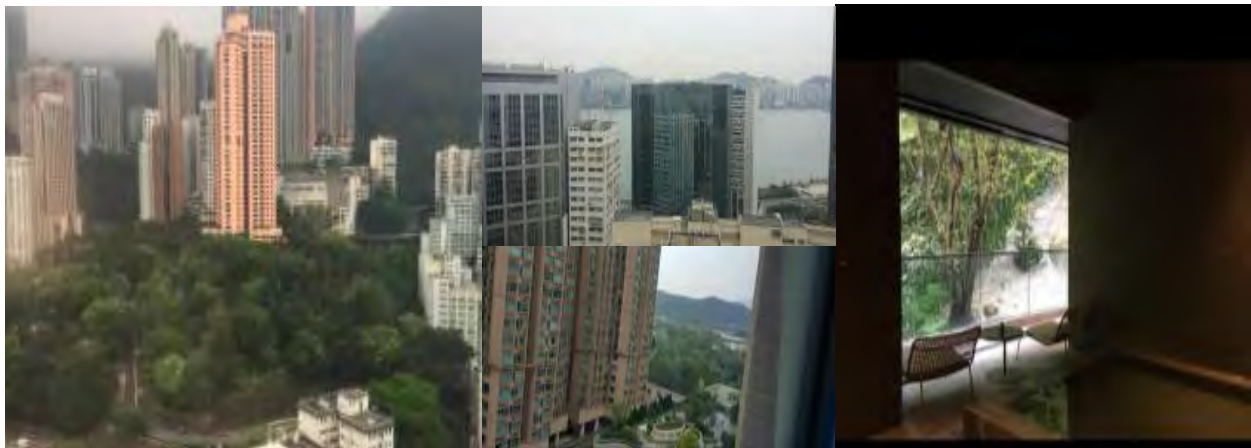
Fig. 5.19 – People desire to view out – participants' photos

Sense

Sounds and smells of natural elements remind the existence of nature. Birds sound *(23.2)*, a floral breeze from blossoming trees in urban streets *(23.4)*, and even artificial products such as perfume with natural favour *(23.3)*. Other direct contacts with nature are found, such as *"Mosquito kisses" (21.2)*. Doing exercises associates a connection to nature. *"Yoga is about relaxation of mind and body, an activity that is the closest to nature and our Mother Earth"(13.5).*

Fig. 5.20 – Sensory experiences remind the existence of nature – participants' photos

Art

Artwork or installation made of natural elements provokes human association with nature *(23.5)*. *"It is, in fact, a stone, which belongs to nature. However, it was turned into an art piece and placed in the human world in the form of art"(5.2).* Screensaver *(23.6)*, photos *(23.7)*, and painting *(6.3, 7.4, 7.5)* are of a natural scene, and fitness facilities in parks built with natural elements *(11.4, 15.6)*. *"Picked this (a small leaf) up on the floor. It is so green and waxed. I may make it into a bookmark"(11.6).* Some facilities or artwork promote the conservation of nature and urge people's awareness of degrading the natural environment. *"By recycling, we are trying to play our part in*

taking care of the natural environment''(11.5).

Fig. 5.21 – Artworks and installations associated with nature – participants' photos

This public engagement survey provided insightful observations on urban dwellers' interactions with nature in different urban settings. Based on the photo-elicitation survey, all urban nature-related elements allow the public to experience nature directly. Green and weather are the two main types of elements representing urban nature, while trees and sky are the most common elements found in all photos. These elements share non-static and non-rigid characteristics while having their natural patterns of change. Although these elements are easily accessible in urban living, they are disconnected from urban dwellers without proper design.

5.3   Photo-Elicitation Survey – Perception of Nature in Urban Living

The second photo-elucidation survey involved 104 urban dwellers. They were asked to express their interpretations of nature in their urban living by taking photos and writing. The photos illustrated substances or representations of nature from urban dwellers' perspectives. Their narratives implied diverse spiritual or physical connections to nature. The study revealed that nature existed in various forms, statuses or situations, but its existence was limited, distorted and sometimes conflicting with human activities. Fig. 5.23 displays the photos collected in this survey, while the details of the photo and writing can refer to Appendix 3.

5.3.1 Findings

Content analysis was carried out in two steps: coding and data reduction. Firstly, analytical visual coding sets up a list of descriptive labels to identify and describe the composition in photos (Hao

et al., 2016). The labels were set according to the cultural context and image content to reflect the visual elements physically presented in the photos.[282]

Photos collected in this survey were coded by sorting out three major elements in each photo, the most significant or the most prominent element within the image. Secondly, the data reduction technique is to group photos based on shared stimuli and characteristics (Nejad & Ali, 2015).[283] Pattern of participants' perception could then be investigated, analysed and interpreted. Based on the survey result analysis, elements were classified into seven categories based on their nature: green, weather, water, artificial substances, human, animals, and natural materials. On the other hand, another grouping considered both photos and writings to understand further how participants look and interpret nature from their perspective, not simply visual elements themselves. The photos were grouped into six categories: visual/view, sensation, plant/vegetation, habit/action, space, and user. An explanation of each category will be discussed later, and the total survey results can be referred to in Appendix 3.
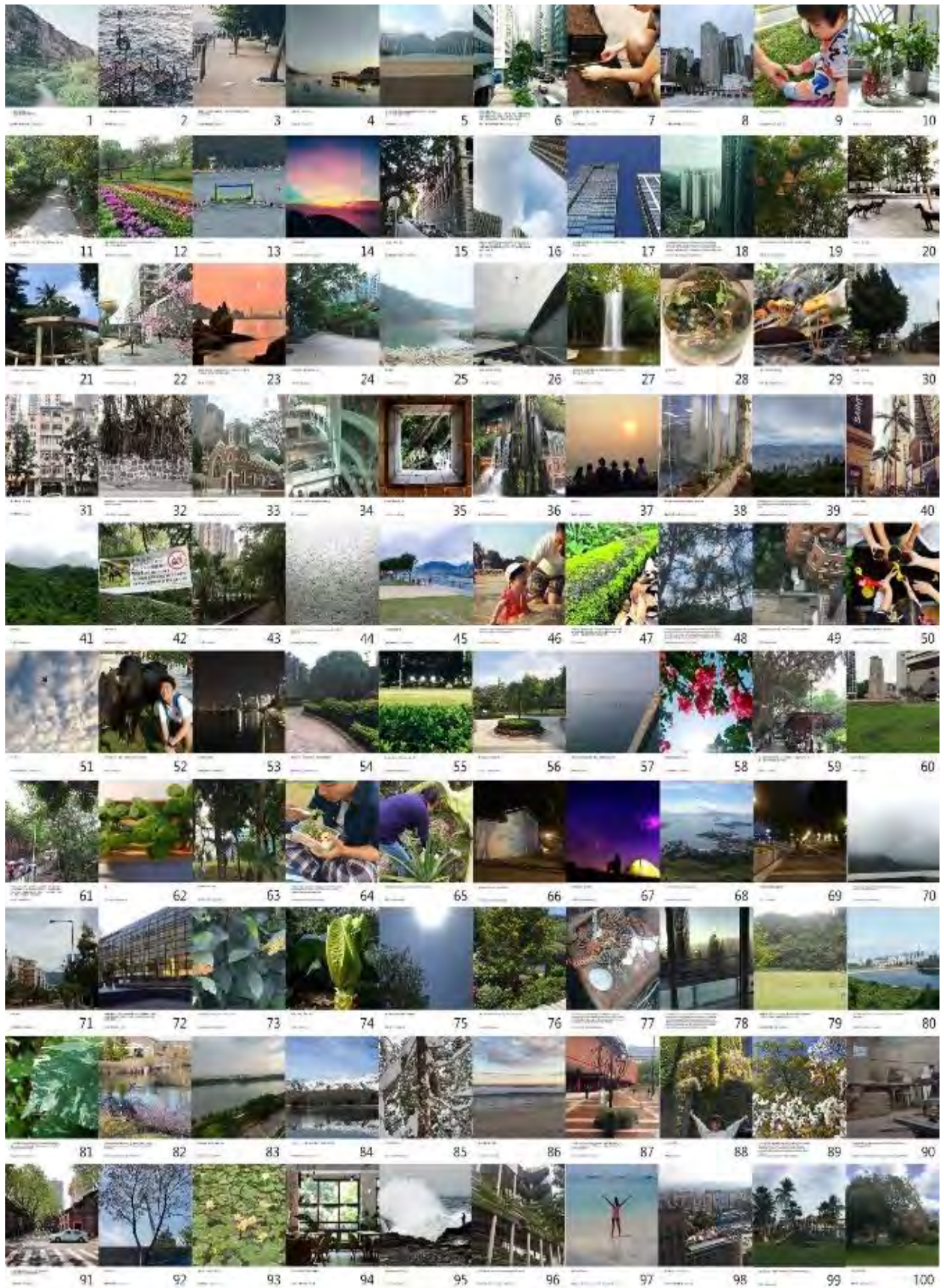
Fig. 5.22 – Photos were taken by the participants in the photo-elicitation survey

5.3.2   Analysis

The second photo-elicitation survey included 104 participants' photos of their perception of nature in urban living. Since each participant was required to take one photo only, the participants likely presented the most representative image. Hence, some photos were taken far away from the daily living or working environment. Instead, they might take photos of their weekend activities or scenes far away from their daily living places, e.g. countryside parks and beaches. Furthermore, some photos involved participants' companions, such as children, interacting with nature. The photos were captured deliberately, and the narratives were interpretative to their perception of nature or interaction with nature.

Visual Elements

Fig. 5.23 presents the complete list of categories and respective elements by developing a code. Elements are found visually in the photos and classified into seven categories based on their nature. Green is the most popular category, followed by artificial substances and weather, 35%, 25% and 19%, respectively, as shown in Fig. 5.24. Tree, sky and buildings are the three most common elements in all photos, while the respective percentage are 41%, 39% and 38%.

Categories	Element
Green	Tree, vegetation, leaves, plant, mountain, flowers, grassland, mushroom, stone tree wall, moss, salad
Weather	Sky, sunlight, cloud, sun, fog
Water	Sea, water, fountain, snow, mist
Natural material	Rock, soil, branches, pinecones, sticks, snail shells, wood
Human	
Animal	Bird, cow, butterfly, monkey
Artificial substances	Building, road, window, vehicles, lamp post, stairs, pavilion, infrastructure, banner, lamp, art installations, doll, wall, bridge, tent, machines, crane, furniture, recreational equipment. Rainwater tank, sculpture, ship

Fig. 5.23 – Photo-elicitation category and element list - visual elements
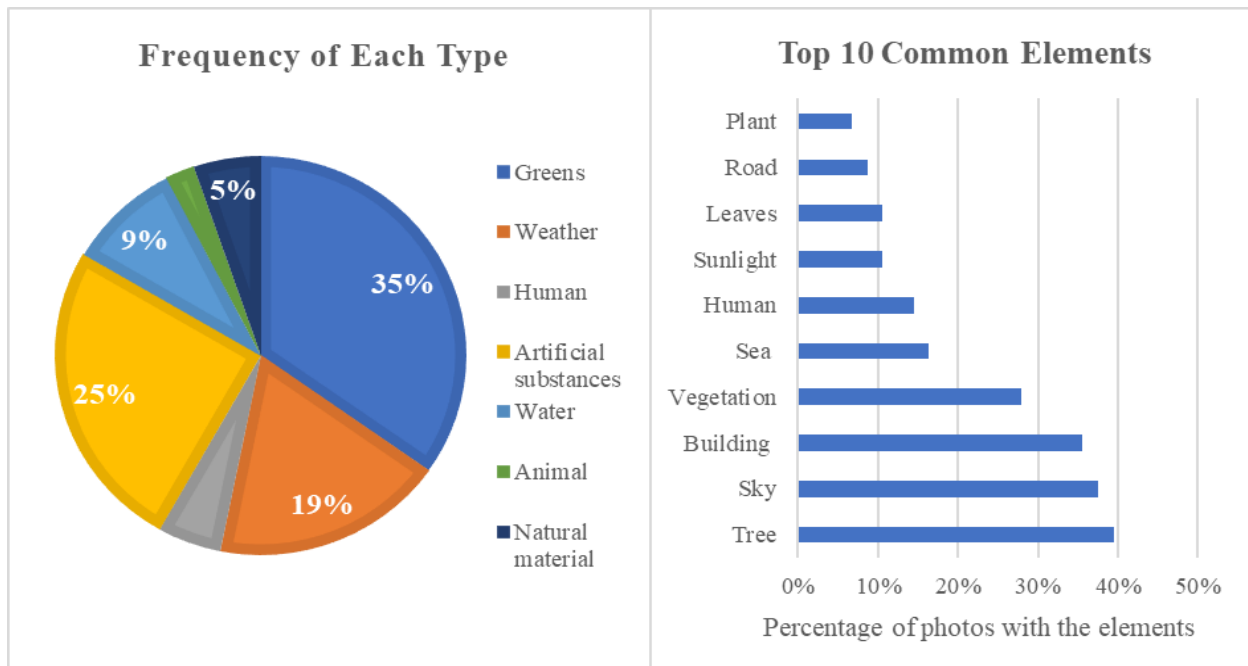
Fig. 5.24 – Photo-elicitation category & element frequency for "Visual Elements"

Participants' Perspectives survey

These categories were set to understand how participants perceive the relationship with or consider nature in urban living. Photos were then classified by reviewing the writing to interpret how participants understand the role of nature in their urban living. Six categories or scenarios were found in Fig. 5.26. For example, 56% of participants considered urban nature as natural scenery in the categories of visual/view. The second common category is the sensation which represents 15% of photos.

Categories	Explanation
Visual/View	Visual enjoyment through sight
Sensation	Four senses: hearing, touch, smell, and taste
Plant/Vegetation	Focus on greenery
Habit/Action	Involving as part of the daily living or working pattern
Space	Volume/Sense of space
User	Shareholders of nature in urban living

Fig. 5.25 – Photo-elicitation category and element list - participants' perspectives
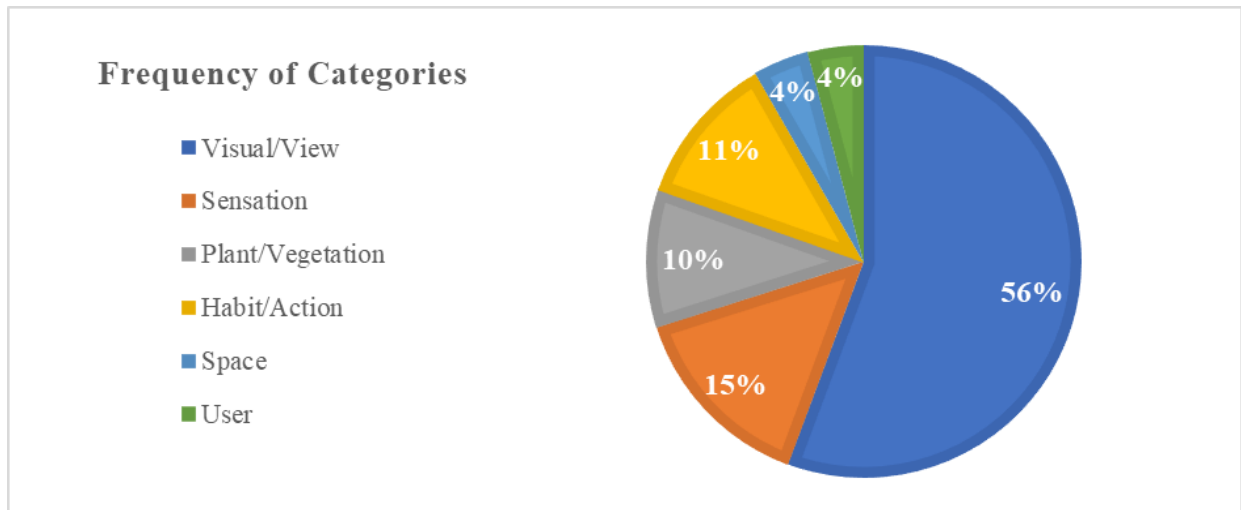
Fig. 5.26 – Photo-elicitation category & element frequency for "Participants' Perspectives"

5.3.3 Discussion

Visual Elements

In general, all elements found in the photos enable dwellers to have direct contact with nature. People can connect to nature at either close distance or within sight. Artificial substances are the type that indicates dwellers located in urban areas, which mainly include human-made substances, as listed in Fig. 5.25. Those are common equipment, facilities and infrastructures found in urban contexts.

The first and second types most associated with nature are green and weather. There is a clear allusion to the colour green with natural elements, although nature also encompasses many other colours. This can be perhaps due to urban communal green spaces having more leafy greenery than other colours due to the ease of landscape design strategies. These two categories can be found in urban areas comparatively easier and exist in diverse forms, statuses and situations. Among all elements, a tree is the most common element, which can be explained in the following three reasons, according to the survey results.

Firstly, the tree is one of the most easily found green elements in the city, ranging from space along streets and stairs, under bridges, around buildings, near waterfronts, and parks. It grows in various situations to accommodate urban development.

Secondly, it has functional and recreational uses, such as fences in-between spaces and shading

for urban dwellers to provide natural cooling. Thus, it can be grown as part of the community rather than merely a decoration.

Thirdly, it exists in a wide variety of forms, such as lines of a hedge, a single tree or stonewall trees. They grow according to the environment and urban development to survive in between and around city infrastructures. The survival of trees in front of human intervention has evinced the strong vitality of trees. As a result, trees can be found and grown easily around cities, which has helped to increase their significance in urban nature.

Furthermore, vegetation, leaf and planting are other top elements in most photos. Planting vegetation is the most common element appearing both indoor and outdoor. Planting can link urban dwellers to nature in indoor spaces such as offices and homes. It brings living nature to urban dwellers by providing a sense of nature and allowing them to participate in the natural process of growing (Gillis & Gatersleben, 2015).[284] Urban dwellers will develop a stronger sense of connecting with nature upon the time and effort accumulated along the process.

Weather is the second most popular category, as elaborated by two main reasons. Firstly, the weather can be felt in outdoor spaces. Weather refers to the atmospheric condition, which is also the medium for understanding the condition of nature in the cityscape. People will understand the external environment by observing the sky, which explains why the sky is the second most popular element. Secondly, the sky is ever-changing throughout the day with the diurnal light condition due to sun circulation. It is the law of nature to humans, which is uncontrollable and independent of human activities. Thus, people will look at the natural change of sky when they search for nature in urban contexts.

Water, natural materials, humans and animals are the less significant categories to provide a sense of nature. Water and natural materials are substances that can be found naturally. Their natural occurrence is the primary reason behind their sense of nature to people in the urban context, where most substances are built and installed artificially. This illusion of artificially installed yet naturally occurring and nourishing elements triggers dwellers to realise the existence of nature represented by water, natural materials, humans and animals.

Humans and animals are the two big groups of living things in the world. From the perspective of

urban dwellers are the principal inhabitants of urban cities, while animals are of nature. One of the qualities of nature is wild, untouched and rich in species which animals fulfil as a representation (Grahn & Stigsdotter, 2010).[285] Animals can easily remind people of nature in cities. Birds, cows, butterflies and monkeys are wildlife captured by participants, but few photos represent domestic animals such as pets, including dogs and cats. Birds are the most popular choice of animals as they can be found relatively easy in urban districts. Animals provide a direct opportunity for people to connect with nature, echoing the direct experience of nature mentioned in "The Practice of Biophilic Design" by Stephen Kellert and Elizabeth Calabrese (Kellert and Calabrese, 2015).[286]

Participants' perspective

Visual enjoyment is the most popular category, according to the survey result. People tend to see the existence of nature in urban as natural scenery. The narratives of the photos in this category were more likely to describe the photo content directly, while the photos were generally pictured without focusing on an object. The two photos in Fig. 5.27 describe some of the samples in this category. Viewing elements of nature is the most popular and direct method for dwellers to associate with nature.

Fig. 5.27 – Photo elicitation sample photos

Moreover, green is a signature colour and term for the public to identify nature in urban contexts. It is a colour and term that is most commonly found in photos and writings when nature is referred to. Therefore, green in the city reminds dwellers of nature while allowing dwellers to see the natural element is the most direct medium for dwellers connecting to nature.

The sensation is the second most popular category in how participants perceive nature in urban cities. People could connect to nature with the other four senses: hearing, touch, smell, and taste, such as hearing the sea's sound and touching the water. Again, sight is the primary medium. Although many people rely on eyesight to capture urban nature, exploring through different senses could open more opportunities for discovering and experiencing nature around cities. People can then develop a sense of nature more quickly. In addition, as nature exists in various forms and statuses, utilizing the five senses could provide people with a more comprehensive feeling and connection to nature.

Vegetation refers to the photos in which only greenery was taken. It is a group of photos and writings that explicitly focus on vegetation or growing plants. Plants serve as a clear, strong and direct connection to nature as people's sense of nature is found and built along the process. In addition, the remaining categories, Habit, users and space, have widened the dimension of how people associate nature within the urban context. Nature exists as a separate entity from people and integrates into different living cultures as a sharing resource. Furthermore, nature exists in an intangible form that people learn to explore and appreciate with the five senses. It has also provided insight into a further study of how nature could be incorporated into urban contexts on a broader spectrum.

Apart from the analysis of visual elements and perspectives of photo-taking, it is found that 89% of the photos are taken outdoor while the remaining 11% are indoor, in Fig. 5.28. It implied that urban nature tends to exist in outdoor spaces. People usually associate with nature outdoors. On the other hand, people do not find a sense of nature in indoor space as those photos taken indoors generally captured plants, sunlight or external view through windows. These elements are ever-changing and grow or change over time.
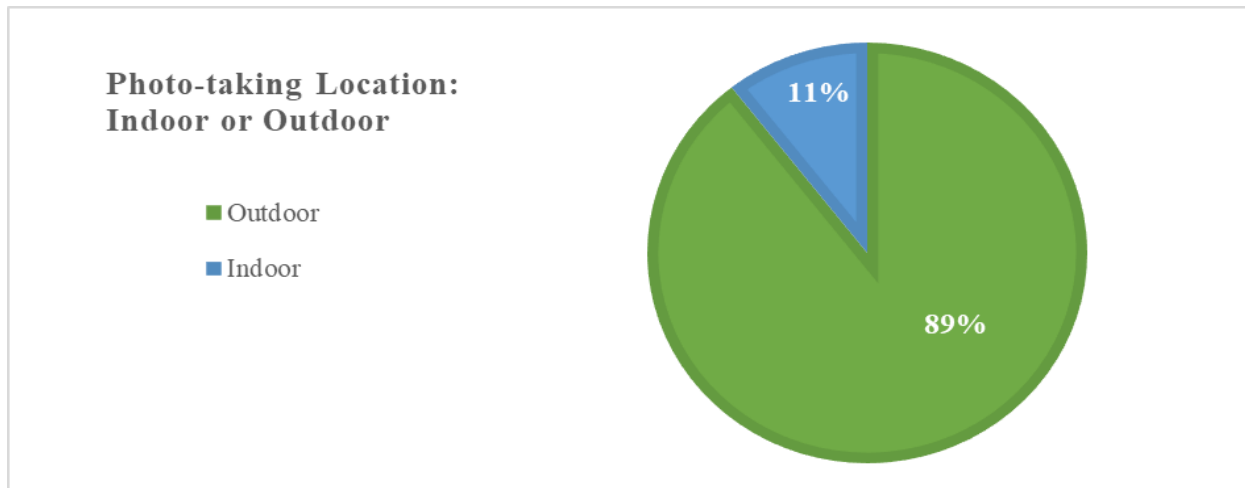
Fig. 5.28 – Photo elicitation category and element frequency for "Indoor vs Outdoor"

Nature interpreted by the participants is more versatile and ever-changing than artificial substances. The elements associated with nature selected by the participants are generally non-static and non-rigid. They will change or grow over time. Nature is found everywhere in urban cities; nature and human interactions can happen in different urban settings. However, their existence requires more urban dwellers' attention, appreciation and action. They can exist in various forms, situations and statuses that should be experienced and explored in a broad spectrum of mediums. A well-considered human-nature urban living environment may thus be helpful to connect urban dwellers with nature better.

5.3.4   Interpretive Exhibition Created from the Findings of the Photo-Elicitation Survey

To further collect data on urban dwellers' perceptions, the photos with narratives collected in the photo-elicitation survey on the perception of nature in urban living, as described in Section 5.3.1, were exhibited to the public. The visitors could express their preferences and comments on the exhibited photos. The following paragraphs describe the exhibition's details and the collected data analysis.

The exhibition was held at Oil Street, North Point, from June 2017 to August 2017.

Fig. 5.29 – The exhibition of the photos with narratives in the photo-elicitation survey

Through the exhibition, urban dwellers' interpretations of nature were displayed, encouraging visitors to rethink the boundaries of nature in different contexts. Visitors were invited to vote for their most-liked photos from the exhibition and elaborate on why they chose a specific photo. Boomsma et al. (2016) revealed that environmental imagery could have an important influence on pro-environmental goals. These images, internalised as mental images, strengthen existing and newly developed pro-environmental goals that promote a sustainable lifestyle and behavioural change.[287]

Fig. 5.30 – Visitors' voting for the most-liked photos of "Urban Living with Nature"

As discussed in Sections 5.3.1 & 5.3.2, the photo-elicitation survey involved 104 urban dwellers and their photos of nature in urban living. Thus, more than 150 visitors participated in the election, and the purpose of the photo-elicitation survey was to find out the interpretation of nature from urban dwellers' perspectives. The visitors voted on the image they liked the most and commented on why choosing such an image. It intended to collect more data on people's perceptions of nature.

Fig. 5.31 – Number of votes for the exhibited photos on "Urban Living with Nature"

The photo descriptions from the photographers and the visitors' comments were compared. The highly voted images tried to capture the scene of nature or their daily lives. Moreover, most of the visitors' comments were positive. It revealed that they all felt optimistic about nature. None of them had a negative impression or unpleasant perception of nature. Additionally, one of the common characteristics of these photos was fewer people. The photographers unconsciously took places with fewer people involved, or even if there was a person within the image, which the photographers used to link with nature or animals.

Fig. 5.32 – Photos with a high number of votes – Most-liked "Urban Living with Nature"

In addition, most of the highly voted images had elements of artificial substances intersecting with natural elements, as previously indicated in 5.3.3 – water and trees, as well as animals. The photo descriptions and visitors' comments generally indicated that the photographers had successfully transferred their messages to the visitors. Among these images, photo number 14, as shown in Fig. 5.33, had the most votes. The description of photo number 14 was "one moment, sky in two colours", while the visitors' comments were "spectacular colour and view", "a moment of silence within the crowded city", and "nature is always in our surroundings". Hence, the visitors seemed to have more in-depth feelings stimulated by this image than the photographer's narrative.

Fig. 5.33 – Photo with the highest number of votes – Most-liked "Urban Living with Nature"

Nevertheless, there were forty-two photos without any votes. Their similarities were pale with no colour contrast; some stories were not very clear and lacked a sense of atmosphere. These "zero votes" images attempted to capture the same theme or topic of the top six, such as photo number 100 and photo number 31, as shown in Fig. 5.34. They both captured trees and buildings; however, photo number 100 was one of the top six images visitors voted for, and photo number 31 had no one vote. Photo number 100 was taken in a rural area, with a building surrounded by trees and green elements. However, number 31 was taken in an urban area, with two trees surrounded by buildings. The sky might be one of the reasons that affected the visitor's perception. Photo number 100 could see the sky, which gave a sense of prospect. On the other hand, photo number 31 showed layers of high-rises blocking the sky. Thus, these might be the reasons why visitors were not voting for photo number 31 but photo number 100.

Fig. 5.34 – The photos captured trees and buildings

The above observations from the visitors' responses have indicated how artificial substances facilitate interactions with nature, the most appealing natural substance of the ever-changing sky, and the composition of the natural and built environment is appreciated. These responses echoed and further verified the findings of key substances of interaction with nature in urban contexts in Section 5.3.3.

5.4   Photo-Elicitation Survey – Children vs Elderly Persons' Interpretation of Nature

The research participants were asked to invite one elderly person over 65 years old and one child less than ten years old to use mobile phones to take one photo of anything or place they associate with "nature" in their daily life, together with a description of the photo in one sentence. Meanwhile, the research participant (namely authors in the following paragraphs) took one photo of their interpretation of "nature" and wrote one sentence to describe it. Eleven complete data sets were received, as illustrated below and in Appendix 4.

5.4.1   Findings

	Children/ Youth	Author	Elderly
1	She is a 6-year-old south Asian kid; nature means a park near her home.	I am a 22-year-old university student. I like to cross the Tuen Mun centre park to go to the bus stop.	She is an 82-year-old elder. Nature means a square to which she can chat with friends.
2	Youth thinks nature is related to flowers and leaves those greening.	Real nature is a foil in our city, and the building breaks our real nature. Every building surrounds our city. By year, those high buildings become Hong Kong's "Nature".	To the elderly, there is a place for them to have morning exercise; nature means to the elderly is having a place that the surrounding is greening to make them feel comfortable.
3	They just want a playful space. It is a better space for the children to play.	The green space, I want a whole piece of green that can let people bottom-up develop.	The green space wants a space that can let them gather with their friend.

4	I come here to play with my friends after school	I can get close to nature when I pass through this staircase every day to school	I will sit here during my free time; I feel comfortable when I see trees around me
5	Park, where you can play with a tree in nature.	It can relax and feel comfortable at any time.	There are forests and fields in nature.
6	My family are very busy; they are less play with me. I think the grass is like dancing.	I think the cloud reflect nature because the cloud is changeable weather.	I am an old fisherman. The photo can show the vagaries of wind and waves. I can see the sky then guess the weather in the future.
7	The child said nature is an outdoor place for me to play, and it must have a tree.	I said nature which is lock into the building; it is the combination of the city planning, that is why we call it Concrete Forest.	The elderly said nature which is cannot see the building and have plants.
8	He loves a place full of trees.	I think nature is not just about a plant, but also the interaction between humans & nature.	Ashes to ashes, dust to dust are nature.
9	The green or plants are natural.	Nature is nearby where I live here.	The park that walks every morning is nature.

| 10 | Nature is green which can be seen everywhere. | Nature is now being isolated by this suffocating city. | Nature is free in the air and good for our health. |
| 11 | Nature provides a comfortable playground. | Nature is a cycle, endless. It can be quiet and serene. It can also be lively and full of life. | Nature is an interest—spice up my life. |

Fig. 5.35 – Participants' photos and narratives are illustrated

5.4.2   Analysis

The third photo-elicitation survey involved 33 participants at distinctive age groups of children, adults and older adults over 65 years old in taking photos of their interpretation of nature. Their photos were mostly taken from their daily living environments, such as playgrounds and parks.

Authors

All photos included green elements. Nature served as a visual symbol and a medium for participants to reflect on the relationship and value of nature. They generally expressed that nature provided an impression of free and comfortable space among buildings, but buildings limited or isolated nature in urban contexts. The sky was also photographed and associated as a symbol of nature. This was the only non-green form of nature photographed. What was described was the ability to change and react with time, creating various colours.

Children

Green was a visual symbol of nature to children, while nature allowed them to play and have fun. 70% of the children described nature as a playground for them. Nature was like a place where children could move or express themselves freely. Park, therefore, was a popular venue among them. Also, green was easily found in parks. Furthermore, the sky was another common element found in children's photos, as they were usually shot in outdoor spaces.

Elderly Persons

Older adults generally identified nature through a social perspective in which nature was a place where they could socialise with friends and families. Some participants considered green as a necessary element. Half of the older adults photographed an open space with greenery and seating space. Buildings were usually avoided or minimized in the photos. They evaluated nature not only by what they saw visually but also by utilising or interacting with space. A comfortable social space was a criterion for identifying with nature.

5.4.3 Discussion

Most of the photos were taken outdoor. Only four were taken in indoor space. Three categories of participants generally interpreted nature from different perspectives. Nature in the children's minds was livelier and more explicit, which they found in their daily lives and surroundings. For the author's category, the participants considered nature a place where they could feel comfortable and examine the relationship between humans and nature. Older adults were evaluated through the function of space to determine if it represented nature. The social value of nature was generally emphasised in the photographs. The criteria of nature varied as participants' perceived value of nature changed with their life experiences.

Green was a common element in most photos. All photos shot in outdoor spaces contained green elements even participants did not mention in their descriptions. It might indicate that green elements were a necessity in nature, which participants naturally included in their photos. Playgrounds and people were photographed, and happiness might be reflected as the meaning of nature to them.

Furthermore, two participants from the author and elderly categories considered nature from a spiritual perspective as part of the life cycle. Both of them took photos of a cemetery with green in the surrounding. They believed nature was a constant process rather than an element or environment.

5.5   Conclusion

The three sets of photo-elicitation surveys were conducted to investigate whether urban dwellers

appreciate the significance of human-nature interactions, how they interpret, perceive and experience nature in urban living, and whether their perception and experience are various from different ages. The analytical findings are summarized in Fig. 5.36 & 5.37.

Interpretations of nature vary, distinctive and even conflicting, such as nature as object vs scene, static vs ever-changing, and scientific vs romantic. The meaning of nature for urban dwellers is multi-faceted and relates to their own experiences and perception. Their perceived values of nature are the crux of their interpretation of nature and intention to interact with nature, which are summarized under three perspectives (i) human relies on nature, (ii) human co-exists with nature, (iii) human intervenes in nature.

Perceived Value of Nature	Interpretation & Perception of Nature	Key Substances
Human relies on Nature	Nature is a scene of daily life	• Sky, moon, sunrise, sunset, sunshine • Park, playground, country park, a palette of lush vegetation • Harbour, mountains, green slopes behind buildings, roadside greenery, trees
	Nature is a resource for consumption	• Vegetables, fruit, fish • Bamboo poles for laundry, trees for shading
	Nature is from human's romantic appreciation	• Imagination and dialogues with nature, e.g. trees, sky, sun, rain
	Nature is various from a different culture	• Earth tone fashion, ancestor worship, tomb
Human co-exists with Nature	Nature is a natural occurrence	• Raining, withered flowers, fallen leaves, growing plant, blossom
	Nature is a living thing	• Trees, plants, flowers, fruit, birds, dogs, cats, fishes, monkey
	Nature and humans are separate entities	• Trees and buildings
	Nature is science	• Wind
Human intervenes Nature	Nature is fighting with human intervention	• Trees on retaining walls, tree trunks in conflict with balustrade, plants at gaps of paving blocks
	Nature exists with human intervention	• Green walls, landscape, bird nests at buildings
	Nature is disappearing due to human intervention	• Trees, greenery, and birds are disappearing due to urban development and construction

Fig. 5.36 – Interpretation and perception of nature and key substances

Despite different interpretations and perceptions, the key substances are similar: green, weather,

sky, mountain, harbour, water, animals, and artificial or building features. Green is the most common substance, and the ever-changing sky is the second. These key substances stimulate people in association with nature. Furthermore, these substances stimulate people's inherent affinity to nature, and they appreciate nature's intrinsic value by noticing conflict with nature and the ecosystems due to urban development and human activities.

Human-Nature Interaction	Key Substances
Visual / View	• Visual enjoyment through sight • Distant view to sky, trees, mountains, sea
Sensation	• Aural, smell, taste and touch • Mosquitos' bites
Planting	• Plant their indoor plants at the office and at home • Gardening, urban farming
Habit / Action	• Involving as part of daily living or working patterns • Desire to live with nature • Enjoy connecting nature
Playing	• Playground, park – where allow them to play
Socializing	• Open space with greenery, park, and sitting space – which allows them to socialize with friends and families
Memory	• Personal memories or attachments
Art	• Artworks made of or themed on natural elements

Fig. 5.37 – Human-nature interaction and key substances

To segment the findings into two forms of human-nature interaction:

1. **Direct interactions** with nature include visual enjoyment, sensation, planting and living with nature in daily life.
2. **Indirect interactions** with nature comprise playing and socialising in green spaces or natural environments, personal memories or attachments to the existing or disappeared natural features, and artistic expression of nature.

Besides, these interactions can be distinguished on different scales of an individual, a social circle of family, friends and neighbours, and a community.

Different age groups have various focuses. Nature in the children's minds is livelier and more explicit, which they find in their daily lives and surroundings. Older adults were evaluated through the function of space to determine if it was natural. The social value of nature was generally emphasized among them.

These public engagement surveys provided insightful observations on urban dwellers' interactions, interpretations and discovering the forms of interactions with nature in different urban settings. The urban-nature elements are identified, which share non-static and non-rigid characteristics while having their natural patterns of changes. Although these elements are easily accessible in urban living, they are disconnected from urban dwellers without proper design.

Anthropocentric   Non-anthropocentric

| Nature is disappearing due to human intervention | Nature is fighting with human intervention | Nature exists with human intervention | Nature is a natural occurrence | Nature is a scene |
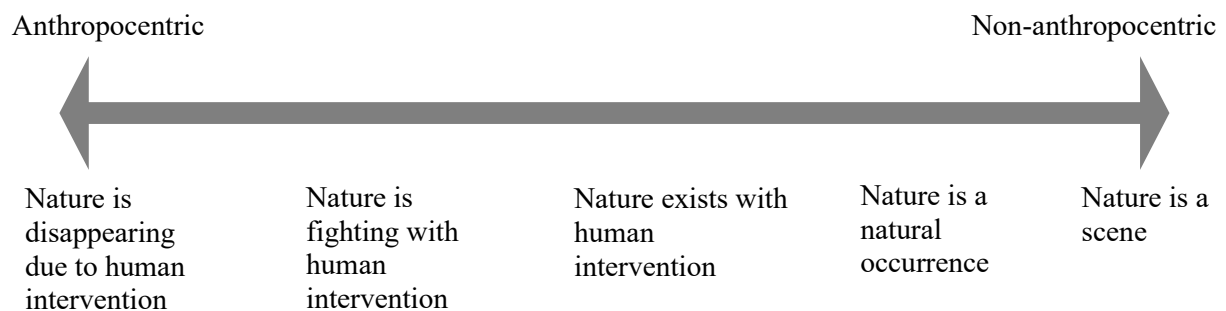
Fig. 5.38 – Spaces / Scenes: Anthropocentric vs Non-anthropocentric

Along the spectrum of anthropocentric – non-anthropocentrism in Fig. 5.38, some commentaries and photographs reveal a spectrum of engaging with anthropocentric thought. Most of the participants recognize the separation between humans and nature. At the same time, some participants identified nature as part of a scene and part of a collective world. This thread of analysis also identifies how natural interventions by humans are perceived and establishes the framework to consider what urban settings are beneficial from the anthropocentric and non-anthropocentric perspectives.

Static   Ever-changing

| Amenity Facilities | Building Features | Natural Features | Greenery | Water | Light & Air | Sky |
| *- Seating* *- Shelter* *- Recreational, play & fitness equipment* | *- Retaining wall* *- Slope* *- Shade* | *- Mountain* *- Sea* *- River* | *- Trees* *- Shrubs* *- Grass* *- Flowers* *- Green wall* *- Green roof* | *- Rain* *- Pond* *- Fountain* | *- Daylight* *- Sunset light* *- Air* *- Wind* | *- Sky* *- Cloud* *- Sun* *- Moon* |
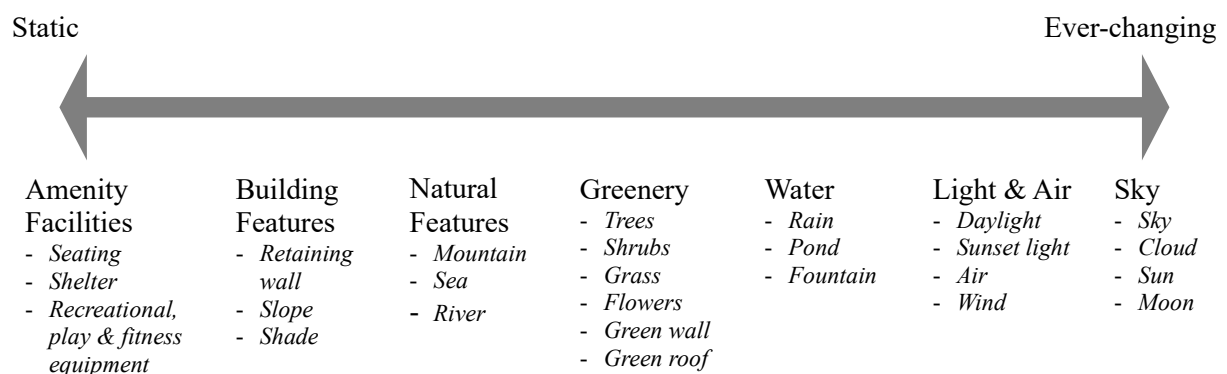
Fig. 5.39 – Objects / Elements: Static vs Ever-changing

According to the findings of the photo-elicitation surveys, these key substances in Fig. 5.39, which

stimulate people in association with nature, range from static objects to ever-changing elements of the natural world. This spectrum has consolidated different objects and elements representing urban nature and presented a similar distinction between anthropocentric (static) and non-anthropocentric (ever-changing) perspectives.
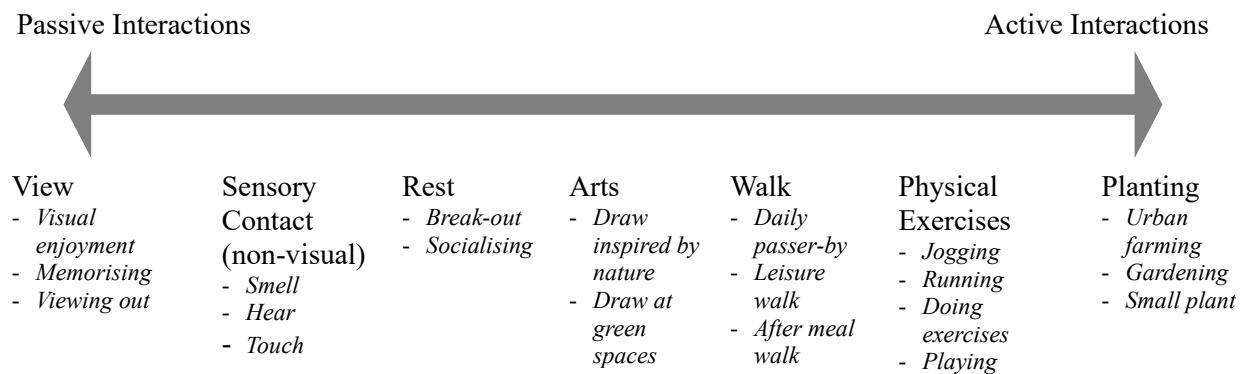
Fig. 5.40 – Activities: Passive vs Active

The findings also revealed a wide spectrum of activities based on nature's existence or engagement with the natural elements in Fig. 5.40. Activities involve passive and active interactions. It relates to different degrees of engagement with nature in daily urban living.

The hypothetical model of human-nature interactions "SOA" model in Fig. 2.5 is referred to. Given the above discussions, the interpretations of nature are categorized into three aspects of spaces/scenes, objects/elements and activities and conceptualized with their inter-relations as illustrated in Fig. 5.41.
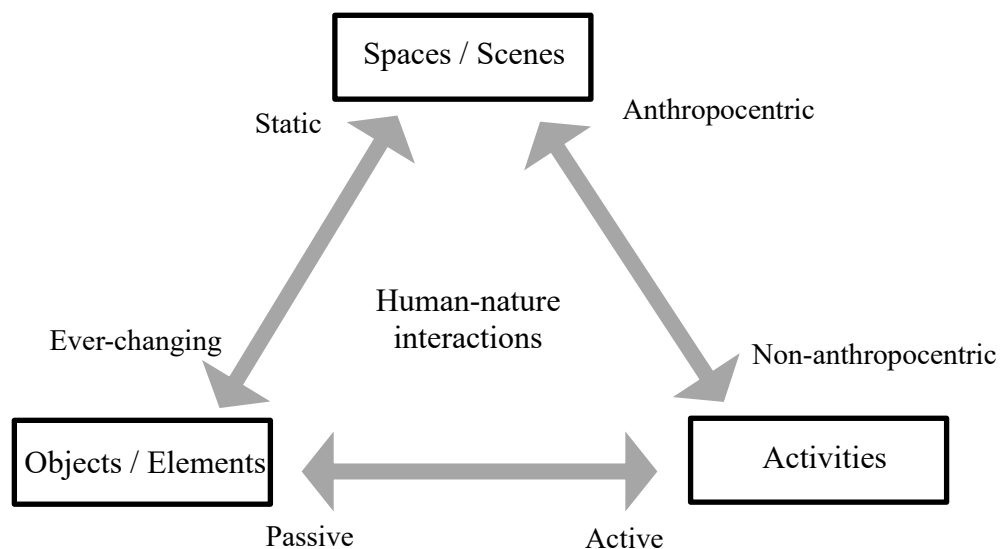
Fig. 5.41 – A hypothetical model of human-nature interactions "SOA" model

Chapter 6: Design for Nature vs Design for Human

6.1 Introduction

Regarding Research Question 2, another set of photo-elicitation surveys and case studies were carried out, as elaborated in this and the next chapters, respectively.

This chapter will investigate a new possibility for biophilic design to advocate human-nature interactions in high-density, high-rise contexts through photo-elicitation surveys testing the anthropocentric scale when interpreting nature. To further develop the discussion on the human-nature relationship, this series of findings will express the perception of how humans rely on nature, co-exist with nature, and intervene in nature. The fourth photo-elicitation survey was conducted in search of "Design for Human" and "Design for Nature" interactions in urban contexts.

6.2 Photo-Elicitation Survey – Design for Nature vs Design for Human

A photo elicitation survey was carried out on the specific topic of the interpretation of "Design for Human" and "Design for Nature". "Design for Human" interprets nature manipulated for human consumption, viewing, and navigating around. "Design for Nature" indicates a design for the natural world. The participants of the survey will determine this interpretation. Participants are required to have a basic understanding of design. Sixty participants, who had architectural education backgrounds, participated in this survey. By adopting content analysis on the findings, sixty sets of collected survey results would be analysed in three following stages: (i) analysis of photos for "Design for Human"; (ii) analysis of photos for "Design for Nature"; (iii) comparison of the photos for "Design for Human" and "Design for Nature". In addition, both descriptions and photos would be evaluated to understand how participants interpreted the two terms and determine key elements in representing a respective idea.

Participants were asked to take photos representing their interpretation of "Design for Human" and "Design for Nature" with descriptions, respectively. Full records of participants' photos and narratives of their interpretation of "Design for Human" and "Design for Nature" are in Appendix 5.

Fig. 6.1 – Photos of participants' responses on "Design for Human"

Fig. 6.2 – Photos of participants' responses on "Design for Nature"

6.3   Analysis

The fourth photo-elicitation survey invited 60 participants to take photos of their interpretations of nature. There were specific topics on photo-taking instead of asking for general interpretations. Each participant was required to take one photo of a design for humans and one of a design for

nature. Hence, their photos had more definitive meanings, and their narratives delineated the meanings in detail. They identified the substances of nature and further elaborated on how it designed for humans or nature.

6.3.1   Design for Human

Based on the participants' interpretation, three aspects can be classified in "Design for Human": psychological/physiological, social, and environmental. The psychological/physiological aspect refers to personal experiences, such as visual enjoyment and soft fascination. The social aspect describes activities that activate spaces at a community level, namely community gardening and urban farming. The environmental aspect refers to environmental mitigation at the district level, for example, enhancing thermal comfort and alleviating the heat island effect. Sixty samples' classification results are shown in Fig. 6.3.
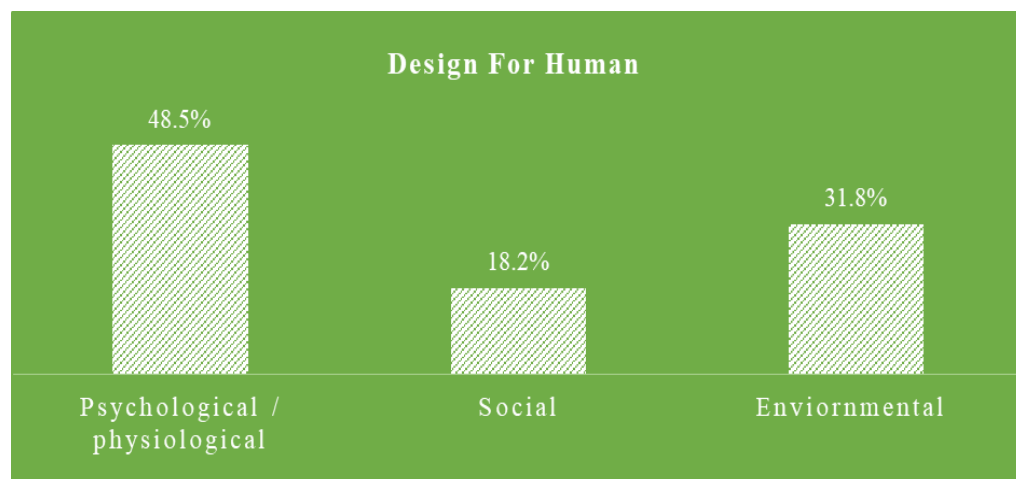
Fig. 6.3 – Classification of photos on "Design for Human"

The next three sections will analyse the three aspects listed in Fig. 6.3 under the category "Design for Humans". They will be evaluated with the photographs presented in the photo-elicitation survey.

6.3.1.1   Psychological / Physiological Aspect

The psychological/physiological aspect is the most popular aspect, and 48.5% of participants found pleasure and comfort in their selected places. In Fig. 6.4, 53.1% of the participants had a desirable sensory experience. Participants mainly found a pleasant experience in the senses of

vision, touch and space. For instance, cool and spacious are the most common adjectives participants use to describe their sensory experience. Fig. 6.5 presents some selected works from participants. Participants' visual enjoyment mainly refers to greenery's aesthetic aspect or beauty, not limited to any form or type of greenery. 31.3% and 15.6% of participants interpreted the experience as relief, restorative, and connection to nature. They described the places as recreational and leisure spaces to interact with nature to satisfy intrinsic needs.
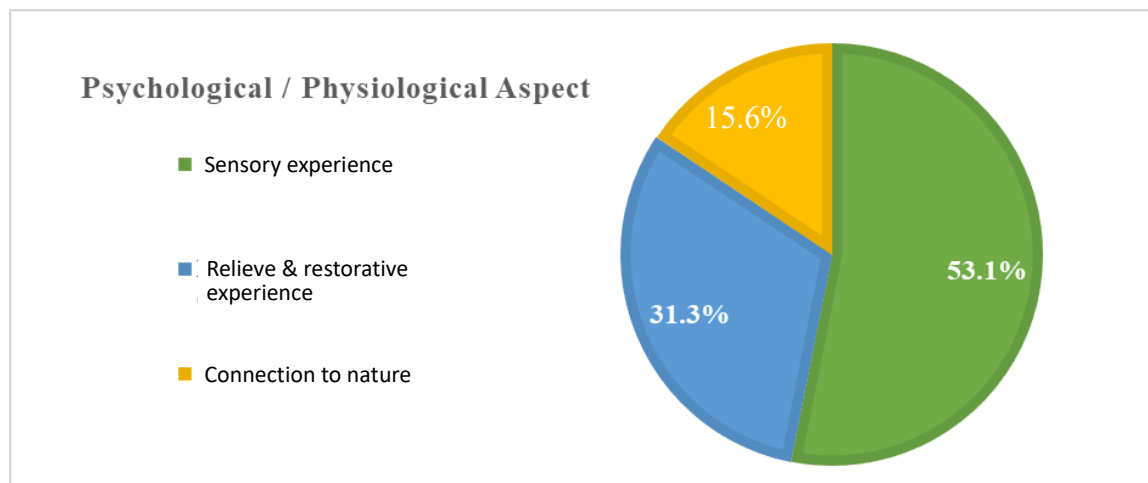
Fig. 6.4 – Classification and distribution of "Psychological / Physiological Aspect"

		Participant's description:
(D)H-23		*This non-typical fountain not only favours the flowing of water but also incorporates walkways and benches that allow humans to engage with water; this is an exceptional cooling space in the summertime.*
(D)H-56		Participant's description: *Urban parks improve the neighbourhood and social interaction by creating spacious, scenic entertaining and safe green areas. They allow intimate exposure to greenery in daily life.*

Fig. 6.5 – Selected examples of participants' photos associated with psychological/physiological aspects

6.3.1.2   Social Aspect

18.2% of participants are classified to the social aspect, while 58% commented on how social interaction was improved in the places "Design for Human". The photos are mainly shot in outdoor open spaces with seating, such as the courtyard, park, and under a flyover. It is not limited to outdoor but indoor spaces with sitting areas, as shown in Fig. 6.7. These places shared the common feature of providing sufficient space and amenities for people to stay and gather, while nature was used as either decoration or the connecting medium. An urban farm was illustrated as a place where people could be gathered regularly for a long-term basis, along the growing process of vegetables. Participants took pictures of using greeneries as a buffer zone between pedestrians and vehicles to offer pleasant communal spaces.
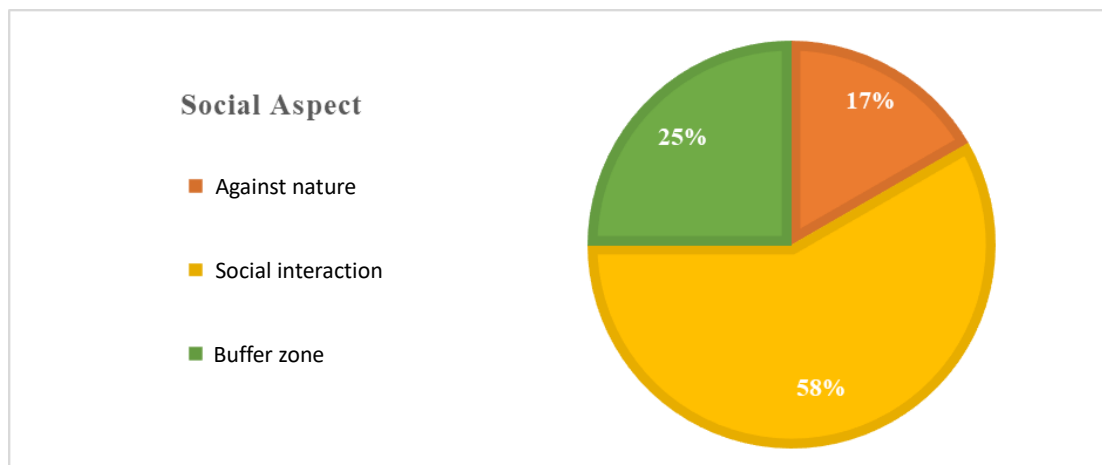
Fig. 6.6 – Classification and distribution of "Social Aspect"

		Participant's description:
(D)H-9		*Indoor bar tables implanted with trees promote face-to-face interaction between humans and nature.*
(D)H-31		Participant's description:
		This picture depicts how nature plays a vital role in bringing people together in a social setting, providing them with a public space away from the urban context's hustle and bustle.

Fig. 6.7 – Selected examples of participants' photos associated with the social aspect

6.3.1.3   Environmental Aspect

The environmental aspect is the second-highest aspect which 31.8% of participants have interpreted. Improving human comfort is the most considered among participants. The aims of the mitigation measures for human comfort include (i) improving ventilation, (ii) reducing solar radiation, (iii) improving air quality, and (iv) reducing sound disturbance. The mitigation strategies include the adoption of passive design and greeneries, as illustrated in Fig. 6.9 has shown some samples from the participants. Moreover, space is found in various scales ranging from indoor to district. Sunlight and airflow are the two major comfort parameters mentioned by the participants. 19% of participants have considered trees growing along the streets as the natural shading designed for people. Natural infrastructure refers to the drainage strategies that perform floodwater management.
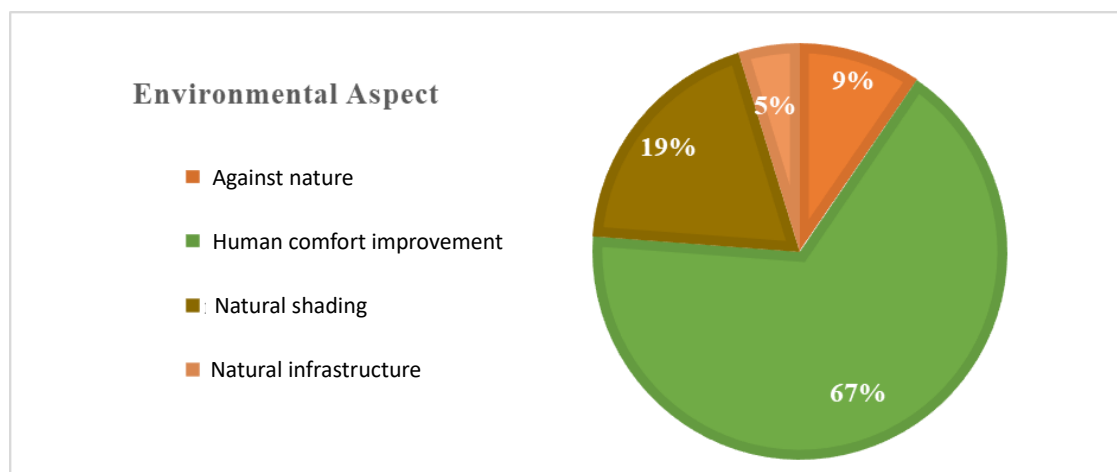
Fig. 6.8 – Classification and distribution of "Environmental Aspect"

(D)H-37		Participant's description: *Festival Walk Shopping Mall uses glass skylight provided indoor natural lighting and created a spacious shopping environment. This design saves electricity and reduces emissions. With natural sunlight, good Indoor air quality, and suitable temperature, the experience in Festival Walk is pleasant for shoppers.*

		Participant's description:
(D)H-17		*The green islands are built only to reduce sound disturbance and mimic the natural environment.*

Fig. 6.9 – Selected examples of participants' photos associated with the environmental aspect

6.3.1.4   Against Nature

Some participants' photos and narratives expressed the built environment in conflict with nature. In the social and environmental aspects, 17% and 9% of the data were categorised as against nature, respectively. Some selected photos are shown in Fig. 6.10. There are four issues raised by the participants: (i) limiting the growth of greenies; (ii) endangering animals' living; (iii) no opportunity for human-nature interaction; and (iv) creating pollution.

		Participant's description:
(D)H-37		*A clean, smooth surface of glass façade in celebration of modern, artificial materials and the manufacturing process of humankind, defiant toward all-natural elements, unwelcoming to any potential symbiotic plants and poses a threat to birds which cannot distinguish glass from the air.*
(D)H-17		Participant's description: *Even though the designers claimed that the house respected the existing tree and integrated it into the design of a bathroom, this forced gesture turns the outdoor environment for the tree into an indoor humid and cramped setting which is much unhealthier for it to stay in an outdoor courtyard, not to mention its natural environment with much sunlight*

Fig. 6.10 – Selected examples of participants' photos associated with being against nature

6.3.2   Design for Nature

"Design for Nature" is classified into ecologically responsible and regenerative. The ecologically responsible and regenerative aspects refer to the built environment posing a harmless effect and benefits to the ecosystems. As shown in Fig. 6.11, 28.4% of photos are classified in the third aspect: "Design for Human / Human with Nature". This aspect dismisses the notion of design for nature. Instead, they commented on how the utilisation of natural elements was consumed, thus ultimately benefiting humans.
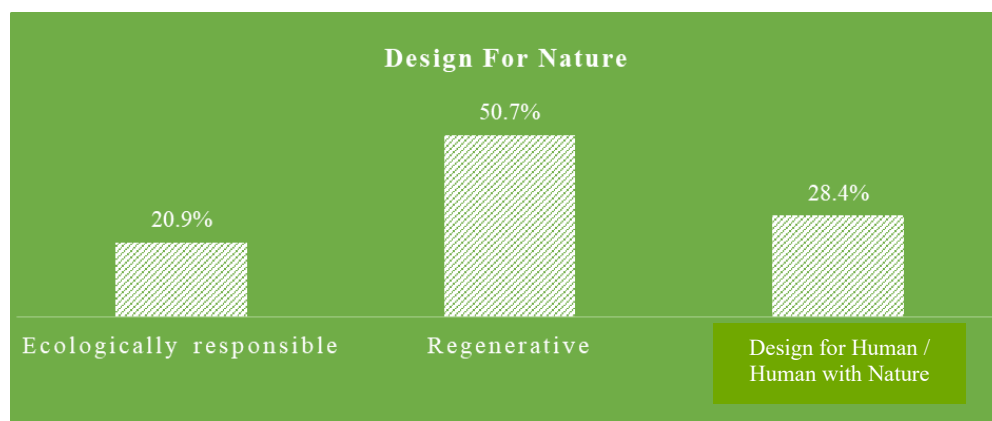
Fig. 6.11 – Classification of photos on "Design for Nature"

6.3.2.1   Ecologically Responsible Aspect

In Fig 6.11, 20.9% of photos are classified into an ecologically responsible aspect, mainly about conservation and respecting the ecosystems. Participants mainly took photos in the places that had imposed minimal intervention or alteration based on the existing ecosystems, including plants and animals. There are several sub-categories to describe the qualities of ecologically responsible aspects, and will be discussed in Section 6.3.2.2.

The group classified under "Respect" has 57% of participants who acknowledged the need for co-living between nature and people, which they shot on urban spaces adaptive to the existing natural habitats, as shown in Fig. 6.13. The classification of respect also exemplifies the possible design solutions which humans have created to facilitate and acknowledge the patterns and presence of nature from an anthropocentric perspective.

43% of photos are grouped under "Conservation, Preservation and Protection" as they showed spaces where action had been made to create a nature-centric environment, for example adding labels and warning stickers to prevent birds from colliding on the wall, which was in line with the

bird-friendly building design (Sheppard & Philips, 2015)[294], and preserving the river stream for natural habitat.
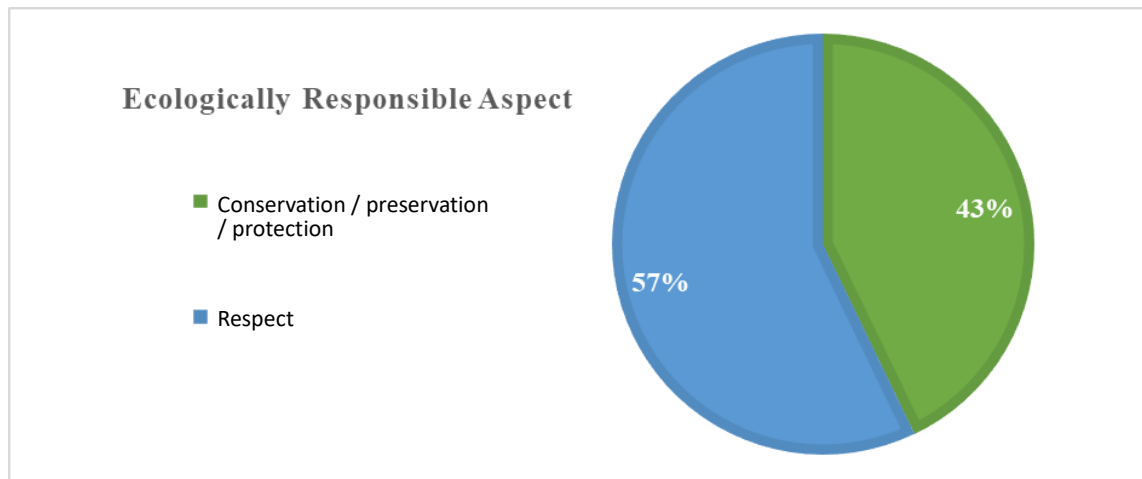
Fig. 6.12 – Classification and distribution of "Ecologically Responsible Aspect"

(D)N-3		Participant's description: *An elevated zig-zag footbridge was designed to preserve the trees for fruit bats to inhabit.*
(D)N-17		Participant's description: *The bird labels alert birds to the transparent noise barriers to avoid bird collisions.*

Fig. 6.13 – Selected examples of participants' photos associated with ecologically responsible aspects

6.3.2.2   Regenerative Aspect

In Fig. 6.14, 50.7% of the photos are classified as regenerative. There are two main classifications: (i) the provision of habitat and (ii) the utilization of water resources. 85% of regenerative photos captured the provision of habitat for plants and animals in urban contexts. Planting greenery is the

major approach mentioned by participants while revitalizing underused urban spaces or utilizing existing infrastructure for plants to grow, as shown in Fig. 6.15. 15% of regenerative photos described rainwater harvest and irrigation for vegetation, supporting nature to grow in the city.
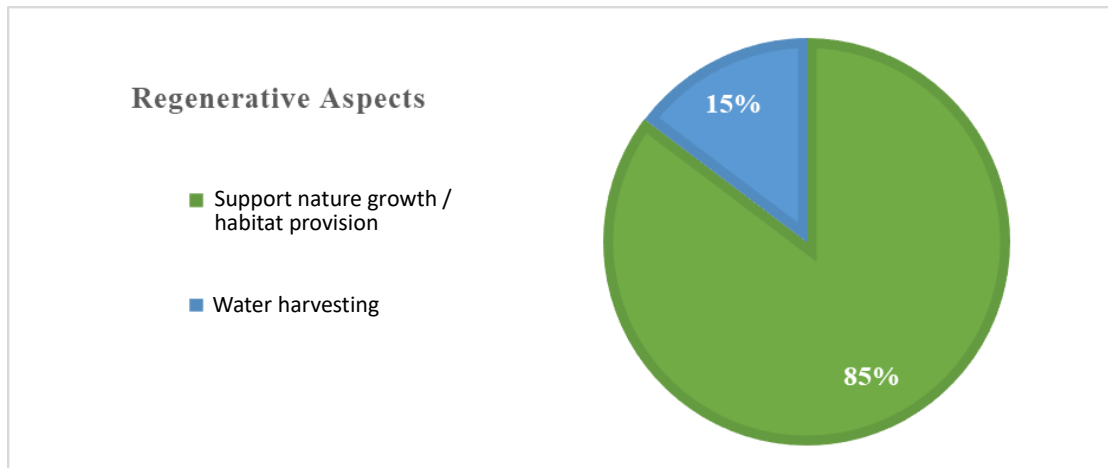
Fig. 6.14 – Classification and distribution of "Regenerative Aspect"

(D)N-21		Participant's description: *Recovering the highways back to streams and greenery natural environment, adaptable for lots of birds and ducks and other urban creatures who have difficulty living among buildings.*
(D)N-14		Participant's description: *This is part of the rainwater harvesting system, located on top of the estate for collecting rainwater recycled for irrigation of vegetation in the estate area.*

Fig. 6.15 – Selected examples of participants' photos associated with regenerative aspects

6.3.2.3 Design for Human / Design for Human with Nature

28.4% of the photos could not be classified as "Design for Nature". Instead, they showed how to utilize natural resources for humans. These photos can be further sub-categorised into

psychological/physiological, social, and environmental aspects, as shown in Fig. 6.16 and Fig. 6.17.

68% of the photos under "Design for Human / Human with Nature" related to the environmental aspect and captured how the natural elements assisted in creating a thermally comfortable environment or improving urban micro-climate. 21% related to the social aspect, described how humans might connect to nature by providing more green spaces in the community. Some are relevant to people's attention towards nature. The remaining 11% of the psychological aspect captured the city's leisure spaces with lush vegetation.
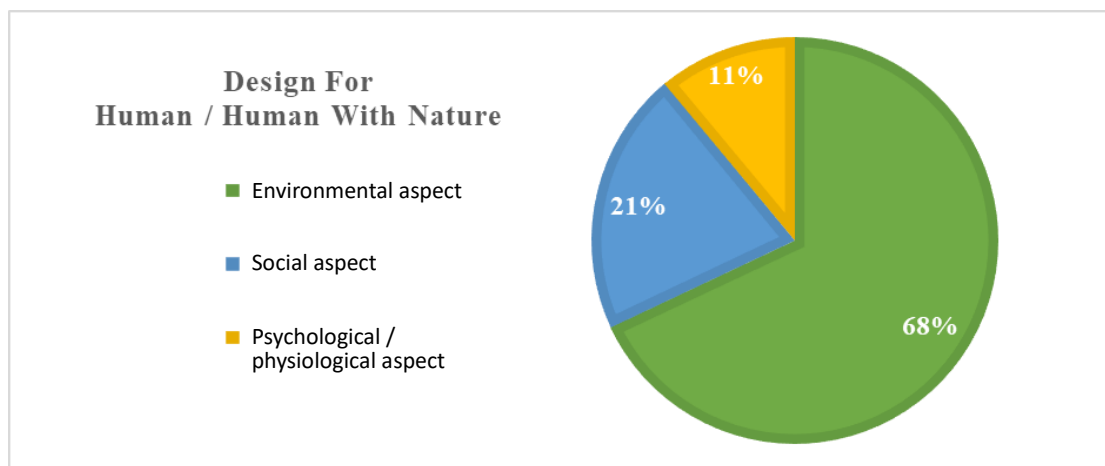
Fig, 6.16 – Classification and distribution of "Design for Human / Human with Nature"

(D)N-9		Participant's description: *Harbour with floating trees as an avant-garde green space provoking human reflection on environmental issues.*
(D)N-34		Participant's description: *Four towers raised the suspended podium above the ground, allowing unobstructed wind penetration through the building.*

Fig. 6.17 – Selected examples of participants' photos associated with "Design for Human / Human with nature"

It has implied that the idea of "Design for Nature" may have been misunderstood as design with nature, i.e., any design that utilized natural elements. The participants might have less awareness of the nature around them and thus do not think about how their built environment is natural. They might not notice if humans have impacted the existing nature. Furthermore, they might not consider nature as a separate entity in the urban space; they consider "Design for Nature" as improving the relationship between humans and nature by providing more interaction opportunities.

6.3.3 Key Elements on Photos of "Design for Human"
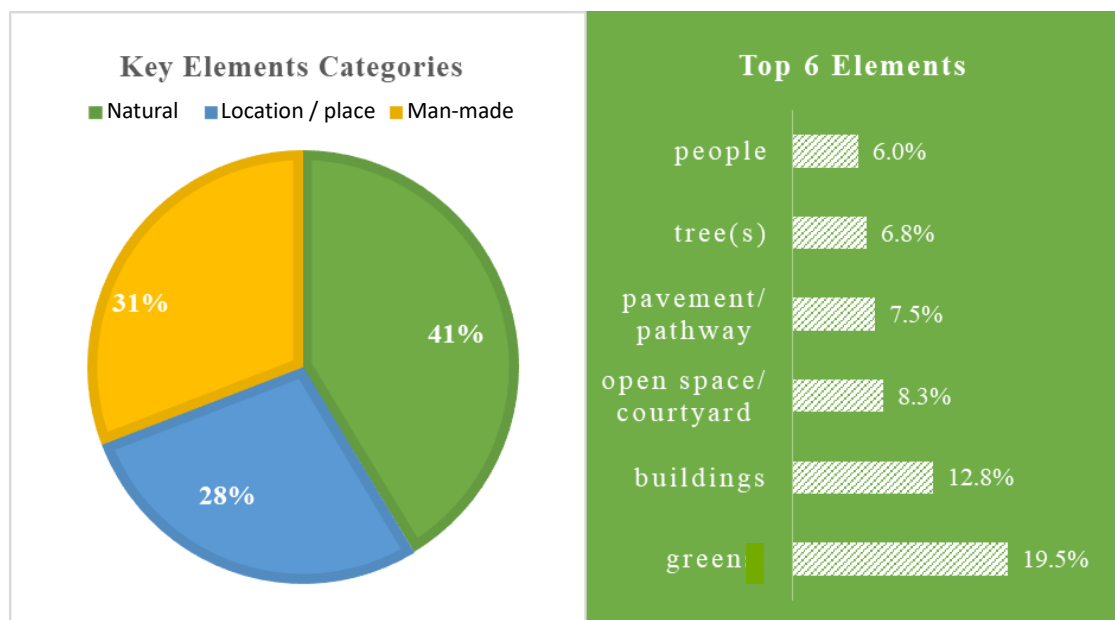
Fig. 6.18 – Classification of key elements and top 6 elements for "Design for Human"

Key elements, both tangible and intangible, are identified from each photo to find any significant representation of "Design for Human" shared among participants. In Fig. 6.18, the key elements are classified into three categories: natural, human-made and location. 41% of the photos refer to the natural category. Greeneries are the significant elements in the natural category, of which green and trees are the two principal elements. Sky, sunlight and water are other natural elements found in the photos, while water is described as a biophilic medium indoors. 31% refer to the human-made category. Buildings in various forms, ranging from residential houses, offices and shopping malls, are included, but most are high-rises. The remaining 28% is in the location category, in which the courtyard and pavement are the two principal elements. Spaces with seating provided are commonly found in the photos.

In Fig. 6.18, the top 6 elements found in "Design for Human" photos are shown. Again, green is the top element with 20%, followed by buildings, open space/courtyard, pavement/pathway, trees and people. Apart from the top six elements, skylights and retaining walls were captured.

6.3.4   Key Elements on Photos of "Design for Nature"

For "Design for Nature" photos, the natural element is the most common category, which occupied 47%. Human-made elements and location categories are 39% and 14%, respectively.   Fig. 6.19 shows the top six key elements: green is mainly found in 31% of photos. People easily associate nature with greenery, so natural elements and green are the most popular, but it may also reflect the limited understanding of nature in participants' minds. People have paid less attention to ecosystems and wildlife around them. Although both "Design for Human" and "Design for Nature" have green and buildings as the two top elements, they are of different representations. Green is a more pronounced element in "Design for Nature".
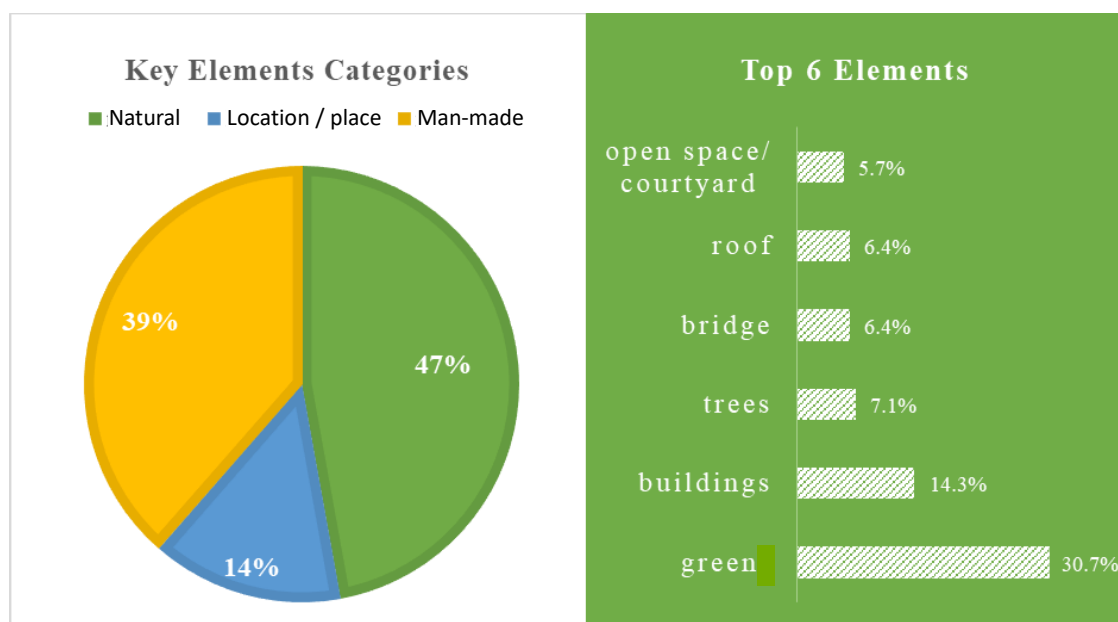
Fig. 6.19 – Classification of key elements and top 6 elements for "Design for Nature"

Buildings in the two sets of photos have different implications. In "Design for Human", the building indicates urban contexts, while in "Design for Nature", the building offers a space where nature can grow and survive. Apart from buildings, bridges and rooftops are two places commonly recognized by participants as "Design for Nature". It can also be a potential place to develop for "Design for Humans with Nature" when people are aware of the existence of nature in such places.

The courtyard is another space that shares a similar potential as it is one of the top key elements for both categories. On the other hand, a retaining wall is also considered a design for nature, a growing platform for trees. It has acknowledged the ecological value of retaining walls in the city, not limited to its functional value.

6.3.5   Comparison of "Design for Human" and "Design for Nature"

Based on the above analysis, four key observations were made. Firstly, people are generally less familiar with "Design for Nature" than "Design for Human". People can distinguish "Design for Humans" not "Design for Nature". It is hard for people to imagine what is needed for natural conditions. People are more used to considering the built environment from the human point of view and evaluating the design according to the benefits of humans. Over 70% of the participants can recognize the difference, which reveals a change or new trend in the future of the built environment as people have more and more awareness. However, the public still needs to realize, understand, and acknowledge the existence and importance of nature within the built environment to promote further "Design for Nature".

Secondly, green is found as the top key element in both categories. It has implied that green is an important medium to connect humans and nature, as it symbolises nature to the public. Green is a practical starting point to introduce nature into the urban built environment and the idea of "Design for Nature". Further study can be done to explore how and what kinds of design of green contribute benefits to both humans and nature and promote the connection between them.

Thirdly, various architectural features such as skylights, retaining walls, bridges, and rooftops share the idea of "Design for Humans" and "Design for Nature". It is worthwhile to explore further what qualities shared among them have triggered public awareness and helped improve such places for both humans and nature. The built environment is not limited to the design of buildings, and the surrounding features should also be well-considered for total utilization.

Fourthly, open space is another key feature found in many photos for both categories. It has implied that both people and nature are inclined to a spacious environment to interact easily. An open space provides more flexibility for humans and nature to utilise according to their needs and will, which is the critical reason for access to natural resources such as sunlight and wind. Natural

resources are essential to the intrinsic need of both humans and nature, which should be included in the design.

6.4 Discussion

Further to examining the key substances relating to design opportunities for human-nature interactions, this section discusses their implications in terms of anthropocentrism, experience and space use.

6.4.1 Anthropocentric vs Non-anthropocentric

This anthropocentrism evaluation discusses to what extent the design is centred around humans. Three main categorizations are (i) "Design for Humans" - utilizing nature for the benefit of humanity; (ii) "Design for Humans with Nature" - allowing humans and the ecosystems to co-exist; and (iii) "Design for Nature" – adopting human intervention for the benefit of the ecosystems. This evaluation aims to analyse what design elements are associated with human-nature interactions. Data collected under design for humans mostly referred to architectural design elements, while nature-centric design typically referred to either urban or open green space.

Design for Human
According to its level of anthropocentrism, data was categorized in this section, ranging from design for humans to design for nature.

In the first half of the research, participants were asked to take photos of designs for humans that showed the interaction between humans and nature. 60% captured a design merely for humans, 10% captured a design merely for nature, and 30% captured a design for both humans and nature. 45% of the results demonstrate different methods of utilizing nature for human benefit, with less attention to the impact on nature. In addition, only 18% demonstrated respect for nature, and regeneration of nature seemed to be almost absent. 71% referred to interactions on a community level, and 26% referred to interaction personally, while the interaction on an environmental level took an almost ignorable percentage of the results.

It could be justified by the purpose of this study as participants were asked to capture design for

humans; however, design for humans did not necessarily ignore nature.

Two-thirds of the data showed that interactions with nature primarily served either psychological or physiological purposes. At the same time, a third touched on the environmental, biotic, and social purposes, and only one instance demonstrated an educational purpose to influence human behaviour and attitude favourably towards nature.

Nature was experienced as comfort in 33% of the data, ranging from visual to thermal and air-quality-related comfort.10% were concerned with microclimate enhancement, 10% related to either protecting nature or producing it, and 18% attempted to connect with nature or respect it.

Design for Nature
In the second half of the research, participants were asked to take photos of a design for nature that showed the interaction between humans and nature. 7% of the total respondents captured a design merely for humans, 43% captured a design merely for nature, 48% for both humans and nature, and 2% submitted invalid information.

Of these results, 3% were educational and aimed to influence human behaviour and attitude towards nature, 12% attempted to interact with nature physiologically, and the rest demonstrated ecological, environmental, and ecosystem-related responsibility.

Out of those, 23% aimed to utilize nature, and the rest to either maintain or enhance the growth of nature. In addition, 28% were on either a personal or small-group level, and the rest were on the ecosystem; 17% of the collected data was concerned with microclimate enhancement, 10% with achieving thermal and air-quality related comfort, and the rest aimed to protect, produce, appreciate or respect nature.

Implications
The anthropocentrism suggested by design determines approaches used to deal with nature and promote human-nature interaction. The more anthropocentric the design, the more it utilised nature, and the less anthropocentric the design, the more it tended to respect nature and create an indirect visual connection to it.

The majority of the photos showed that design for humans followed two main approaches to create interaction between humans and nature. Utilizing nature for human benefits had the highest percentage of 45%, while visual connection to nature came next with 18%.

(D)H-15		Participant's description: *Human beings can interact with and enjoy natural sunlight, even in interior spaces, through the design of skylights.*
(D)H-57		Participant's description: *Greeneries are planted alongside the carpark, making the building more aesthetically appealing, improving air quality, and absorbing carbon emissions from automobiles, providing a better living environment for people who work and live nearby.*

Fig. 6.20 – Utilizing nature for human – participants' photos and narratives

Utilization of nature primarily aimed to create a physiological relationship between humans and nature by bringing them to specific interaction points. Passageways demonstrated outstanding potential for promoting physiological interaction and attraction to nature associated with the use of water and greenery spots within a design.

Another way to utilize nature was the thermal and air quality-related comfort space provided. As the collected photos showed, the most influential architectural aspects in this regard were:

(I)   Building structures:

Building structures would facilitate human-nature interactions through:

(i)   Spatial arrangement - positioning building structures in relation to the created space;

(ii)   Orientation - orienting building structures in relation to spatial and ecological features; and

(iii)   Configuration – profiling building structures in relation to ecological features.

(II) Building envelopes:

Building envelopes would facilitate human-nature interactions through:

(i)   Facades - the way a facade controls different natural aspects such as sunlight, air and wind; and

(ii)   Windows - the number and size of openings defined this interaction.

In addition, multi-level vegetation was considered a meaningful contribution to the interactions between humans and nature, not only in decoration or a visual and psychological connection to nature but also in providing the level of privacy needed in a dense urban environment.

While creating a visual connection to nature, it mainly focused on indirect, intangible interactions. The inclusion of natural greenery prompts this interaction; these features appeared in most of the collected data, such as (i) water, (ii) trees, and (iii) animals, especially birds.

Respect for and co-existence with nature were more widely documented when the mass of nature was relatively large, such as a jungle or giant old tree, or when nature had other contributions to functional use. For example, the retaining wall and the banyan tree co-existed as the wall provided a vertical surface for the tree roots, while the tree roots stretched into the soil deeply to stabilize the wall, slope or platform behind.

| (D)H-7 | | Participant's description: *Banyan trees are planted on walls to provide natural shade for humans without using extra land.* | (D)N-27 | | Participant's description: *The stone wall protects the Banyan Trees from foaling or landslides.* |
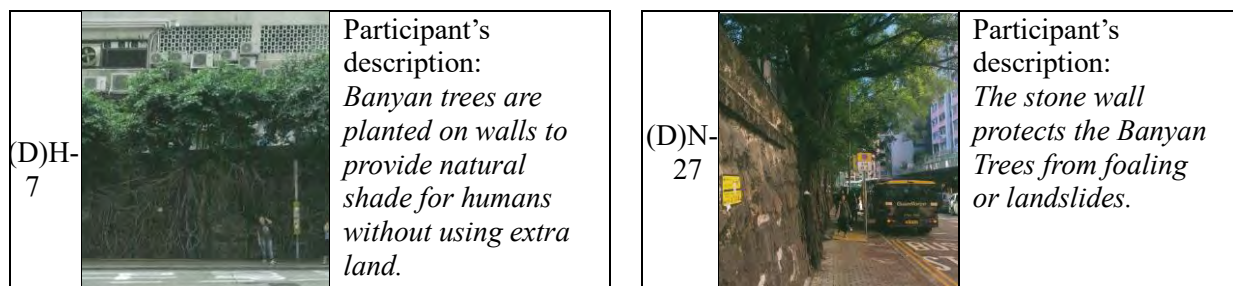
Fig. 6.21 – Co-existence with nature – participants' photos and narratives

On the other hand, 48% of the photos captured as designed for nature were multifunctional, took both humans and nature into consideration, and demonstrated a high level of ecological and biotic responsibility. The sense of ecological responsibility was usually shown through (i) maintaining and respecting natural growth, (ii) providing habitats, and (iii) guiding and controlling natural growth.

Architecturally and from a design point of view, respect for nature was usually shown through:
(i)   Site planning – allocating the built environment responsibly to the existing ecosystems;
(ii)   Building structures – avoiding from or guiding the growth of greeneries;
(iii)   Building service systems – boosting and regulating the growth of greeneries; and

(iv)   Communal green spaces – facilitating multiple functions for both humans and nature.

In view of the non-anthropocentrism, the findings of this photo-elicitation survey, together with the previous photo-elicitation surveys in Chapter 5, coincidentally indicate the participants' attention to respect for and co-existence with nature. Urban dwellers have appreciated nature's intrinsic value by noticing conflict with nature and the ecosystems due to urban development and human activity. To further understand nature-centric design, case studies on the current design practice on ecologically responsible design in local urban contexts will be carried out and elaborated in Section 7.3.

6.4.2   Perception vs Experience

There are three ways of interpretation in categorisation. "Perceived" refers to passive interaction or visual connection with a space; "experienced" refers to active interaction or engagement; and "complementary" refers to a combination of observation and interaction. This evaluation aims to analyse what kinds of activities are in relation to human-nature interactions.

"Perceived"	(D)H-27		Participant's description: *The green space is used to diffuse the density of transportation systems.*
"Experienced"	(D)H-36		Participant's description: *A little farmland is designed for residents to enjoy the process of growing food on their own, from sowing to harvesting, as there are much elderly living in this housing estate who may want to reminisce about the good old days and spend time leisurely.*

Fig. 6.22 – "Perceived" vs "Experienced" – participants' photos and narratives

The following classifications were considered to examine the relation of the activities to the existence of nature:

(i)   Active - having a direct performative contribution to the interaction with nature;

(ii)   Passive - having an indirect contribution to the significance of nature in the space;

(iii) Absent: having no clear relation between the activity and the ecosystems, other than humans, of the space; and

(iv) Varied: a combination of active and passive contribution.

Design for Human

Experiencing nature was mostly linked with leisure activities, especially active and motion-related programs such as physical exercises in green spaces. Nature was perceived in 23% of the collected data; in 35%, it was experienced; and in the rest, human-nature interaction was realized through a combination of observation and interaction. Narratives regarding thermal comfort were frequently found in experiencing nature.

Design for Nature

When it came to designing for nature, these interactions had less importance on experiencing nature and even being absent from humans, such as inaccessible roofs to be bio-diverse landscapes for birds and butterflies. It relates to space use and will be further elaborated on in the next section. Meanwhile, for those photos of lush vegetation and permeable building forms for mitigating urban microclimate, thermally comfortable experiences would be anticipated.

Implications

Human-nature connections were mainly promoted through active programs, such as physical exercises and walking. Leisure-related interactions are the most closely associated with nature and are the activities during which people develop profound physiological, psychological and environmental connections with nature.

As a result, more outdoor activities in nature-perceived settings shall be encouraged. It has two implications for the design of urban settings. First, indoor activities can be carried out outdoors, enhancing the chances of experiencing nature (i.e., green, sunlight and air) for health and wellness benefits. Second, specific features or amenities in the nature-perceived space can facilitate active interactions and multi-sensory experiences with nature.

		Participant's description: *This non-typical fountain not only favours the flowing of water but also incorporates walkways and benches that allow humans to engage with water; this is an exceptional cooling space in the summertime.*			Participant's description: *The grassland in Tamar Park creates a green oasis among the soaring buildings in the central district, opening up to the sea. The expansive open space helps the sea breeze permeate through summer, generating natural ventilation and regulating the surrounding microclimate. The greeneries also improve surrounding air quality. In addition, the lawn is friendly to both humans and animals.*
(D)H-23			(D)N-59		

Fig. 6.23 – Leisure-related interactions – participants' photos and narratives

To further understand leisure-related interactions with nature in urban green spaces, an experimental project, "Mobile Art Cart in Urban Green Space", was proposed to engage the public of all ages at the outdoor green space in Tamar Park, as elaborated in Section 7.4.

6.4.3   Purposed vs Undesignated

Purposed space vs undesignated space can offer insight into the interpretations of human vs nature design principles. In this location evaluation, four main categorisations comprised (i) "purposed space" - designed to contain nature; (ii) "partially purposed, partially undesignated space" - a space with multiple uses, to contain nature and also other functions; (iii) "undesignated space" - a space that was not designed for nature and was harmless to nature; and "undesirable space"- a space that was not designed for nature and was harmful to nature. This evaluation aims to analyse what kinds of spaces or urban settings people associate with nature.
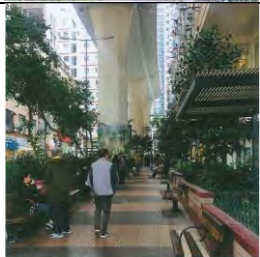
"Purposed Space"	(D)H-20		Location: *Park* Participant's description: *Human-made pathways being incorporated into the natural landscape, ideal for jogging and other recreational activities*
"Partially Purposed & Partially Undesignated Space"	(D)H-31		Location: *Under the flyover* Participant's description: *This picture depicts how nature plays an important role in bringing people together in a social setting, providing them with a public space away from the hustle and bustle of the urban context.*
"Undesignated Space"	(D)H-39		Location: *Retaining Wall* Participant's description: *Retaining wall to protect residents from landslide danger. The vegetation creates great scenery and desirable living condition.*
"Undesirable Space"	(D)H-5		Location: *Roadside* Participant's description: *This is a planting pit to put trees for street decoration. Furthermore, the plants cannot grow as they want as the pit is limited.*

Fig. 6.24 – "Design for Human" – participants' photos and narratives

Design for Human

According to the participants' interpretations, though 63% of the collected data considered nature when deciding the location, dealing with nature varied. Regarding the locations that promoted interactions, 47% were recreational and 33% functional. Parks, passageways, public spaces, and courtyards were common locations that allowed human-nature interactions. Some purposed spaces, comprising 12% of the total, had adverse effects on nature. There were 68% of the data referred to outdoor spaces, 17% to semi-outdoor spaces, and 15% to indoor spaces. In addition, 48% were meant to connect with nature, while 57% were concerned with the humans' visual, thermal, or psychological comfort.

Design for Nature

63% of the collected data referred to spaces purposed to contain nature, while 2% undesirable spaces for nature. 62% of the data referred to outdoor spaces, 30% to semi-outdoor spaces, and

6% to interior spaces. Facades and infrastructure were found to have the most frequent interactions with nature. Recreational spaces comprised 23% of the collected data. The data generally showed less concern for the comfort of the space and more concern, at 63%, for natural growth through maintaining, boosting, or controlling greeneries.

"Purposed Space"	(D)N-56		Location: *Green space adjacent to a building* Participant's description: *Biodiversity is promoted in urban green spaces without causing nuisances to urban dwellers. It regulates the human-nature relationship by providing a comfortable barrier between the two.*
"Partially Purposed & Partially Undesignated Space"	(D)N-24		Location: *Roof* Participant's description: *The green roof provides a rainwater buffer, purifies the air, reduces the ambient temperature, saves energy and encourages biodiversity in the city. It reduces the heat flux through the roof, and less energy for cooling or heating can translate into fewer greenhouse gas emissions.*
"Undesignated Space"	(D)N-18		Location: *Old warehouse* Participant's description: *The old warehouse frame supports the climbing plants, and there is one example of how human infrastructure can benefit nature.*
"Undesirable Space"	(D)N-7		Location: *Roadside* Participant's description: *The people cut and trim the barricades to avoid displacing the ancient trees.*

Fig. 6.25 – "Design for Nature" – participants' photos and narratives

Implications

Locations with specific spatial settings and architectural designs below boosted the interactions between humans and nature. For instance, courtyards served as the purposed spaces for appreciating nature and social interactions.

(i)   Space - spacious areas encouraged outdoor activities;

(ii)   Sky view - open outdoor spaces facilitated interactions with sunlight and air;

(iii)   Seating area - features facilitated staying in the space and contributing to visual, comfort-

related, direct and indirect interactions with nature; and

(iv)   Greenery and water features contributed to thermal and psychological comfort.

Regarding nature-centric design, human interactions or interventions with nature aim to offer wildlife natural growth and habitats. For instance, building structures and service systems could facilitate the growth of greeneries and existing ecosystems. Facades played a significant role in encouraging (i) a visual connection to nature, (ii) thermal comfort by nature, and (iii) active interaction with nature. Meanwhile, communal green spaces, including rooftops, sky gardens, podium gardens, balconies and passageways, were added to boost natural growth and encourage living landscapes.

| (D)H-40 | | Location: *Roof*
Participant's description:
The sky garden, which is relatively rarely seen in Hong Kong, provides a great open view towards the sea and a greenery space that allows people to get a break from research work and interact intimately with nature. | (D)N-57 | | Location: *Roof*
Participant's description:
The rooftop of the kindergarten, grown with plants, is a habitat for animals such as birds and butterflies, and at the same time, it helps improve air quality and sewage stormwater runoff. |

Fig. 6.26 – Green spaces at high levels – participants' photos and narratives

Furthermore, examples demonstrate how undesignated spaces were revitalized for interactions with nature. For inaccessible undesignated spaces, greenery acted as a scene for enhancing the material connection with nature. The greenery was of multi-dimensional growth, visual buffers, and possibly bio-diverse landscapes. The inaccessibility of the space might be in favour of urban wildlife as it reduces the chances of physical contact between humans and wildlife and associated conflicts. For accessible undesignated spaces, pocketed communal green spaces were potentially developed, especially for those spaces adjoining pedestrian paths or main circulations. Greenery and amenities, i.e., seating furniture, were means of intervention. Greenery served as a buffer against air pollution and noise nuisances and provided natural shades for human comfort. In addition, the existing green became a symbolic feature of collective memory or personal attachment to the place.

To further study how to utilize undesignated spaces, two experimental projects, "Community Urban Farm under Flyover" and "Organic Rooftop Farm", were carried out. These projects involved nature-based activities in transforming undesignated spaces under the flyover and on the building roof into active communal green spaces. The details will be elaborated on in Section 7.4.

6.5   Discussion on Biophilic Design in High-density High-rise Contexts

This section intends to discuss and investigate the similarities and differences of biophilic design in high-density, high-rise contexts. The findings of photo-elicitation surveys are adopted to substantiate the human-nature interactions based on biophilia.

As discussed in Section 2.2, biophilia is a concept that human interaction links with nature and other life. Biophilic design is a deliberate attempt to transform the understanding of human affinity into a connection with natural systems and processes in the design of the built environment.[288] The fourteen patterns of biophilic design, as discussed in Section 2.2, aim to close the gap between research and implementation to enhance cognitive functionality and performance effectively, psychological health and well-being of individuals and society.[289] The findings discussed in Chapters 5 and 6 further elaborate on these patterns of biophilic design in the city; furthermore, additional patterns of biophilic design are observed in high-density, high-rise contexts, as summarized in Fig. 6.27 and discussed in the following paragraphs.

Nature in the Space	Natural Analogues	Nature of the Space
(i) Visual Connection with Nature (ii) Non-Visual Connection with Nature (iii) Non-Rhythmic Sensory Stimuli (iv) Access to Thermal & Airflow Variability (v) Presence of Water (vi) Dynamic & Diffuse Light (vii) Connection with Natural Systems	(viii) Biomorphic Form & Patterns (ix) Material Connection with Nature (x) Complexity & Order	(xi) Prospect (xii) Refuge (xiii) Mystery (xiv) Risk / Peril
Additional Patterns **Nature in the Space:** (xv) Presence of Sky **Nature of the Space:** (xvi) Playfulness **Nature in the Activities:** (xvii) Social Gathering (xviii) Garden-based Activities		

Fig. 6.27 – Possible patterns of biophilic design in high-density high-rise contexts

The hypothetical model of human-nature interactions "SOA" model in Fig. 5.42 is referred to. It is used as the framework for discussion on patterns of biophilic design in this section.

Spaces / Scenes

Nature is a scene – Prospect

Prospect is a place with an unobstructed view over a distance that resembles the endless sea and sky in high-density, high-rise contexts. For instance, the sea view or cityscape created a distant prospect, where it provided a sense of attentiveness and comfort through the feeling of spaciousness and freedom.

Prospect			
(A) 9-35	(A) 20-4	(A) 21-7	(B) 69
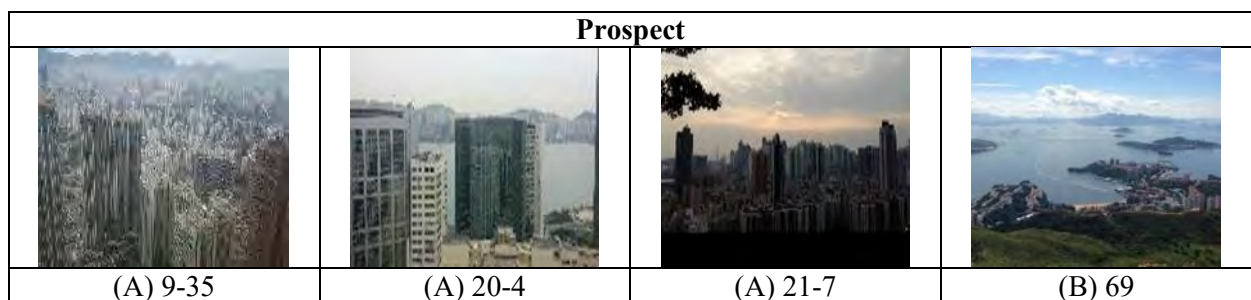
Fig. 6.28 – Prospect

Nature is a scene - Refuge

Refuge is a place with natural elements where people can mentally or physically hide or escape from unfavourable situations, including weather conditions. Pocketed green spaces and courtyards created a place of withdrawal for people to escape the city's hustle and bustle, as illustrated below.

Refuge			
(A) 12-3	(D) H-17	(A) 9-25	(D) N-13
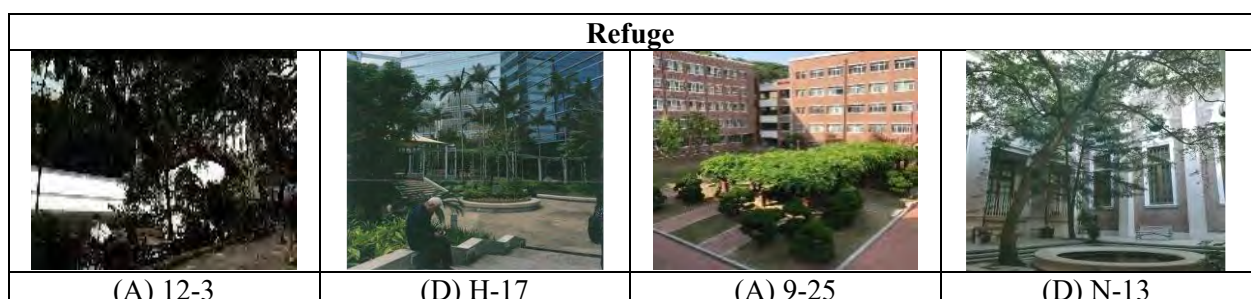
Fig. 6.29 – Refuge

Nature is a scene - Mystery

Mystery is a place that has unforeseeable elements or events within a space. For instance, the peek-

a-boo window into nature encouraged passers-by to explore and see what was behind the wall; it created a sense of mystery. Likewise, the green slope behind the city building created a sense of secrecy.
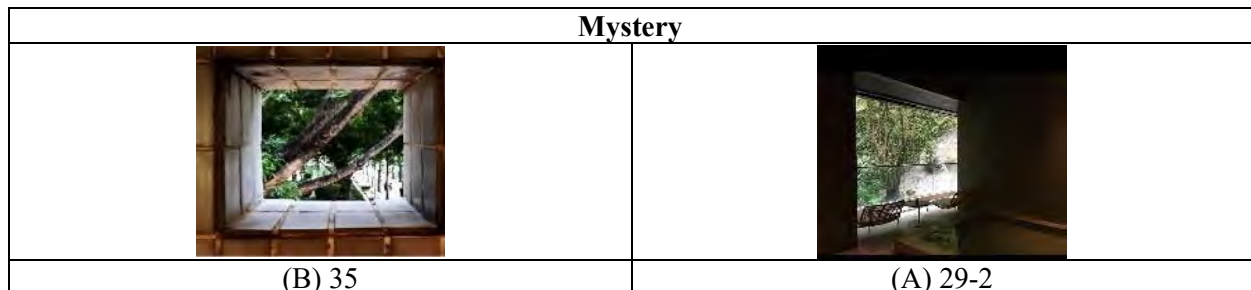
Mystery	
(B) 35	(A) 29-2

Fig. 6.30 – Mystery

Nature is a scene - Playfulness

Nature as a playground, as informed by the findings of the photo-elicitation survey, especially for children's responses. Playfulness is a space that encourages people to play and interact with nature through touching, looking, smelling, feeling, and learning in a green environment. For instance, children enjoyed playing in the outdoor areas, where they preferred to play in gardens, parks and playgrounds with greenery, having joyful memories and building positive emotions with nature. Physical activities in outdoor areas and exposure to the natural environment could enhance children's attention and reduce stress.[290]

Playfulness				
(B) 9	(C) 1	(C) 3	(C) 5	(C) 7

Fig. 6.31 – Playfulness

Nature is fighting with human intervention - Risk / Peril

Risk is a place or activity that presents potential risks with nature elements but is secured by human interventions. For example, there are risks of trees growing on the retaining walls since trees might collapse and injure pedestrians. Meanwhile, these trees became the community's collective memories of the places.
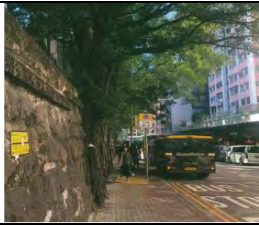
Risk / Peril		
(A) 29-3	(B) 32	(D) N-27

Fig. 6.32 – Risk and peril

Nature disappears, and artificial resemblance remains - Biomorphic Form & Patterns

Biomorphic forms and patterns are artificial forms and patterns that resemble existing textures, patterns and geometrical arrangements found in nature. For instance, the pillars of the building mimicked trees. Profiled building facades with lush vegetation resembled a tree-like biomorphic form. However, these nature-mimicked forms and patterns are rarely found. It may be explained that high-rises emphasize functionality and efficiency, neglecting nature-inspired expressions.

Biomorphic Forms & Patterns	
(D)N-35	(B) 97

Fig. 6.33 – Biomorphic forms & patterns

Nature disappears, and artificial resemblance remains - Complexity & Order

Complexity and order are rich sensory information that mimics spatial distribution and hierarchy in nature. For instance, the skylight design, flooring patterns and window features created visual complexity and order, as illustrated below.

Complexity & Order		
(A) 11-3	(A) 28-1	(B) 33

Fig. 6.34 – Complexity and order

Objects / Elements

Air – Access to Thermal & Airflow Variability

Thermal and airflow variability connects people with changing temperature, humidity and airflow to imitate different environmental conditions. Urban microclimate design is adopted in high-density, high-rise contexts to improve outdoor thermal comfort and mitigate the urban heat island effects.[291]

Access to Thermal & Airflow Variability		
(A) 4-1	(B) 103	(D) H-21
(A) 22-2	(D)N-35	(D)N-59
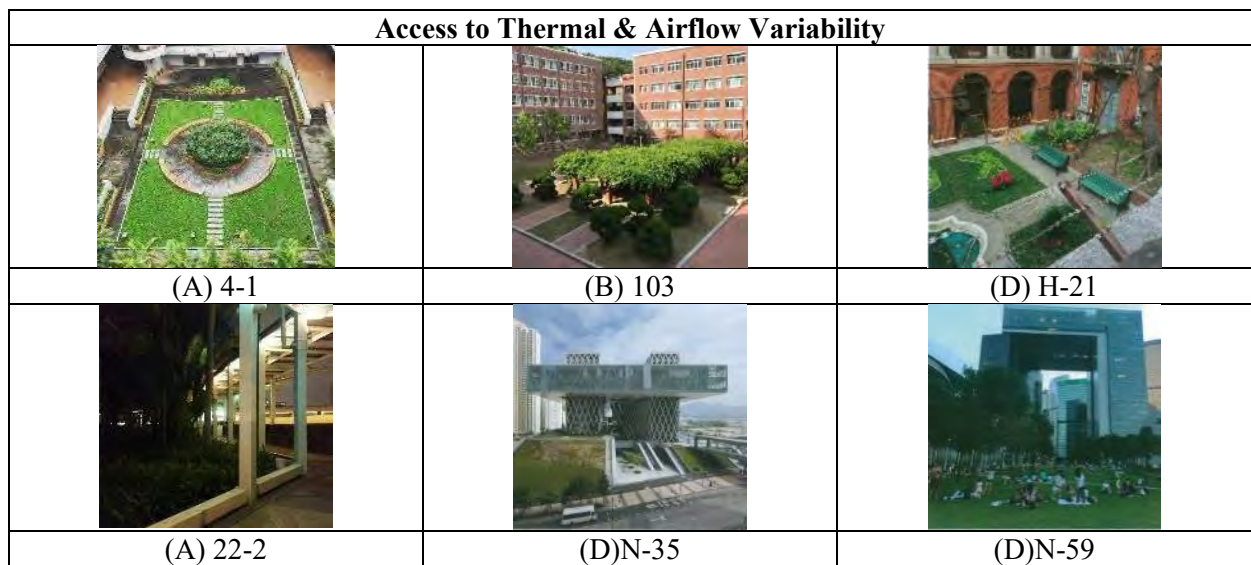
Fig. 6.35 – Access to thermal and airflow variability

Light - Dynamic & Diffuse Light

Dynamic and diffuse light create a distinctive intensity of light and shadow that constantly changes naturally or artificially to imitate nature. For instance, the space allowed natural daylight to penetrate at variable levels of diffusion through the hollow ceiling with semi-transparent material. Sunlight created ever-changing light and shadow on the ground. Besides, artificial light in the space was used to set a mood, creating a romantic and relaxing atmosphere.

Dynamic & Diffuse Light			
(A) 11-3	(D)H-37	(D) H-15	(A) 24-7
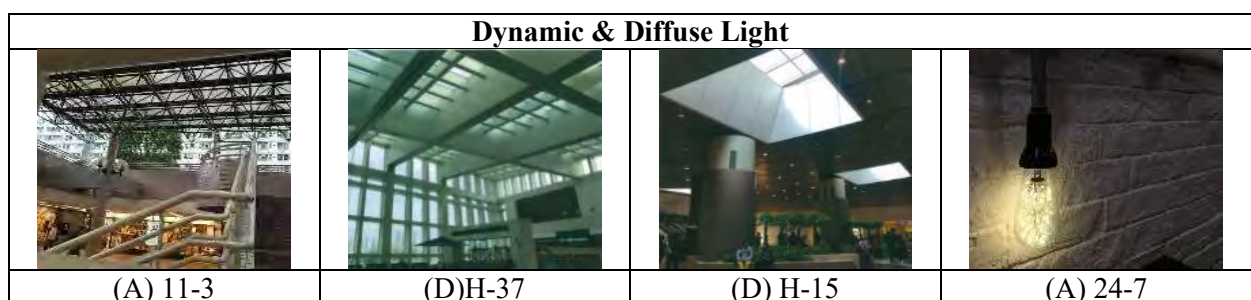
Fig. 6.36 – Dynamic and diffuse light

Water - Presence of Water

The presence of water connects people with water through different senses, including seeing, touching, hearing and smelling. For instance, the water feature wall and fountain mimicked the waterfall in the natural environment, creating a visually pleasing and relaxing atmosphere. Furthermore, rainwater harvesting on rooftops and greywater recycling systems were associated with nature for water conservation in urban living.[292]

Presence of Water				
(A) 13-10	(A) 9- 34	(D) H-14	(D) H-23	(D) N-14
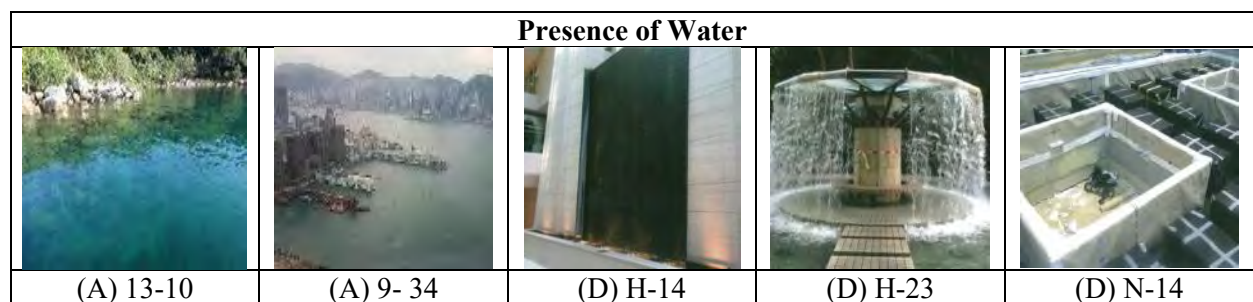
Fig. 6.37 – Presence of water

Greenery - Connection with Natural Systems

Connection with the natural systems presents the natural processes, including seasonal and temporal changes in the local environment and ecology. For instance, trees alongside roads, green walls as property fences and green rooftops were constructive connections with nature that allowed people to observe plant growth and seasonal changes. Besides, bio-diverse and brown roofs are designed for wildlife, enhancing biodiversity in the proximity of the living environment.

Connection with Natural Systems		
(A) 9-20	(A) 15- 4	(A) 20-7
(D)H-48	(D)N-48	(D)N-57
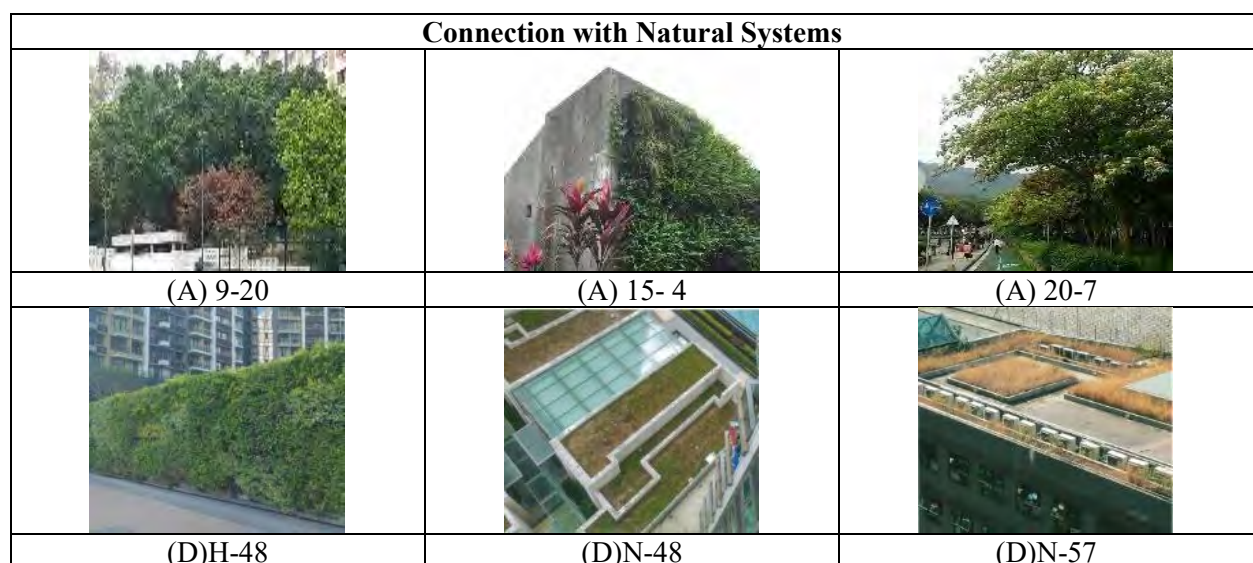
Fig. 6.38 – Connection with natural systems

Greenery and natural materials - Materials Connection with Nature

A material connection with nature is natural material or element replicating the local environment through minimal human intervention or natural occurrence to create a natural sense of place. For instance, the photos captured pavement with pebbles, trees on walls, grass through the ground, and plants on pillars of bridges.

Material Connection with Nature			
(A) 15- 6	(A) 19-4	(A) 27-1	(B) 48
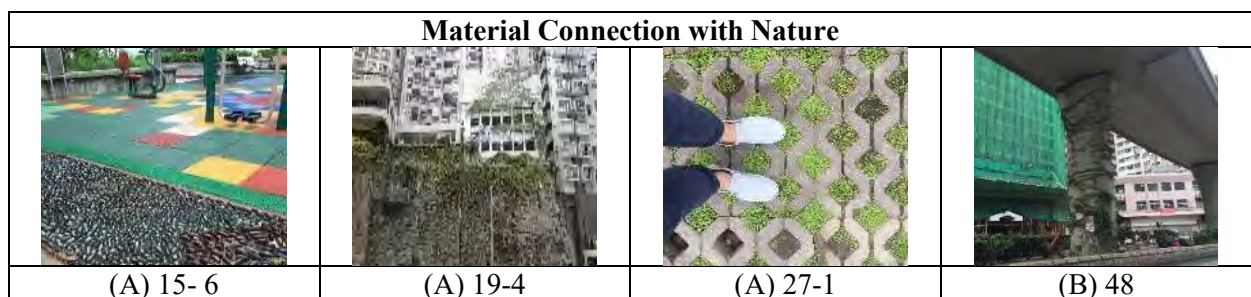
Fig. 6.39 – Material connection with nature

Sky - Presence of Sky

The findings of the photo-elicitation surveys have informed us that the sky is the key substance in association with nature. The presence of the sky is a condition that improves one's experience of a place by looking at the sky. This presence is significant in a compact, high-rise city. The participant narrated that *"the sky in between the gap of buildings is the most accessible nature in the city."* Several photos and narratives highlighted that the sky became an essential element that provided people with a sense of connection with nature in this concrete jungle. In addition, the sky was shown as intriguing or calming, conveying a sense of time and weather.

Presence of Sky		
(A) 5- 1	(B) 17	(B) 39
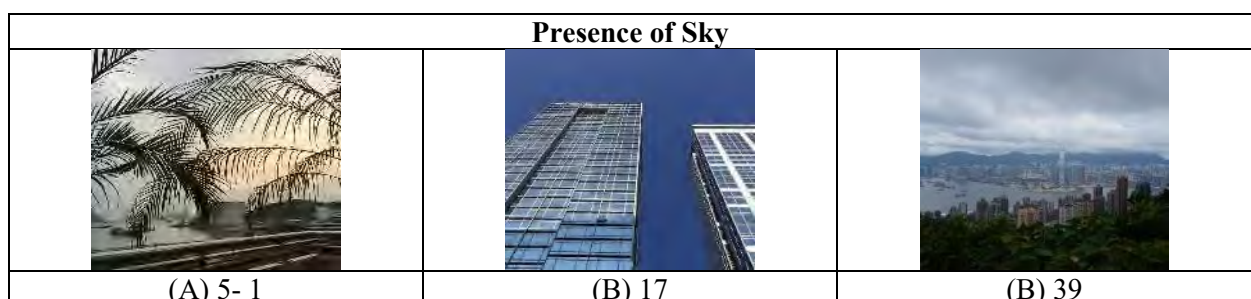
Fig. 6.40 – Presence of sky

Activities

Visual Connection with Nature

Visual connection with nature connects people by observing natural elements, processes and settings for positive psychological and physiological effects. The nature associated by the participants mainly referred to greenery and sky. The greenery ranged from small potted plants to heavily vegetated mountains. Participants' thoughts of connecting to nature were through visual enjoyment, memorising and viewing.

Visual Connection with Nature		
(A) 2-1	(A) 2-7	(A) 3-5
(A) 7-3	(A) 2-6	(A) 8-4
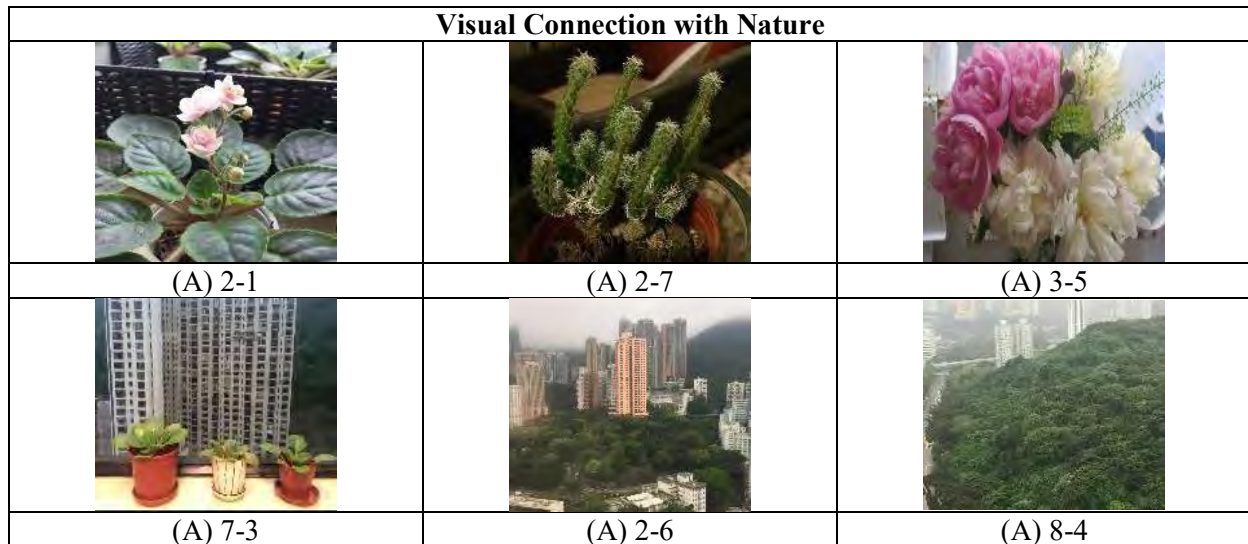
Fig. 6.41 – Visual connection with nature

Non-Visual Connection with Nature

Non-visual connection with nature connects people with nature through sensory contacts apart from sight, which includes touching, hearing, smelling, and tasting natural products, scents, and processes. The participants indicated connections with nature through the auditory, olfactory, haptic and gustatory systems. For instance, rain and waterfall created refreshing nature sounds. Some photos showed interactions with animals through haptic sensory for calming, enjoyment, and joyfulness.

Non-Visual Connection with Nature			
(B) 36	(A) 6-3	(A)24-6	(A) 21-2
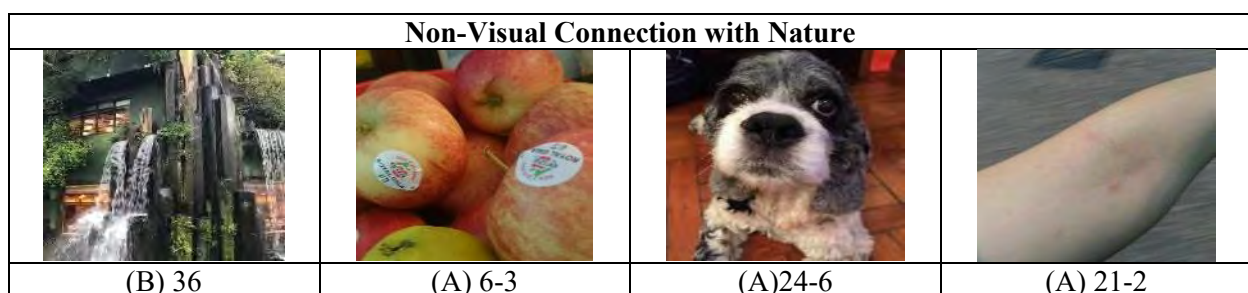
Fig. 6.42 – Non-visual connection with nature

Non-Rhythmic Sensory Stimuli

Non-rhythmic sensory stimuli connect people with nature through different senses, such as seeing, listening, and feeling on the skin, which is unpredictable and happens over time without rhythm. Some photos expressed ephemeral experiences of birds chipping, swaying trees and moving water, which were distractions for brief mental and eye muscle breaks.
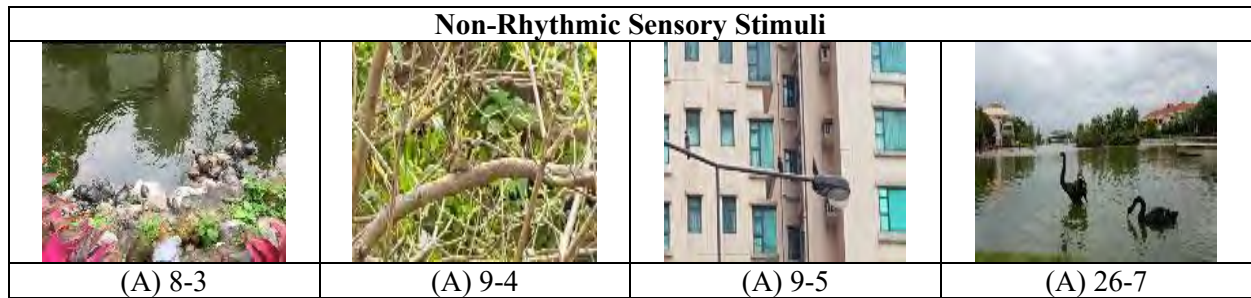
Fig. 6.43 – Non-rhythmic sensory stimuli related to animals

Ever-changing weather and natural growth were examples of non-rhythmic sensory stimuli. For instance, when it was raining, the participants enjoyed staying indoors, watching raindrops hit on glasses, and listening to windy sounds. Some photos showed the participants enjoying looking at sunset and sunrise with beautiful scenery created by the reflection of sunlight at a particular time.
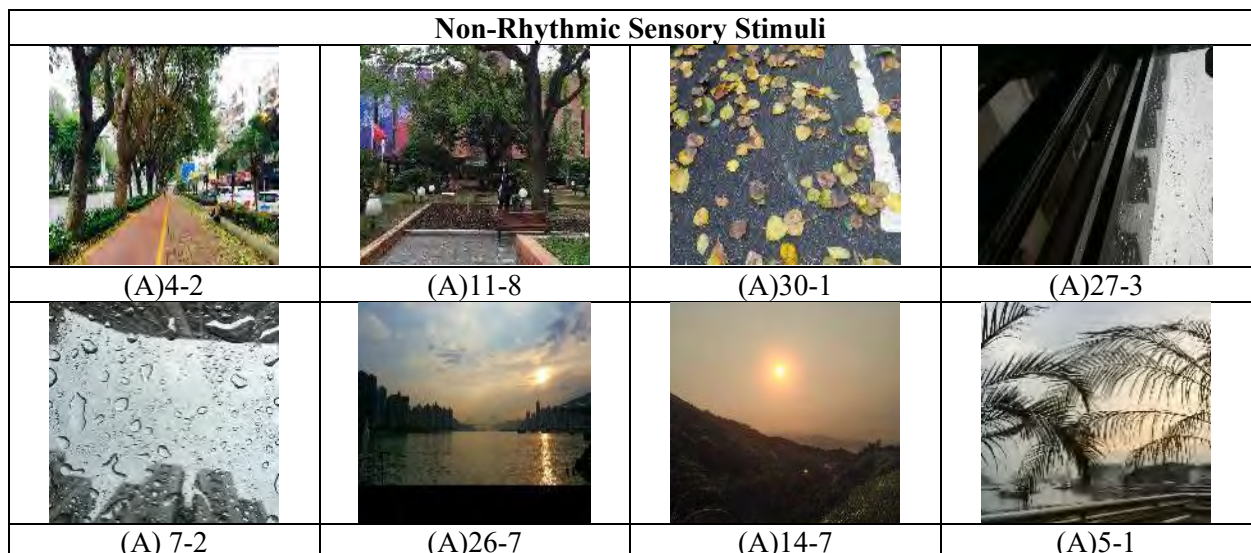
Fig. 6.44 – Non-rhythmic sensory stimuli related to ever-changing weather and natural growth

Social Gathering

Nature, though a social perspective, is a place with people can socialize with friends and families. This perspective is much more important in urban contexts, as discussed in the literature review.

Social gathering is an activity in which people gather to chat, exercise, play or hang out in a green space. The survey findings indicated that urban dwellers preferred to chat, hang out and exercise at a place with greenery. In addition, the photos showed elderly gatherings at the park where older adults breathed in the fresh air and enjoyed the breeze, sunlight and greenery with their companions.

Social Gathering		
(B) 60	(C) 1	(C) 3

Fig. 6.45 – Social gathering in green spaces

Garden-based Activities

As discussed in the literature review and the photo-elicitation surveys, garden-based activities have positive impacts on psychological, physiological, social and ecological aspects. Garden-based activities include gardening and activities of recreation, leisure or environmental education in green spaces. Community farming is also advocated through a social perspective, which is not for commercial agricultural production or livelihood subsistence.[293] Community farming and gardening allow citizens to learn to be respectful and responsible to nature and bring joy and relaxation to urban residents, particularly older adults.[294] For instance, rooftop farming and gardening are sustainable and cost-effective ways that allow people to connect with nature.[295]

Community Farming			
(B) 7	(B) 51	(B) 66	(D)H-42

Fig. 6.46 – Garden-based Activities

6.6 Conclusion

This photo-elicitation survey searches for human-nature interactions to benefit humans and nature. This research study examines the relationship between architectural design and urban settings to human-nature interactions. Key findings are summarized in Fig. 6.47.

Design for Human	Psychological / physiological aspect	・Desirable sensory experience ・Relieve and restorative experience
	Environmental aspect	・Improving thermal comfort
	Social aspect	・Enhancing social interactions
Design for Human with Nature	Aware of intervening against nature	・Limiting the growth of plants ・Endangering animals' living ・Depriving interaction with nature ・Creating pollution and nuisances
	Ecologically responsible	・Respect for co-existence with nature ・Conservation, preservation and protection of nature
Design for Nature	Regenerative – beneficial to the ecosystems	・Creating habitat for plants and animals in urban space ・Planting at multi-levels or multi-dimensions (e.g., wall, roof) with the assistance of building structures or features (e.g., fence, wire, planter) ・Building services design or landscape design (e.g., rainwater collection, irrigation system) to facilitate ecosystems ・Utilizing underused urban spaces or existing infrastructure for greeneries

Fig. 6.47 – Interpretations of "Design for Human" vs "Design for Nature"

The findings reveal that human-centric design for interaction with nature is more emphasized on the individual level. People pay more attention to desirable sensory experiences, relief and restorative experiences and improving thermal comfort. Enhancing social interactions is mentioned and associated with the community or neighbourhood level.

Echoing the findings of other photo-elicitation surveys discussed in the previous chapter, people are aware of humans intervening against nature in urban development. Limiting the growth of plants, endangering wildlife, depriving interactions with nature and creating pollution and nuisances to the ecosystems are aspects of concern. Thus, it supports the significance of environmental ethics and nature-centric design approaches, embodying the concept of "Design for Humans with Nature".

Green is a practical starting point to introduce nature into the urban built environment and the idea of "Design for Nature". The findings reveal that the research participants were able to find or associate with different ways of contributing to the growth or co-existence of nature in urban contexts, for instance, creating habitat for plants and animals in urban space, utilizing undesignated urban spaces or infrastructure for greeneries, planting in multi-dimensions and building services or landscape design to facilitate ecosystems.

The possible patterns of biophilic design are co-related to the hypothetical SOA model, as summarized in Fig. 6.48. Nature-perceived settings include non-rhythmic sensory stimuli scenes, spaces with biomorphic form and patterns, spaces with the natural analogue of complexity and order, and spaces of prospect, refuge, mystery, risk or peril and playfulness. Urban-nature elements comprise air, light, water, sky, natural systems and materials connected with nature. Nature-based activities include viewing nature, non-visual experiences with nature, social gatherings and community gardening.

- Non-Rhythmic Sensory Stimuli
- Biomorphic Form & Patterns
- Complexity & Order
- Prospect
- Refuge
- Mystery
- Risk / Peril
- Playfulness

Spaces / Scenes
Nature-perceived settings

Objects / Elements
Urban-nature elements

Activities
Nature-based activities

- Access to Thermal & Airflow Variability
- Dynamic & Diffuse Light
- Presence of Water
- Connection with Natural Systems
- Materials Connection with Nature
- Presence of Sky

- Visual Connection with Nature
- Non-Visual Connection with Nature
- Social Gathering
- Garden-based Activities

Fig. 6.48 – Possible patterns of biophilic design in the high-density high-rise contexts

Observations of the participants' photos matching the biophilic design patterns have implied urban dwellers' affinity into connections with natural substances, settings and processes. Furthermore,

additional patterns of biophilic design are observed in high-density, high-rise contexts. As mentioned earlier, the findings and observations have established the directions to develop design strategies for human-nature interactions.

Chapter 7: Strategies for Human-Nature Interactions

7.1   Introduction

Human-nature interactions are demonstrated to be advocated in three layers: designing for humans, humans with nature, and nature. As previously explored, interpretations of designing for human versus designing for nature is not so clear. There is an obvious overlap where an in-between anthropocentric and non-anthropocentric views are offered. This chapter will carry out case studies of strategies for human-nature interactions and discuss nature-centric design for urban contexts.

7.2   Case Studies – Co-existence with Nature

In spite of the aforementioned conflicts with nature, this section discusses various case studies on co-existence with nature in urban contexts. Human-nature interactions, in turn, exhibit qualities of working with one another, developing programmes, infrastructure and design.

Bees

Bees play a vital role in maintaining the ecosystem. Bees collect pollen and nectar as food. When they move between plants, they can help plants pollinate. Several groups of people work hard to maintain the ecosystem with bees. Apart from working as beekeepers and producing by-products of honey, they also host workshops and seminars to spread the word to the public and the next generations. For instance, HK Honey, an organisation located at a rooftop garden in Ngau Tau Kok, runs a bee farm.[296] Working as a beekeeper, they often host workshops on different honey by-products like candles and cakes. In addition, they occasionally host tours to harvest honey from wild bees, sharing this niche profession with the public.[297]

Fig. 7.1 – Bee hives in the park, Fanling, Hong Kong

With a bee farm on Lamma Island, Lammabee organizes the Bees Family Adoption Program, to

which participants contribute a fixed donation annually for creating a bee-friendly environment and setting up an education centre on ecological sustainability.[298]

Besides producing honey, ForME HONEY is an organization to host nature walks, experiential workshops and lectures. Based in rural areas of the city, ForME HONEY brings participants opportunities for close observation and personal experience on bees' ecosystem, spreading knowledge and raising awareness on the importance of bees in nature.[299]

COME BACK toME is an organization from Taiwan that encourages every household to plant flowers on the balcony and build a small shelter for bees, protecting these pollinators from their predators. It could also maintain the biodiversity of both bees and plants for a higher successful rate of pollination.[300]

Birds

Each year, over 100 million birds die from hitting glass windows.[301] Such a consequence of ecological imbalance becomes a major concern. While the government and some developers become aware of such issues, different organizations are formed to monitor and protect the birds. Reflective or transparent glass facades are unintentionally killing birds. By reflecting the surrounding foliage or the sky, they become death traps for birds that collide with them. Likewise, poorly designed semi-open courtyards and glass atriums that intend to aid natural ventilation and lighting could be a bird trap as well. Many foreign countries enforce regulations and guidelines to tackle these problems. An example included bird-friendly building and design guidelines initiated by the American Bird Conservancy in 2011.[302]

"Neighbirdhood", a local non-government organization, organizes bird-watching tours in urban districts, educates the public to cherish their surroundings and ecology, and builds a sense of belonging with the community.[303] The unique bird ecology downtown is presented.

Cammack et al. (2011) revealed that despite some people listing environmental concerns for their participation, the majority seemed to be motivated to observe birds in more significant quantities and diversity.[304] This relationship is similar, in a way, to an "unspoken contract", where the residents provide food for the birds, and the birds allow themselves to be observed. This disputes the previous assumptions that nature is exploited by humans, as in this situation, humans conform

to the "terms and conditions" of the birds that feed. Ferreira (1998) indicated that the provision of relevant information is "critical to equip people with the knowledge needed to make sound decisions and develop a sense of awareness".[305]

Fig. 7.2 – Bird watching and education programme in urban districts, Hong Kong

Furthermore, the following case studies explore the current design practice of nature-centric design in a compact high-rise city. These architectural projects have demonstrated various ecologically responsible design approaches. The selection of case studies is based on the discussion on design for nature in the previous chapter, as shown in Fig. 7.3.

Design for Nature	Ecologically responsible	・Respect for co-existence with nature ・Conservation, preservation and protection of nature
	Regenerative – beneficial to the ecosystems	・Creating habitat for plants and animals in urban space ・Planting at multi-levels or multi-dimensions with the assistance of building structures or features ・Building services design or landscape design to facilitate ecosystems

Fig. 7.3 – Interpretation of "Design for Nature" as discussed in the previous chapter

Hong Kong Zero Carbon Park

Hong Kong's zero-carbon building and the first urban native woodland were about 2,000m^2, accounting for about 13% of the total area, and more than 220 native trees of more than 40 types were planted.[306] The design of the urban primary forest maintained the ecological balance itself, providing food and shelter for wild species and creating an urban ecosystem conducive to human life. At the same time, the composition of the urban forest imitated the natural environment

through the combination of different sizes and different types of tree species to achieve a dense shading effect.[307] Although the urban forest could not provide the ideal shading effect upon the project completion as it took time to grow, it had a good reference as a measure of nature-centric design.

This case study has demonstrated a dedicated species selection for biophilic green spaces, finding methods to diminish the human-nature gap. The design concept of the native woodland advocates biodiverse landscape design with native and non-invasive species and vegetation diversity to enhance biodiversity in urban contexts.

New Campus of the Hong Kong Institute of Technological Higher Education THEi

The new school building of the Hong Kong Institute of Higher Technology Education (THEi) created multi-level and bio-diverse green spaces. The design combined natural ventilation and other sustainable design measures, selected native and non-invasive species, and set different levels of communal green spaces and ecological corridors connected with surrounding ecological habitats in the building. At the same time, the design emphasized the nature of people being close to nature, forming a visual connection with the surrounding public green space through "skyscraper greening" and enhancing the contact between people and nature.[308] Furthermore, establishing contact with the natural and ecological environment and cultivating students' attitudes towards nature and ecological awareness was the design focus of this project.[309]

This case study has shown multi-level communal green spaces with a nature-centric landscape design regarding ecological corridors and nearby green spaces.

Fig. 7.4 – Zero Carbon Park, Kowloon Bay   Fig. 7.5 – THEi Campus, Chai Wan

The Chinese University of Hong Kong Library

First built in 1972, the university decided that an expansion for its library was needed in 2005. Before the extension began, the university consulted with an ecologist from June 2007 until October 2008 to research and study wildlife around the area. A conclusion was made that more than 150 birds' nests were situated on the roofs and eaves of the original building. Seven installations for the birds to "move homes" were situated south of the site to reside during the construction stages. The move included calculating birds' paths, wind direction and other environmental factors. After the construction in late 2012, the new extension was equipped with human-made birds' nests under the balconies and areas where the birds could reside. The reinstallation of the ecosystem happened right after completion.[310] Furthermore, the new extension included dotted patterns on exterior glazing panels. The dotted patterns aimed to signal birds from far to reduce any occurrence of a bird strike.[311]

This case study has depicted the practical means of preserving the existing bio-habitat in the redevelopment project. It has demonstrated a bird-friendly approach throughout the design, construction and operation stages.

Fig. 7.6 – Bird nests attached to the building

Fig. 7.7 – Dotted patterns for birds

Tai Po Green Hub (Revitalization of Tai Po's Old Police Station)

Tai Po old police station was first used in 1899. After 88 years of service, the police station was moved out, and the building was graded as a historic building and put forward for revitalization with adaptive use in 2010. The revitalization project started with identifying major ecosystems around the site. The ecologist noticed a large area of high biodiversity for birds residing. In order to encourage more birds to stay and reside, the project team removed existing waste and restored the plantation in that area.[312] Additionally, there was a space where a small vegetable patch as an organic farm was developed.[313] The farm aimed to provide vegetables and herbs for the restaurant located inside the building for vegetarian foods. Furthermore, it allowed the reduction of the carbon footprint of foods produced upon delivery. Besides, a hundred-year-old tree was conserved with extreme attention to materials and construction methods to be adopted, not jeopardising its health and sustainable growth in another hundred years.[314]

Fig. 7.8 – Ecosystems are conserved
in design and construction

Fig. 7.9 – Tai Po Green Hub

King George V School, Ho Man Tin

In a new school construction project, there was a banyan tree at the centre of the site. The architect decided to design with the Banyan Tree for conservation and to inspire the building's form and space. An amphitheatre made of the recycled wood patio was constructed to create a space for students to play and take lessons under the tree. The marble rock under the tree allowed water to filtrate down to the soil and the tree's roots; meanwhile, it prevented the students from treading on the roots.[315]

The above two case studies have demonstrated how the existing ecology became design merit for placemaking. The ecological assessment was carried out to understand the existing fauna and flora conditions and evaluate their impacts during construction and completion of future development. Rare and valuable species, i.e., old trees, must be identified with close attention. Appropriate preventive and mitigation measures have to be taken to minimise adverse impacts and irreversible damages to the existing nature. Restoration of plantations is also considered for the existing ecosystem. Indeed, these designs for the conservation and restoration of nature become feature spaces for students and visitors to appreciate nature for leisure and environmental education.

Fig. 7.10 – Banyan Tree shapes the building   Fig. 7.11 – King George V School, Ho Man Tin

7.3   Case Studies – Nature-based Activities in Communal Spaces

In addition to the co-existence with nature, urban naturalness positively influences urban dwellers in high-density urban contexts, which can be manifested under simple urban interventions and community programmes to promote human respect, interaction, and co-living with nature. These

programmes are forms of nature-based activities in communal spaces where the public can participate and cultivate further knowledge of the natural world. Case studies are listed below of such possible programmes and the limitations of each.

7.3.1   Urban Farming and Community Gardening

As discussed in the previous chapters, green is the most symbolic element of nature. Urban farming and community gardening are strategies for engaging urban dwellers to interact with nature.

In 2017, the Development Bureau of the Hong Kong government issued a technical circular to advocate community planting in government projects.

"All capital works contracts with an estimated value of planting and associated landscape works at or exceeding $10 million should allow for community planting near or after the completion of projects. Works departments may exercise discretion to allow community planting in projects or contracts with an estimated value of planting and associated landscape works less than $10 million if considered appropriate." Extracted from the Development Bureau Technical Circular (Works) No. 5/2017 Community Involvement in Planting Works.[316]

Furthermore, the Community Garden Programme launched by the government allows citizens to plant in communal areas and enjoy the entire process, from seeding to harvesting. All these happening at different types of developments in this dense city are just examples of encouraging the public to adopt greening activities as part of daily life.

Fig. 7.12 – LCSD community garden   Fig. 7.13 – Project GROW To Kwa Wan

Community Garden Programme

To encourage green activities in the community, the Leisure and Cultural Services Department (LCSD) implemented this programme to provide more opportunities for citizens to try out urban farming. Besides cultivating their gardens, participants could learn through their personal experience by witnessing the lifecycle of plants and understanding plants at a deeper level but not just recognizing them as an end product.

Project GROW To Kwa Wan (Industrial Building)

Located on the rooftop of a To Kwa Wan industrial building, Project Grow is a community-based urban farm initiative launched by the Film Culture Centre (HK) and design workshop.[317] The project promotes organic agricultural practices and the design of eco-friendly planting containers. More importantly, it encourages participation in green activities from the To Kwa Wan community.

As discussed in Sections 2.4, 2.5 & 2.6, humans have an ingrained relationship with plants. Some may see gardening as a hobby, but there are many voluntary activities hosted by individuals and organizations that aim to spread the importance of greenery and empower urban dwellers with the ability to cultivate their environment.

Apart from government-initiated projects, self-driven organisations challenge the notion of planting in communal spaces, such as guerrilla farming. In addition to growing and maintaining plants, these organizations empower citizens through education, which is crucial for developing urban gardening from a long-term perspective.

Fig. 7.14 – Self-driven gardening in a private housing estate

Fig. 7.15 – Self-initiated gardening in a public housing estate

Fig. 7.16 – Upcycled flower planter for shops

Fig. 7.17 – Guerrilla Planting in Sai Ying Pun

Pacific Palisade Food Waste Recycling & Organic Farming

The residents of Pacific Palisades, Braemer Hill, are passionate about promoting environmental protection by organising food waste recycling and organic farming, as shown in Fig. 7.14.[318,319] To encourage more neighbours to join, different engagement activities such as game stalls were organised to educate the others and encourage contribution to their community. Furthermore, the residents and property management staff worked together to set up a planting area and convert some existing planters for organic farming and community gardening at the podium garden.[320]

PermaTSW (Tin Shui Wai Self-initiated Community Action Program)

A group of Tin Shui Wai residents has requested Housing Authority permission to use planting areas in the public housing estate to plant herbs around the community, as shown in Fig. 7.15. Residents are invited to maintain the plants voluntarily.[321] This project thus encourages interactions among neighbours and a rethink of the community's needs and the usage of public space.

To Kwa Wan Wheel Thing Makers, Upcycled Flower Planter

Wheel Thing Makers noticed that the locals occupied their storefronts with many plants that occasionally invaded part of the street and hung pots on street railings. It led to the group's ideas of upcycling planters with locally scrap materials and then distributing them to the locals.[322] These planters are unique with local community characteristics, which also tackle shopfront extensions and encourage upcycling at the community level, as illustrated in Fig. 7.16.

Go Green SYP, Guerrilla Planting

"Go Green SYP", a local Sai Ying Pun group, reuses wastes such as plastic bottles and eggshells

to contain seedlings. Passers-by are invited to collect these seedlings and grow them elsewhere, as shown in Fig. 7.17.[323] Apart from promoting a green culture, it aims to improve community cohesion and encourage locals to be more aware of the existing community.

Therapeutic Horticulture

As discussed in Section 2.5, horticulture therapy is a therapeutic treatment by engaging people in gardening and plant-based activities facilitated by a trained therapist. It is suitable for all ages and even people with different illnesses, from children with mental illness to older adults with dementia. Furthermore, older adults spend more time with nature than other age groups. They often stroll in the park and rest under the tree shade. Therefore, horticultural activities are beneficial to them. They would feel empowered through the process, injecting positive energy into their lives. Appreciation of nature is also a way to slow down dementia. Older adults can involve in planting activities with a carefully chosen method and environment. Hence, inclusiveness design and universal accessibility are key considerations for planting facilities.

Fig. 7.18 – Accessible planting facilities

Fig. 7.19 – Serene Oasis for therapeutic horticulture

Serene Oasis

Based in Kwun Tong, Serene Oasis is a community farm offering horticulture therapy, which combines planting activities with social service.[324] The natural environment and the enjoyment of the planting process offer treatment for those with dementia and depression.

Accessible Planting Facilities

Urban Oasis, a community farm, aims to offer accessible planting facilities to those physically and mentally in need, such as keyhole-shaped farm lots and elevated planters, as shown in Fig. 7.18.[325]

Produce Green Foundation has set up community gardens for the elderly in various locations in Hong Kong, such as Tsuen Wan.[326] As a result, older adults can discover the fun of farming, enjoy nature and share farming knowledge with their friends and relatives. They can also understand that vegetables are essential for a healthy diet.

Meanwhile, urban farming is driven by commercial sectors on different operation modes, as summarized in Fig. 7.20.

Organization & Programme		Main Services
Rooftop Republic[327,328] Urban rooftop farming		• Farm design and installation • Rooftop and other customised designs • Edible green wall installation • Farm Management • Workshops, events and community programmes • Farm to School Programme
Wildroots Organic[329,330] Urban rooftop farming		• Farm set up • Farm management • Seedling supply • Educational Workshops • For schools, companies and organisations
K11 MUSEA[331] 3-month urban farming programme		• Rooftop rental service 1m x 1m farm plot for three months
Hysan Urban Farms[332] Urban rooftop farming		• Rooftop farm rental service • open to stakeholders of Hysan Place to grow plants and vegetables organically. Each session lasts for three months. • Organic farming workshops, Green Wonders (tour & workshop for parent & kids) tenants, staff and other members
Urban Oasis[333] Large scale recreational and community farm		• Urban farming rental service open to the public • Social, medical and rehabilitation services • Green recreational space • Environmental education space

City Farm[334] Urban rooftop farm		• Urban farming course • Urban rooftop space rental
Leisure Farm[335] Urban Rooftop Farm		• Urban farmland rental • Urban farming course

Fig. 7.20 – Commercially-driven urban farms in Hong Kong

The above farms allowed people and visitors to plant their produce for a short period under paid conditions. While these urban farms brought green space to dense cities, the biotic effects and impact of the nature of these urban rooftops were limited and primarily for human use and comfort. Almost none of the urban farming programmes and facilities had a nature-centric design for wildlife. Most urban rooftops are designed towards human needs in wellness and enjoyment.

The popularity of these urban farms and community gardens implies that these nature-based activities are well received by urban dwellers and can be implemented in different urban settings.

7.3.2   Urban Interventions for Human-Nature Interactions

Three experimental community engagement projects were conducted to understand human-nature interactions in urban contexts. These experimental projects were intended to explore opportunities for human-nature interactions in urban contexts by either bringing people to nature or bringing nature to humans.

Mobile Art Cart in Urban Green Space

This experimental project was to design and build a mobile art cart to facilitate a series of sculpture playground creative models doing and art creation workshops for the public of all ages at Tamar Park, Admiralty, from March 2018 to May 2018. A total of eight workshops were carried out on weekends. Each workshop was two hours and involved about twenty participants. The mobile art

cart revitalized nine dilapidated desks and an extended chalkboard, serving as a mobile art classroom to promote art and architecture. This cart was an initiative for an alternative take on learning.

Fig. 7.21 – Mobile art cart in urban green space

Outdoor learning cultivates connectedness with nature. This was found in the Kuo et al. (2018) study, which revealed the quantified improvement of outdoor learning. By conducting the same lesson in an indoor and natural outdoor environment, lessons greatly improved classroom engagement after lessons in nature than lessons in the traditional classroom.[336]

Being mobile, the cart allows for flexibility and movement in learning, enabling students to learn while surrounded by green spaces. A study using remote sensing and comparison of student test results showed the positive correlation between the greenness of a school surrounding and the performance on both English and math tests of students, even after the consideration of socio-economic factors and urban residency, providing evidence that green space in a learning environment can help with academic performance (Wu et al., 2014).[337] Another advantage of

outdoor learning is that it allows students to learn under sunlight, a biophilic element that helps improve the performance of students due to improved visibility due to better light quality, mental stimulation, and better moods and well-being, according to a study conducted by Heschong (2002).[338]

Fig. 7.22 – A mobile art classroom to promote art and architecture in urban green space

Evaluation

The success of the mobile art cart in facilitating human-nature interaction rests on its flexibility. With relatively low cost and effort, the cart allows organisers to easily host events in various locations in the city with different levels of connection with nature, ranging from amphitheatres, parks, lawns, or even harbourfront.

While the cart is mainly designed for hosting workshops outdoors, depending on the features of the location and the nature of the event, it can promote both active and passive interactions with nature. For instance, when parked at an amphitheatre for hosting public lectures, where the

greenery serves as a backdrop, the cart creates a pleasant setting for participants to appreciate nature as they listen to the lecture, which induces comparatively passive interaction between humans and nature. On the other hand, more active interactions with nature, such as planting, could be facilitated if the cart is parked on a lawn for a gardening workshop.

Nevertheless, the flexible and versatile cart has one shortcoming. As the cart is not specifically designed for any location or audience, and the level of connection between participants and nature depends heavily on the event and the location, it could be quite difficult for the participants to develop a sense of belonging with the cart and associate it with nature during the short workshop session. Therefore, a modification of the cart might be needed to foster a deeper level of human-nature connection.

Community Urban Farm under Flyover

Fig. 7.23 – An undesignated space under a flyover in the central business area

There was an undesignated space under a flyover adjacent to busy traffic roads in the central business area. The pedestrian flow was low, and smokers working in the adjoining buildings gathered there. The public engagement project involved architects, farmers, office workers, students and the public to co-create and transform an under-flyover space into an improvised community green education hub and urban farm with a container shed and upcycling discarded wood pallets. An improvised urban farm was established for the community to explore and experience the life cycle of plants from December 2017 to March 2018. Urban farm was

constructed with upcycling wood pallets arranged in various height levels to engage a broader range of social groups, such as families, office workers and older adults, and encourage public gathering and contribution, as shown in Fig. 7.24 and Fig. 7.25.

Within the 4-month demonstration period, three batches of vegetables were harvested by over 200 participants, and over fifteen workshops and tours were conducted. Workshops were co-organized by farmers and architects to teach farming and gardening techniques and share pro-environmental attitudes and knowledge. In addition, participants offered hands-on experiences in planting their green on-site. Almost half of the participants were office workers who worked in the adjoining office building. They are excited and devoted to the planting programme. They visited their plants several times daily and enjoyed harvesting and sharing planting experiences with their companions. As a result, this undesignated space under the flyover suddenly turned into a community hub, and neighbours found a sense of belongingness to the place.

Another observation was that participants were eager to acquire knowledge of gardening. They asked questions about their plants at home and gardening on balconies in their apartments. They were also interested in the process of organic farming and information about organic vegetables. On the other hand, the farmers enjoyed sharing knowledge and experience and expressed gratitude that the project connected urban dwellers to nature and caring for healthy vegetation. The farmers usually stayed and worked on farms in the new territories. This project offered them a new experience to share and farm in the urban area, especially this leftover space under the footbridge in the central business area, inspiring them with a new insight into urban farming.

Fig. 7.24 – An improvised urban farm for the community to experience organic farming

Fig. 7.25 – A social gathering hub for neighbouring office workers, especially at lunchtimes

Participants developed a sense of appreciation for nature throughout the period as they learnt about how greens are grown in various climates and urban contexts. Farm-to-table experience of Indian and Romaine lettuce introduced the entire life cycle of vegetables to enhance the public's environmental attitudes and ecological behaviours. They realised and experienced how greens could involve in their daily urban life. A sense of attachment was built when the public was fostered to gather and socialize along with their duty to maintain the urban farm.

Evaluation

Despite the undesirable conditions of the flyover – air pollution, low pedestrian flow, and noise from nearby busy traffic, with the gardening and farming workshops, the improvised community farm has successfully improved the participants' knowledge and attitude towards nature and green living and simultaneously encouraged behavioural changes.

First, during the workshops, farmers and architects promoted practical farming and gardening knowledge among the general public and raised participants' awareness of green living in the city. This instilled a pro-environment attitude into the participants and encouraged them to adopt a green lifestyle. Besides, the emphasis on co-creation and hands-on urban farming experiences has allowed the participants to interact with nature while actively fostering community-building. As the participants developed a sense of ownership and belonging to the site and activity, they began visiting the once-avoided site more frequently and enthusiastically, gradually incorporating nature into their daily life. The sense of accomplishment during harvesting also reinforced the positive experience of human-nature interaction, motivating the participants to become more connected with nature outside of the workshops. As the site became more welcoming, it also became a 'green refuge' for the general public.

In conclusion, the success of the improvised community garden has showcased that even at an unwelcoming site, the right kind of activities that offers active interaction with nature drives knowledge, attitude and behavioural changes, as well as the development of a sense of belonging, ownership and accomplishment, it is possible to facilitate human-nature interactions and outdoor activities in the concrete jungle.

Organic Rooftop Farm

An experimental rooftop farming project with a focused group of young building professionals was conducted to explore design opportunities to advocate nature-based activities in the existing high-rise contexts. Through personally practising urban farming work, the project hoped to awaken the public's attention to local farming, urban greening, upgrading and transformation in Hong Kong. This informal, community-initiated project helped spread the word about the ease and social benefits of urban farming and the practice of urban revitalization.

Two key objectives of the project were as follows:

    (i)   Transform an undesignated rooftop into an urban green space, and

    (ii)   Experience organic farming in urban contexts.

Fig. 7.26 – A vacant rooftop of an industrial building

A group of young building professionals, comprising architects, planners, engineers, surveyors and landscape architects, was engaged in this experimental project. There were seven core team members to design and coordinate the project. The project site was about 800m^2 on the roof floor of an industrial building in Fanling, New Territories. The project period was from November 2015 to June 2016.

Process

There were four stages – setting up, farming, nurturing and harvesting. First, setting up the farm adopted an environmentally sustainable approach. The planting boxes and pots were made of unused timber planks, wood pallets, banners and aluminium cans by upcycling and fabricating on-site. The focus group members and volunteers of young building professionals carried out this carpentry and installation work in approximately two months. Although they were not skilled workers and spent only weekends and holidays on the set-up, a sense of belongingness and personal attachment to the project were developed.

Second, the core team members arranged other necessary substances, including soil, seeds and fertilizers, for farming in an organic way. Third, an organic farmer was consulted, and team members exchanged gardening knowledge.

Fig. 7.27 – Hands-on experiences in rooftop organic farming

Third, nurturing came across various challenges and interventions by nature in the subsequent five months. For example, the seedlings and small plants could not withstand severe sunlight on hot sunny days and required frequent watering. Because of this, the team installed sun shading devices and an automatic irrigation system. In the case of typhoons and rainstorms, precautionary measures and rectification works were carried out before and after the strong wind and heavy rain. It seemed that damages to vegetation and planters were unpredictable and unavoidable due to the

weather. Furthermore, an extra layer of nets is a shelter to protect the plants from birds and other invasive insects. Fourth, harvesting was rewarding. Gathering events were held to share the harvests and experiences of the project.

Evaluation

Through transforming an undesignated space into an active urban green space, the participants engaged in renewing the rooftop by placing planters, repainting the rooftop, and repainting cans to reuse in planting. This self-initiated community work visually enhances the view of the neighbourhood and strengthens community ties between the participants.

Fig. 7.28 – Harvest of vegetables

At the planning stage and the outset of the project, the participants focused on designing and transforming the roof space pleasantly and sustainably, researching and learning the criteria and procedure of setting up an organic farm and organising engagement programmes for gardening duties. During the nurturing process, however, it was found that the farm setting should be adaptive and climatic responsive to severe sunlight, typhoon, rainstorms and other natural occurrences. The project brought the participants closely connected to everyday weather and climatic condition in the five-month nurturing period. There was no strict way to plan for natural growth but experience and react in due course.

Because of experiencing organic farming, the project brought attention to interdependency in nature and biodiversity's mechanism. Participants were reminded of the natural processes that allowed growth to occur, sun, rain, insects and birds, which need to be managed suitably. The participants reconnected with nature through urban farming, which is a type of material reconnection towards nature. A study has shown that this connection between personal and consuming food can simultaneously promote sustainability and contribute to emotional attachment to the place. From a more measurable environmental perspective, consuming locally grown food is also directly tied to reducing carbon emissions and reducing biodiversity loss (Ives et al., 2018).[339] On a more spiritual level, this project of growing a vegetable from seed to harvest evokes a greater appreciation for food and the people that work to produce food, influencing our eating behaviours and habits for the better (Mark, 2013).[340]

The World Health Organization's "Urban Green Spaces: A Brief for Action" (2017) mentioned that urban communal green space has potential challenges. For instance, potential conflicts are between users and competition for space.[341] Respective considerations are early community engagement; providing adequate urban green space to allow for similar functions catering to different groups; and mixing determined use of urban green space with specific equipment features for certain activities, with less structured spaces and all kinds of activities.

7.4   Discussion

Although there are conflicts with wildlife in urban living, as discussed in Section 7.2, urban naturalness positively influences urban dwellers in high-density urban contexts, and some urban dwellers have a sense of appreciation for nature, as exemplified in the case studies in Section 7.3. Hence, there are limitations and opportunities for human-nature interactions in high-density, high-rise contexts.

In the next section, specific forms of biophilic design in urban contexts drive an eco-friendly building environment that people love and evoke people's longing for nature, which will be further elaborated on the individual, community, and ecological aspects.

Nature Interaction: Individuals
Nature interactions on a personal level relate to psychological, physiological and environmental

aspects, as discussed in Sections 2.4, 2.5 and 2.7, respectively. Communal green spaces offer a comfortable outdoor environment to facilitate multi-sensory experiences for individuals.

- Communal green spaces
  - *Building permeability*
  - *Floor height, openness, orientation*
  - *Natural ventilation for thermal comfort*

Spaces / Scenes

Objects / Elements

- Daylight & air
- Skyview
- Greenery
  - *Green coverage*

Activities

- Visual enjoyment
- Sensory experience
- Self-retreat / contemplating
- Walking, strolling, jogging
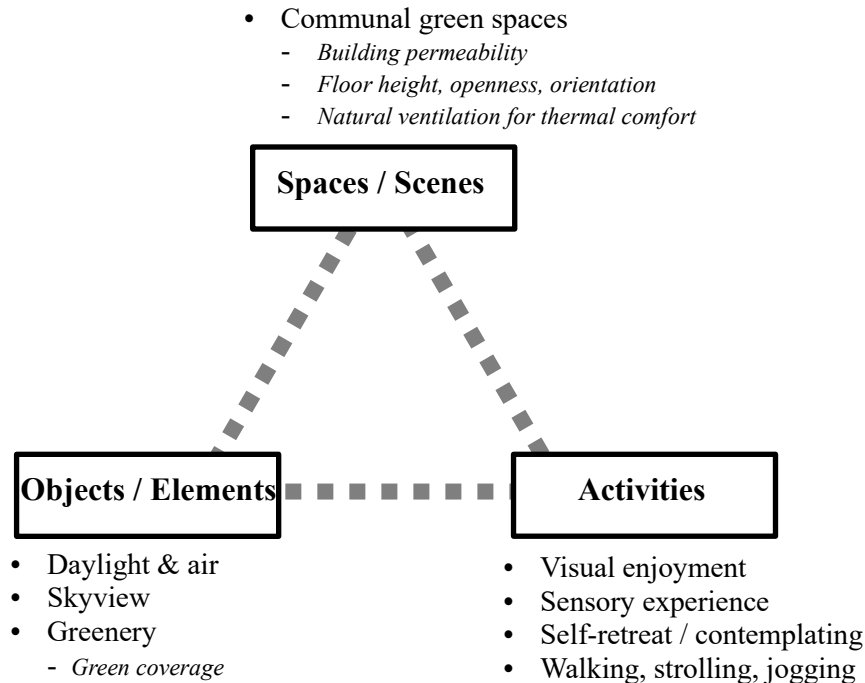
Fig. 7.29 – Nature Interaction: Individuals

Research findings elaborated in Sections 5.2.3 and 5.3.3 reveal that people perceive nature through various sensations. Therefore, design decisions centred around nature interactions for individuals incorporate sensory stimuli into our green environments. This kind of stimulation is rare and precious in the urban environment and should be integrated into our urban lifestyle.

For visual stimuli, this includes a scene including elements such as birds, butterflies, a diverse variety of vegetation, and a living landscape. The previous discussions in Sections 7.3.1 and 7.3.2 suggest the effective use of spaces, such as urban rooftops and biophilic gardens at multi-levels that are nearby and accessible from our living units, physically bringing nature closer to our daily lives.

Aura is also significant in natural interaction, especially for the ecosystems in proximity to residential developments, as highlighted in Sections 6.5 and 7.2. Bird calls, bugs, and the sound of running water are essential in creating the proper sense of peace in nature. It is achieved by including appropriate irrigation systems and diverse vegetation structures, attracting more wildlife.

Olfactory elements are incorporated through fresh air, plant aromas, and scents after rain. These are all naturally occurring elements in nature, as described in Sections 6.5 and 7.2. A lesser thought-about stimulus is taste. Urban farming and plant diversity can increase our opportunities to taste the sweetness of locally grown fruits and vegetables and even honey from beehives, as mentioned in Sections 7.2 and 7.3.

Nature Interaction: Community

Green design can facilitate a higher sense of community by activities in a neighbourhood aligning with the social aspects in Section 2.6. Communal green spaces emphasize spatial characteristics of flexibility and adaptability, with good connectivity and accessibility and in the sense of safety. Greenery in place-making contexts and visual amenities can improve surrounding environments, so people are more likely to utilise these spaces for socialisation purposes. Spaces that merge biodiversity and green coverage and adapt to diurnal changes, such as more substantial daylight at certain times of the day, are optimal for these place-making events.

- Communal green spaces
  - *Spatial characteristics*
  - *Connectivity & accessibility*
  - *Safety & security*

Spaces / Scenes

Objects / Elements

- Amenities
- Greenery
  - *Old / collective memory*
  - *Vegetables*

Activities

- Purposeful interactions
- Serendipitous / casual interactions
- Community gardening
- Garden-based activities
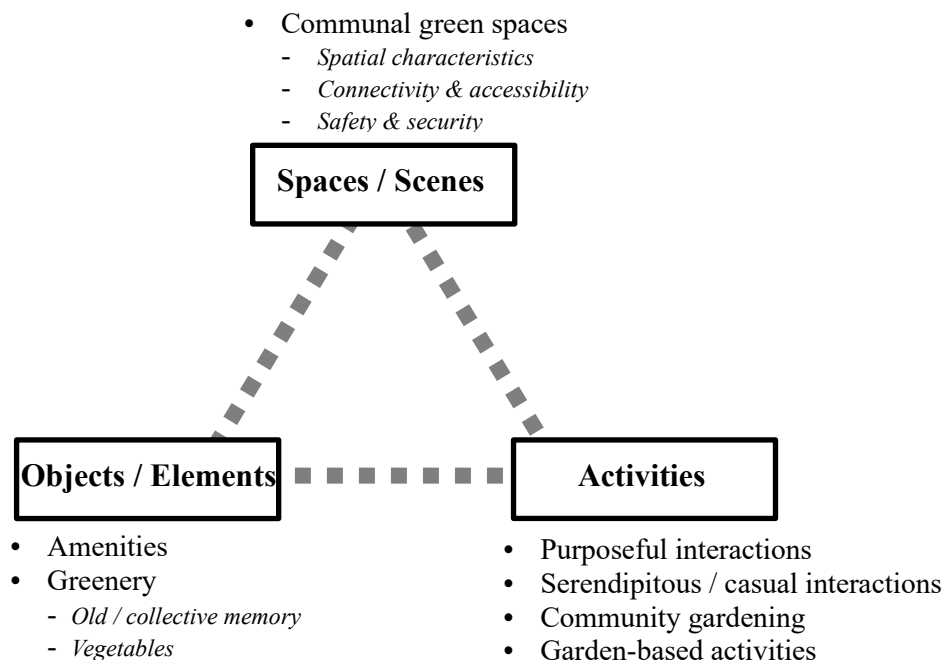
Fig. 7.30 – Nature Interaction: Community

Research findings from the case studies in Sections 7.3.1 and 7.3.2 exemplify that urban spaces can include design practices that initiate community garden practices, such as planting pots and sufficient soil depth on urban roofs and landscapes, connectivity, and accessibility to these farming

units. In addition, these communal green spaces allow people to interact better with nature and other people by consuming edible vegetation and co-sharing community urban farm spaces. Thus, even though there is an undesignated or not purposely built space, it can be a community gathering space through gardening and farming practices.

Nature Interaction: Ecology

The significance of ecological aspects has been discussed in Section 2.8. It is further elaborated that communal green spaces are integrated with the existing ecosystems. Three core components of a habitat, namely food, water, and shelter, should be integrated into our urban design. Seasonal changes, such as hibernation and migration, should also be considered when designing widely usable spaces for wildlife. Therefore, the nature-centric design should adapt to seasonal changes and be resilient against strong wind and rain, yet low and easy maintenance. In an urban environment such as Hong Kong, where there are prime weather conditions for different insect species to flourish, pesticides should be used sparingly or even avoided in human and wildlife-populated green spaces, such as urban parks. Plant and animal species should be integrated and connected across the urban area. This ecological network allows them to contact nearby green areas and increase the scope of activities, such as gathering, feeding, and building nests.

- Communal green spaces
    - *Bio-diverse roof & living landscape*
    - *Ecologically responsible envelope*
    - *Connected to ecological corridors & ecosystems*

Spaces / Scenes

Objects / Elements

- Daylight & air
- Greenery
    - *Vegetation structure*
    - *Species*
- Features for building reliant biodiversity

Activities

- Viewing of nature
- Sensory experience
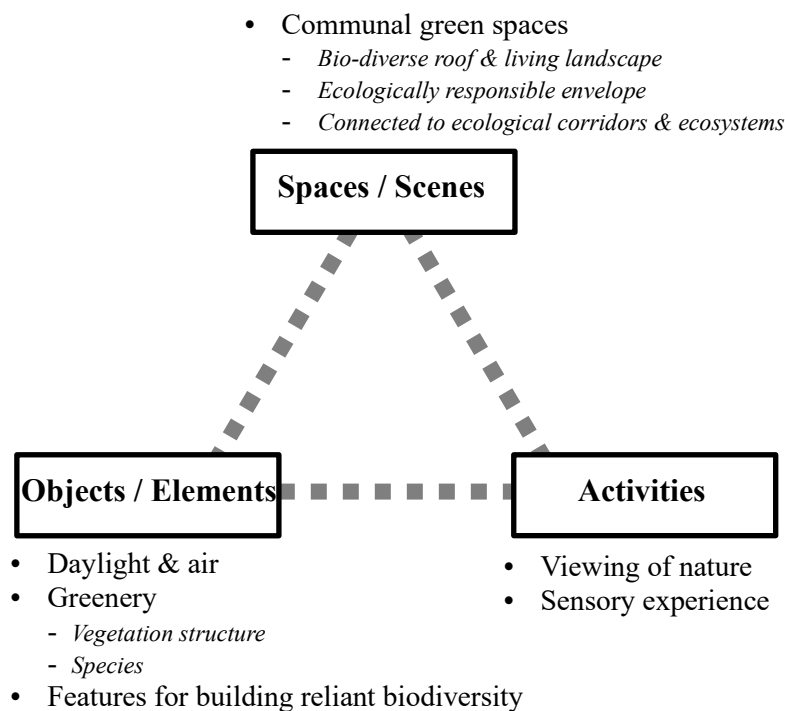
Fig. 7.31 – Nature Interaction: Ecology

In a high-rise, high-density urban environment, architecture is the essential constituent element and has excellent potential to improve biodiversity. Therefore, the architectural design shall incorporate the concepts and principles of nature-centric design and become a medium for unified communication and interaction with nature. The nature-centric design strategies for hypothetical residential high-rise design are exemplified, including design strategies for bio-diverse roofs and living landscapes, ecologically responsible designs, and biophilic gardens at multi-levels, as shown in Fig. 7.32.

Nature Interaction: Individuals

Visual
- Distant & quality view
- Birds & butterflies
- Diverse vegetation
- Lively landscape

Aura
- Bird's call
- Bugs
- The sound of running water

Smell
- Fresh air
- Floral aroma
- The fresh smell of plants after rain

Taste
- The sweetness of the fruit & vegetables

Touch
- Gardening
- Fauna & flora
- Pets

Nature Interaction: Community

Greenery
- Place-making
- Visual amenity
- Community gardening

Urban Farming
- Edible vegetation
- Community farming
- Co-sharing

Awareness & Perception
- Nature affinity
- Urban biodiversity
- Healthy lifestyle

Nature Interaction: Ecology

Existing Ecology
- Ecological assessment
- Existing fauna & flora
- Rare & valuable species

Species' Selection
- Native species
- Non-invasive species
- Diversity

Bio-habitat
- Seasonal birds' temporary stay
- Food, water & shelter
- Avoidance of pesticides

Ecological Network
- Ecological corridor
- Contact with nearby green areas
- Insect life and range of activities

Bio-diverse Roof & Living Landscape
- Bio-diversity / brown roof
- Respect of ecological corridor
- Diverse vegetation structure & seasonal change
- Green coverage & green plot ratio
- Urban native woodland
- Porous pavement & integrated drainage & flood management
- Bio-swale / retention lake for water harvesting
- Rain garden

Ecologically Responsible Design
- Features for building reliant biodiversity
- Soften building edges & vegetation with adequate maintenance
- Preserved existing trees & ecosystems
- Vertical greening
- Bird-strike preventing glass balustrade
- Bird-friendly window design / bird-strike preventive glazing

Biophilic Gardens at Multi-Levels
- Roof farming
- Greenery as physical buffer for sense of safety & wind breaking
- Doorstep gardens at proximity to living units for social gathering
- Community garden for residents
- Inclusive planting facilities for different ages & universal accessibility
- Garden for therapeutic horticulture
- Tree-lined walkway with seating
- Sky garden with high headroom for urban ventilation
- Green space with amenities for children & elderly

Fig. 7.32 – Nature-centric design strategies in high-rise and high-density contexts

Bio-diverse Roof & Living Landscape

Existing wildlife habitats and green areas with ecological value should be protected. From the macro perspective of urban planning, the connection between urban land and the surrounding ecological green land and natural environment should be strengthened to enhance the ecological value of urban land. From the micro perspective of architectural design, ecological green space can improve the environment of the building and provide an ecological habitat for wildlife in the city.

Fig. 7.33 illustrates design strategies for bio-diverse roofs and living landscapes for a hypothetical residential high-rise design, regarding the findings from the previous chapters as tabulated in Fig. 7.34.

Respect of ecological corridor

Bio-diverse / Brown roof

Rain gardens

Diverse vegetation structure & Seasonal change

Bio-swale / Retention Lake for water harvesting

Green coverage & Green plot ratio

Porous pavement & Integrated drainage & Flood management

Urban native woodland
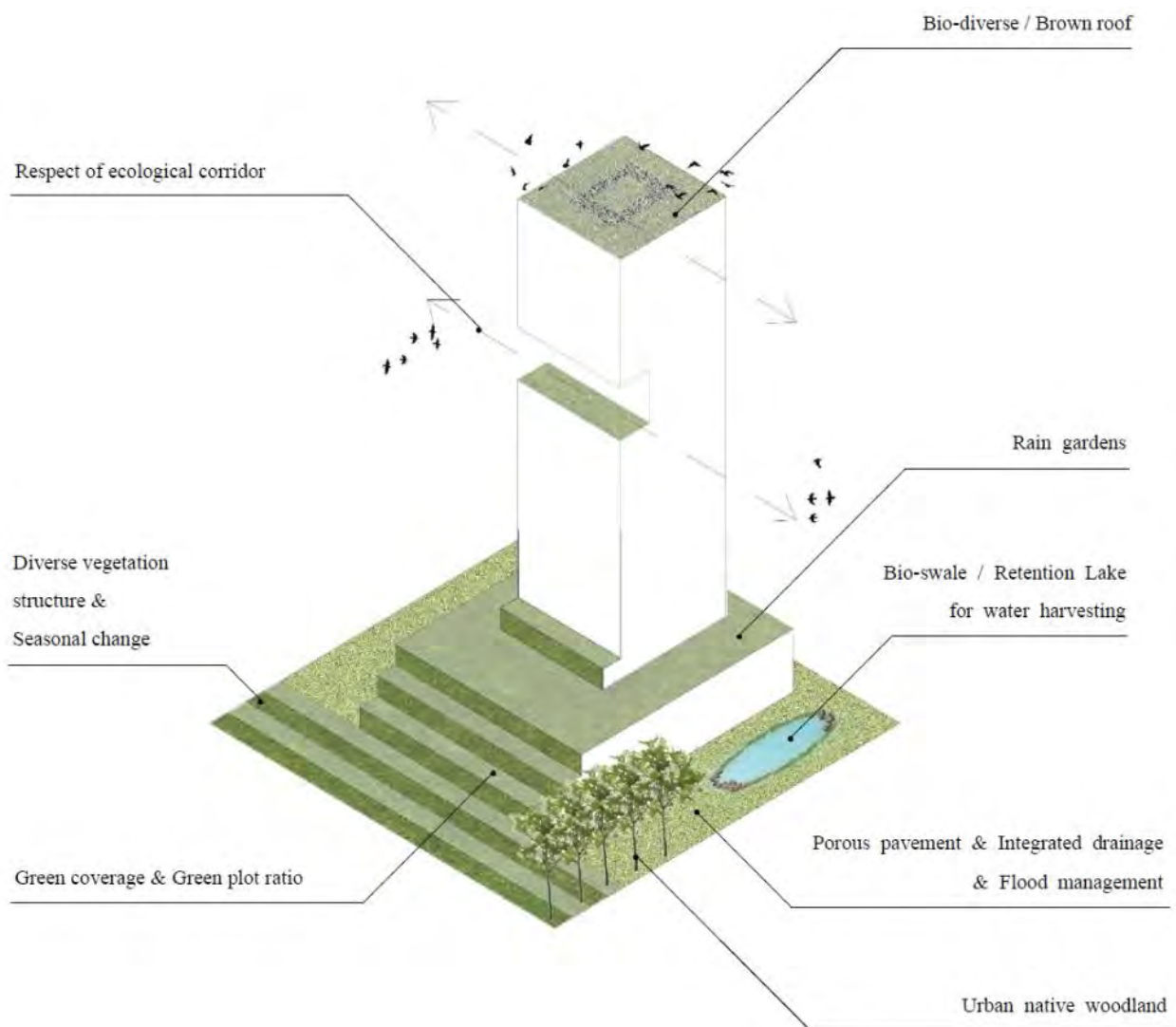
Fig. 7.33 – Design strategies for bio-diverse roofs and living landscapes

Design Strategies	Literature review (section no.)	Photo-elicitation surveys (photo no.)	Case studies (section no.)
Bio-diverse / brown roof	2.8	(D)N-26, (D)N-46, (D)N-48, (D)N-57, (D)N-60	
Respect for an ecological corridor	2.8	(D)N-16	7.2
Diverse vegetation structure & seasonal change	2.8	(B)12, (B)55, (D)N-17	
Green coverage & green plot ratio	2.7	(B)9, (D)H-19, (D)H-26, (D)H-30	
Urban native woodland	2.8		7.2
Porous pavement & integrated drainage & flood management	2.7	(A)27-1, (D)N-41	
Bio-swale / retention lake for water harvesting	2.7	(D)N-14. (D)N-36	
Rain garden	2.7	(D)H-26	

Fig. 7.34 – Summary of the research findings related to bio-diverse roofs and living landscapes

Bio-diverse roofs can utilize the remaining open spaces of the city to form a patchy ecosystem. Inaccessible roofs are ideal spaces where potential conflict with wildlife can be minimized and undesignated spaces can be utilized. Building design promotes biodiversity spaces, such as bio-diverse roofs and multi-level and diverse layouts of vibrant landscape spaces, such as butterfly gardens. The design of bio-diverse or brown roofs should consider the choice of species, choose local or non-invasive species, set a variety of plant structures, suitable soil coverage, irrigation systems, and settings that can attract species and promote the formation of ecological habitats. "Design of Biodiversity: A Technical Guide for the Design of New and Existing Buildings"[342] outlines the design details of ecological-reliant buildings, such as the construction of nests and hubs suitable for bats, birds and invertebrates. The butterfly-friendly gardens comprise nectar-producing plants, larval food plants, shallow pools of water, and a free pesticide environment.[343]

The first brown earthen roof carefully designed for the survival of birds appeared in the U.K.[344] In New York, the United States, the vibrant rooftop landscape provided a natural habitat for birds, bats, and butterflies and improved air quality and rain runoff. Besides, roof farming is also an important measure to create a vibrant roof landscape. A rooftop farm located at Brooklyn Navy Yard in the United States could produce 20,000 pounds of fresh food each year and 1,500 pounds of honey from April to November each year.[345]

Ecologically Responsible Design
Ecologically responsible architectural design is another way to protect and improve urban

biodiversity, as discussed in Section 7.3.2.

Fig. 7.35 illustrates design strategies for ecologically responsible designs for a hypothetical residential high-rise design, regarding the findings from the previous chapters as tabulated in Fig. 7.36.
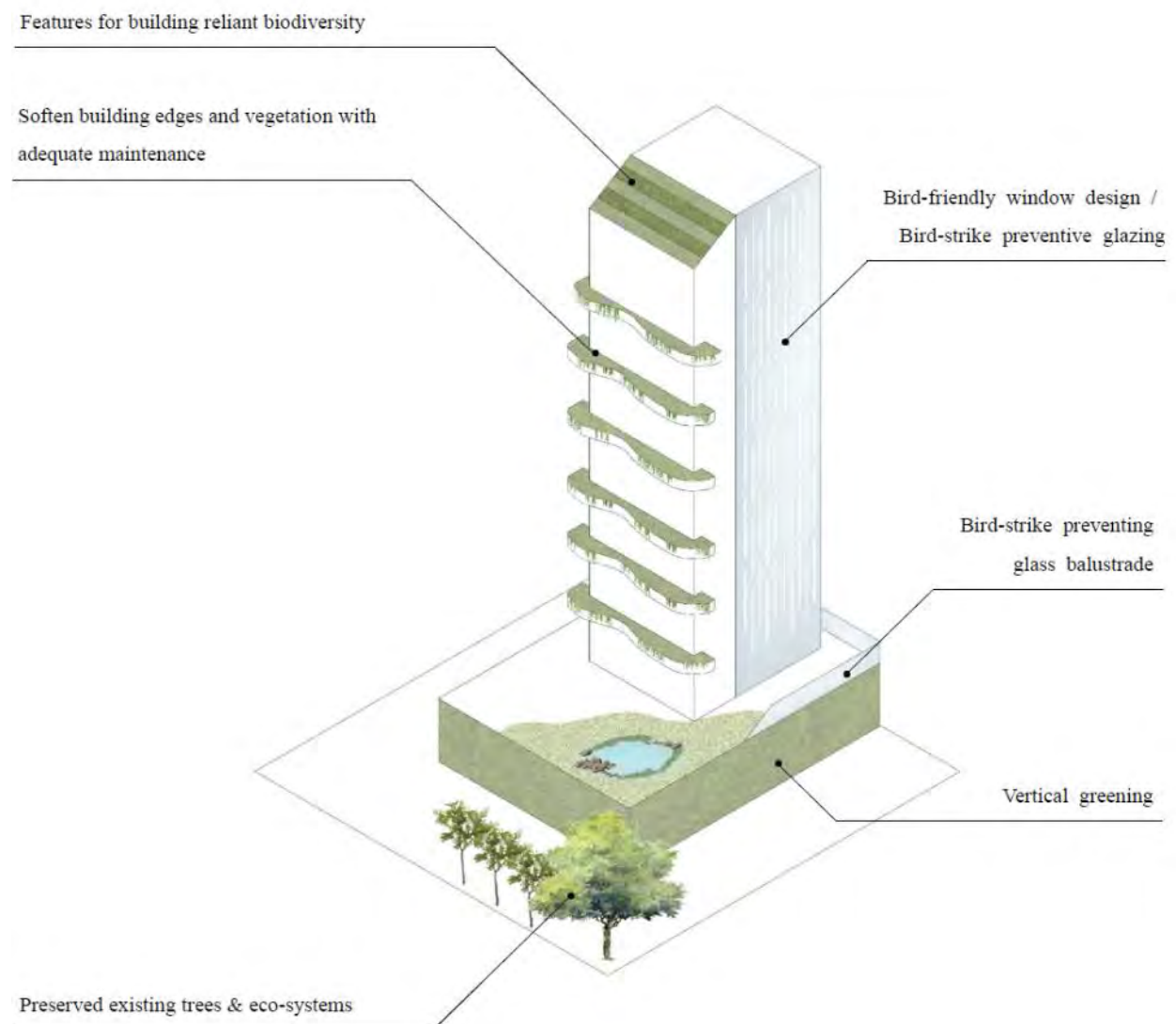
Fig. 7.35 – Design strategies for ecologically responsible designs

Design Strategies	Literature review (section no.)	Photo-elicitation surveys (photo no.)	Case studies (section no.)
Features for building reliant biodiversity	2.8	(A)9-23, (A)19-3, (D)N-2, (D)N-56	7.2
Soften building edges and vegetation with adequate maintenance	2.8	(B)97	7.2

Preserved existing trees & eco-systems	2.8	(A)9-1, (A)9-24, (B)32, (B)43, (D)H-7, (D)N-3, (D)N-4, (D)N-7, (D)N-8, (D)N-15, (D)N-27, (D)N-40	7.2
Vertical greening	2.7 & 2.8	(A)15-4, (B)48, (B)89, (B)101, (D)N-11, (D)N-12, (D)N-23, (D)N-34, (D)N53	
Bird-strike preventing glass balustrade	2.8	(D)N-19	7.2
Bird-friendly window design / bird-strike preventive glazing	2.8	(D)N-19	7.2

Fig. 7.36 – Summary of the research findings related to ecologically responsible designs

Because the facade design of modern buildings is mostly a large-area glass curtain wall, bird impact on the facade frequently occurs. As discussed in Section 2.8 and case studies in Section 7.3, visual signals shall be provided on glazing to prevent bird-window collisions. Furthermore, the ultraviolet pattern of the window glass can give birds a warning to prevent impact.

Light pollution also affects the survival of birds to a certain extent. Therefore, the outdoor light environment design should minimise the nuisance to people and birds. A list of good external lighting fixtures that eliminates ecological light pollution presented by Dark Sky Society with a theme "Good Lights for Good Nights".[346]

It can be seen that in high-rise and high-density cities, the facade design of the building should combine vertical greening and new curtain wall technology to be responsible for ecology and maintain the balance between the building and the natural environment.

Biophilic Garden at Multi-levels
Nature has benefits to promote physical and mental health. As discussed in Section 3.4, communal green spaces at multi-levels facilitate urban residents to interact with nature, making it possible for people and nature to interact and diversify.

Fig. 7.37 illustrates design strategies for biophilic gardens at multi-levels for a hypothetical residential high-rise design, regarding the findings from the previous chapters as tabulated in Fig. 7.38.
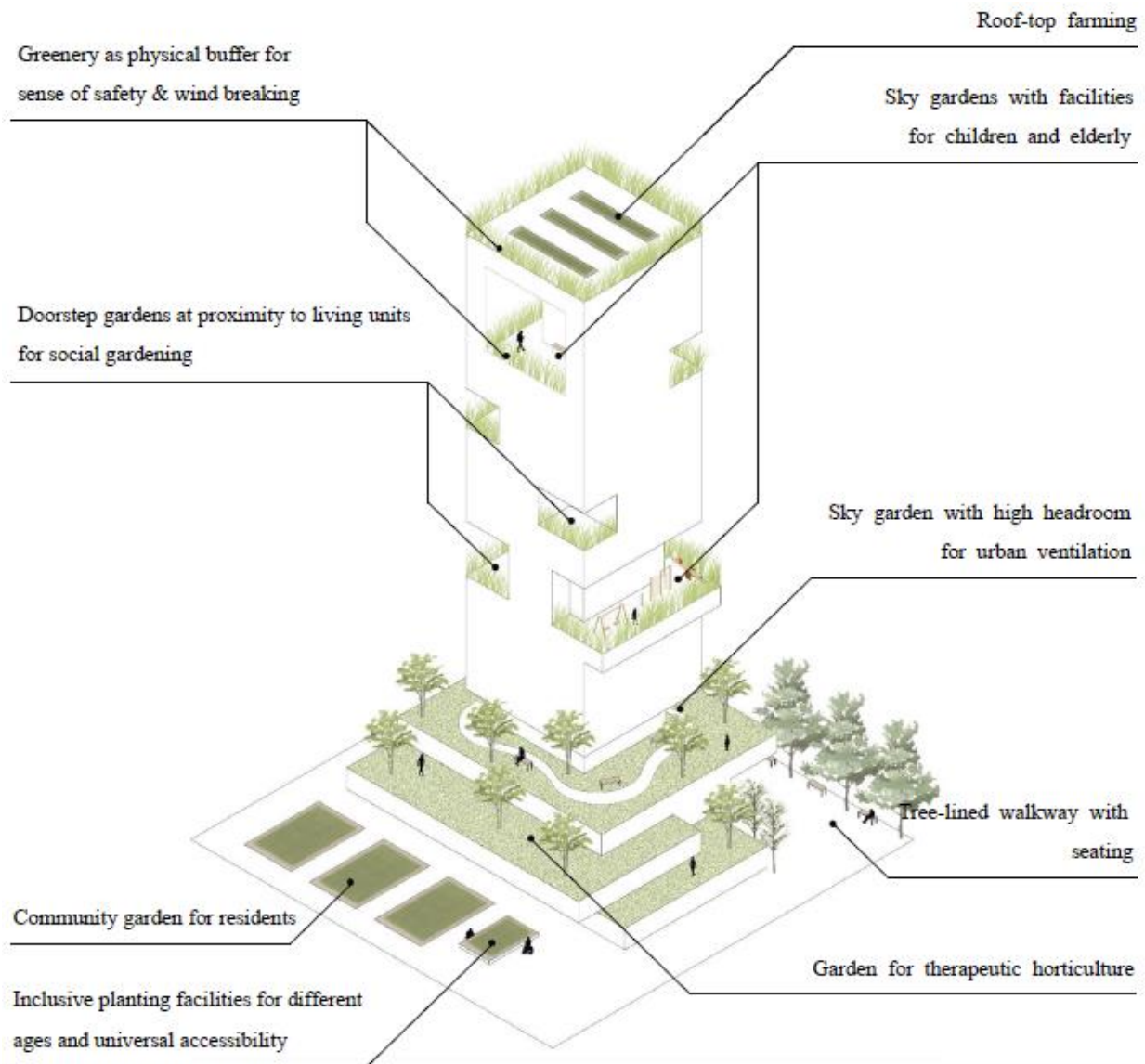
Fig. 7.37 – Design strategies for biophilic gardens at multi-levels

Design Strategies	Literature review (section no.)	Photo-elicitation surveys (photo no.)	Case studies (section no.)
Roof farming	2.6	(D)H-42	7.3.1
Greenery as a physical buffer for a sense of safety & wind-breaking	2.7	(D)H-40, (D)N-24	
Doorstep gardens in proximity to living units for social gathering	2.6	(D)H-1, (D)N-29	
Community garden for residents	2.6	(B)7, (B)51	7.3.1 7.3.2
Inclusive planting facilities for different ages & universal accessibility	2.6		7.3.1 7.3.2
Garden for therapeutic horticulture	2.5	(B)80	7.3.1

Tree-lined walkway with seating	2.4, 2.5	(A)2-3, (A)4-5, (A)4-6, (A)20-7, (B)11, (B)24, (B)43, (B)82, (D)H-4 (D)H-44, (D)H-45, (D)H-47	
Sky garden with high headroom for urban ventilation	2.7	(D)N-35, (D)N-43	
Green space with amenities for children and elderly	2.6	(B)100, (C)1, (C)3, (C)4, (C)5, (C)7, (C)11, (D)H-25	

Fig. 7.38 – Summary of the research findings related to biophilic gardens at multi-levels

The concept of biophilic design encourages urban dwellers to observe, smell and contact various flora and fauna communities, and learn to appreciate native species and ecosystems. In addition, the therapeutic landscape actuates positive physiological benefits. The combination of neighbourhood gardens and communal spaces expands improvised living spaces. These communal green spaces are scattered at different levels to accommodate residents' daily activities. For example, doorstep gardens near living units encourage social interactions. Community farming can be accommodated at the rooftop or ground levels. Garden-based activities include setting up neighbourhood gardens, participating in the maintenance of garden vegetation, and planting plants by hand to inspire people to get close to nature.

7.6   Conclusion

This chapter explores design strategies for human-nature interactions in an urban living environment. The design strategies include form, space, process and intent. In addition, case studies were carried out on design intention for the co-evolution of nature concerning nature's interactions with individuals, community, and community ecology.

Further to the experimental engagement projects, this chapter explores and discusses different urban farming and community gardening types in the city. Implications to human-nature interactions for benefits to humans and nature are discussed.

Humans have an ingrained relationship with plants.[347] Some may see gardening as a hobby, but there are many voluntary activities hosted by individuals and organizations that aim to spread the importance of greenery and empower junior and senior citizens with the ability to cultivate their environment. Even though a high-density, high-rise city, there are locations to plant greens, from indoors to outdoors, from communal to private spaces; furthermore, undesignated spaces can be transformed into communal spaces with nature-based activities.

Given the improvised place-making projects, human-nature interactions in urban living can be progressively developed. Human-nature interactions are built upon humans' discovery and acknowledgement of the co-existence, connection, and co-living of nature and humans, which was explored in community engagement projects to understand urban nature. The case studies of nature-based activities and event spaces and nature-centric design projects demonstrate how human-nature interactions could develop from three different main perspectives: design for humans, design for humans with nature, and design for nature, respectively, in the urban contexts.

Chapter 8: Design Opportunities for Human-Nature Interactions in Communal Green Spaces at Residential High-rises

8.1 Introduction

The strategies for human-nature interactions that biophilic gardens at multi-levels in the previous chapter put forward to answer the Research Question 3 together with case studies.

This chapter will discuss whether the creation of communal green space at a high level (also known as a sky garden) facilitates human-nature interactions at residential high-rises. As mentioned in Section 3.3, which introduces the concept and alignment of terminologies around the typology, the term sky garden will be replaced by Communal Green Space at a high level (CGS) for the basis of this thesis.

In this chapter, the current designs of CGSs will be reviewed. Then, policies and incentives for the design of CGSs and green building criteria on communal green spaces in residential buildings in Hong Kong and Singapore are studied, followed by case studies of forty CGSs in both cities.

Design considerations of the existing CGSs are evaluated on (i) spatial quality, (ii) connectivity and accessibility, (iii) greeneries and (iv) amenities. Discussions are drawn between the CGSs in response to the psychological, physiological, social, environmental, and ecological aspects.

8.2 Current Design Practices on Communal Green Spaces in Residential High-rises

To better understand the new typology of residential high-rises as aforementioned in Chapter 3, this section compares Hong Kong and Singapore governments' policies and initiatives in the last two decades. Singapore has similar urban, cultural and climatic conditions as Hong Kong. Residential high-rises are not uncommon in urban districts of both cities.

Two governments emphasise the purposes and encourage the implementation of CGSs as sustainable building design features. However, there are fundamental differences, as observed from the guidelines. These differences also drive the as-built CGSs in diverse typologies.
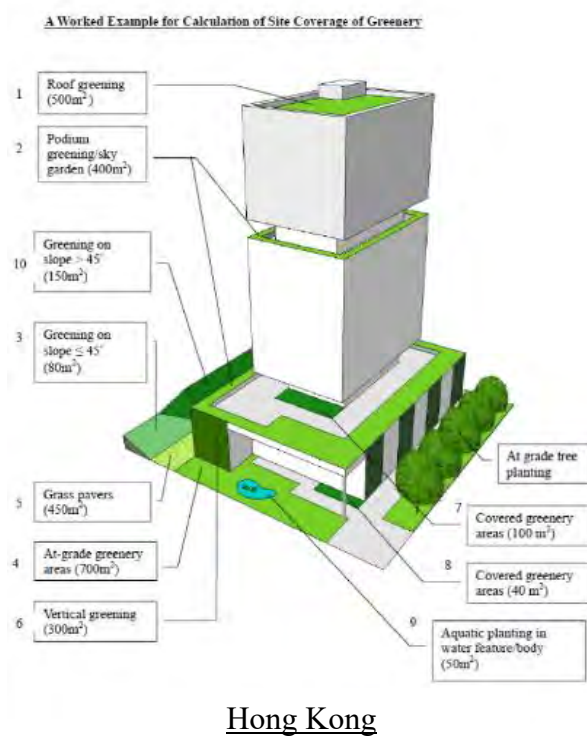
Fig. 8.1 & Fig. 8.2 – Hong Kong and Singapore Governments' design guidelines on sky-rise greening for green incentives [348,349]

In 2001, the Hong Kong government issued "green incentives" for communal green spaces in residential buildings, including exempting gross floor area (GFA) and relaxing the regulations on the allowable overall building height for CGSs. Such incentives, stipulated in the practice notes jointly issued by the Buildings Department, Lands Department and Planning Department, were conceived to encourage developers to incorporate greening measures in new residential high-rise buildings. According to the practice notes, CGSs aim to provide natural ventilation, greenery, and recreational green spaces. The locations of the CGSs are recommended to be determined by wind tunnel tests or by computation fluid dynamic modelling, but it is not compulsory. The maximum number of CGSs provided is equal to or less than the number of residential floors divided by fifteen. Such a CGS can be divided into multiple floors, but it should not be less than one-third of the floor area.

Singapore has policies on promoting what is described as "sky-rise greenery". These are part of larger urban planning green initiatives in the city. In 2009, the Singapore government announced a target of adding 50 hectares of sky-rise greenery by 2050 and its intermediate target of 30 hectares by 2030. These targets were written in the sustainable development blueprint, which the Inter-ministerial Committee on Sustainable Development developed. In addition, to advocate sky-

rise greenery, the Urban Redevelopment Authority of Singapore launched Landscaping for Urban Spaces and High-rises (LUSH) programme in 2009 and has issued a series of gross floor area (GFA) incentives for balconies, planter boxes, outdoor refreshment areas on rooftops of existing buildings and communal green spaces or terraces. Meanwhile, the government funded up to 50% of the installation cost of green roofs or green walls for renovating and implementing in existing buildings.

GFA exemption for communal green spaces in Singapore was first introduced in 1997, aiming to promote more quality communal spaces and contribute to the surrounding areas' overall greenery and environmental quality. In principle, the CGS area within a 45-degree line taken from the edge of the overhead projection is exempted from GFA calculation. Additional floor height allowance is granted if the CGS exceeds 60% of the floor plate and is subject to the total number of storeys. Additional GFA exemptions for areas covered corridors serving as barrier-free access and fire escape routes were introduced in 2009 to encourage more landscape areas in CGSs and CGSs in a larger size.

	Hong Kong	**Singapore**
Government Policy	Joint Practice Note (JPN) issued by the Buildings Department, Planning Department & Lands Department. (JPN 1)	Circular to Professional Institutes issued by Urban Redevelopment Authority. (Circular No. URA/PB/2009/12-DCG)
Year	First issued in 2001; revised in 2011	First issued in 1997; revised in 2009
CGS Objectives	CGSs provide natural ventilation, greenery and recreational garden space for communal use.	CGSs serve as quality communal spaces and contribute to the surrounding area's overall greenery and environmental quality.
Configuration	The minimum headroom is 4.5m, and it is open-sided above safe parapet height on at least two opposite sides for cross ventilation.	The proposed depth should be at least 5m.
Quantities	The maximum number of CGSs provided is equal to or less than the number of residential storeys divided by 15. Such a CGS can be split into multi-levels, but it occupies not less than one-third of the floor plate area.	The flexibility of quantities and configurations. Areas of a 45-degree projection line and a meaningful size of 5m in depth. No maximum number of CGSs is specified.
Locations	Locations of CGSs are recommended to be determined by wind tunnel test or computation fluid dynamic modelling, but it is not compulsory. The first CGS is located at not more than ten storeys. The CGS is at least ten storeys above any lower CGS or podium garden in the same building.	No specific requirement.
Openness	Open-sided above safe parapet height on at least two opposite sides to provide cross ventilation	At least 40% of the perimeter should be open and 60% for additional GFA exemption.

Height	A clear height should not be less than 4.5m. There is no concern from the Planning Department on the overall building height.	The guideline, which states areas of a 45-degree projection line for GFA exemption and a meaningful size of 5m in depth, implicitly defines the headroom of the CGS as 5m.
Connectivity	It is accessible from the common area only.	One set of communal access via a lift or staircase serves the sky garden. If the CGS is less than 60% of the floor plates, it should serve a minimum of 2 strata units to ensure its communal use in nature.
Greenery	Not less than 15% of the CGS area is planted with greenery.	Lushly landscaped with a suitable variety of plants is required. The greenery should be enjoyed by the building users and be visible from the surrounding environment.
Incentives	GFA exemption for CGSs if the above requirements comply. However, the floor height of CGSs may not be exempted if the overall building height is capped under the OZP or the land lease.	GFA exemption: Flexibility of quantities and configurations. Areas of a 45-degree projection line and a meaningful size of 5m in depth. No maximum number of CGSs is stated. Additional floor height allowance for predominant sky gardens: If CGS area exceeds 60% of the floor plate, additional heights of 10m(7-20storeys), 15m(21-30storeys), 20m(31-40storeys), 25m(41-50storeys) & 30m(>50stoerys).

Fig. 8.3 – Governments' incentives and guidelines on CGSs in Hong Kong and Singapore[350,351]

Hong Kong's CGS is relatively environmental driven, while Singapore's is socially oriented. This is determined by how Hong Kong's requirements restrict locations and numbers of CGSs and are more prescriptive about the details. For instance, CGSs are at least ten storeys apart from each other or podium gardens unless under exceptional circumstances with solid environmental justifications. On the other hand, doorstep CGSs, which are easily accessible green spaces adjacent to residential units, are scattered at various storeys or seamlessly integrated with common circulations. The scattered approach facilitates incidental neighbour interactions observed in Singapore but not in Hong Kong.

The design guidelines in Singapore encourage the implementation of doorstep CGS. Examples in Singapore illustrate how CGSs are integrated with barrier-free and fire escape corridors in front of living units under various scenarios for GFA computation. On the other hand, Hong Kong's guidelines consider CGSs as separate floors from residential storeys. For instance, an example is shown that a 55-storey building requiring two refuge floors may have two refuge-floor-cum-CGSs and one independent CGS eligible for GFA exemption.

Relaxation of floor heights for CGSs is the main incentive, as observed in the case studies.

Building height and site coverage requirements under various departments most likely limit development bulks with respect to maximising allowable development potentials. Without a relaxing floor height limit, it may not be feasible to squeeze CGSs into the compacted floor plates in many cases. It may be argued that the contexts of Hong Kong and Singapore are fundamentally different. The city fabric of the former is much denser and more compact. However, the adverse impact of raising overall building height but enhancing building permeability on urban ventilation at street level or to the surrounding environments shall be further studied.

8.3   Case Studies – Communal Green Spaces in Residential High-rises

As mentioned in the previous section, the objectives of CGSs are to enhance social interactions and neighbourhood place-making while simultaneously improving environmental conditions.

Ip (2011) surveyed residents' experiences in CGSs at three residential high-rises in Hong Kong.[352] The questionnaires were completed through face-to-face interviews with individuals, and the number of successful respondents was ninety in total and thirty per development. Overall, 33.3% of residents never visited their CGSs, 40% visited during festivals or occasions, and 26.7% regularly visited weekly or monthly, but none paid a daily visit. Residents who never visit sky gardens considered "lack of amenities" as the main reason. Other reasons for not visiting CGSs, including "too windy", "difficult to access", "safety concerns", and "insecure sense", were quite distinctive amongst the three developments. Most expected more greenery in the CGS, and the existing garden spaces were too small. More seating and recreational facilities should also be provided, especially for children playing. It revealed that the design of CGSs might not match residents' expectations, and the CGSs' social and environmental performances were in doubt.

In this section, case studies will be carried out to identify correlations between the diverse forms and functions of existing CGSs. Twenty residential buildings with CGSs in Hong Kong and twenty in Singapore are selected. These buildings were designed or built in the last twenty years since the governments of the two cities have implemented policies and incentives to encourage the provision of CGSs. The functions, configurations, connectivity and amenities of the selected CGSs are shown in Fig. 8.4. The detailed information on the study cases is in Appendix 6.

	Development	No. of storeys (residential floors)	Nos. of CGSs	CGS location	Separate floor	Refuge floor	Doorstep from units	Near podium clubhouse	Near sky clubhouse	At roof level	Connect different blocks	Amenities, apart from seating
Hong Kong	The Orchard (2003)	38	2	17, 32/F		●						
	The Arch (2005)	50-51 (5-82/F)	1	62/F		●			●		●	
	Centre Place (2006)	27	1	25/F	●				●			●
	Grand Promenade (2006)	55-58 (7-73/F)	1	47/F		●						●
	Indi Home (2006)	55	1	45R/F		●						●
	31 Robinson Road (2007)	30 (8-42/F)	1	7/F	●			●				
	Manhattan Hill (2007)	40-42	1	25-26/F		●						
	The Apex (2007)	44 (2-50/F)	1	R/F	●					●	●	
	SOHO38 (2008)	26 (5-38/F)	1	27/F	●							
	The Forest Hills (2008)	48 (8/F-51/F)	1	29/F		●						●
	The Sparkle (2008)	37 (7-49/F)	1	45/F	●				●			●
	i-home (2009)	37	1	20/F		●						●
	Shining Heights (2009)	48 (5-60/F)	2	27, 50/F		●			●			
	The Masterpiece (2009)	38	2	9, 47/F	●	●		●				●
	Aria (2010)	30 (5-39/F)	1	37/F	●				●		●	●
	Island Crest (2010)	36 (2-50/F)	1	29/F		●						
	Larvotto (2011)	25-28 (7-39/F)	1	20-24/F		●					●	
	Lime Stardom (2011)	36 (5-45/F)	1	18R/F		●						
	Harbour One (2012)	29 (9-42/F)	2	7, 32/F		●		●				
	De Novo (2015)	23 (1-23/F)	1	23/F	●				●	●	●	●
Singapore	Newton Suites (2007)	36	7	every 4 floors			●					
	Central Horizon (2008)	11/40	1	12/F		●				●	●	
	Pinnacle at Duxton (2009)	50	2	26, 50/F	●				●	●	●	●
	RiverGate (2009)	43	20+	every 2-3 floors			●					
	Skypark at Somerset (2010)	32	15	every 2 floors			●					
	Reflections at Keppel Bay (2011)	24/41	4	8, 15, 22, R/F	●		●			●	●	
	Martin Place Residences (2011)	33	1	14/F	●						●	●
	Soleil@Sinaran (2011)	33	1	14/F	●						●	●
	Parc Seabreeze (2012)	20	1	14/F	●							●
	Ascentia Sky (2014)	45	10	every 5 floors			●		●	●		●
	Novel 18 (2014)	36	8	11-26/F	●				●			
	Lincoln Suites (2014)	30	1	24/F	●				●		●	●
	Spottiswoode Residence (2014)	36	3	2, 10, 22/F	●			●			●	●
	Spottiswoode 18 (2015)	36	2	14, 24/F	●							●
	Skyville@Dawson (2015)	40-43	2	19,33/F	●			●			●	
	Sky Habitat (2015)	38	3	14,26,38/F	●				●	●	●	●
	Robinson Suite (2016)	42	2	7, 19/F	●		●					●
	Scotts Tower (2016)	31	1	25/F	●							●
	The Tembusu Kovan (2017)	18	3	6,12,18/F			●		●	●	●	●
	City Gate (2019)	30	2	6,24/F	●			●	●		●	●

Fig. 8.4 – Case studies of CGSs in Hong Kong and Singapore – locational characteristics

8.3.1   Findings

In the case studies of CGSs, it was found that:

i)   Height concessions from policies seem to be the main driver.

ii)   Two-thirds of CGSs at mid-& high levels are 80m-150m from the street.

iii) CGSs at mid-levels act as refuge floors.

iv)   CGSs at low-& high-levels act as an extension of clubhouse areas or main circulation to clubhouses.

v)   Total openness in proportion to the overall building height is merely 2-3%.

vi)   15-20% of the net floor areas are vegetated; narrow planting strips at the perimeters of sky gardens are common.

vii) The most popular amenities in CGSs are sitting areas, viewing platforms, strolling paths and foot massage trails.

There are four common physical topologies, as illustrated below.

CGS at a separate floor

CGS connecting different towers

CGS as doorstep garden in front of living unit

CGS integrated with clubhouse
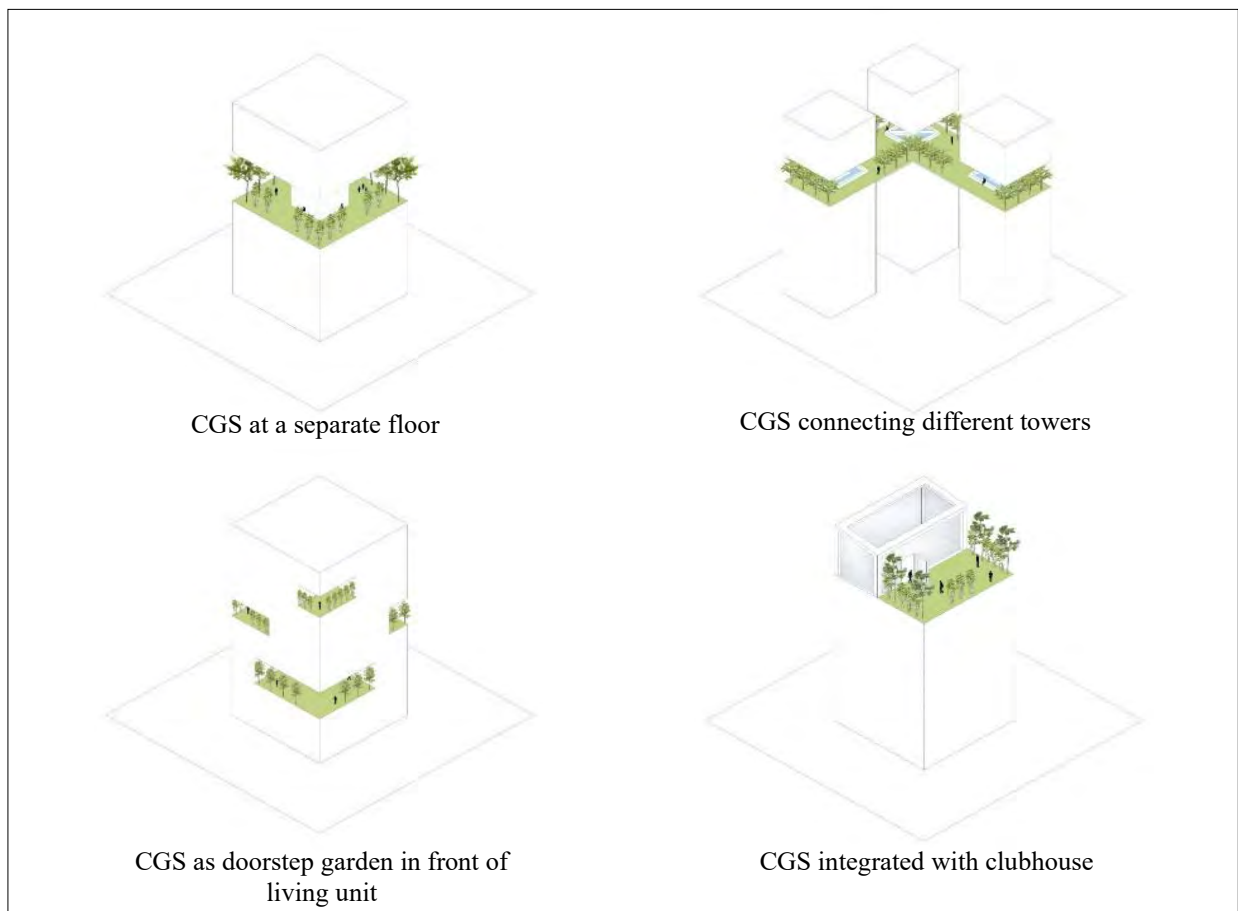
Fig. 8.5 – Physical typologies of CGSs

These characteristics inform that the current design guidelines merely focus on environmental performances with prescriptive dimensions, configurations and locations of CGSs. Further to discussing the benefits of urban green spaces in the literature review section, four essential substances of CGSs potentially contribute to multi-faceted positive effects. The substances are (i) light, air and distant view; (ii) greenery in terms of quantity, quality, interactions and species; (iii) communal spaces in terms of spatial quality, connectivity and accessibility, and sense of safety at high and security; (iv) amenities for individuals and community.

Spatial Quality

Communal green spaces at high levels provide better light and air quality than outdoor spaces at ground or podium levels, especially in a high-density, high-rise environment. However, structures and fire service provisions restrain the spatial configuration of CGSs, particularly CGSs as refuge floors. On average, the area distribution in a CGS in Hong Kong is 20% greenery, 45% outdoor circulation and event spaces and 35% indoor circulation, services zones and plant rooms. The change in the structure required to create large event spaces is hardly found, thus restraining the configuration of spatial planning for activities and amenities in CGSs. The largest dimensions of outdoor space among the twenty CGSs are about 6m x 6m, equal to a combination of two large unit living rooms. Since the average depth from an opening is about 4-5m, it is observed that 4.5m clear headroom can allow appropriate daylight to the inner part of CGS. However, in the case of the standard refuge floor height of 2.7-3.2m but reverted to CGS, daylight receiving is insufficient for greenery and pleasant outdoor spaces for leisure.

Connectivity and Accessibility

Connectivity enhances the chances of neighbours' interactions and accommodates various recreational activities. Most of the CGSs in Hong Kong are sandwiched between intermediate levels of buildings, which are mainly accessed by passenger lifts. Staircases reaching these floors are mainly used for escape routes in the event of a fire but not for daily use. In the interest of rendering efficient lift service arrangements, passenger lifts are usually split into high and low zones or odd and even numbers of floors for operation. Therefore, not all lifts can access CGSs, and, in most cases, only one lift, which is also the firemen's lift, is made available on the floor of the CGS. In the case of Indi Home, Hong Kong, residents living in the high zone must take another lift to the CGS by going down to the ground floor as the CGS is allocated to the low zone lift operation. Inconveniences may be induced under such lift arrangements. On the contrary, scattered

communal gardens in proximity to the doorsteps of residential units are found in Singapore, which makes garden spaces more accessible. Moreover, doorstep gardens or CGSs can facilitate daily activities and intentional or causal interactions as part of the main circulations.
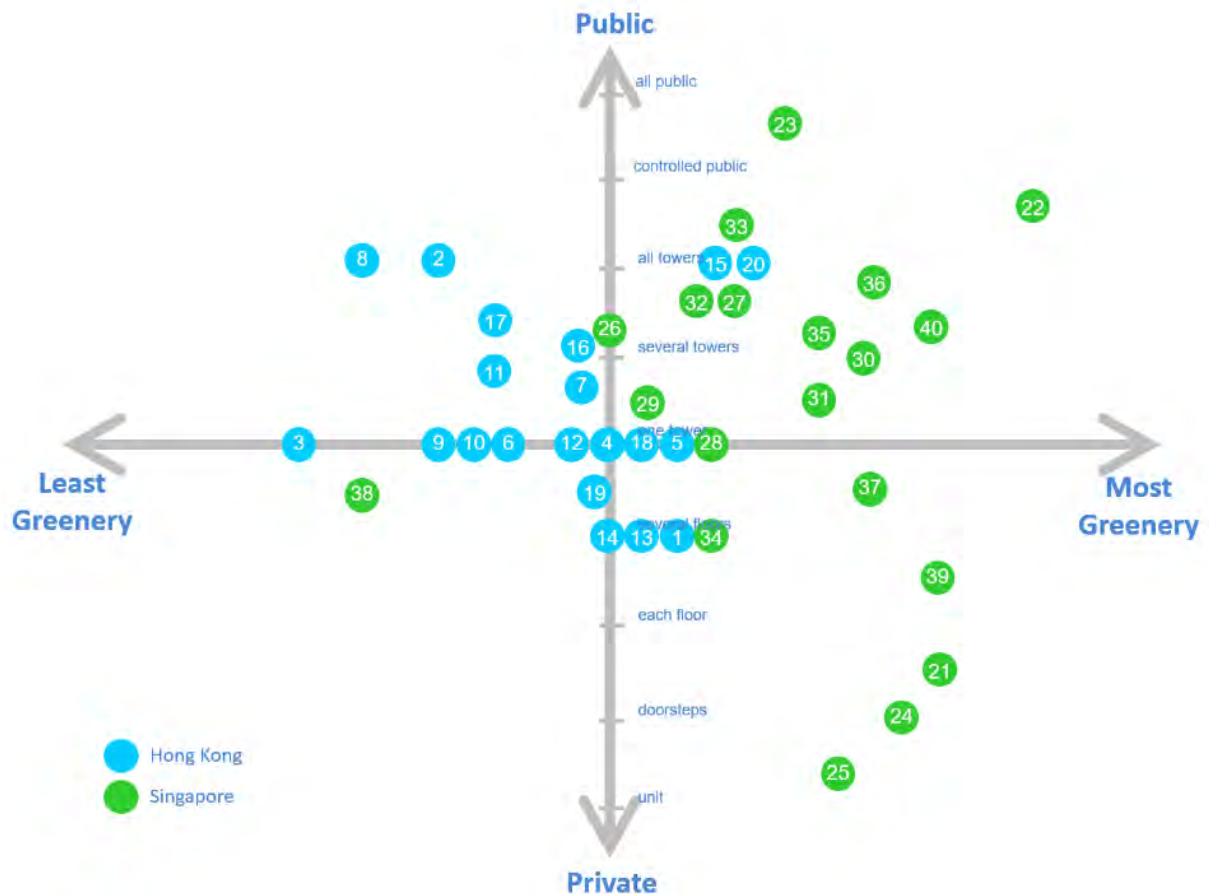
Fig. 8.6 – Forty cases of CGSs have different characters in terms of quantity of greenery and connectivity and accessibility by residents

8.4   Discussion

The following paragraphs evaluate the CGSs on the psychological, physiological, social, environmental and ecological aspects. The key substances of human-nature interactions discussed in the previous chapters are reviewed with the current designs of CGSs, as tabulated in Fig. 8.7. Criticisms on the CGSs for human-nature interactions in urban living are made.

Development	Psychological			Physiological			Social			Environmental			Ecological		
	Presence of Sky	Presence of Greenery	Vertical Greenery & Others	Amenities (Passive)	Amenities (Active)	Therapeutic Landscape	Casual Interaction	Community Gardening	Children / Elderly Friendly	Outdoor Thermal Comfort	Microclimate Mitigation	Energy Conservation	Nature Conservation	Biodiverse Landscape	Features for Wildlife
Hong Kong															
The Orchard (2003)	●	●		●			●			●	●				
The Arch (2005)	●	●		●		●	●			●					
Centre Place (2006)	●	●		●			●			●					
Grand Promenade (2006)	●	●		●		●	●			●					
Indi Home (2006)	●	●		●			●		●	●					
31 Robinson Road (2007)	●	●		●			●			●	●				
Manhattan Hill (2007)	●	●		●			●			●					
The Apex (2007)	●	●		●			●			●					
SOHO38 (2008)	●	●		●			●			●					
The Forest Hills (2008)	●	●		●	●		●		●	●					
The Sparkle (2008)	●	●		●			●			●					
i-home (2009)	●	●		●			●		●	●	●				
Shining Heights (2009)	●	●		●			●			●					
The Masterpiece (2009)	●	●		●			●		●	●	●				
Aria (2010)	●	●		●	●		●			●			●		
Island Crest (2010)	●	●		●			●			●					
Larvotto (2011)	●	●		●			●			●	●				
Lime Stardom (2011)	●	●		●			●			●					
Harbour One (2012)	●	●		●			●			●	●				
De Novo (2015)	●	●	●	●	●		●	●	●	●		●			
Singapore															
Newton Suites (2007)	●	●	●	●			●		●	●	●				
Central Horizon (2008)	●	●		●	●	●	●		●	●	●	●		●	
Pinnacle at Duxton (2009)	●	●		●	●		●		●	●		●			
RiverGate (2009)	●	●		●			●		●	●					
Skypark at Somerset (2010)	●	●		●			●		●	●	●	●			
Reflections at Keppel Bay (2011)	●	●		●			●			●					
Martin Place Residences (2011)	●	●		●	●		●			●		●			
Soleil@Sinaran (2011)	●	●		●	●		●			●		●			
Parc Seabreeze (2012)	●	●		●	●		●			●		●			
Ascentia Sky (2014)	●	●		●	●	●	●		●	●		●			
Novel 18 (2014)	●	●	●	●	●	●	●			●		●			
Lincoln Suites (2014)	●	●		●	●	●	●			●		●			
Spottiswoode Residence (2014)	●	●		●	●		●			●		●			
Spottiswoode 18 (2015)	●	●		●	●	●	●			●		●			
Skyville@Dawson (2015)	●	●		●	●		●			●		●			
Sky Habitat (2015)	●	●		●	●		●			●		●			
Robinson Suite (2016)	●	●		●	●		●			●		●			
Scotts Tower (2016)	●	●		●	●		●			●		●			
The Tembusu Kovan (2017)	●	●	●	●	●		●	●	●	●		●			
City Gate (2019)	●	●		●	●	●	●		●	●		●			

Fig.8.7 – Evaluation on psychological, physiological, social, environmental and ecological aspects

8.4.1   Psychological Aspect

As discussed in Chapters 5 and 6, the psychological aspect refers to the individual experience of visual and non-visual connections to nature. The visual connections refer to visual enjoyment through sight to the beauty of greenery and a distant view of the sky, trees, mountains and sea. Non-visual connections relate to sensory experiences on aural, smell, taste and touch with nature. The presence of natural elements, i.e., sky and greenery, in the CGSs and their connectivity and accessibility will be discussed.

Connection with Nature - Presence of Sky
Most of the CGSs offer panoramic, open and distant views to residents for enjoyment. These CGSs at high levels provide better light and air environments than outdoor spaces at grounds or podia. In addition, all occupants are offered distant sky views, even those living in tiny units with limited outdoor views.

For instance, The Arch, Hong Kong, has a CGS on the 62nd floor, which connects four tower blocks and serves as a refuge floor and the main access path to the clubhouse on the 59th floor to the 62nd floor. The CGS offers a panoramic scenic view of Victoria Harbour, facilitating residents to enjoy watching fireworks and festival performances on the harbour. As half of the apartments are located facing the harbour and another half facing the city, all residents can benefit from this sky garden to enjoy scenic views.

As illustrated below, another case of Aria, Hong Kong, accommodates a CGS with a 6m high headroom that facilitates residents to enjoy sunlight and air for leisure. The distant view from the CGS dovetails the pattern "Prospect" of biophilic design and echoes some photos captured by the participants in the photo-elicitation surveys.

Fig. 8.8 – Aria, Hong Kong, shows how well-received sunlight and air for residents

Connection with Nature - Presence of Greenery

Both the quality and quantity of greenery are essential. Extensive greenery in a deliberately designed volume of vegetation creates a thermally comfortable outdoor environment and may even act as a visual buffer for the densely populated surroundings. In addition, the diversity and complexity of vegetation structures enhance visual interests and ecological values.

Recreational space is the prioritized element of CGSs, while the provision of greenery comes second. Fig. 8.9 illustrates the disposition of greenery and communal spaces at CGSs in Hong Kong.
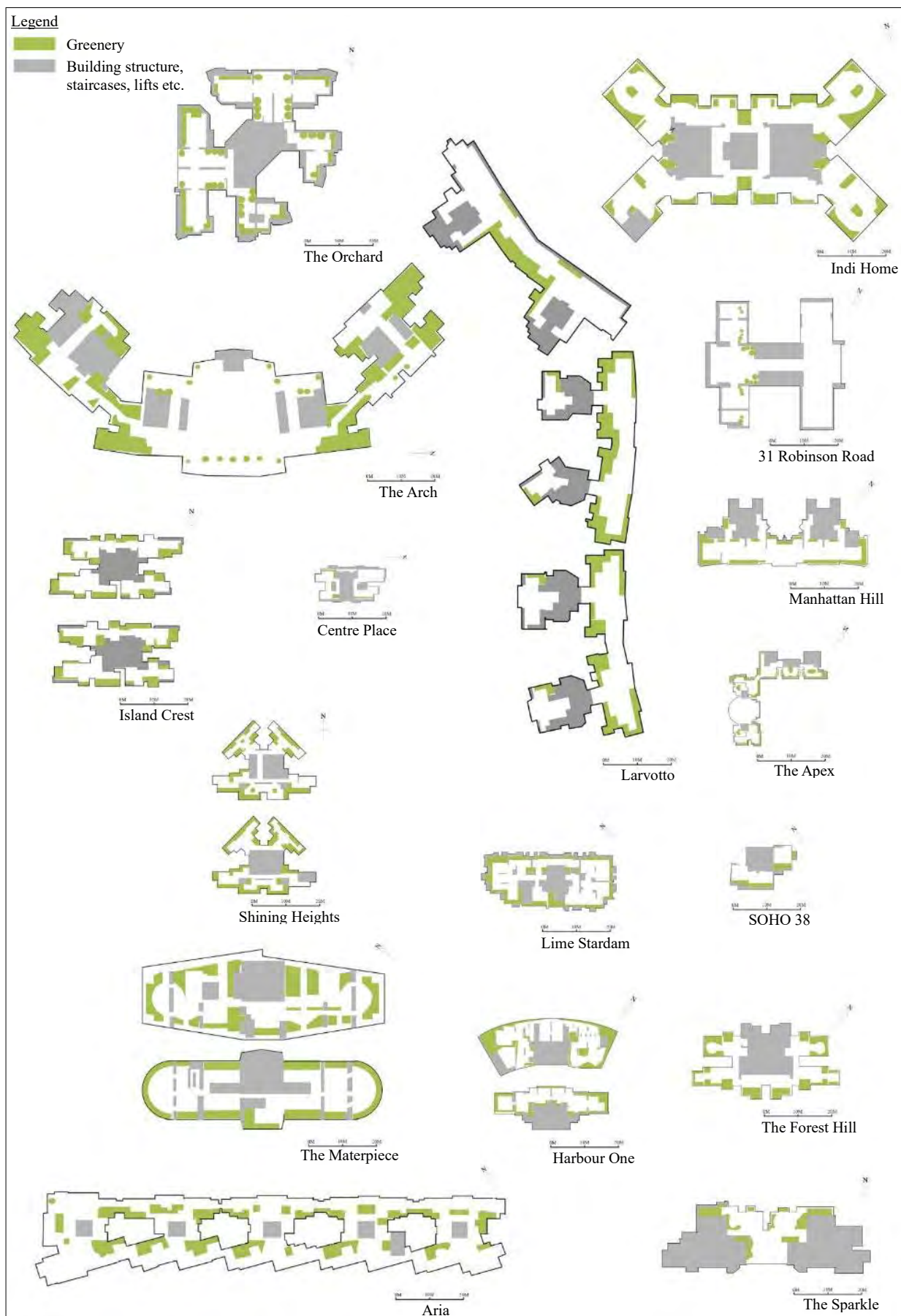
Fig. 8.9 – The disposition of greenery and communal spaces at CGSs in Hong Kong

Different configurations of greenery are observed, such as greenery lining the edges or screening the structure core. Vegetation at the edges and vegetation structures with deliberate height and species variation intend to ameliorate wind at high levels but not block daylight penetration. Planting strips at the edges set around the edge creates a physical barrier and acts as a visual barrier, enhancing the residents' sense of safety. Planters are also found in the centre of the floor plate, out of reach of sunlight. Fig. 8.10 summarizes the configurations of greeneries at the forty cases of CGSs.

Hong Kong

	Trees	Planters at edges	Planters at inner parts	Grass/turf areas	Vertical green
The Orchard (2003)	●	●			
The Arch (2005)		●			
Centre Place (2006)		●			
Grand Promenade (2006)	●	●			
Indi Home (2006)		●			
31 Robinson Road (2007)		●			
Manhattan Hill (2007)		●			
The Apex (2007)		●			
SOHO38 (2008)		●			
The Forest Hills (2008)		●			
The Sparkle (2008)	●	●			
i-home (2009)		●	●		
Shining Heights (2009)		●			
The Masterpiece (2009)		●	●		
Aria (2010)			●		
Island Crest (2010)		●			
Larvotto (2011)		●			
Lime Stardom (2011)		●			
Harbour One (2012)		●			
De Novo (2015)	●	●			

Singapore

	Trees	Planters at edges	Planters at inner parts	Grass/turf areas	Vertical green
Newton Suites (2007)	●	●			●
Central Horizon (2008)	●	●	●	●	
Pinnacle at Duxton (2009)	●		●	●	
RiverGate (2009)	●	●			
Skypark at Somerset (2010)	●	●		●	
Reflections at Keppel Bay (2011)	●		●		
Martin Place Residences (2011)	●	●	●		
Soleil@Sinaran (2011)	●	●			
Parc Seabreeze (2012)	●	●			
Ascentia Sky (2014)	●	●			
Novel 18 (2014)	●	●	●	●	●
Lincoln Suites (2014)	●	●			
Spottiswoode Residence (2014)	●	●			
Spottiswoode 18 (2015)	●	●	●	●	
Skyville@Dawson (2015)	●	●	●		
Sky Habitat (2015)	●	●			
Robinson Suite (2016)	●	●	●	●	
Scotts Tower (2016)	●		●		
The Tembusu Kovan (2017)	●		●		●
City Gate (2019)	●	●		●	

Fig. 8.10 – Summary of configurations of greeneries at forty cases of CGSs

Fig. 8.11 – The top images show the planters at the edges, and the bottom images illustrate the inner parts. The top images are Indi Home, Hong Kong, and the bottom images are Scotts Tower, Singapore.

It is observed that greeneries in most of the CGSs in Hong Kong are situated at the building edges. Trees are rarely found. Grass and vertical green are not provided. On the other hand, in the CGSs in Singapore, greeneries are in a variety of forms, including trees, shrubs at edges and inner parts, grass and turf areas, and green walls. Furthermore, it is also found that the quantity of vegetation at the CGSs in Singapore is higher than at the CGSs in Hong Kong.

The popularity of the planters at the edges of the CGSs in Hong Kong can be explained by government guidelines. Fig. 8.12 shows the zone accountable for greenery area calculation along the edges of the floor plates. The accountable greenery area is directly related to the exemption of the gross floor area for recreational facilities, including CGSs. On the contrary, there are no such criteria in Singapore.
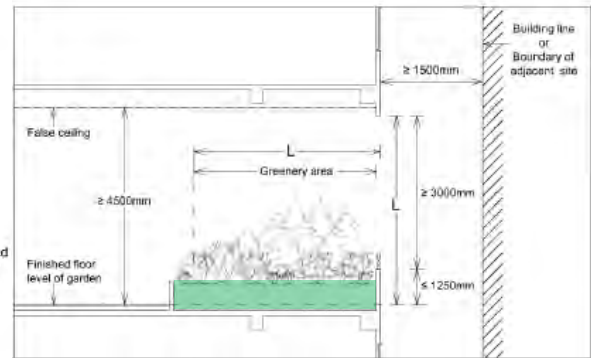
Fig. 8.12 – Hong Kong government guidelines on accountable greenery area for CGSs[353]

The selection of plants is decided upon the atmosphere the architect or developer intends to create. Technically, some plants and trees are not wind-tolerant. For example, some trees with big canopies may be uprooted when placed at a high level under windy conditions. On the other hand, utilizing trees with more open canopies can prevent uprooting during typhoons and avoid blocking sunlight penetration in the daytime. Greening, Landscape and Tree Management Section of the Development Bureau of the Hong Kong government issued "Pictorial Guide to Plant Resources for Skyrise Greenery in Hong Kong".[354] It serves as a database for plant information, including biological and physical properties, wind tolerance, recommended soil depth, seasonal effects, support modes for vertical greenery, maintenance demand and points of interest for plant appraisal and selection.

Trees

In De Novo, Hong Kong, the CGS of the lower residential block is planted with Osmanthus trees.[355] The fragrance of the trees adjacent to the main entrance intends to welcome the residents and offer them a non-visual connection and sensory experience with nature. The trees also act as symbolic features for the communal green space, as shown in Fig. 8.13.

Fig. 8.13 – A case of a sky garden, De Novo, Hong Kong, shows two fragrant Osmanthus trees on the CGS [356]

In RiverGate, Singapore, three 43-storey residential blocks at the edge of the Singapore River incorporate forty-five CGSs, a mixture of communal and private garden spaces distributed every two to three storeys on different sides of the building blocks. It demonstrates that trees are close to the living units in favour of connection with nature in daily life.

Fig. 8.14 – RiverGate, Hong Kong, demonstrates the proximity of greenery adjacent to living units facilitating daily connection with nature

Central Horizon, Singapore, demonstrates an exceptional case of a CGS with lush vegetation and the complexity of vegetation structures. A long CGS of 4,600m^2 elevated green spaces connects the 12th floor of five 40-storey residential towers and rooftop gardens of an 11-storey high podium slab block and a 7-storey multi-storey carpark. The size of the CGSs is comparable to a park in an urban district. The composition of trees and shrubs creates visual interest.

Fig. 8.15 – Central Horizon, Singapore, demonstrates a CGS with lush vegetation

Green Walls

Vertical greening at high levels is found in the cases of Singapore's CGSs. For instance, Newton Suites, Singapore, is a 36-storey residential high-rise with greening and CGSs in a vertical dimension. Cantilevered CGSs adjoining the elevator lobbies are situated at every four levels as a natural retreat for the residents. Most available horizontal and vertical surfaces were landscaped, constituting a total area of landscaping of 130%, of which 110% was vegetated. It has exemplified a high green plot ratio and demonstrates an example of doorstep gardens for daily contact with nature.

Fig. 8.16 – Newton Suites, Singapore, shows green walls connecting CGSs at various storeys

8.4.2   Physiological Aspect

As discussed in previous chapters, the physiological aspect refers to exercises in green spaces and therapeutic landscapes. With reference to the findings of the photo-elicitation surveys, CGS will be categorised by identifying the possibility of enabling jogging, walking, running, and doing exercises with nature to be favourable in everyday life. The following paragraphs will discuss amenities to facilitate various activities at CGSs.

Exercises in Green Spaces - Amenities

Leisure or passive activities are anticipated in CGSs, which can be categorized into six aspects.

1.   Enjoyment in a landscaped garden with scenic views;
2.   Self-retreat / seating / reading in a peaceful environment;
3.   Leisure walk with family and friends;
4.   Children play/doing exercises and stretching;
5.   Chatting and social gathering with neighbours and friends; and
6.   Specific amenity facilities (e.g., barbeque and gym).

The key design consideration of amenities is the structural configuration and possible nuisances to the adjacent residents. For example, it is not expected to have a barbeque area next to a bedroom of a unit below the CGS floor. As shown in Fig. 8.17, amenities are analysed in terms of the

popularity in CGS provision, facilities requirements, specific spatial requirements, appropriateness in green areas, and appropriateness at high levels.

Amenities / Features	Popularity in CGS provision	Facilities requirements	Spatial requirements	Appropriateness in green areas	Appropriateness at high levels
Landscape garden with scenic views					
Water features	●	●●●	●●	●●	●
Sculpture / Artwork	●●	●	●	●	●
Audio devices	●	●●●	●	●	●
Lighting effect	●●	●●	●	●	●
Feature paving	●●●	●	●	●●	●
Planting	●●●	●	●	●●●	●●●
Self-retreat / seating / reading in a peaceful environment					
Sitting area	●●●	●	●	●●●	●●
Reading	●●	●	●	●●●	●
Swinging beds	●	●●●	●	●●●	●●
Leisure walk with family and friends					
Strolling path	●●●	●	●	●●●	●●
Viewing platform	●●●	●	●	●	●●●
Children play/doing exercises and stretching					
Children play facilities	●●	●●●	●●●	●●●	●
Elderly exercises facilities	●●	●●●	●●●	●●●	●
Foot massage trail	●●●	●●	●●	●●●	●
Taichi square	●●●	●	●●●	●●●	●●
Meditation studio	●	●	●●	●●●	●●
Yoga zone	●	●	●●	●●	●●
Aerobic area	●	●	●●●	●●	●●
Chatting and social gathering with neighbours and friends					
Tea leisure	●●●	●	●	●●●	●●
Lounge / café	●	●	●	●●●	●●
Other amenity facilities					
Barbeque	●	●●●	●●●	●●	●●
Gym facilities	●●	●●●	●●●	●●	●●●
Golf putting green	●	●●●	●●●	●●●	●●
Swimming pool	●	●●●	●●●	●	●●

(Note: '●●●' – more; '●●' – fair; '●' – less)
Fig. 8.17 – Commonality of amenities/features in CGSs in Hong Kong and Singapore

The most popular amenities in CGSs are the sitting area, viewing platform, Tai-chi square, foot massage trail and strolling path. Their spatial requirements are quite flexible without any complicated or high-maintenance facilities required. Except for the viewing platform, these

amenities are not necessarily high-level. CGSs with abundant greenery, good natural ventilation, and appealing distant view are significantly advantageous to outdoor activities, including doing exercises, chatting with family members and self-retreat. Water-related facilities are also found in some CGSs, including swimming pools, jacuzzi pools and spas.

Some CGSs bridge different towers in the form of a footbridge, an observation deck, even a gym, a swimming pool, a garden space or a park. Furthermore, some cases extend the floor plate away from the building edges to facilitate their functional or spatial requirements, such as spacious children's playgrounds and long jogging tracks, as shown in Fig. 8.18.

Fig. 8.18 – Amenities and green spaces to be liveable and enjoyable by frequent daily users

Pinnacle at Duxton is a public housing project in Singapore. Bridges connecting seven 50-storey public housing blocks accommodate the two most extended CGSs in the world at more than 500m each. These CGSs are located on the 26th and 50th floors, as illustrated in Fig. 8.19. The 26th is exclusively for residents only, while the 50th opens to the public as an observation deck for visitors viewing the cityscape and skyline of Singapore. The 26th CGS accommodates jogging tracks, a children's play area, a gym room, a residents' committee centre and others. It offers over 5,000 residents a social interaction place. It serves as an example of how CGSs offer amenities integrated with greenery in public housing.

Fig. 8.19 – Pinnacle at Duxton, Singapore, shows two CGSs for exercises in green spaces

Another example of an elongated CGS is Aria, Hong Kong. A CGS of 1,391m^2 bridges five separate tower blocks on the 37th floor and serves as the main access path to a clubhouse above the CGS. It accommodates a 340m promenade, viewing deck, chess garden, gym, golf putting green, water crescendo, fitness station, swinging beds and lifts to other recreational facilities. The elongated CGS facilitates daily walk, jog and run with green and sky views.

Fig. 8.20 – CGS at Aria, Hong Kong, provides recreational facilities and connects five residential blocks and a clubhouse at high levels

Therapeutic Landscape

Therapeutic themes, including a therapeutic patio, meditation corner, yoga corner and foot massage trail, are adopted as a promotion of health and wellness for residents in some cases.

For instance, in The Forest Hills, Hong Kong, a CGS of 300m^2 is located on the 29th floor and serves as a refuge floor. Various amenities at the CGS comprise a yoga zone, café, foot massage trail, sky aerobics, chess zone, Taichi square and meditation studio.

In Nouvel 18, Singapore, eight CGSs with various design themes and recreational facilities are scattered at two 36-storey residential apartments. Eight themes comprise a therapeutic patio, forest conservatory, fitness arena, wellness terrace, gourmet pavilion, aqua veranda, sky botanique and meditation garden, promoting a lifestyle with greenery and enjoyment at high levels.

Fig. 8.21 – Nouvel 18, Singapore, shows two CGSs with therapeutic themes

However, these therapeutically thematic CGSs lack design intentions for garden-based activities with residents' engagement. Accessible planting facilities for those physically and mentally in need are not found.

8.4.3   Social Aspect

Good accessibility and connectivity to CGSs facilitate building a better neighbourhood. For

instance, CGSs, as part of the main circulations, can facilitate daily activities and incidental or causal interactions among neighbours. On the other hand, nature-based activities such as communal gardening and urban farming induce more social interactions and a sense of belonging to the place, as discussed in the previous chapters. This section will evaluate the cases of CGSs in this social dimension.

Fig. 8.22 – Skyville at Dawson, Singapore, accommodates covered outdoor seating areas for residents to enjoy dining and chatting with family members and neighbours

Casual Interactions

In Singapore, the Tembusu Kovan, a residential development of 337 units, exemplifies how extensively and seamlessly integrated greenery is in communal spaces as much as possible. Three levels of CGSs spread over 18 storeys, as illustrated in Fig. 8.23, connecting three residential towers and facilitating a more intimate experience with nature. In addition, the nominal circulation corridors are enlarged to be lush vegetation decks with various social interaction spaces and plantations, such as fitness corners, reading corners, lounge, dining areas and leisure farm corners. Thus, it has illustrated visible, visitable and usable green spaces. Another example is Skypark at Somerset, Singapore. Fifteen double-volume, large, lush green spaces serve as the doorstep CGSs before arriving at the front doors of individual units.

Fig. 8.23 – Tembusu Kovan, Singapore, showcases how multi-level CGSs and greenery seamlessly integrate circulation and communal spaces

The doorstep CGSs, or CGSs, as part of main circulations, act as an improvised extension of living spaces, facilitating daily activities and incidental or causal interactions. These types of CGSs are only found in the cases of Singapore. It is mainly because these communal areas can be exempted from gross floor area calculation in Singapore, as shown in Fig. 8.24. On the contrary, there is no incentive for doorstep CGS in Hong Kong.
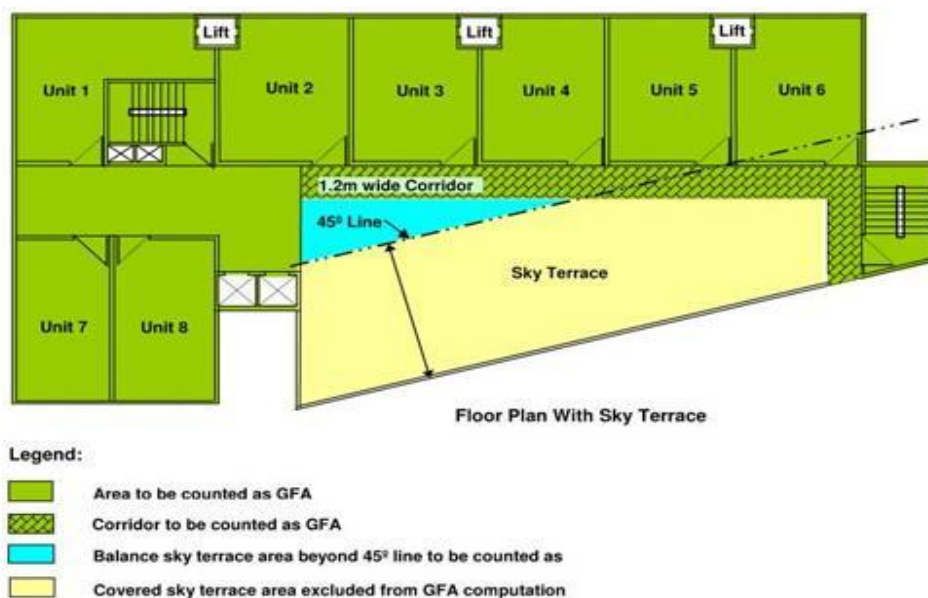
Fig. 8.24 – Singapore government's incentive on CGS areas excluded from GFA calculation[357]

Purposeful Interactions

Some cases of CGSs purposefully improve the neighbourhood and social interactions by creating

spacious, scenic, entertaining and safe green areas with children and elderly-friendly amenities. These CGSs at intermediate and high levels provide leisure and social amenities, such as children's playgrounds, elderly exercise areas, and barbeque areas. In addition, large communal spaces are required for social gatherings and festival events.

As discussed in the previous chapters, the concept of a community garden can be adopted to strengthen the neighbourhood and enhance a sense of belonging to a living place. However, only two cases, De Novo, Hong Kong and Tembusu Kovan, Singapore, accommodate community farming programs for residents.

In De Novo, Hong Kong, there is an allotment of planting areas for residents to rent for farming. The community farming area is suitably located where it is not under the shadow of the adjacent towers and has better sunlight exposure. Each parcel of planting lots can be rented for six months. Residents organize events to share their harvests and experiences with planting. The inclusive design includes raised planters to facilitate wheelchair users to plant. There are only ten parcels of planting lots. Therefore, only a small group of residents amongst over five hundred families can participate in farming each time.

Fig. 8.25 – Allotment of planting corners for residents to farm at De Novo, Hong Kong

Nevertheless, property management plays a crucial role in determining what can and cannot do on CGSs. Two examples in Fig. 8.26 show that no food, drink and pets are allowed in CGSs, which is not favourable to all-inclusive activities.

Fig. 8.26 – Signage shows CGS house rules at Aria, Hong Kong (left) and Pinnacle at Duxton, Singapore (right)

Children and Older Adults' Neighbourhood

Children's play areas are commonly found at communal green spaces at podium levels and often at sky gardens in Singapore but seldom at CGSs in Hong Kong. These children's playgrounds are demarcated areas with the installation of children's play equipment, mainly slides and climbing units, and safety flooring mats.

Children in contact with nature are beneficial to their healthy development, as discussed in the literature review and observed in the photo-elicitation surveys. Planters with greenery and flowers bring nature to CGSs, sometimes with snails, worms and butterflies. However, natural elements such as grass, sand and water are seldom found, and none of them is part of the children's play elements in these CGSs. Besides, garden-based activities, i.e., planting seeds and caring for vegetation, are not encouraged. Moreover, the CGS house rules, such as no ball games, restrict children's activities, particularly younger kids, to play with neighbouring kids and develop friendships and neighbourhoods.

Thermally comfortable green spaces and gardening programmes are favourable to older adults' health and social integration. The spaces with seating and greening located adjacent to main circulations or doorstep CGSs facilitate social interactions with neighbours. These features are common in Singapore's CGSs but rare in Hong Kong.

8.4.4   Environmental Aspect

Urban Micro-climate - Light and Air

Permeable tower design consists of CGSs or openings in building facades, as illustrated in Fig. 8.27, to enhance wind penetration high up from the ground through the building.[358] Green networks can be developed at a district level with visual or physical connections among CGSs at low levels of new developments and roof gardens of existing low-rise buildings. It forms urban ventilation corridors or another layer of streetscapes with vivid greenery.[359]

08 Increase building permeability

09 Permeable sky gardens

H>3m
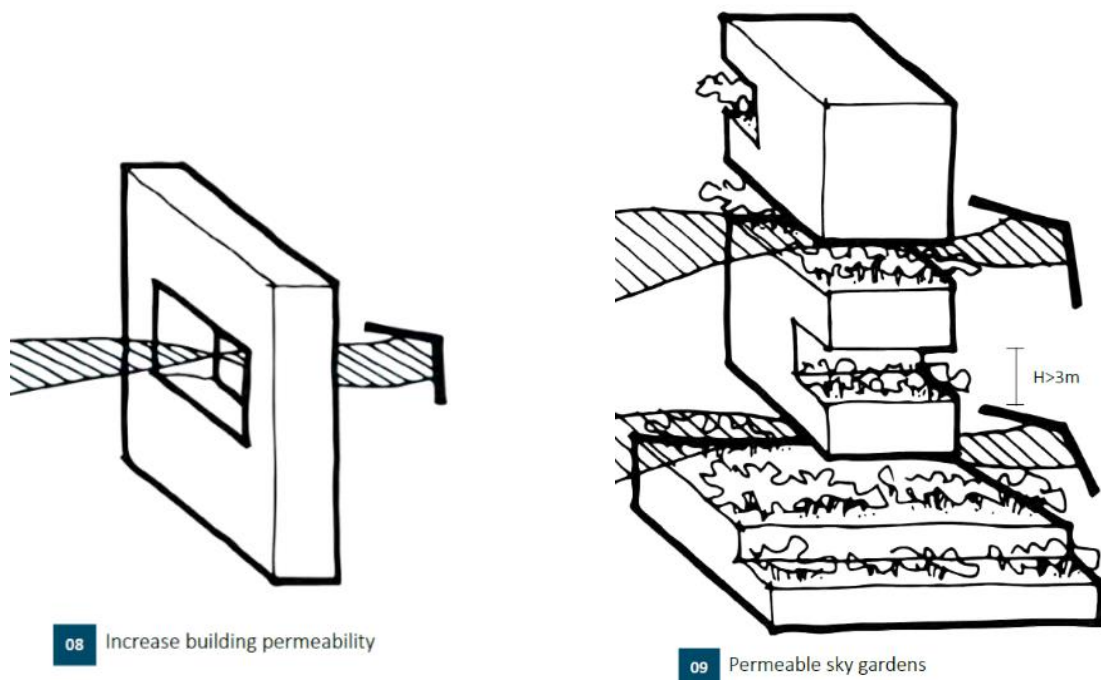
Fig. 8.27 – Extracted from HKGBC Guidebook on Urban Microclimate Study (2017)

CGSs with high headroom at low levels between 20m and 60m improve urban ventilation, which is particularly beneficial to the street pedestrian environment. References can be made to the case of Larvotto, Hong Kong, in Fig. 8.28 below, with a four-storey high CGS, enhancing building permeability.

Fig. 8.28 – Larvotto, Hong Kong, has four-storey high CGSs for alleviating urban ventilation

Development	SG1 height from street level H1(m)	SG1 H1/Ht	SG1 floor height h1(m)	SG2 height from street level H2(m)	SG2 H2/Ht	SG2 floor height h2(m)	Overall building height Ht(m)	Height ratio (h1+h2) /Ht	Effective openings SG1& SG2 /Ht
The Orchards	43	0.34	6	85	0.66	6	128	0.09	6%
The Arch	148	0.69	6	-	-	-	216	0.03	2%
Centre Place	89	0.77	6	-	-	-	115	0.05	3%
Grand Promenade	131	0.64	5.6	-	-	-	205	0.03	2%
Indi Home	127	0.71	6	-	-	-	180	0.03	2%
31 Robinson Road	25	0.19	6	-	-	-	134	0.04	2%
Manhattan Hill	95	0.63	6	-	-	-	183	0.03	2%
The Apex	143	1.00	-	-	-	-	143	-	-
SOHO38	83	0.72	6	-	-	-	115	0.05	3%
The Forest Hills	81	0.53	6	-	-	-	151	0.04	2%
The Sparkle	101	0.86	9	-	-	-	118	0.08	6%
i-home	60	0.33	5.3	-	-	-	138	0.04	2%
Shining Heights	83	0.43	3.2	149	0.77	6	192	0.05	2%
The Masterpiece	45	0.19	6	167	0.71	6	235	0.05	3%
Aria	115	0.88	6	-	-	-	130	0.05	2%
Island Crest	100	0.63	6	-	-	-	160	0.04	2%
Larvotto	60	0.50	14.5	-	-	-	120	0.12	11%
Lime Stardom	67	0.42	5.6	-	-	-	160	0.04	2%
Harbour One	25	0.18	5.3	100	0.73	5.3	137	0.08	4%

(Note: 'SG1' & 'SG2' are the 1st and 2nd CGSs from the street level, respectively. CGSs at or below 60m are highlighted in green. Effective openings of CGSs mean openings above parapets/balustrades.)

Fig. 8.29 – Characteristics of CGSs in Hong Kong

Fig. 8.29 and Fig. 8.30 indicate openings, floor heights and design considerations of CGSs in Hong Kong. None of the CGSs is below 20m since the podium is composed of non-residential uses, always found in the high-rise residential high-rises at 15-20m high from the street level.

Considering the effectiveness of building permeability at or below 60m with good environmental performance, one-third of the selected cases have CGSs at one-fifth to one-third of the buildings. These CGSs are situated as an extension of the adjoining clubhouses or at a level higher than the roof level of surrounding buildings in the old districts where 10-storey tenement buildings are commonly found.

Development	SG1 H1(m)	SG1 H1/Ht	SG1 h1(m)	Effective opening SG1/Ht	Design considerations
The Orchards	43	0.34	6	7%	Air Ventilation
31 Robinson Road	25	0.19	6	12%	Adjoining podium clubhouse
Harbour One	25	0.18	5.3	12%	Adjoining podium clubhouse
The Masterpiece	45	0.19	6	7%	Adjoining clubhouse & in an old district
Larvotto	60	0.50	14.5	22%	Air Ventilation (statutory requirement)
i-home	60	0.33	5.3	5%	Urban renewal project in an old district

Fig. 8.30 – Design considerations of CGSs in Hong Kong

In order to achieve a 4.5m clear height in a CGS as per the government requirement in Hong Kong, 5.3-6m floor-to-floor heights are mostly found. The Buildings Department of Hong Kong would not approve more than 6m high CGS floors to avoid the abuse of height concession subject to technical justification on environmental necessity. For instance, the project of Larvotto, Hong Kong, 14.5m floor height of CGS was designed for wind path penetration as required by the Planning Department of Hong Kong.

1.2-1.5m high glass balustrades or parapet walls are installed at the perimeter of CGSs. Hence, it results in a 3m opening above the balustrades or parapets in typical cases of CGSs with a 4.5m clear height. On average, in all selected cases in Hong Kong, the ratio of openings of CGSs to the overall building height is merely 2-3%. The sustainable building guidelines state that 20% permeability or 15m building separation is desirable for the continuous length of a building block of more than 60m. Compared with 20% permeability on the building length, the CGSs contributing to natural ventilation in the urban context is insignificant. Even for those cases with CGSs at 60m, the ratio of CGS opening to the CGS level from the street level is about 5%. Furthermore, if it is adopted that 20% permeability or 15m separation for the continuous length of a building block in a vertical dimension, only the project of Larvotto, Hong Kong can achieve.

Outdoor Thermal Comfort

Mak et al. (2005) stated that CGSs at high levels with wind-breaking designs, such as parapets and vegetation, shall be considered to avoid windy, thermally uncomfortable conditions.[360] Aiming

at improving building permeability and urban microclimate, locations, orientations and openness of CGSs are deliberately designed with due consideration of vegetation for air filtering, wind-breaking, noise shielding and air cooling.

Vegetation structures with deliberate height and species variation intend to ameliorate wind at high levels but not block daylight penetration. Vegetation shall be wind resistant, grow under shade, have less irrigation, and not be uprooted, especially for trees or plants with large leaves.[361] A example of an appropriate plant species is in Fig. 8.31. Native species are selected for biodiversity, less irrigation, and avoiding bleeding from mosquitoes.

Fig. 8.31 – Extracted from *Pictorial Guide to Plant Resources for Skyrise Greenery in Hong Kong*

Fig. 8.32 – Vegetation structures with deliberated height and species variation intend to ameliorate wind and shield strong sunlight for a comfortable green environment in De Novo, Hong Kong (left) and Pinnacle at Duxton, Singapore (right)

Safety and windy condition shall be deliberately considered in the design, such as planting strips with trees or scrubs along the periphery of CGSs, which serve as windbreakers to ameliorate microclimate and outdoor thermal conditions and provide setback of looking from high levels to alleviate the fear of heights, especially for children and the elderly.

Energy Conservation for Recreational Amenities

Aiming at a low-carbon living environment, a CGS can act as a naturally-ventilated sky clubhouse and as an alternative to provide amenity facilities in a more energy-efficient way. One of the distinctive characteristics of the CGSs in Singapore is the energy-efficient design approach. Most of the CGSs in Singapore accommodate clubhouse or recreational facilities, except gym rooms, without air-conditioning, as illustrated in Fig. 8.33. These facilities are integrated into the CGSs with a thermally and visually comfortable environment. On the contrary, the provisions of air-conditioned clubhouses are commonly found in the cases of Hong Kong. Therefore, from the energy-saving point of view, Singapore's cases are more environmentally friendly than Hong Kong's.

Fig. 8.33 – Lincoln Suites, Singapore, has a clubhouse at the 24/F. Only the gym centre is enclosed and air-conditioned

8.4.5   Ecological Aspect

As discussed in the previous chapters, the ecological aspect refers to ecologically responsible and regenerative design approaches. The composition of naturalness involving vegetation structure and layers, flowering and rich in species offers a vibrant, lively visual amenity and facilitates urban biodiversity. However, none of the cases in both cities is explicitly designed to enhance urban biodiversity. For example, neither biodiverse roof nor wildlife-friendly building feature discussed in the previous chapter is found. It may be explained that the property developers would avoid any potential conflict with wildlife after occupancy, or ecologically responsible design is not advocated under the CGS design guidelines in both cities. On the contrary, the ecological aspect is related to minimising adverse ecological impacts on greenfield sites and conserving existing mature or rarely valuable trees.

Conserve Existing Trees / Existing Nature
One of the design intentions of considering CGSs above ground is to reduce the development footprint to conserve or minimise disturbances to the existing natural environment and ecosystems.

In Aria, Hong Kong, the site comprises over 60% of the land on sloping ground and is heavily vegetated with many mature trees and existing eco-habitats. Moreover, to avoid disrupting the

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existing natural environment, the building footprints are restricted within 35% of the land areas, and the recreational spaces are designed at multi-levels of the buildings, as shown in Fig 8.34. Hence, the existing ecological contexts can be maintained, and the natural environment offers residents scenic views of lush green.

Fig. 8.34 – An aerial view (left) of Aria, Hong Kong, and an image (right) at the CGS viewing a heavily vegetated natural environment

8.5   Conclusion

In conclusion, communal green spaces at multi-levels can potentially contribute to improving human thermal comfort and urban microclimate; providing green space for communities; providing individuals with a place away from busy urban life; improving community integration and social cohesion so that people of different ages improve their health; understanding and being intimate nature. These positive impacts are exemplified in the case studies of CGSs. However, none of the cases can contribute to all these benefits.

Purpose-led design of communal green spaces is proposed to advocate socially-oriented, environmentally-driven and ecologically-friendly design considerations for different direct and indirect interactions and the co-evolution of humans and nature at residential high-rises. The design criteria of the CGSs shall not only appeal to residential high-rises with a nominal amount of green but also advocate the CGSs to be liveable and enjoyable by frequent daily users comprising children and older adults. The design of CGSs is recommended to include considerations of specific environmental, social and ecological functions. Qualitative and

quantitative designs of CGSs are equally important. For instance, CGSs located at relatively low levels emphasize building permeability with sufficient headroom. CGSs at high levels serve the purposes of recreation, social gathering, and ambient cooling. CGSs with wider spaces and attractive amenities act as naturally ventilated clubhouses. Scattered CGSs with extensive planting integrate well with circulation spaces at multi-levels of a building.

Daily activities in green spaces, including physical exercises, gardening, walking, jogging, and even viewing nature, can offer psychological and physiological benefits to urban dwellers. Besides, children and older adults are frequent users of communal green spaces during the daytime; meanwhile, working adults spend time in these spaces for leisure or exercise in the evening time. Further to the discussions in the previous chapters and the observations from the case studies, design considerations of CGSs are suggested as follows:

(i)   Vegetation volume and multi-dimensional vegetation rich in species enhance the level of variety as the natural world has.

(ii)   CGSs indirectly help supervise children and older adults in impoverished urban neighbourhoods and enhance their exposure to nature and outdoor activities.

(iii)   Garden-based activities, such as picking fruits, planting seeds or taking care of vegetables, nurture positive ecologically responsible attitudes and enhance social interactions amongst neighbours. Hence, active participation by residents and appropriate operational management of the CGS are important.

(iv)   A safe, secure and spacious environment offers a feeling of adventure and semi-wildness. Children can freely use and easily modify materials in building their playground. Special features like water features and recreational amenities catch their attention and stimulate their soft fascination.

(v)   Design of soft landscapes shall consider native or non-invasive species of plants, vivid vegetation structures, appropriate soil depths and substrate compositions, and features that attract or facilitate bio-habitats like a butterfly-friendly environment.

(vi)   CGSs should be scattered at multi-levels and adjacent to living areas of residence to stimulate intimate touch with green in daily life. Doorstep CGS areas are recommended. Residents are encouraged to maintain the vegetation and even plant their vegetation there to encourage collective ownership of communal green spaces, developing a deep affinity with nature. Furthermore, children are allowed to play outdoors with neighbouring

children under better supervision from their parents. Older adults have more chances to stay outdoors and interact with neighbours.

Chapter 9: Conclusion

This thesis aims to study human-nature interactions in a compact high-rise city and investigate a new form of biophilic design in high-density urban contexts. The study has examined the significance and design considerations of human-nature interactions for the benefit of humans and nature, particularly in high-density, high-rise contexts. The hypothesis is that human-nature interactions are significant in urban living and communal green spaces facilitate these interactions at residential high-rises. Different types of direct and indirect human-nature interactions facilitate the co-evolution of humans and nature.

The literature review has informed that the meaning of nature is multi-faceted and varies from different philosophical points of view. As discussed in Chapter 2, nature is interpreted as a scene, a thing, a principle, a resource or a romantic appreciation from human perspectives. A clear separation between humans and nature is exhibited. Environmental ethics poses a paradigm shift from human-centric to nature-centric interpretations of nature. Culture and civilisation also influence interpretations of instrumental and intrinsic values of nature and respective human-nature relationships. Therefore, human-nature interactions are advocated broadly, ranging from anthropocentric to non-anthropocentric according to different forms, statuses and situations of nature and human activities. The framework of human-nature interactions for the co-evolution of humans and nature in urban contexts is summarized in Fig. 9.1.
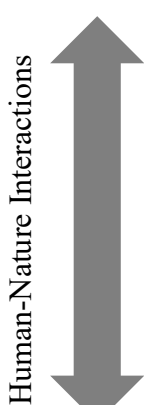
Anthropocentric Human–Nature Interactions Non-anthropocentric	Design for Human	Psychological/physiological aspects on a personal level (e.g., visual enjoyment & sensory pleasure; stress relief & attention restoration; soft fascination)
		Social aspects on a community level (e.g., community garden, urban farming)
		Environmental aspects on a district level (e.g., improving micro-climate for thermal comfort; mitigating urban heat island effect)
	Design for Human with Nature	Appreciation of the existence of nature (i.e., ecosystems) for its non-instrumental / intrinsic value
		Influence of human behaviour and attitude to protect the biotic community for its intrinsic value
	Design for Nature	Ecologically responsible built environments harmless to the ecosystems
		Regenerative built environment beneficial to the ecosystems

Fig. 9.1 – Human-nature interactions for the co-evolution of humans and nature in urban contexts

Summary of the Study - Scientific Inquiry vs Design Research

In this study, the first research objective examines the interpretation, perception and experience of nature in urban living from urban dwellers' perspectives. The second research objective identifies the key substances to advocate human-nature interactions. The third research objective outlines the design opportunities for human-nature interactions in communal green spaces at residential high-rises.

The first and second research objectives refer to scientific inquiry as a theoretical construct is followed by conceptualisation with inquiry activities. A series of photo-elicitation studies are conducted to investigate how urban dwellers consider or associate nature in daily life. Urban dwellers are asked to express their interpretations of nature in their everyday urban life by taking photos and writing. The photos illustrate framing or representations of nature from urban dwellers' perspectives. Their narratives imply diverse spiritual or physical connections to nature, followed by content analysis to depict key substances in human-nature interactions. A hypothetical model of human-nature interactions SOA (space, object and activity) model is formulated. Another set of photo-elicitation surveys and case studies were carried out. This comes up with the conceptualization of hypothetical solutions for the new form of biophilic design in the high-density, high-rise contexts based on the SOA model; and nature-centric design strategies for nature interactions with individuals, communities and ecology.

The third research objective relates to research into design as design practice for CGS (communal green space) is evaluated. Case studies, together with experiential engagement activities, are carried out to explore and examine design opportunities for interacting with nature in urban contexts, in which the empirical inquiries reveal an in-depth understanding of a phenomenon, event, activity or process within real-life contexts, especially for investigating a complex setting with multiple pertinent variables of human-nature interactions in communal green spaces. The current designs of communal green spaces are reviewed. Policies and incentives for the design of communal green spaces and green building criteria on communal green spaces in residential buildings in Hong Kong and Singapore are studied, followed by case studies in both cities. Discussions on multi-level communal green spaces in response to the psychological, physiological, social, environmental, and ecological aspects are carried out. Design criteria and considerations

of multi-level community green spaces to advocate human-nature interactions are proposed.

Research Objective 1 - Purposes and significance of urban dwellers to interact with nature

This study has examined the perceptions and experiences of urban dwellers in interacting with nature in urban living. In response to the Research Question 1, "What are the perceptions and experiences of urban dwellers to interact with nature in urban living?" the meaning of nature is multi-faceted and varies — culture and civilization influence urban dwellers' interpretation, particularly intrinsic values of nature. The elements associated with nature are ever-changing over time. The research participants interpreted nature as a scene, a phenomenon, a memory of the place, personal attachment, play and social spaces. They had an affinity to and demand for nature and notified conflicts at the interfaces of humans and nature in urban development.

This study identifies the positive and negative impacts on human-nature interactions in communal green spaces. As discussed in Sections 2.4 and 2.5, human-nature interactions positively affect people's psychological and physiological health, including stress reduction, attention restoration, soft fascination, mood and heart rate variability, and blood flow and pressure moderation. Furthermore, based on the literature review in Section 2.6, communal green spaces facilitate causal and purposeful social interactions, especially for a children-friendly living environment and an elderly-integrated neighbourhood. Meanwhile, as discussed in Sections 2.7 and 2.8, communal green spaces improve urban microclimate and facilitate garden-based activities to enhance people's ecological knowledge and nurture their eco-conscious attitudes and behaviour. Conflicts and negative impacts on interfaces of human-nature interactions in urban contexts are identified in Section 2.9.

Different sets of photo-elicitation surveys were conducted to investigate further the first research objective from the urban dwellers' perspectives. These surveys investigated whether urban dwellers appreciate the significance of human-nature interactions, how they interpret, perceive and experience nature in urban living, and whether their perception and experience are various from different ages. The key findings are summarized as follows.

(i)   The elements associated with nature are green, weather, open space, and park. They are ever-changing over time. Trees and the sky are the most common elements.

(ii)   Nature is a scene, a phenomenon to look at from afar. It refers to the perception or memory of the place and its association with personal stories is there. It also relates to experiences such as play and social spaces for children and older adults.

(iii)   People have an affinity to and demand nature. People like drawings and paintings on nature-related topics or grow their plants at their working and living places.

(iv)   Urban dwellers have notified conflicts at the interfaces of humans and nature in urban development. Limiting the growth of trees and endangering birds living in urban development are examples.

The research findings from the photo-elicitation surveys in Sections 5.2 and 5.3 show that interpretations of nature vary, are distinctive and even conflicting, such as nature as object vs scene, static vs ever-changing, and scientific vs romantic, which are closely related to the philosophical review in Section 2.2. It revealed that the meaning of nature for urban dwellers is multi-faceted and relates to their own experiences and perception. Their perceived values of nature are the crux of their interpretation of nature and intention to interact with nature, which are summarised under three perspectives (i) human relies on nature, (ii) human co-exists with nature, (iii) human intervenes in nature. As elaborated in Section 5.3.2, the key substances are similar despite different interpretations and perceptions. Green is the most common substance, and ever-changing weather ranks second. These key substances stimulate people in association with nature. These substances stimulate people's inherent affinity to nature, and they appreciate nature's intrinsic value by noticing conflict with nature and the ecosystems due to urban development and human activity, which echoes the desktop studies in Section 7.2.

As interpreted from the findings of the photo-elicitation surveys in Sections 5.2.3 and 5.3.3, direct interactions with nature include visual enjoyment, sensation, cultivating vegetation and living with nature in daily life. Indirect interactions with nature comprise playing and socialising in green spaces or natural environments, personal memories or attachments to the existing or disappeared natural features, and artistic expression of nature.

These interpretations are varied in different age groups. The children and older adults' interpretation of nature in Section 5.4 revealed that nature serves as a visual symbol, medium, and association for playing and socialising. Green is a visual symbol of nature to children, while nature allows them to play and have fun. Older adults generally identify nature through a social

perspective in which nature is a place where they can socialise with friends and families. The criterion of nature varied as participants' perceived value of nature changed with their life experiences.

Research Objective 2 – A new form of biophilic design in high-density, high-rise contexts

In response to the Research Question 2, "What is a new form of biophilic design to advocate human-nature interactions in high-density, high-rise contexts?", a new discourse on biophilic design for human-nature interactions in high-density, high-rise contexts is presented on the SOA model.

Regarding the second research objective of the thesis, the urban-nature substances are interpreted from the research findings in Sections 5.2, 5.3 and 5.4, which share non-static and non-rigid characteristics while having their natural patterns of change. Although these substances are easily accessible in urban living, they are disconnected from urban dwellers without a proper design concerning the detailed discussion in Section 6.4.

The research findings of design considerations of communal green spaces for human-nature interactions in high-density high-rise contexts are summarized in the SOA model Fig. 9.2. To facilitate human-nature interactions in these contexts, nature-perceived settings, urban-nature elements and nature-based activities are vital considerations, as illustrated in Fig. 9.3 to Fig. 9.6.
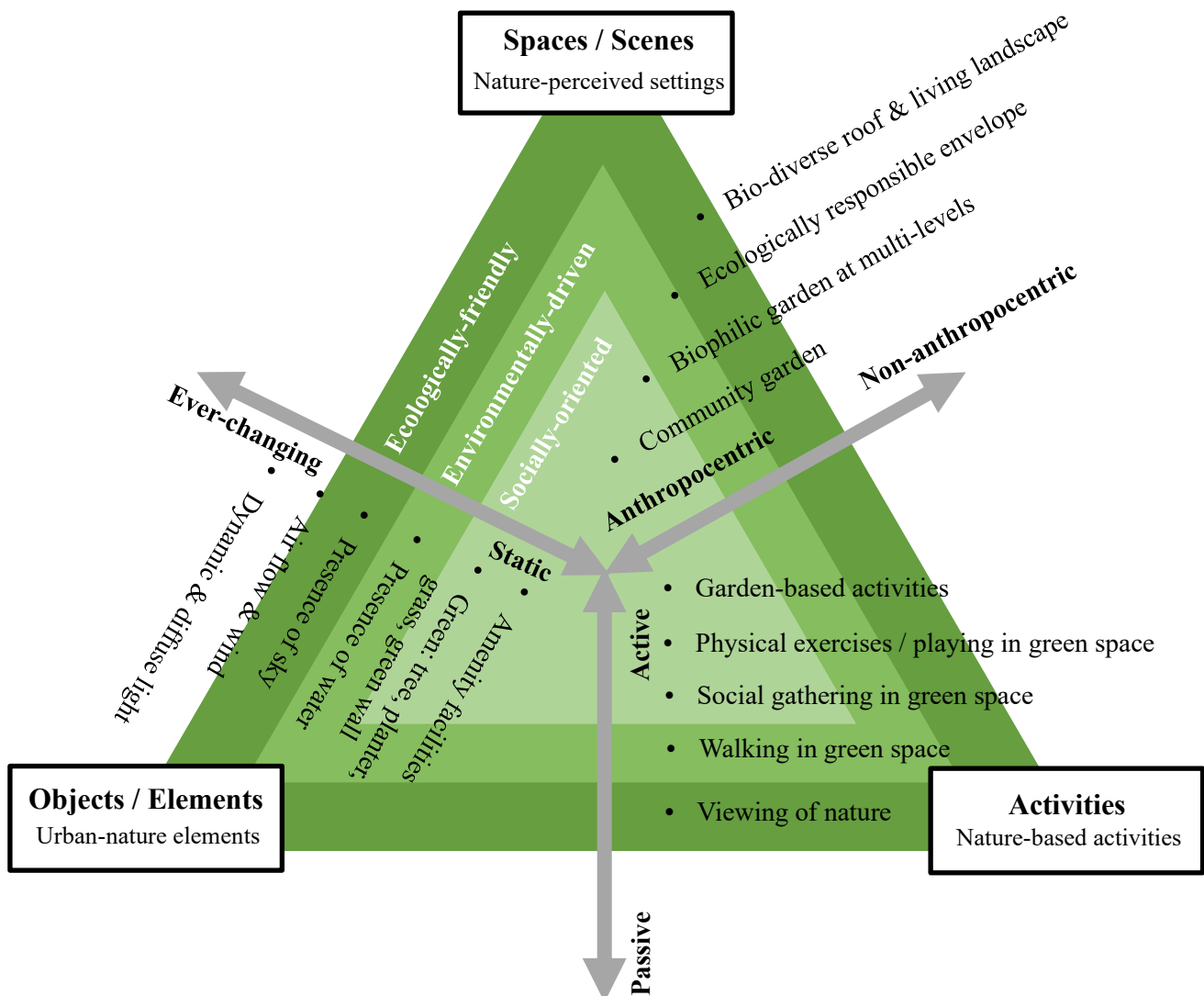
Fig. 9.2 – The research findings of design considerations of communal green spaces for human-nature interactions in high-density, high-rise contexts.
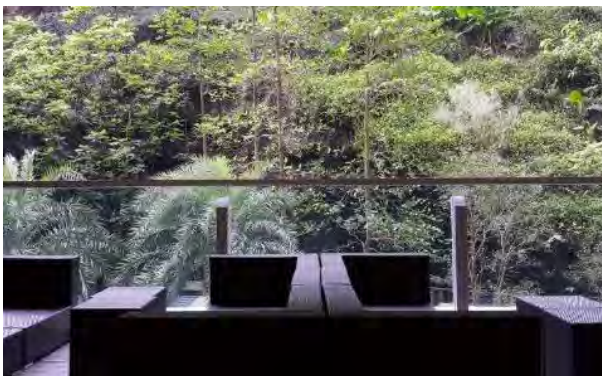
Fig. 9.3 – Nature-perceived setting

Fig. 9.4 – Urban-nature elements at a high level

Fig. 9.5 – Urban-nature elements at ground level   Fig. 9.6 – Nature-based activity

The research findings from the fourth photo-elicitation survey, as discussed in Sections 6.4.1, 6.4.2 and 6.4.3, reveal that locations with certain spatial and architectural qualities boost the interactions between humans and nature. Given the site contexts with or adjacent to the natural environment, the spatial design and urban setting facilitate direct contact with nature and create visual and multi-sensory connections with nature, as shown in Fig. 9.7. In the contexts of residential high-rises, panoramic and open, distant views are offered at communal spaces, instead of privileged living units exclusively, for residents' enjoyment, as exemplified in some cases of sky gardens in Sections 8.4.1 and 8.4.2.
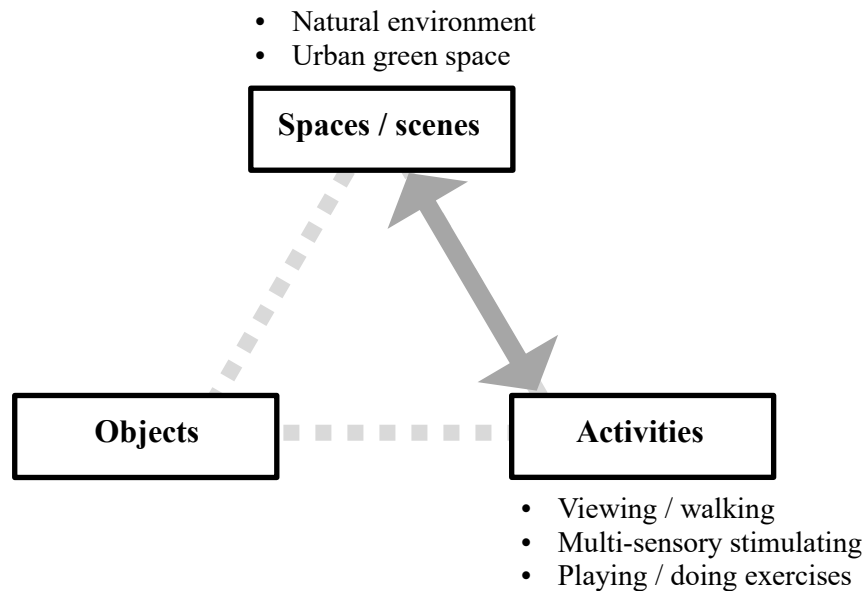
Fig. 9.7 – Scenario 1 of SOA model: Nature interactions with nature-perceived setting

The findings also identify that green and weather are the two main elements representing urban nature, while trees and sky are the most common elements found in photo-elicitation surveys. As delineated in Section 5.3.3, planting brings living nature to urban dwellers, and thus, people

develop a stronger sense of nature upon the time and effort accumulated along the process. Old trees usually become symbolic features of collective memory or personal attachment to the place. Weather is a linkage to the exterior for urban dwellers. The sky is ever-changing throughout the day with the diurnal light condition due to sun circulation. People look at the natural change of the sky when searching for nature in the urban context. Water, natural materials, human and animals are the remaining categories that are possible but less significant to provide a sense of nature.
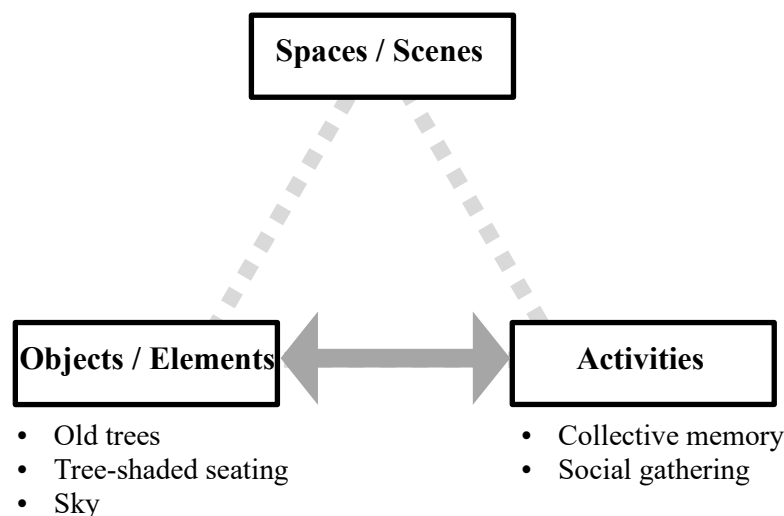
Fig. 9.8 – Scenario 2 of SOA model: Nature interactions with urban-nature elements

Architectural features such as skylights, retaining walls, bridges, and rooftops are associated with nature in people's minds, as analysed in Section 6.4.1. It is worthwhile to explore further what qualities shared among them have triggered public awareness and helped improve such places for both humans and nature, as illustrated in Fig. 9.8. The built environment is not limited in the design of buildings which the surrounding features should also be well-considered for total utilisation.

This study informs that people are aware of humans intervening against nature in urban development. As illustrated in Section 6.3.1.4, limiting the growth of plants, endangering animals' living, depriving interactions with nature and creating pollution and nuisances to the ecosystems are concerns. Thus, it supports the significance of environmental ethics and nature-centric design approaches.

The nature-centric design considers an ecologically responsible or friendly approach and a regenerative approach to the ecosystem's benefits. Referring to Sections 6.3.2.1 and 6.3.2.2, the

findings reveal that the research participants were able to find or associate with different ways of contributing to the growth or co-existence of nature in urban contexts, for instance, preserving existing trees, creating habitat for plants and animals in urban space, utilising underused urban spaces or infrastructure for greeneries, planting in multi-dimensions and building services or landscape design to facilitate ecosystems. The nature-centric design strategies in a high-rise and high-density city mainly include biodiversity roofs and vibrant landscapes, ecologically responsible facade design and biophilic gardens, as discussed in Section 7.4.

- Bio-diverse / brown roof
- Ecologically responsible façade

Spaces / Scenes

Objects / Elements

Activities

- Existing trees
- Native species
- Bird-friendly glazing
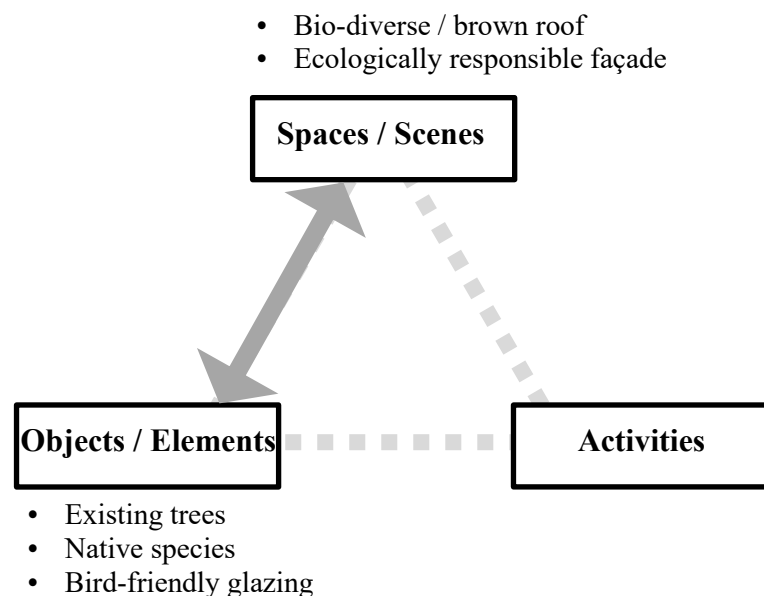
Fig. 9.9 – Scenario 3 of SOA model: Nature interactions with urban ecology

The literature review has mentioned that deficiencies in high-rise compact living comprise a high degree of anonymity and social isolation, a sense of insecurity, a lack of exposure to nature in daily life and hurdles for children's healthy development, as discussed in Section 3.2. Therefore, aligning with the third research objective of the thesis, design opportunities for human-nature interactions in high-density, high-rise contexts are explored. These design opportunities include form, space, process and intent. In Chapter 7, case studies on coexistence with nature and urban interventions for human-nature interactions were carried out.

Furthermore, human-nature interactions are built upon humans' discovery and acknowledgement of the co-existence, connection, and co-living of nature and humans, which was explored in the community engagement projects to understand what urban nature is to people. This research perspective ascertains that design for humans with nature brings either humans to nature or nature

to humans. As examined in Section 7.3.2, the case study has informed design intervention that brings people to outdoor activities in communal green spaces. The design allows flexibility and mobility, enabling children to learn, adults to relax, and elderlies to socialise with peers while surrounded by green spaces. It depicts how improvised spatial settings could activate purposeful social interactions with nature. On the other hand, the case studies of the transformation of undesignated spaces have showcased design interventions with urban-nature elements and nature-based activities to bring nature to humans. As demonstrated in Section 7.3.2, the improvised urban farm project under a flyover transformed an undesignated space for the community to explore and experience cultivating vegetables; meanwhile, it turned into a community hub, and neighbours found a sense of belongingness to the place. Furthermore, the organic rooftop farm experimental project brought participants' attention to the idea of interdependency in nature and the mechanism that biodiversity could provide. People are reminded of the natural processes that allow growth to occur, sun, rain, insects and birds, which need to be managed suitably but also co-dependent. The research findings have demonstrated design interventions in the existing communal spaces with dedicated urban-nature elements and nature-based activities that can activate and enhance human-nature interactions, as shown in Fig. 9.10.

- Undesignated space
- Communal space

Spaces / Scenes

Objects / Elements
- Planters
- Amenities

Activities
- Community gardening / farming
- Garden-based activities
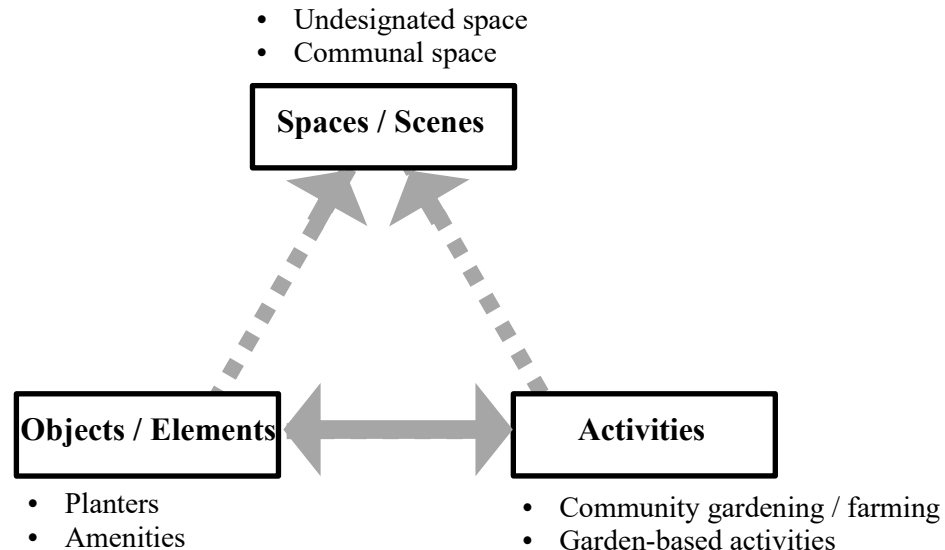
Fig. 9.10 – Scenario 4 of SOA model: Placemaking for human-nature interactions

Research Objective 3 – Design for human-nature interactions in communal green spaces at residential high-rises

In response to the Research Question 3, "What are design opportunities for human-nature

interactions in communal green spaces at residential high-rises?" this study identifies key substances of multi-level communal green spaces to advocate human-nature interactions at residential high-rises are summarized. As discussed in Chapters 6, 7 and 8, the key substances of multi-level communal green spaces for human-nature interactions in relation to psychological, physiological, social, environmental and ecological aspects are delineated in Fig. 9.11. Based on the SOA model established in this study, the design directions of communal green spaces at residential high-rises are developed in terms of nature-perceived settings, urban-nature elements and nature-based activities.

Nature-perceived settings

This study has elaborated that locations with certain spatial and architectural qualities boost the interactions between humans and nature, as discussed in Section 6.4.3. These qualities include spaciousness, flexibility in use, exposure to nature, weatherproofing and sun-shading. The research findings depict that CGSs purposefully improve the neighbourhood and social interactions by creating spacious, scenic, entertaining and safe green areas with children and elderly-friendly amenities. However, spatial design, accessibility and connectivity are pivotal factors for the popularity and usability of these spaces. These pocketed green spaces stimulate more causal or incidental interactions among neighbours. For instance, the CGS is located at a relatively low level, emphasizing the permeability of the building with sufficient clearance. The high-altitude CGS is used for recreation, social gathering, and ambient cooling. The CGS, with more expansive spaces and attractive amenities, acts like a naturally ventilated clubhouse. Refuge floors are good opportunities to be converted and co-used as fire refuge spaces and communal green spaces. Higher headroom is required for better daylight access and natural ventilation. The scattered doorstep CGSs can be integrated with the multi-level circulation spaces nearby living units for social interactions and intimate contact with nature. Naturally ventilated corridors and lift lobbies on residential floors are potentially for daily interactions with nature by inserting pocketed green spaces with vegetation, daylight, natural air and seating.
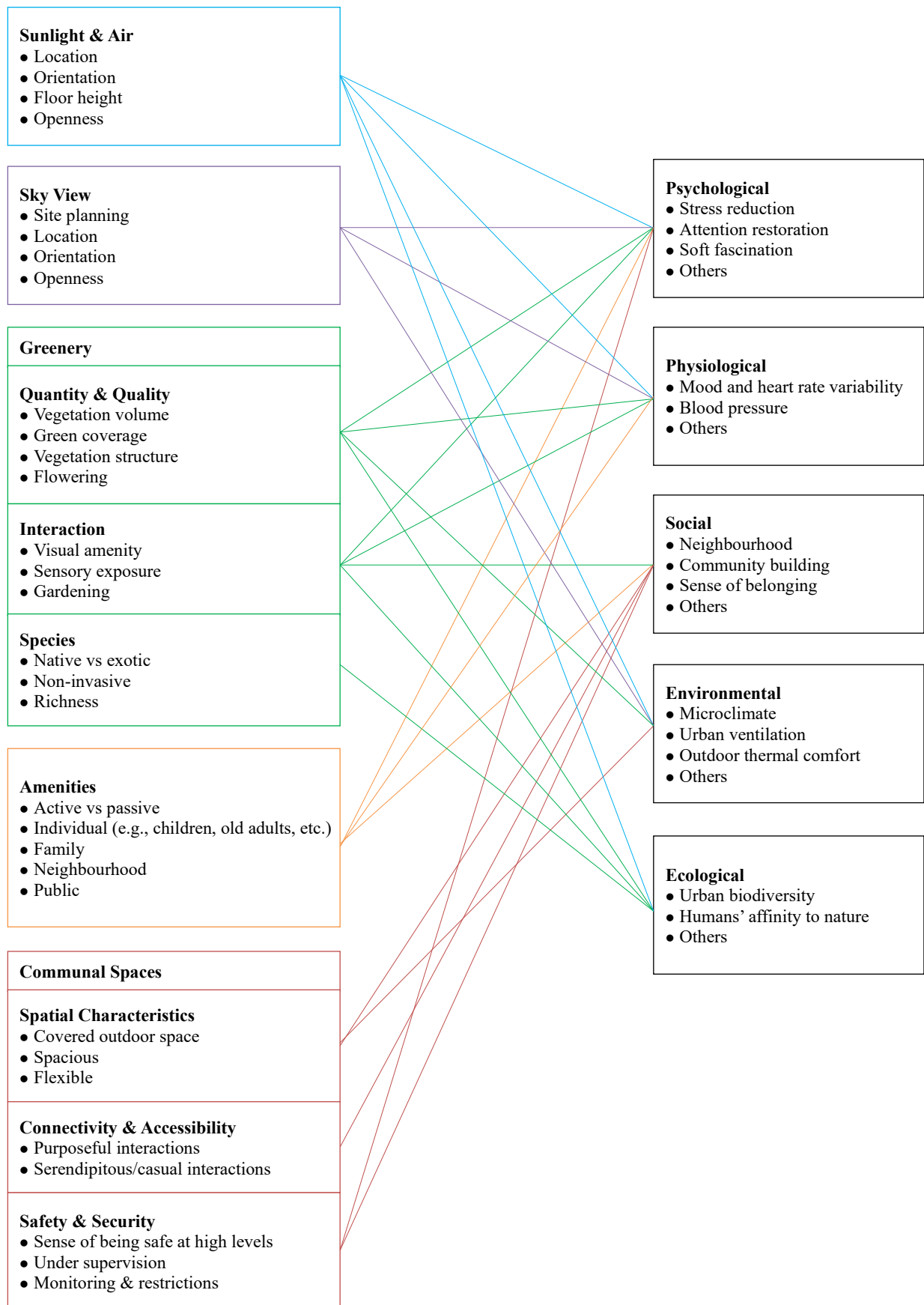
Fig. 9.11 – Key substances of multi-level communal green spaces to advocate human-nature interactions at residential high-rises

Urban-nature elements

The research findings affirm that greenery is the most demanding substance requested by urban dwellers. The urban-nature elements assist in creating a better living space and micro-climate that is beneficial to humans eventually rather than nature itself, as discussed in Section 6.3.3. In Section 6.3.1.1, multi-dimensional greenery offers visual enjoyment and sensory experience as relieving, restorative, and connected to nature. Trees are key contributors to natural experience; however, their presences at CGSs have concerns about windy conditions at high levels and future maintenance and replacement. Involving the structure and hierarchical structure of vegetation, the natural composition of flowering and the rich natural environment provide a vibrant, lively visual comfort to individuals. Urban dwellers prefer careful design and well-maintained landscapes over more natural alternatives based on the literature review and the photo-elicitation surveys. Furthermore, the fragrance of thematic vegetation can stimulate non-visual connection and sensory experience. Sunlight and air are also essential urban-nature elements for habitation and are considered the major comfort parameters in the photo-elicitation survey in Section 6.3.1.3. Even living in a small unit with limited outdoor vision, CGSs can provide all occupants with panoramic and open sky views. CGSs at high levels are designed to support and encourage such elements to integrate with our residential environments.

Nature-based activities

Leisure-related programs are the most closely associated with nature and are the activities during which people develop a profound physiological and psychological connection with nature, as elaborated in Section 6.4.2. Seating areas in communal green spaces contribute significantly to the level of visual, comfort-related, physical, and active human-nature interactions. As discussed in Section 8.4.2, amenities for landscape gardens with a scenic view, self-retreat and, reading in a peaceful environment; leisure walk with family and friends are the most popular. Furthermore, outdoor fitness-friendly spaces encourage residents to continue to engage in fitness-related activities, such as playgrounds, fitness stations and jogging tracks. Furthermore, this study identifies that garden-based activities are the most rewarding active interactions with nature, which positively impact psychological, physiological, social and ecological aspects, as discussed in the literature review. The concept of a community garden can be adopted to strengthen the neighbourhood and enhance a sense of belonging to a living place. Accessible planting facilities for those physically and mentally in need should be considered. The sense of accomplishment

during harvesting also reinforced the positive experience of human-nature interaction, motivating more connected with nature outdoors.

Research Contribution to Theory

This study contributes the findings to fill in the knowledge gaps in research on the topic of urban living with nature in a compact city by examining the significance and design considerations of human-nature interactions. It contributes to the body of knowledge of human-nature interactions in urban contexts for academic use.[a] The research findings affirm the significance of human-nature interactions in urban living and reveal urban dwellers' multi-faceted interpretation of nature in urban living and identify key substances for interactions with nature, which extends the biophilic design theories to the high-density high-rise contexts. This study establishes the SOA model of nature-perceived settings, urban-nature elements and nature-based activities and proposes additional patterns of biophilic design in high-density, high-rise contexts.

Research Contribution to Design Practice

In architectural design practice, multi-level communal green space acts as the new typology of residential high-rises; however, there was a lack of research findings on its impacts on human-nature interactions in urban living. This study suggests nature-centric design strategies for human-nature interactions, which contribute to architectural and urban design practice for planning urban settings, designing residential high-rises and revitalizing communal spaces with biophilic design for the co-evolution of humans and nature in urban contexts. This study reveals that the current design guidelines of CGSs merely focus on environmental performances with prescriptive dimensions, configurations and locations. With reference to the outlined biophilic design framework in high-density, high-rise contests, this study proposes essential substances of CGSs potentially contribute to multi-faceted positive effects on psychological, physiological, social,

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[a] The published papers based on the research findings of this study have been cited on the research papers below.
- Li, Y., Du, H. and Sezer, C. (2022) Sky Gardens, Public Spaces and Urban Sustainability in Dense Cities: Shenzhen, Hong Kong and Singapore. *Sustainability*, 14, 9824.
- Wang, Z., Miao, Y., Xu, M., Zhu, Z., Qureshi, S. and Chang, Q. (2021). Revealing the differences of urban parks' services to human wellbeing based upon social media data. *Urban Forestry & Urban Greening*, 63, 127233.
- Humera, M. and Corrao, R. (2018). Role of Sky-gardens in Improving Energy Performance of Tall Buildings. *Conference Proceedings of SER4SC (Seismic and Energy Renovation for Sustainable Cities) 2018, Catania, Italy.*

environmental and ecological aspects. Design criteria and considerations of the CGSs are suggested for architects' and urban designers' design references. Furthermore, this study signifies the qualitative and quantitate designs of the CGSs that advocate the policymakers to review the current policies, practice notes and incentives on the CGSs and the role of CGSs in the sustainable design of the residential high-rises.[b]

Research Conclusion

This study has examined that human-nature interactions are significant in urban living and communal green spaces facilitate these interactions at residential high-rises. The research findings affirm the significance of human-nature interactions in urban living. Direct and indirect human-nature interactions have positive impacts on psychological, physiological, social, environmental and ecological aspects. Direct and indirect human-nature interactions facilitate the co-evolution of humans and nature in urban contexts. "Design for humans" utilises nature for the benefit of humans; "design for humans with nature" allows humans and the ecosystems to co-exist; and

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[b] The findings of this study have been shared with the government officers, design professionals and students.

- Speaker, *"Experimental Interactions with Nature in the City"*, Hong Kong Gardening Society, Hong Kong, 6th April 2022.
- Speaker, *"Green Neighbourhood in High-density High-rise Cities"*, CPD webinar, The International Association of Elevator Engineers, Hong Kong, 5th November 2021.
- Speaker, *"Green Neighbourhood in High-density High-rise Cities"*, CPD webinar, Hong Kong Institute of Surveyors, Hong Kong, 18th October 2021.
- Speaker, *"Green Neighbourhood in High-density High-rise Contexts"*, seminar – Shaping a Sustainable Eco-City – Liveability, Harmonization, Regeneration, Graduates and Students Division, Institution of Civil Engineers Hong Kong Association, Hong Kong, 24th April 2021.
- Speaker, *"Interactions with Nature in the City"*, public lecture, Division of Landscape Architecture, The University of Hong Kong, Hong Kong, 15th March 2021.
- Speaker, *"Biophilic Urban Architecture"*, open class - City Of Symbiosis, Make a Difference School 2019, MaD, Hong Kong, 10th August 2019.
- Speaker, *"Biophilic Urban Architecture"*, design talk for exhibition of exploring Hong Kong's living style and cultures through architecture, Hong Kong Institute of Architects and Hong Kong Trade Development Council, Hong Kong, 29th June 2019.
- Speaker, *"Sustainable Urban Living with Sky Gardens"*, experience sharing session, Buildings Department, Hong Kong, 31st August 2018.
- Speaker, *"Green Neighbourhood in High-density High-rises Contexts"*, technical seminar, Institution of Engineering and Technology (IET), Hong Kong, 24th July 2018.
- Speaker, *"Design Research in Green Architectural Practice"*, CUHK School of Architecture Phd Seminar 2018, School of Architecture, Chinese University of Hong Kong, Hong Kong, 30th April 2018.
- Speaker, *"Sustainable Urban Living with Sky Gardens"*, guest lecture, City University of Hong Kong, Hong Kong, 2nd March 2018.
- Speaker, *"Urban Living with Sky Garden"*, CPD seminar, Hong Kong Institute of Architects, Hong Kong, 16th November 2017.

"design for nature" considers human intervention for the benefit of the ecosystems.

This thesis reveals the inter-relationships among nature-perceived settings, urban-nature elements and nature-based activities to facilitate human-nature interactions, and establishes the SOA (space, object and activity) model to present a new discourse on biophilic design for human-nature interactions in high-density, high-rise contexts. These interactions can be initiated by nature-perceived settings, urban-nature elements and nature-based activities. The nature-perceived settings range from anthropocentric (i.e., artificial resemblance of nature) to non-anthropocentric (i.e., preserved natural environment). The urban-nature elements include greenery, sky, sunlight, wind, water and amenities. The nature-based activities comprise viewing nature, walking in green spaces, social gathering in green spaces and garden-based activities.

In view of limitations and opportunities for human-nature interactions in high-density, high-rise contexts, possible patterns and specific forms of biophilic design are proposed. Hence, strategies for human-nature interactions from individual, community and ecological perspectives are identified, and design interventions for multi-level communal green spaces at residential high-rises are evaluated. Urban naturalness positively influences urban dwellers in high-density, high-rise contexts.

This thesis contributes to architectural and urban design practice for planning urban settings, designing residential high-rises and revitalizing communal spaces with biophilic design. Purpose-led design of communal green spaces advocates socially-oriented, environmentally-driven and ecologically-friendly design considerations for different direct and indirect interactions and the co-evolution of humans and nature at residential high-rises. Direct and indirect interactions with nature can be facilitated in multi-level communal green spaces through design interventions with nature-perceived settings, urban-nature elements and nature-based activities. These findings inform new design directions for communal green spaces at residential high-rises.

Research Limitation

Non-probability sampling methods, including convenience sampling and purposive sampling, were adopted. The samples might not be representative of the entire population of urban dwellers. Moreover, the sampling periods were short; the photos taken by participants might have been

affected by the weather in a particular season.

This thesis study commenced in 2013 and was substantially completed in 2020. Meanwhile, the governments of Hong Kong and Singapore have been advocating sustainable building design by updating or imposing new policies, regulations and incentives continuously. Their latest changes may not be entirely incorporated.

Future Research

The idea of the co-evolution of nature requires further studies on implications to strategic planning for urban development. Design for nature happens in purposed spaces or features like communal green spaces and undesignated spaces to regenerate the place's vibrancy and natural substances. Meanwhile, it can occur in undesignated spaces or underused spaces where nature-centric design approaches may help regenerate or revitalise the place.

The implication of urban and architectural design practice with community engagement processes may contribute to human-nature interactions. Therefore, design for humans with nature shall not be rigid and shall be multi-faceted, people-initiated and community-based, which requires more design research.

Design of engagement processes will also develop design features or displays associated with people's interpretation of nature. People engagement enhances a sense of belonging in the design and operation stages. In the design stage, they think about the related natural elements with the site or end-users who see their works. In the operation stage, they have a sense of belongingness to their works and tell stories behind their interpretation of nature to others. For instance, older adults identify nature through a social perspective in which nature is a place where they can socialize with friends and families and even consider green as a necessary element. The older adults' attainment and stories with nature have been engraved into the centre's interior design. When they come back to the centre, they can share their drawing concepts and experience of the participatory workshop with others, which they develop a sense of belongingness and ownership of the place.

Fig 9.12 – Engagement workshop for creating a green art wall.

Furthermore, through an experiment conducted using skin conductance level (Burnard & Andreja, 2015), which is an indicator of emotional stimulation, fell found that skin conductance respondents decreased when participants were placed in a room with wood elements after a stressful task, when compared to a room without wood, showing the stress-relieving effects of wood.[362] The biophilic design, such as the painted greenery's organic shapes, has also proven beneficial in physiological and cognitive fields. It decreases blood pressure and skin conductance and increases short-term memory and positive emotions, making the biophilic design well-suited for the elderly centre (Yin et al., 2018).[363]

Fig. 9.13 – Community engagement for the new renovation of the neighbourhood elderly centre

Participatory practices, such as the creative painting workshop facilitated by architects, also encourage a stronger sense of belonging and community ties. According to a case study conducted by the Hong Kong Housing Authority (Kee, 2015), community participation through a series of engagement activities, such as the "names of the new estates was written in Chinese calligraphy by a renowned resident of the old estate", created a more transparent design process to the renovation through knowledge illumination, and, helped strengthened the collective memory and fostered a stronger sense of belonging and ownership to the newly redeveloped estate.[364] This process of co-creation and collective participatory practices with the community can possibly develop a model with the biophilic design element identified in this research body. Further research on these design practices for creating a biophilic built environment is suggested. Much further study is needed to transform the two-dimensional quality of previous studies into a spatial interpretation of biophilic design.
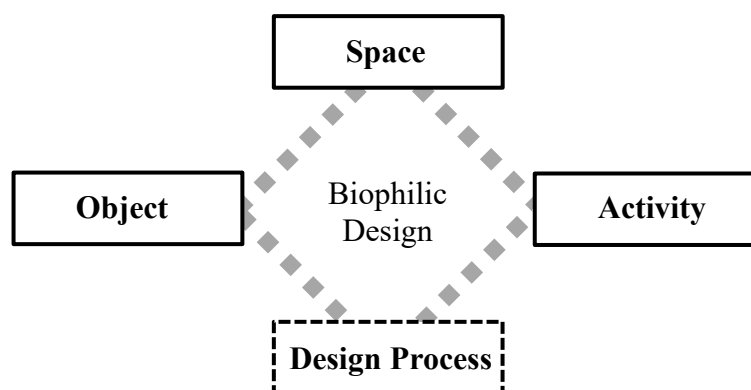
Fig. 9.14 – A hypothetical model for further research

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Appendices

Glossary

Communal Space

Communal space implies a space for communal use that is not used by a single entity solely. However, the interpretations of communal use are various in terms of different degrees of communality.

Communal spaces at residential estates can be distinguished into the following categories:

(i)   Space is dedicated for public, including residents and non-residents, to access and use, such as setback areas from the site lot boundaries for widening of pedestrian paths or roads, providing spaces for recreational use, or allowing spaces for maintenance of the building, utilities or slopes. These communal spaces can be used by the public and maintained by the property agent or owners of the residential estate.

(ii)   Space is designed for all residents, visitors and property management staff to access and use, such as circulation areas and pathways from the entrances of the estate to the individual tower blocks.

(iii) Space is purposedly built for all residents to use for leisure, recreation and entertainment, such as gardens, playgrounds and landscaped areas.

(iv)   Space is limited for specific groups of residents to access and use in view of security and property management. For instance, residents can only access the residential tower block and floor of their apartments. They need to present their access cards to entry the tower block at the entrance and use the lift to reach the specific floor. The communal spaces are mainly for circulation. In some cases, some recreational spaces are located at the tower block and dedicated for residents living at the block to use exclusively.

(v)   Space is inaccessible by residents but owned by residents, such as inaccessible roofs, facades and ancillary areas for building services systems and equipment or property management operation.

Communal Green Space

Communal green space describes communal space with presence of greenery. The presences of greenery can be considered as follows:

    (i)   Greenery is purposedly built due to the residential development, such as vegetation with planters, green walls and green roofs.

    (ii)   Greenery exists within the premises of the residential development, such as existing trees. The existing trees may be retained, transplanted or felled due to construction of the residential development.

    (iii)   Greenery exists outside the premises of the residential development, which acts as a scene and part of the existing eco-system that the residents interact with.

Sky Garden

A communal green space at a high level, which is an open, covered or partially covered naturally ventilated landscape area.

Appendix to Chapter 5.2 –

(A) Photo-Elicitation Survey – Urban Dwellers' Daily Records of Nature

Number of Respondents: 30

Number of photos: 262

Age: 25-34 (60%); 35-44 (33%); 45-54 (7%)

Gender: Female (73%); Male (27%)
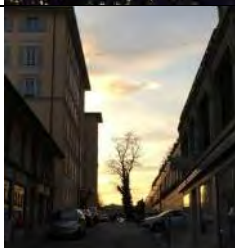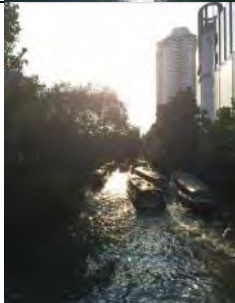
Location: Hong Kong

Appendix 2   Photo-Elicitation Survey – Urban Dwellers' Daily Records of Nature

Survey Record No.: 1
Respondent: 1   Gender: Female   Age: 25-34
Location: Hong Kong   Date: 16.4.2016 - 23.4.2016

No.	Photo	Description
(A)1-1		Nature is always around us but we are seldom aware of.
(A)1-2		Don't take for granted everything that nature gives you.
(A)1-3		Nature is the natural painter of any masterpieces in the world
(A)1-4		Nature is the last thing to be remembered in human development.
(A)1-5		Everything in nature is a gift.
(A)1-6		The aesthetic beauty of nature heals us

| (A)1-7 | | Nature should be something that we respect, we appreciate, and we fear of. |

Appendix 2　　Photo-Elicitation Survey – Urban Dwellers' Daily Records of Nature

Survey Record No.: 2
Respondent: 2　　　　　　　　　Gender: Female　　　　　　　　　Age: 25-34
Location: Hong Kong　　　　　Date: 21.4.2016 - 27.4.2016

No.	Photo	Description
(A)2-1		A touch of greenery in the office; a sip of nature. (原文：辦公室內的一點綠，一點 "自然"。)
(A)2-2		The mango tree at the front door cheers for me every morning when I leave home. 😊😊 (原文：每天早上出門，家門口的芒果樹，總像為我加油。😊😊)
(A)2-3		In the weekend that is not too hot, I enjoy walking along this shady trail instead of taking any vehicle. (原文：天氣不太熱的周末，總愛走路代替乘車，走走這樹蔭小路。)
(A)2-4		N/A
(A)2-5		On my way to work, I see the long-awaited sunshine, getting energized. 🌞🌞 (原文：上班路上，看到了久違了的太陽，精神抖擻。🌞🌞)
(A)2-6		While being accompanied by the blu-ray computer at office, I gaze at the splash of green outside, wishing to walk through it. 🌿🌿 (原文：辦公室內與電腦藍光為伴，心中卻希望整天呆望窗外的一片綠，甚至置身其中。🌿🌿)
(A)2-7		Busy… Busy … Busy… On a busy day, the chance for us to get in touch with the nature is almost zero… and my only plantation at home is a cactus. However, when I saw it today, it seemed to be an oasis in the desert. (原文：忙、忙、忙…原來忙碌的一天，能夠與自然接觸的機會近乎零…家中唯一的植物是仙人掌…今天看到它，像是沙漠中的綠洲…)

Survey Record No.: 3
Respondent: 3   Gender: Female   Age: 25-34
Location: Hong Kong   Date: 20.4.2016 - 26.4.2016

No.	Photo	Description
(A)3-1		Under the big tree, human is really insignificant. (原文：在大樹下，人真的很渺小。)
(A)3-2		The strongest foundation!
(A)3-3		It was very refreshing after a rainstorm! Mirror Effect.
(A)3-4		Nature should be around the corner, should be touchable, should be a shelter to people, but not artificial.
(A)3-5		A beautiful gift from the nature, it brings hope and happiness to life.
(A)3-6		A sudden rainstorm washed away monday blues...
(A)3-7		The nature has gradually submerged in the buildings; fish ponds and homeland are gone. (原文：大自然慢慢淹沒在村屋樓房中；魚塘和家園都沒有了。)

Appendix 2   Photo-Elicitation Survey – Urban Dwellers' Daily Records of Nature

Survey Record No.: 4
Respondent: 4   Gender: Female   Age: 25-34
Location: Hong Kong   Date: 24.4.2016 - 1.5.2016

No.	Photo	Description
(A)4-1		This little garden is a combination of natural and artificial scenery, this allows people to feel the nature in the geometrical and symmetrical garden planning.
(A)4-2		This pavement is surrounded by big trees, inside the city, people can also feel the natural environment: big trees, trees shade, and slowly falling leaves.
(A)4-3		The beach, the breeze from the sea, the wide sea scenery are very enjoyable. People who live in a fast pace of life in the city, like me, can feel the time seems to slow down here.
(A)4-4		The power of natural growth.
(A)4-5		A resting place is surrounded by trees. It is also a quiet area inside the nature.
(A)4-6		Talk like these two women in the picture, enjoy this serenity. ☀️ 🌲
(A)4-7		When I stare on the sky, the shadow of trees makes me feel peaceful.

Survey Record No.: 5
Respondent: 5   Gender: Female   Age: 35-44
Location: Hong Kong   Date: 24.4.2016 - 27.4.2016

No.	Photo	Description
(A)5-1		Why such a photo was taken? It was because I saw a beautiful sunset when I walked past a MTR station, yet its view was blocked by a lot of buildings nearby. The so-called nature was indeed very limited. (原文：點解會影呢張相？因為琴日行過地鐵站見到個日落幾靚，但好多樓遮住曬，所以想影低。所謂大自然其實好有限。)
(A)5-2		It is in fact a stone, which belongs to the nature. However, it was turned into an art piece and placed in the human world in the form of Art. (原文：其實佢係石頭，係屬於大自然，但係變左一個藝術品，用藝術品嘅方式，進入左人嘅世界。)
(A)5-3		We twisted the nature into a form that we wanted. (原文：我地將大自然，扭成一個我地想要嘅模樣。)
(A)5-4		We are so lazy that we don't even plant the trees. (原文：我地連樹都懶得種。)

Appendix 2   Photo-Elicitation Survey – Urban Dwellers' Daily Records of Nature
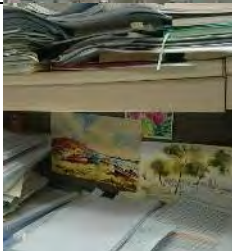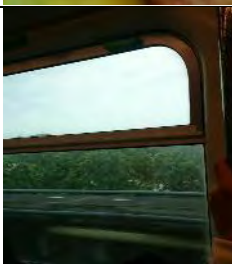
Survey Record No.: 6
Respondent: 6   Gender: Female   Age: 35-44
Location: Hong Kong   Date: 17.4.2016 - 22.4.2016

No.	Photo	Description
(A)6-1		When I am at home, the only nature I can find is this.
(A)6-1		It's cool to wait the bus under the tree, always can hear bird's singing.
(A)6-2		I can have a feeling of nature only by looking at the paintings. 😅
(A)6-3		😅 Healthy food from the nature.
(A)6-4		Nature is out there.
(A)6-5		Human beings. 😜
(A)6-6		The moonlight.

Appendix 2   Photo-Elicitation Survey – Urban Dwellers' Daily Records of Nature

Survey Record No.: 7
Respondent: 7   Gender: Female   Age: 25-34
Location: Hong Kong   Date: 23.4.2016 - 29.4.2016
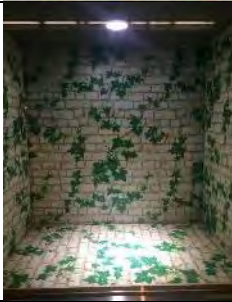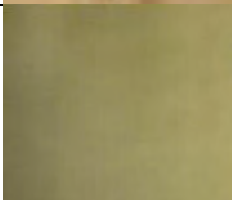
No.	Photo	Description
(A)7-1		The nature is something vibrant to me.
(A)7-2		Learning to expect the unexpected, rapid changing nature.
(A)7-3		Try to get close to nature in office.
(A)7-4		Enclosed nature, just like myself planting in office.
(A)7-5		My unfinished painting.
(A)7-6		Plant has a strong adaptability to environmental. This is how they survive in nature.
(A)7-7		Weekend is a good time to return to nature.

Appendix 2   Photo-Elicitation Survey – Urban Dwellers' Daily Records of Nature

Survey Record No.: 8
Respondent: 8   Gender: Male   Age: 35-44
Location: Hong Kong   Date: 21.4.2016 - 27.4.2016

No.	Photo	Description
(A)8-1		I walk past this path everyday, witnessing it from green to leafless and now it becomes "lively" again!
(A)8-2		It would be nice to have a walk everyday in this park.
(A)8-3		So many tortoises! Amazing!
(A)8-4		City Oasis.
(A)8-5		Nature within a 'touching' distance.
(A)8-6		Natural green roof! The plant finds its way to survive.
(A)8-7		The 'forest' is close to a housing estate in Taiwan.

Survey Record No.: 9

Respondent: 9   Gender: Male   Age: 35-44

Location: Hong Kong   Date: 16.4.2016 - 22.4.2016
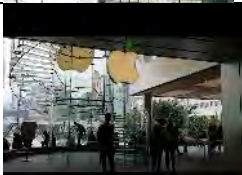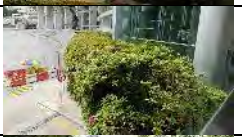
No.	Photo	Description
(A)9-1		A very old tree (Ficus microcarpa) in Ma Tao Wai estate.
(A)9-2		Near by the Ficus microcarpa, some more trees there next to the bus station.
(A)9-3		BQQ at Mei Foo.
(A)9-4		Passer montanus (Mahjong), one of the most common birds in Hong Kong.
(A)9-5		Pigeon in the city, taking rest at the lamp on the road.
(A)9-6		The pigeons were standing at the lamp next to a MTR construction site, the site was previously a small green area which was also the pigeon's home.
(A)9-7		Heavy rain in the morning.
(A)9-8		King George V Memorial Park, Kowloon. This is the first park I go with my parents when I was still a baby 40 years ago. Full of good memory and glad it is still there.
(A)9-9		Trees at both side of Argyle Street, near to the Kowloon Hospital.
(A)9-10		Ma Tao Wai road playground.

(A)9-11		Trees on the street next to the Ma Tao Wai road playground.
(A)9-12		Palm trees on the street at night near Austin road. Date time they do Photosynthesis and giving out oxygen, while at night it becomes completely different, the nature was so amazing.
(A)9-13		N/A
(A)9-14		Little flower net to the road.
(A)9-15		Plant outside a small shop.
(A)9-16		A strong little plant successfully survived in the middle of the road.
(A)9-17		Fish in the pool at a park.
(A)9-18		A tree with most of it's dropped at Ma Hang Chung road, looks like it is not as healthy as in the past.
(A)9-19		At Ma Hang Chung road, the root of the tree was being covered with a warning sign, looks like it was due to the homeless pigeon at the other end of the road.

(A)9-20		Simply few trees with different colours can become a beautiful picture. Life can be just that simple.
(A)9-21		"Apple" shop cannot find real apple but you can see some real trees outside.
(A)9-22		A small green area in Central CBD.
(A)9-23		Pigeons living at the old Central market building.
(A)9-24		Many many old trees and birds next to the Central government office building.
(A)9-25		A man taking rest under the old tree.
(A)9-26		St. John's Cathedral is a quiet place with trees around and a grassplot. I often came when I feel upset as it was just next to the office. This place helps me to relax and passed through a lot of tough moments.
(A)9-27		Azalea outside the bridge between HK Park and Citibank Tower, it bloom around Jan/Feb time, full of purple and pink flowers, very beautiful.
(A)9-28		The HK Park.

(A)9-29		An old Ficus microcarpa at Kowloon park.
(A)9-30		Full moon in the sky.
(A)9-31		A cat living in a restaurant.
(A)9-32		The ocean in Lei Yuen Mon.
(A)9-33		A dog.
(A)9-34		The HK victory harbour.
(A)9-35		People living in Kowloon can see the lion rock mountain.
(A)9-36		Matthiola incana, my little plants in the office.
(A)9-37		The sea and a beautiful sunset. 🌞

Appendix 2   Photo-Elicitation Survey – Urban Dwellers' Daily Records of Nature

Survey Record No.: 10
Respondent: 10   Gender: Female   Age: 35-44
Location: Hong Kong   Date: 19.4.2016 - 25.4.2016
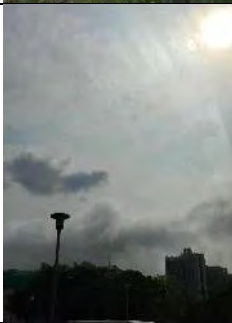
No.	Photo	Description
(A)10-1		Morning Tony, I take it this morning.
(A)10-2		The gift from god.
(A)10-3		Nature Architecture.
(A)10-4		Rainy day; slide on the road.
(A)10-5		The Natural Setting. (原文：自然報局。)
(A)10-6		Sunny? Rainy? It's all depends.
(A)10-7		Protection wings.

Survey Record No.: 11
Respondent: 11   Gender: Female   Age: 25-34
Location: Hong Kong   Date: 23.4.2016 - 29.4.2016

No.	Photo	Description
(A)11-1		At polyu, first thing I see at podium is the glass structure intertwined with these branches.
(A)11-2		Seems nature grows into our infrastructure by time.
(A)11-3		The only tall one amongst other short shrubs. Seems can add privacy in see-through spaces.
(A)11-4		We build these seating areas in parks for people to appreciate the plants built (but the reality is people just sit around).
(A)11-5		The Natural Setting. (原文：自然報局。)

(A)11-6		By recycling, we are trying to play our part in taking care of the natural environment.
(A)11-7		Picked this up on the floor. It's so green and waxed. I may make it into a bookmark.
(A)11-8		Cleaner is cleaning up dead leaves from the ground. Despite the nice scenery around, nature requires us to pay some affort in cleaning up.
(A)11-9		Bamboo is a source / extract of raw natural material - and we can make good use of these materials into building materials.

Appendix 2   Photo-Elicitation Survey – Urban Dwellers' Daily Records of Nature

Survey Record No.: 12
Respondent: 12   Gender: Male   Age: 25-34
Location: Hong Kong   Date: 19.4.2016 - 24.4.2016

No.	Photo	Description
(A)12-1		N/A
(A)12-2		N/A
(A)12-3		N/A
(A)12-4		N/A
(A)12-5		N/A
(A)12-6		N/A
(A)12-7		N/A

Appendix 2   Photo-Elicitation Survey – Urban Dwellers' Daily Records of Nature
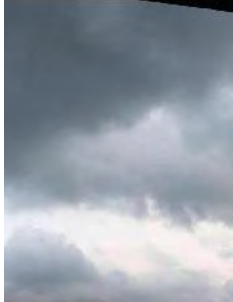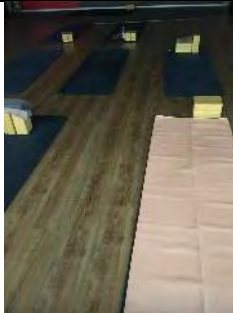
Survey Record No.: 13
Respondent: 13   Gender: Female   Age: 45-54
Location: Hong Kong   Date: 26.4.2016 - 2.5.2016

No.	Photo	Description
(A)13-1		Nature is green.
(A)13-2		The force of nature.
(A)13-3		Nature changes.
(A)13-4		Nature gives.
(A)13-5		Yoga is about relaxation of mind and body, an activity that it the closest to nature and our Mother earth.
(A)13-6		All things and creatures find their way to grow and outgrow in nature.

(A)13-7		We feel so small and humble in front of the Nature
(A)13-8		N/A
(A)13-9		Mankind works hard to co-exist well with the Nature as much as possible.
(A)13-10		Nature not just includes what's on earth, but also what's beneath it.
(A)13-11		N/A
(A)13-12		Man likes to be in control when coming in front of the nature. Can we succeed?

Appendix 2   Photo-Elicitation Survey – Urban Dwellers' Daily Records of Nature

Survey Record No.: 14
Respondent: 14   Gender: Female   Age: 25-34
Location: Hong Kong   Date: 22.4.2016 - 28.4.2016

No.	Photo	Description
(A)14-1		Feel so comfortable to look out the window and see the nature.
(A)14-2		Habitat for wild animals.
(A)14-3		Caught from the nature.
(A)14-4		Ancestry return to the nature.
(A)14-5		Simplicity.
(A)14-6		Preserved nature.
(A)14-7		Sunrise and Sunset - the nature's routine.

Survey Record No.: 15
Respondent: 15   Gender: Male   Age: 25-34
Location: Hong Kong   Date: 18.4.2016 - 24.4.2016

No.	Photo	Description
(A)15-1		A bit of green for the busy road. (原文：給繁忙道路帶來一點綠。)
(A)15-2		It looks fragile, yet it has stronger vitality than we do. (原文：它看似比我們脆弱，卻比我們頑強的生命力。)
(A)15-3		It looked like a coral reef in the first glance. (原文：驟眼看有點珊瑚的感覺。)
(A)15-4		When the plants on the right are obviously made to grow on the wall; those on the left demonstrate how to be true climbers. It's interesting. (原文：很明顯地 相片右方的植物是刻意被鋪排成攀爬牆身，但仔細看，左面卻出現了一些作出示範的「真攀爬」，很有趣。)
(A)15-5		We always look to the front when we walk; without paying attention to the decoration that nature makes for the boring ground. (原文：走路時經常只向前望，卻沒留意到大自然原來為沉悶的平面帶來了小點綴。)
(A)15-6		Look forward to seeing more fitness facilities built with natural elements, providing a calm and peaceful mood when use. (原文：期待見到更多以取自大自然為素材的健康身心設施，使用時更添平和和自然。)
(A)15-7		Please don't climb, except for them. (原文：「請勿攀爬」，它們除外。)
(A)15-8		Bamboo poles for laundry and scaffolding are wholly taken from mother nature. (原文：曬衣竹桿，維修竹棚，充份取自自然。)

Appendix 2   Photo-Elicitation Survey – Urban Dwellers' Daily Records of Nature

Survey Record No.: 16
Respondent: 16   Gender: Female   Age: 25-34
Location: Hong Kong   Date: 23.4.2016 - 29.4.2016

No.	Photo	Description
(A)16-1		Sneak peek of Nature. 即使只是狹縫，仍嚮往家中望見的一片綠。
(A)16-2		Choice for waiting bus: looking up or mobile addiction. 抬頭望上去，大自然只在乎你的選擇。
(A)16-3		Nature is sport: wake up at 5am, run at 7am, fresh Monday fresh air in the body throughout the day! 兩條腿便可跑，清晨起牀，晨早跑步，自然清新的空氣喚醒週一的身心，自然就是坐然起跑。
(A)16-4		Can we be composed of just nature? Full of body, entire life, nothing artificial. It's a matter of balance. 生活可以完全無添加嗎？全智賢真的全天然？刻意自然便不是天然。
(A)16-5		All about green 🍀. Nature is being surrounded by green. 綠抱環路，能種綠的也給綠，不言而喻的城市與自然結合。
(A)16-6		To me, nature cannot state without sunshine. ☀️☀️☀️ So, raining scene cannot fully represent the beauty of nature. I need sun. 陽光是「自然」不可或缺的元素。只有晴天才可完美顯現自然美。
(A)16-7		After 7 days, I found that nature is far away but close. It always surrounds us but not enough. How can we build a better world with nature? There's always hint in our daily life. Although it seems to be long way to go, the better world awaits us there. 觀察、聯想、感受，「自然」已融入生活，但仍需去發現。雖然路途漫長，更好的世界已在那裏等著，等待我們向前邁進。

Survey Record No.: 17
Respondent: 17   Gender: Female   Age: 35-44
Location: Hong Kong   Date: 17.4.2016 - 23.4.2016

No.	Photo	Description
(A)17-1		View of the sky.
(A)17-2		I won't normally consider this nature in any sense, but I don't foresee seeing anything more nature than this today… other than repeating what I sent yesterday. Weekdays are pretty mundane.
(A)17-3		Evergreen indoors. (原文：室內長青。)
(A)17-4		Bamboo.
(A)17-5		Lush outdoors.
(A)17-6		Sea and lights afar.
(A)17-7		Mountains; Clouds. (原文：山、雲)

Appendix 2   Photo-Elicitation Survey – Urban Dwellers' Daily Records of Nature

Survey Record No.: 18
Respondent: 18   Gender: Female   Age: 25-34
Location: Hong Kong   Date: 23.4.2016 - 29.4.2016
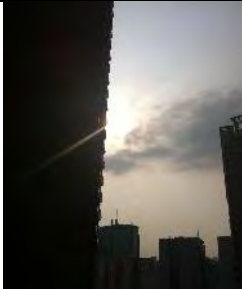
No.	Photo	Description
(A)18-1		Looking up, not for high-rises, but the birds' heaven. (原文：抬頭看，不是高樓，是鳥的天堂。)
(A)18-2		Walk slowly to the front. (原文：慢步走進。)
(A)18-3		@ Tsuen Wan Park.
(A)18-4		Plant at home.
(A)18-5		Moonlight.
(A)18-6		Night Run along the seafront. (原文：夜跑海濱。)

(A)18-7		Sunrise in the morning.
(A)18-8		Blossom of rose.
(A)18-9		Walk past a restaurant which with flower decoration.

Appendix 2   Photo-Elicitation Survey – Urban Dwellers' Daily Records of Nature

Survey Record No.: 19
Respondent: 19   Gender: Male   Age: 35-44
Location: Hong Kong   Date: 16.4.2016 - 22.4.2016

No.	Photo	Description
(A)19-1		In several rainy days; new lives are brought up. (原文：幾個雨天，造就新生。)
(A)19-2		Life breeds new life; ring after ring. (原文：生命孕育生命，一環扣接一環。)
(A)19-3		Birds no longer have to find any forest to take shelter from rain. (原文：雀鳥已不用找樹林避雨。)
(A)19-4		The nature and human beings are in harmony. (原文：自然，人為，本是互融。)
(A)19-5		Forest - animals (原文：森林 － 動物。)
(A)19-6		Another kind of "Forest" - Human (原文：另類森林 － 人類。)
(A)19-7		Orientation of humans and animals is very similar. So, they have to respect each other in order to live together. (原文：人與動物的取向是相近的！所以共同生存就要互相尊重！)
(A)19-8		Nature.
(A)19-9		Nature.

(A)19-10			Nature.
(A)19-11			Nature.
(A)19-12			Nature.
(A)19-13			Nature.
(A)19-14			Nature.
(A)19-15			Nature.

Appendix 2　　　Photo-Elicitation Survey – Urban Dwellers' Daily Records of Nature

Survey Record No.: 20
Respondent: 20　　　　　　　　Gender: Female　　　　　　　　　Age: 25-34
Location: Hong Kong　　　　　Date: 19.4.2016 - 25.4.2016
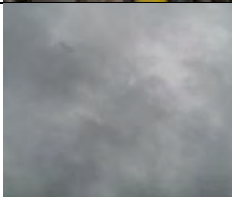
No.	Photo	Description
(A)20-1		The neighbour sits quietly outside his / her home, and enjoys the music and refreshing air from nature. Such kind of living is yearning. (原文：鄰舍靜靜坐在家門外，享受著大自然帶來樂韻和清新的氣息，簡直生活令人嚮往。)
(A)20-2		We have very limited time to get in touch with the nature on working days. We could only walk around the park near our home after dinner. (原文：上班日接觸大自然的時間十分有限，只有晚飯後才有機會靜靜走到家附近的公園逛逛。)
(A)20-3		Cycling to work helps reduce air pollution, but it seems to be mission impossible in the urban area! Honestly, breathing in fresh air instead of travelling on air-conditioned bus. (原文：踏單車返工減少空氣污染在市區是 mission impossible 吧！能呼吸一下新鮮空氣而非坐在冷氣巴士上的感覺真令人羨慕。)
(A)20-4		Looking out of the window from the office, I found that the whole week is dull. (原文：從辦公室望出窗外，整個星期都是灰矇矇的，赫然發現大自然離我們日常生活太遠。)
(A)20-5		Both plants and humans keep changing themselves to adapt to the environment. (原文：適者生存，植物跟人一樣都在改變自己去適應生環境。)
(A)20-6		On a dull rainy day, i saw a bird getting lost in the concrete jungle. It seems that our moods are disturbed by the poor weather. (原文：灰矇矇的落雨天，見一隻鳥像迷失在石屎森林中亂竄，似乎我們的好心情都被壞天氣破壞了。)
(A)20-7		It is to travel daily from the New Territories to the eastern part of Hong Kong Island to work. How should we make a balance between a good living environment and convenience? Though I love the nature, I would still choose the latter one. (原文：每天由新界到港島東區上班路途遙遠，究竟應如何取捨生活環境與交通方便的居所？雖然我極愛大自然，但作為上班族我終歸會選擇後者。)

Appendix 2   Photo-Elicitation Survey – Urban Dwellers' Daily Records of Nature

Survey Record No.: 21
Respondent: 21   Gender: Female   Age: 25-34
Location: Hong Kong   Date: 19.4.2016 - 25.4.2016

No.	Photo	Description
(A)21-1		Impossible to escape from cement and concrete at work but a few pots of greenery at my colleague's seat give us a glimpse of nature.
(A)21-2		Mosquito kisses.
(A)21-3		Manmade nature at HKU.
(A)21-4		What's better than sitting at the seashore, enjoying the music of the waves after a week of hard work?
(A)21-5		The heat and humidity. Summer is approaching.
(A)21-6		A baby yearned for his mommy and his food, and he got them!
(A)21-7		Skyscrapers under the big big sky.

Survey Record No.: 22
Respondent: 22   Gender: Female   Age: 25-34
Location: Hong Kong   Date: 21.4.2016 - 26.4.2016

No.	Photo	Description
(A)22-1		5-min refreshing bus travel, always feel refreshed and relieved with the calm sea and clear sky!
(A)22-2		Pleasant after-meal walk with trees and shrubs in refreshing breeze.
(A)22-3		Hi, good day, baby leaf! You gonna stay strong and healthy, just like your siblings do.
(A)22-4		Stay inside and watch outside is the perfect activity on rainy day. Time to get oneself poetic and romantic.
(A)22-5		Clear sky, peaceful night. Stay calm, sleep well, nice dream.
(A)22-6		Hi, mr sunshine. You're back finally!

Survey Record No.: 23
Respondent: 23   Gender: Female   Age: 25-34
Location: Hong Kong   Date: 24.4.2016 - 29.4.2016

No.	Photo	Description
(A)23-1		Tree canopy. People always hide from strong sunshine under this canopy made of trees.
(A)23-2		Birds choir. Birdsss (although I can just capture one) around my home sing every morning, feel like I live far away from the urban.
(A)23-3		Refreshing smell of bamboo recalls my nature adventures.
(A)23-4		Urban street, blooming tree, floral breeze.
(A)23-5		Little forest. Reaching a little green in the jar.
(A)23-6		blue sky and sea; big rocks and waves; strong wind and sunshine. All I could find in the real nature; hope I will explore again in the future.
(A)23-7		sky - sea - mountain - beach; natural combination.

Survey Record No.: 24
Respondent: 24   Gender: Female   Age: 25-34
Location: Hong Kong   Date: 16.4.2016 - 22.4.2016

No.	Photo	Description
(A)24-1		Fallen leaves is nature. ^^
(A)24-2		Nature [lime (原文：青檸)] in coke. And the floating ice kinda remind of the melting ice that caused by human damaging the nature. So, this is quite "contradict"... T.T
(A)24-3		In-taking Nature LOL !!!!
(A)24-4		Human nature destroying human's nature...
(A)24-5		Root of nature.
(A)24-6		Bubu is gift of nature, staying with me in her very short life span.
(A)24-7		Light is nature. ^^
(A)24-8		Beautiful sky is nature too. ^^

Survey Record No.: 25
Respondent: 25   Gender: Female   Age: 35-44
Location: Hong Kong   Date: 17.4.2016 - 23.4.2016
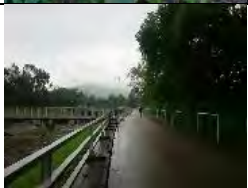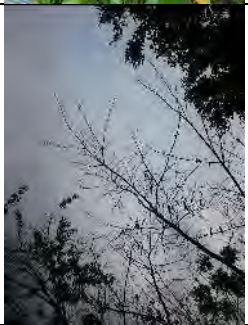
No.	Photo	Description
(A)25-1		Jogging under red flowers and green leaves. (原文：紅花綠葉；外出散步。)
(A)25-2		The first blossom. (原文：第一朵開花。)
(A)25-3		A rainy day. (原文：下雨天。)
(A)25-4		A shiny cat. (原文：花貓。)
(A)25-5		Bloooming. (原文：花開。)
(A)25-6		The sky. (原文：天空。)
(A)25-7		The bird nest. (原文：雀巢。)

(A)25-8		A bird!? A crow ~ (原文：小鳥！？烏鴉~)
(A)25-9		Ground and root.
(A)25-10		Ants and tree.
(A)25-11		The clouds and sunshine after rain. (原文：雨後晴天白雲。)
(A)25-12		The sun. (原文：太陽。)
(A)25-13		The sunflower. (原文：花。)

Survey Record No.:26
Respondent: 26   Gender: Male   Age: 35-44
Location: Hong Kong   Date: 20.4.2016 - 26.4.2016

No.	Photo	Description
(A)26-1		Mini bananas - Aloe vera.
(A)26-2		Yellow flags.
(A)26-3		Water colour.
(A)26-4		Re Claim Da Street - this is how nature ends under human habitation.
(A)26-5		Green Hill.
(A)26-6		Artificial home… but it works.
(A)26-7		Sunset.

Survey Record No.: 27
Respondent: 27   Gender: Male   Age: 25-34
Location: Hong Kong   Date: 22.4.2016 - 28.4.2016
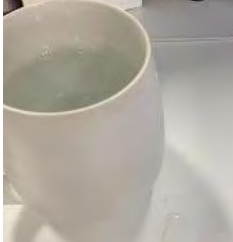
No.	Photo	Description
(A)27-1		Hey, I took this today. It is at the outdoor car park in Taipei, using concrete brick pattern with some gaps to put the green plant in. I feel I stepped on grass when I walked on it.
(A)27-2		I talked to a friend today who loves taking photos. We talked about her photos on Facebook of the sunset at Ha Pak Nai. (原文：下白泥) Then I started to think of nature.
(A)27-3		Heavy rainy day that makes me don't wanna go out. Reading and laying on sofa is the best when seeing the rain outside.
(A)27-4		Always thinking of bringing an umbrella today Geiger going out. Rainy day can directly affecting life.
(A)27-5		Feel nature when going out today.
(A)27-6		I do take care of some plants today afternoon at office.
(A)27-7		Water dropped on table accidentally.

Appendix 2   Photo-Elicitation Survey – Urban Dwellers' Daily Records of Nature

Survey Record No.: 28
Respondent: 28   Gender: Female   Age: 45-54
Location: Hong Kong   Date: 19.4.2016 - 25.4.2016

No.	Photo	Description
(A)28-1		The beauty of sunshine ornamented the beauty of architecture. (原文：陽光的美，點綴了建築的美。)
(A)28-2		Every bit of green represents the courage of living, and gives encouragement to people who are facing challenges. (原文：每一點綠，代表著生存的勇氣，都在暗中鼓勵著每一個在困難中的人。)
(A)28-3		The alarm clock in nature is tender. (原文：自然界的鬧鐘就是這樣溫柔。)
(A)28-4		This is a rain with name. (原文：這是一場有名字的雨)
(A)28-5		Withering is for reborn. (原文：枯萎是為了下一回的重生！)
(A)28-6		A kind of quietness can be witnessed with eyes. (原文：有一種恬靜是用眼睛看到的。)
(A)28-7		Striving hard is an attitude! (原文：搏盡是種態度！)

Appendix 2   Photo-Elicitation Survey – Urban Dwellers' Daily Records of Nature

Survey Record No.: 29
Respondent: 29   Gender: Male   Age: 25-34
Location: Hong Kong   Date: 19.4.2016 - 25.4.2016
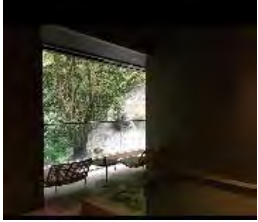
No.	Photo	Description
(A)29-1		Pot plant flower.
(A)29-2		Green slope behind city building. It is remaining piece of greenery in the city that still keeps the serenity of nature.
(A)29-3		Trees on retaining wall. It demonstrates a strong vitality in the harsh growing environment, showing the power of nature.
(A)29-4		Sky. The largest element representing nature is the sky with its unlimited and infinity space.
(A)29-5		Trees at Victoria Park. The enormous numbers of tree is a symbol of "nature" in Hong Kong island.
(A)29-6		Rain. It is a natural phenomenon of "nature".
(A)29-7		Withered flower. It demonstrates the "life-cycle" of the nature.
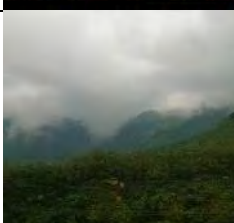
Survey Record No.: 30
Respondent: 30   Gender: Female   Age: 35-44
Location: Hong Kong   Date: 19.4.2016 - 23.4.2016

No.	Photo	Description
(A)30-1		Fallen leaves.
(A)30-2		Growing leaves.
(A)30-3		Lonely branches.
(A)30-4		Flowing water.
(A)30-5		Back to the earth.
(A)30-6		N/A
(A)30-7		Heavy clouds.

(B) Appendix to Chapter 5.3 –

Photo-Elicitation Survey – Perception of Nature in Urban Living

Number of Respondents: 104

Number of photos: 104

Age: 25-34 (70%); 35-44 (30%)

Gender: Female (75%); Male (25%)

Appendix 3 Photo-Elicitation Survey – Perception of Nature in Urban Living
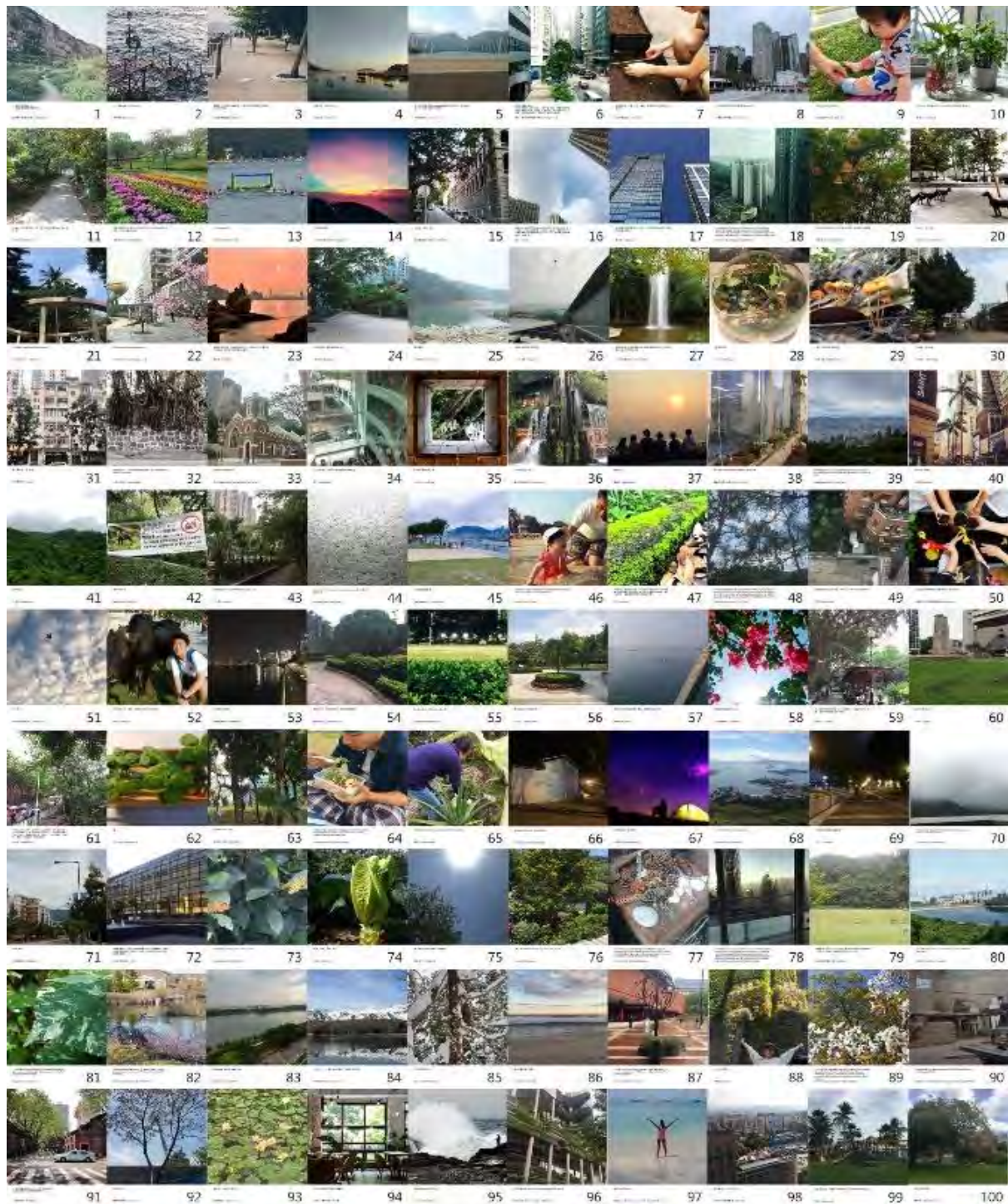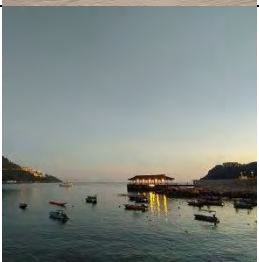
Records of participants' responses

Respondent: 104
Data: May 2017

No.	Photo	Description
(B)1. Gender: Male Age: 25-34 Location: Lei Yue Mun Quarry（Kowloon）		A rural place that is close to city A spacious place that could have echo (一個好近市區嘅郊外, 一個講野有回音嘅空曠地方)
(B)2. Gender: Female Age: 25-34 Location: Sai Wan Swimming Shed		A place where people can fully integrate with nature (令人完全能融入大自然嘅地方)
(B)3. Gender: Male Age: 25-34 Location: Yau Ma Tei Typhoon Shelter		Egretries and people are mutually respect and disciplined users who walk along Waterfront Promenade together. (鷺鳥和人一起漫步海濱長廊，他們都互相尊重和遵守規則的公園使用者)
(B)4. Gender: Female Age: 25-34 Location: Stanley Main Street		The sea melts into sky even in dawn (就算日落，依然海天一色)
(B)5. Gender: Male Age: 25-34 Location: Chek Lap Kok South Road		How many greens will be preserved in this village and the mountain behind after development? 每日上班都經過這座橋遠望逸東邨和其後山巒，在不斷發展之下，將會保得住多少翠綠?
(B)6. Gender: Female Age: 25-34 Location: Wan Chai, on the flyover leading to Hong Kong Academy of Performing Arts		This is the Hong Kong that I know. I find the unique one in the concrete jungle. There is a unique soul in every city corner which can light up the society with energy. I saw the green on the bridge separating local and art. (這是我認識的香港。在石屎森林裡，找到了唯一，是別樹一幟的。每個城市的角落都有著獨特的靈魂，它點亮了一個社會，為它帶來生氣。在分隔本土和藝術的橋上，我看見了綠悠悠的點綴。)

(B)7. Gender: Male Age: 25-34 Location: Platform of a housing estate in Kowloon		Hoping of more sunlight, breeze, greening and planting around residence. (這希望陽光、微風、綠化、種植，更多地出現在住屋空間附近。)
(B)8. Gender: Male Age: 25-34 Location: Former Queen's Pier in Central		Hong Kong's nature is the ever-changing environment. (不斷改變的環境，就是屬於香港的大自然。)
(B)9. Gender: Male Age: 25-34 Location: Lawn in Central Government Offices		First touch if grasses
(B)10. Gender: Female Age: 35-44 Location: Hong Kong		Green living starts from home!A small plant will bring new vitality. (綠色的生活。由家居做起！小小的盆栽，帶來綠色的新命力)
(B)11. Gender: Female Age: 35-44 Location: Lamma Island		As the old saying goes, the rarer the object is, the more precious it is. In Lamma Island, tree is most common, but most precious too. (常言道，物以罕為貴。在南Y島，最不缺的就是樹，卻棵棵珍貴。)
(B)12. Gender: Female Age: 25-34 Location: Lai Chi Kok Park		Filling a new day with happiness and energy through walking pass the park before work. (上班前走過公園，請大自然為新的一天注入滿滿的快樂和正能量。Have a good day!)
(B)13. Gender: Female Age: 25-34 Location: Deep Water Bay		We live on H2O

(B)14. Gender: Female Age: 35-44 Location: T-Park			One moment・sky in two colors (一剎那・兩天色)
(B)15. Gender: Female Age: 25-34 Location: Sai Ying Pun Community Complex			Nature。History。Co-existence (大自然。歷史。並存)
(B)16. Gender: Female Age: 25-34 Location: Tsing Yi			Sky is the powerful in nature. I feel good wherever I see blue sky. However, you can only see a little sky in Hong Kong even looking your head high up. Sky-less Hong Kong always make people tired. (對我來說，最有感染力的大自然是天空。在外地，天氣好。天空藍，心情就自然舒暢。但無奈，在香港，就算天氣好。也要記得奮力抬頭才能看到小小一片天。看不見天的香港總令人覺得好累。)
(B)17. Gender: Female Age: 35-44 Location: Quarry Bay			Sky in between gap of buildings is the most accessible nature in city. (在社會最容易接觸的「大自然」，或者是抬頭時在高樓的罅隙間的藍天)
(B)18. Gender: Female Age: 25-34 Location: Le Point, Tiu Keng Leng			Undoubtedly, the population density of HK ranks high across the globe. However, to achieve the standard of decent living, not only the spaciousness of indoor space but also the outdoor space – connection with nature that counts
(B)19. Gender: Female Age: 25-34 Location: Cyberport 3			Nature in concrete jungle – once thought as in bamboo forest, but is around city (石屎森林中的大自然 - 原以為竹林深處，卻是燈火欄柵處)
(B)20. Gender: Male Age: 25-34 Location: Taikoo Shing			Daily routine。 Work。Life (日常。工作。生活)

(B)21. Gender: Female Age: 25-34 Location: Wong Tai Sin			Stand out from the crowd
(B)22. Gender: Female Age: 25-34 Location: Science Park, HK			When nature meets technology
(B)23. Gender: Female Age: 25-34 Location: Lei Yue Mun			Before the storm in typhoon signal no.8, the silence of dawn is unaffected by the buildings and sea (暴風雨前的日落，八號風球的前一天，天特別紅，高樓與海彼此襯托，毫不影響日落黃昏的寧靜)
(B)24. Gender: Male Age: 35-44 Location: Ma Wan			Enjoying the last silence before working everyday (每天上班前，享受最後的寧靜)
(B)25. Gender: Male Age: 25-34 Location: Shing Mun Reservoir			Silent environment (寧靜環境)
(B)26. Gender: Male Age: 35-44 Location: T.Park			Spreading the wings between T.Park and Landfill (展翅於堆填區與源區之間)
(B)27. Gender: Male Age: 35-44 Location: Kowloon Park			I believe the elegance of nature comes from their vitality and silence as shown in this photo (我覺得這相片的畫面富有生命力及寧靜人心的感覺，亦是我認為大自然的優美的特質！)
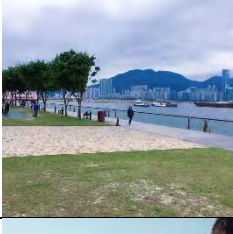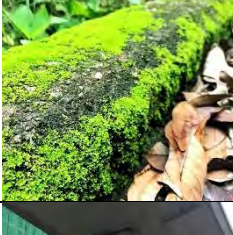
(B)28. Gender: Female Age: 35-44 Location: Home		Totoro's forest (龍貓的森林)
(B)29. Gender: Female Age: 25-34 Location: Shing Mun Reservoir		Hong Kong people cannot live without country parks (香港人不能沒有郊野公園)
(B)30. Gender: Female Age: 25-34 Location: San Po Kong		Waiting bus under tree shade (在樹蔭下等待巴士)
(B)31. Gender: Male Age: 25-34 Location: Lee Tung Street		Trees bring life to the street (樹木讓街道「活」起來)
(B)32. Gender: Male Age: 25-34 Location: Hollywood Road		The toughness of stone tree wall is reminding us to stay focused on our thoughts? (石牆樹的屹立，淡然地表現倔強的個性，是告訴我們時刻要堅持自己的信念嗎？)
(B)33. Gender: Female Age: 25-34 Location: St. Andrew Church, Nathan Road		Silence in hustle and bustle city (繁暄鬧市中的寧靜平安)
(B)34. Gender: Female Age: 25-34 Location: Tsuen Wan		Natural light brings happiness and nature into the indoor space (引入天然光可以將大自然和快樂氣氛帶進室內)

(B)35. Gender: Female Age: 25-34 Location: Wet Market in Sheung Shui		Best scenery is always found out of the window (窗外永遠有最好的風景)
(B)36. Gender: Female Age: 25-34 Location: Chi Lin Nunnery		Small buildings under the falling water (淙淙流水下的小築)
(B)37. Gender: Female Age: 35-44 Location: Mount Davis		Happy childhood (快樂童年)
(B)38. Gender: Female Age: 35-44 Location: Office in Lee Garden One, Causeway Bay		Green brings relaxation into the office (辦公室綠化地帶為高壓的環境帶來一點的抒壓)
(B)39. Gender: Female Age: 35-44 Location: Victoria Peak, HK		Morning Walk. A calming and awe-inspiring daily view of Hong Kong framed by the abundant nature of Victoria Peak
(B)40. Gender: Male Age: 25-34 Location: Central		Hawaii in city (鬧市中的夏威夷)
(B)41. Gender: Female Age: 35-44 Location: Taiwai		Nature and me (自然與我)
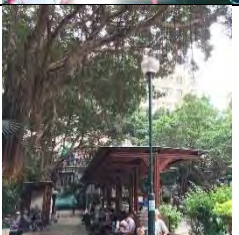
(B)42. Gender: Female Age: 25-34 Location: North Point			Man vs Wild
(B)43. Gender: Male Age: 25-34 Location: Tin Shui Wai			Nature and community are in proximity under proper planning (適當的規劃，社區與大自然也可以在咫尺之間)
(B)44. Gender: Male Age: 25-34 Location: Pak Shek Kok			Colourless and odourless, yet we make out best efforts to avoid
(B)45. Gender: Female Age: 35-44 Location: Kwun Tong Promenade			Beauty of silence covers the hustle and bustle of city (忘卻繁囂的寧靜美)
(B)46. Gender: Female Age: 25-34 Location: Shek O, HK			This little villager from Shek O is experiencing (the cool side of) the nature for the first time
(B)47. Gender: Female Age: 25-34 Location: Wan Chai			Nature can be small but not negligence. Moss along street are full of energy from nature. (大自然可以是卑微的存在，可能是沒有注意就等於不存在的那樣。路傍隨處可見的青苔植物，細小的身體亦組織成一個小小的世界，滿載著由自然帶來的無限生機！)
(B)48. Gender: Female Age: 35-44 Location: Wing Kei Road			Interdependent of plant and bridge (棟橋相依)

(B)49. Gender: Female Age: 25-34 Location: Tai Tong, Yuen Long			The mesmerizing interconnectedness of this tree led me into thinking about the Hong Kong society and the growing influence of social media – your network can build you up or blind you, depending on your perspectives and attitude towards it.
(B)50. Gender: Female Age: 35-44 Location: Sheung Wan			We are all dweller of nature and there is a visitor from nature today (我們都是大自然的寄宿者，而今天，我有一位大自然的訪客)
(B)51. Gender: Female Age: 35-44 Location: Herb garden in a kindergarten in Kowloon			Learning to respect and be responsible to nature from young (從小接觸，學懂對世上各種自然予以尊重及責任)
(B)52. Gender: Female Age: 25-34 Location: Victoria Peak, HK			Extension 伸「然」
(B)53. Gender: Male Age: 25-34 Location: Ngong Ping			Nature is by your side waiting for your discovery (城市中遇上的一頭牛，自然就在身邊，待你發現)
(B)54. Gender: Female Age: 25-34 Location: Kwun Tong Promenade			Daily walk along waterfront (日常散步的海旁)
(B)55. Gender: Female Age: 35-44 Location: Platform in Tierra Verde			Flourishing flowers and grass in podium is a kind of nature! (屋苑的平台，樹木花草茂盛，也算自然景色吧！)

(B)56. Gender: Female Age: 25-34 Location: Causeway Bay			Inhale, exhale, take a deep breath
(B)57. Gender: Female Age: 25-34 Location: Tin Shui Wai			Backyard heaven walked past everyday (每天經過的「後花園天堂」)
(B)58. Gender: Female Age: 25-34 Location: Tsing Ma Bridge			Endless enrgy from infinity seaview (每天上下班不能錯過的窗外景色，海闊天空無窮力量)
(B)59. Gender: Female Age: 25-34 Location: Wai Chi Street			A splash of red above head while waiting for bus (等車抬頭一看見的一抹紅)
(B)60. Gender: Female Age: 25-34 Location: Yau Tong Centre			Elderly are shading under the trees grown in concrete jungle (在一個叫香港的地方有一大片石屎森林，石屎森林中長大樹，大樹為乘涼聊天的老人遮蔭)
(B)61. Gender: Male Age: 25-34 Location: Central			Only Wonderland in city (城市中的唯一樂土)
(B)62. Gender: Female Age: 25-34 Location: Ngau Chi Wan			Cooling and relaxing effect by walking along the storm pipe after work (一條小小的雨水渠。雖然說不上山青水秀，但在城市的小小水源及樹蔭下，特別是在炎熱的夏天，三十多度的高溫下，這一短徑，就頓時為當下泉源，令人冷靜地、放鬆地，踢走一天的辛勞，愉快的回家。)

(B)63. Gender: Female Age: 25-34 Location: Office, HK		Grow (種)
(B)64. Gender: Female Age: 25-34 Location: Tsuen Wan Riviera Park		A little green in concrete jungle (石屎森林中的一點綠)
(B)65. Gender: Male Age: 25-34 Location: West Kowloon, HK		Comparing to mundane shopping or watching movies, we think picnic is a more romantic way of spending quality time with your love ones
(B)66. Gender: Female Age: 25-34 Location: Yim Tin Tsai		has planting become a privilege of rural villagers?
(B)67. Gender: Female Age: 35-44 Location: Tsuen Wan		Nature is the most beautiful art
(B)68. Gender: Female Age: 35-44 Location: Lai Chi Chong		Great scenery with breeze, infinite starry (美景伴寒風，無限星光)
(B)69. Gender: Female Age: 25-34 Location: Islands District		This is the place where I grew up
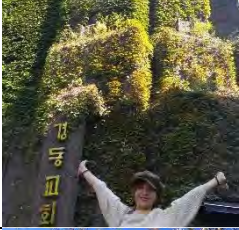
(B)70. Gender: Female Age: 35-44 Location: Tuen Mun			Must-go promenade after work (放工會特意經過的海濱長廊)
(B)71. Gender: Female Age: 25-34 Location: Wu Kai Sha			When wind, rain and mist in perfect harmony… we are worried about the laundry
(B)72. Gender: Female Age: 25-34 Location: Tat Chee Avenue			Concrete. Jungle (石屎。森林)
(B)73. Gender: Female Age: 25-34 Location: Shatin New Town Plaza			Charging in nature by sitting along trees and fountain when people are numb in artificial structures. (冷氣商場林立，城市人的身體細胞都對人工建築麻木，偶爾坐在商場大樹與水池旁邊，合上眼，感受其存在，讓它們成為天然又電機)
(B)74. Gender: Female Age: 25-34 Location: Countryside, HK			Hong Kong country side in early summer
(B)75. Gender: Male Age: 35-44 Location: Tai Po			perseverance, local, organic, seasonality (堅持。本地。有機。時令)
(B)76. Gender: Female Age: 25-34 Location: Lower Ngau Tau Kok Estate			Snowy scenery with great atmosphere (有一場漫天飛雪的場景，很有感覺)

(B)77. Gender: Female Age: 25-34 Location: Shatin			I like the different kinds of green in the picture
(B)78. Gender: Female Age: 25-34 Location: Worthing, UK			This is our (my eldest daughter and I) nature pile, a collection of found objects outside our front door; snail shells, feathers, pine cones, sticks, leaves and flowers. It makes me happy to encourage her interest
(B)79. Gender: Female Age: 25-34 Location: Fontaine I'Eveque, Belgium			I felt lucky to have such a view from home and I regularly take a photo from this landscape and share it on social networks. I relax, think and recharge my batteries every day while looking at this view which is changing over the seasons. On that day, the sky and light were beautiful…
(B)80. Gender: Female Age: 25-34 Location: Park of Wufengci Waterfall, Taiwan			Nature brings not only visual sensation but also healthiness and positiveness (綠意盎然，卸下心中一切煩惱，自然給人帶來的不僅是視覺上的享受，還賦予人們很多健康因子和正能量)
(B)81. Gender: Female Age: 25-34 Location: Menlin, Shenzhen			It combined the nature and architecture and reflect the harmony
(B)82. Gender: Female Age: 25-34 Location: Singapore			I love the wide range of shades of a colour that nature gives us, ever-changing as the day passes by, in the shadows and in the light
(B)83. Gender: Female Age: 35-44 Location: Markam, Ontario, Canada			This is a park pretty near to my home. I went there to enjoy the good weather, fresh air and do some bird watching

(B)84. Gender: Male Age: 35-44 Location: Singapore			My second home, Singapore
(B)85. Gender: Female Age: 35-44 Location: Shiretoko Goko Lakes			Nature: an integration of sky and land to purify your mind (「大自然」：一種天與地的融合，洗滌心靈的空間)
(B)86. Gender: Female Age: 25-34 Location: Japan			Nature is cute (大自然是多麼的可愛)
(B)87. Gender: Female Age: 25-34 Location: Rio, Brazil			Sound of sea will never stop (海洋的聲音從不間斷)
(B)88. Gender: Male Age: 25-34 Location: London, UK			This is the most greenery (nature) that I pass by on my commute each day, which I never really noticed until taking this photo
(B)89. Gender: Female Age: 25-34 Location: Korea			Big nature Big architecture (大自然大建築)
(B)90. Gender: Female Age: 25-34 Location: Montreal, Quebec, Canada			I took a close up photo of a tree (Canadian Service berry)that I planted with my students at Vanier College (Montreal, Quebec, CANADA) as part of an ongoing campus replanting and documentation project called TreeTag.

(B)91. Gender: Female Age: 25-34 Location: Reclaimed wood Furniture Factory, Guangdong			I cannot tell you how grateful and thankful I am. This is a lucky lady's daily life.
(B)92. Gender: Female Age: 35-44 Location: Shanghai Xintiandi			Nature is every-growing and changing along with city (大自然穿越古今中外,生生不息,永不止盡…… 城市不斷前進,大自然亦與時並進)
(B)93. Gender: Female Age: 35-44 Location: Ho Chi Minh City			Which is nature? (那個是自然?)
(B)94. Gender: Female Age: 35-44 Location: Kochi			Red dot in greens (萬綠從中一點紅星(蓮花池))
(B)95. Gender: Male Age: 35-44 Location: Guang Yi Cafe			Greens in space welcome sunlight (日光和煦照耀，空間以綠意歡迎)
(B)96. Gender: Male Age: 25-34 Location: Taiwan			Fisherman and the Sea
(B)97. Gender: Female Age: 25-34 Location: Park Royal Hotel, Singapore			This hotel amuse me in the sense that it corporates

(B)98. Gender: Female Age: 25-34 Location: Hillsborough, Carriacouan, Grenada			Get your feet wet
(B)99. Gender: Female Age: 25-34 Location: Zhongshan Dist., Taipei City			Lunch break at the corner of city jungle (都市叢林裡，中午休息一角)
(B)100. Gender: Female Age: 25-34 Location: Fiji			Layers of greens grow in the playground (在斐濟的街角，有層次的綠色植物於小孩遊樂設施中間生長)
(B)101. Gender: Male Age: 25-34 Location: Cape Town			Co-existence of nature and architecture (自然和建築並存)
(B)102. Gender: Female Age: 35-44 Location: Melbourne, Australia			Passionfruit flower and rainwater tank for toilet flushing and watering gardens
(B)103. Gender: Male Age: 25-34 Location: Keimyung University, Daegu, South Korea			Green oasis- the students and professors like to hang out in between classes. Daegu is the hottest city in South Korea and heat island is a big problem. Little shaded green spaces like that make all the difference.
(B)104. Gender: Female Age: 25-34 Location: Stanley, HK			Blue Mind- I imagine all the ways that the sight, sound, and smell of the water are influencing my brain. I take a moment to notice the feelings that are arising. It produces a profound, immersive and invigorating peace.

Appendix to Chapter 5.4 –

(C) Photo-Elicitation Surveys – Children vs Elderly Persons' Interpretation of Nature

The research participants were asked to invite one elderly person more than 65 years old and one child less than ten years old to use mobile phones to take one photo on anything or place that he/she consider or associate it related to "nature" in his / her daily life. It is his/her own interpretation of the meaning of "nature", together with a description of the photo in one sentence. The research participants were also requested to follow the same instruction to take one photo by his/her own interpretation of the meaning of "nature" and write one sentence to describe. Eleven complete sets of data were received.

Records of participants' responses

Respondent: 33
Data: Oct 2018
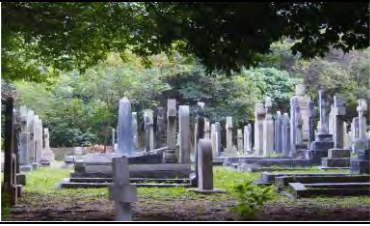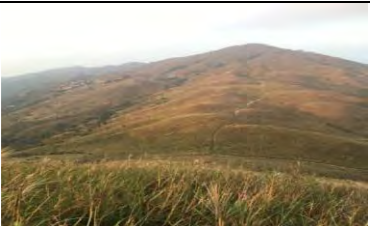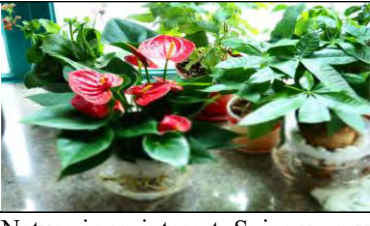
	Children (10 years old or below)	Adult (20 – 45 years old)	Elderly (65 years old or above)
(C)1.	She is a 6-year-old and south Asia kid; nature means a park near her home.	I am a 22-year-old university student. I like to cross the Tuen Mun centre park to go to the bus stop.	She is an 82-year-old elder. Nature means a square to she can chat with friends.
(C)2.	Youth thinks nature is related to flower and leaf those greening.	In my understanding, real nature is a foil in our city and building is breaking our real nature. Every building is surrounding our city. By year, those high buildings become Hong Kong's "Nature".	To the elderly, there is a place for them to have morning exercise; nature means to elderly is having a place that the surrounding is greening to make them feel comfortable.

(C)3.		
They just want a playful space. It better space for the children plays.	The green space, I want a whole piece of green can let people bottom-up develop.	The green space, they really want a space can let them gather with them, friend.

(C)4.		
I come here to play with my friends after school	I can get close to nature when I pass through this staircase every day to school	I will sit here during my free time; I feel comfortable when I see trees around me

(C)5.		
Park, where you can play with a tree in nature.	It can relax and feel comfortable at any time.	There are forest and field is nature.

(C)6.		
My family are very busy; they are less play with me. I think the grass like dancing.	I think the cloud reflect nature because the cloud is changeable weather.	I am an old fisherman. The photo can show the vagaries of wind and waves. I can see the sky then guess the weather in the future.

(C)7.		
The child said nature is an outdoor place for me to play, and it must have the tree.	I said nature which is lock into the building; it is the combination of the city planning, that is why we call it Concrete Forest.	The elderly said nature which is cannot see the building and have plants.
(C)8.		
He loves the place with full of trees.	I think nature is not just about a plant, but also the interaction between human & nature.	Ashes to ashes, dust to dust are the nature.
(C)9.		
The green or plants are nature.	Nature is nearby where I live here.	The park that walks every morning is nature.
(C)10.		
Nature is green which can be seen everywhere.	Nature is now being isolated by this suffocating city.	Nature is free in the air and good for our health.
(C)11.		
Nature provides a comfortable playground.	Nature is a cycle, endless. It can be quiet and serene. It can also be lively and full of life.	Nature is an interest, Spice up my lives.

Appendix to Chapter 6.2 –

(D) Photo-Elicitation Surveys – Design for Human vs Design for Nature

Number of Respondents: 60

Number of photos: 120

Age: 15-24

Gender: Female (71%); Male (29%)

(D) Records of participants' responses on "Design for Human (H)" & "Design for Nature (N)"

Respondents: 60
Data: January 2019
Design for Human
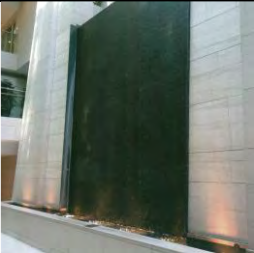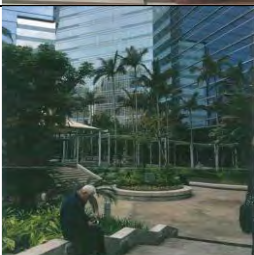
No.	Photo	Description
(D)H-1		Integration of greenery makes the sitting area in campus both psychologically and physiologically more comfortable and enjoyable and it also helps with improving urban ventilation and microclimate, offering a sense of affinity to nature.
(D)H-2		Courtyard spaces are introduced within the packed urban context. Plants are hanged on the wall forming a green façade.
(D)H-3		Plants are primarily used as a barrier between vehicles and pedestrians.
(D)H-4		The straight boulevard inside the park is carefully aligned with rows of trees along it, to provide a comfortable walking experience inside the "natural" shades away from the dense urban fabrics.
(D)H-5		This is a planting pit to put trees for street decoration. And the plants cannot grow as they want as the pit is limited in size.
(D)H-6		Ground is restrained, nature is fitted into 4 walls of bricks, growth is controlled.

(D)H-7		Banyan trees are planted on walls to provide natural shades for human without using extra land.
(D)H-8		A house is built on the pond for the sake of human beings, which allows people to live closely around nature and enjoy the beauty of it.
(D)H-9		Indoor bar tables implanted with trees promoting face-to-face interaction between human and nature.
(D)H-10		This path, despite being described as immediate encounter with nature in the city's urban centre, I find this design focuses on humans and nature is left behind as a background without opportunities for interaction.
(D)H-11		Clean, smooth surface of glass façade in celebration of modern, artificial materials and the manufacturing process of humankind, defiant toward all-natural elements, unwelcoming to any potential symbiotic plants and poses threat to birds which cannot distinguish glass from air.
(D)H-12		The electrical convertor station is made of supporting the electric grid, but creates a lot of heat and noise pollution to the surroundings.
(D)H-13		Shading is crucial to outdoor spaces especially in summer months. However, most plants do not grow well without ample sunlight. In such case, plantations of smaller scale can be useful since the resources they need for growing is comparatively less than that of large-scale plants. Plus, the smaller scale engenders human-plantation interaction since it is more accessible compared with tall trees.

Appendix 5   Photo-Elicitation Survey – Design for Human vs Design for Nature

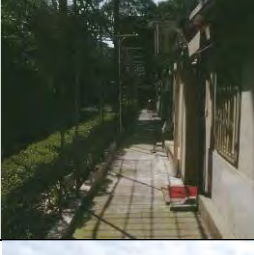| (D)H-14		This is a water wall installation as interior enhancement for human living area. Water, regarded as a natural element is a usual choice of element to be applied in built environment, it corresponds to the biophilic nature of human beings.
(D)H-15		Human beings are able to interact with and enjoy natural sunlight, even in interior spaces, through the design of skylight.
(D)H-16		Even though the designers claimed that the house respected the existing tree and integrated it into the design of bathroom, this forced gesture turn the outdoor environment for the tree into an indoor humid and cramped setting which is much unhealthier for it to stay in an outdoor courtyard, not to mention its natural environment with much sunlight.
(D)H-17		The green islands are built only to reduce sound disturbance and mimic the natural environment.
(D)H-18		Situated in the CBD area in Hong Kong where skyscrapers were densely erected, the Charter Garden provided a leisure green space with artificial water fountains and carefully arranged vegetation for office workers to take breaks from their busy urban lives.
(D)H-19		This greening works improve urban living conditions not only by enhancing visual environment and absorbing gaseous contaminants, but also providing a desirable resting space in the neighbourhood.
(D)H-20		Man-made pathway being incorporated into natural landscape, ideal for jogging and other recreational activities.

(D)H-21		Natural elements well refined by craft to provide leisure and public space for the occupants of urban architecture.
(D)H-22		Barrier with railings at the edge for safety, seatings facing the harbour
(D)H-23		This is a non-typical fountain that does not only favour the flowing of water, but incorporated walkways and benches that allow humans to engages with water thus is an exceptional cooling space in the summer time.
(D)H-24		Glass windows are used as the building façade, allowing students to enjoy the view of the greenery in the courtyard on the ground level and more natural light would be coming into the building to save energy for the interior lighting.
(D)H-25		The podium garden of this housing estate incorporated greenery as a major element in the design of the layout, encouraging more interaction between people and nature. For instance, the bushes are used to form a maze for children to play with.
(D)H-26		This roof garden with extensive grassland, plants, seating areas, walkways and bridge provides place for enjoyment of fresh air, sunlight, distant view, greenery and communal space for users, thus psychologically satisfies the inherent human affinity for nature and enhances health and well-being of people working or living nearby.
(D)H-27		The green space is used to diffuse the density of the transportation systems.
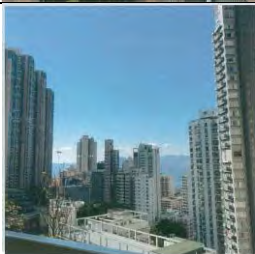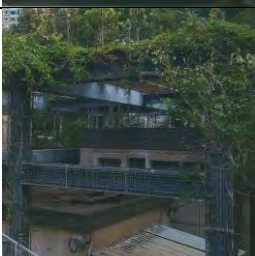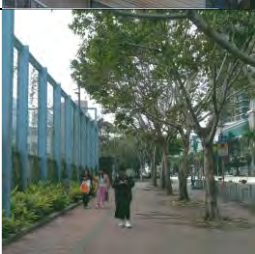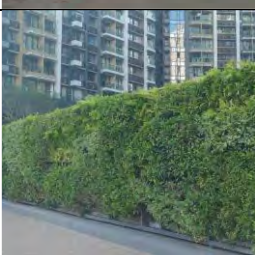
(D)H-28		This is an example of integrating natural foliage as a canopy to prevent any direct solar discomfort, achieving a thriving natural environment and providing a comfortable place for human usage.
(D)H-29		Greenery in urban condition scatter around open space of the city and create natural pocket space for people to gather and rest.
(D)H-30		This urban space is successful in incorporating green spaces within the compact neighbourhood of Admiralty surrounded by tall buildings where people such as the office workers around the area are able to interact with nature inside the busy urban environment.
(D)H-31		This picture depicts how the nature plays an important role in bringing people together in a social setting, providing them which a public space which is away from the hustle and bustle of the urban context.
(D)H-32		Through the use of wide windows and ventanillas (or floor windows below the main larger windows above), Casa Manila takes advantage of cross ventilation to cool the houses indoor living temperature against the hot, tropical climate of the Philippines and retroactively enables occupants to also adjust the openings of the windows according to their physical or social needs.
(D)H-33		Darken windows to reduce UV light directly penetrating into the interior as there are strong sunlight at the area.
(D)H-34		May not be a calculated design decision but definitely a common thing in HK, large number of potted plants being placed on balconies or open-air roofs on low level residential buildings for decorational purposes and also to increase privacy by fencing off gazes from pedestrian without adding physical walls. A case where greenery is used as a crop for human benefits.

(D)H-35		The suspended podium is raised up above the ground by four towers, which allows unobstructed wind penetration through the building.
(D)H-36		A little farmland is designed for residents to enjoy the process of growing food on their own from sowing o harvesting as there are a lot of elderly living in this housing estate who may want to reminisce the good old days and spend time leisurely.
(D)H-37		Festival Walk Shopping Mall making use of glass skylight provided indoor natural lighting and create a spacious shopping environment. This design saves electricity and reduce the emission. With natural sunlight, good Indoor air quality and suitable temperature, the experience in Festival Walk is pleasant for shoppers.
(D)H-38		The leisure garden in HKU was built in between three surrounding adjacent buildings and a slope on the remaining side, it allows people to take a brief refresh from their study, but I believe that its design did not consider other animals that may also use the space. It may be unwelcoming to birds as it was surrounded by other tall man-made structures on all sides.
(D)H-39		Retaining wall to protect residents from landslide danger. The vegetation creates great scenery and a desirable living condition.
(D)H-40		The sky garden that is relatively rarely seen in Hong Kong provides not only the great open view towards the sea, but also a greenery space that allow people to get a break from research work and interact intimately with nature.
(D)H-41		This children recreational facility built on the Sai Wan pier is a case of Design for Human that it provides a safe environment for children to play, however simultaneously, makes then have few interaction with nature.

(D)H-42		The photo features the communal farm of a private housing state, which allows residents to experience the joy of farming and interacting with nature in a highly urbanised and densely populated environment.
(D)H-43		Creating psychologically comfortable and pleasing environment. Therefore, experience in interior space, where we spend most of our times, should be emphasized.
(D)H-44		Planting of trees for shades is a popular move to create a more comfortable environment for not only private gardens but also the urban environment. These trees were also an effort to beautify the streetscape by the Chinese government. Thus, the addition of greenery at this site was both an environmental and political tool for human use.
(D)H-45		Shallow, running water as well as tree shape provide a cool environment to residents in the green space
(D)H-46		The other side of the same building has beams covered in wire mesh for plant growth, providing shade for humans.
(D)H-47		Parallel alignment of trees acts as a natural arcade for the public street, creating a tranquil and relaxing walking experience to the residents.
(D)H-48		Vegetation is grown on the outer wall of the ground floor podium, which can increase the interaction of humans and nature by bridging the greenery to eye level and in close proximity to everyday circulation.

(D)H-49		The green wall installation was installed primarily for commercial use, in which the design is more aesthetically-oriented and ornamental.
(D)H-50		All pedestrian walkways in Tai Hang is adjacent to the building façade. Cantilever structure can be found in most of the local building blocks in Tai hang, which act as a shading structure and protection from the rain. It helps reduce the solar radiation to the street and speed up heat dissipation process when raining in order to provide a better thermal comfort. People living there tends to gather under the cantilever structure.
(D)H-51		To combine natural and artificial elements in order to satisfy human needs.
(D)H-52		The pavement works as the buffer zone to mediate between the residential units and the garden accepting maximum sunlight by avoiding shading by the units as well as for providing natural lighting to the neighbourhood.
(D)H-53		A grass land by the harbour for humans to rest and enjoy
(D)H-54		Drainage system near the house foundation helps to collect water and prevent water flood back to the house which would cause damage to structure and furniture. With drainage system, water will flow away, saving the cost for maintenance and keeping the space clean.
(D)H-55		Courtyard area to allow natural sunlight and ventilation into the enclosed Tulou, which is built with a thick earth exterior wall. Corridors (covered verandas) serve as communal spaces for residents to interact.
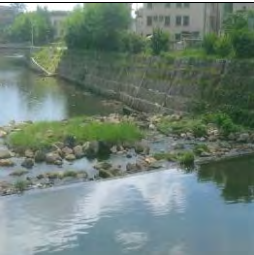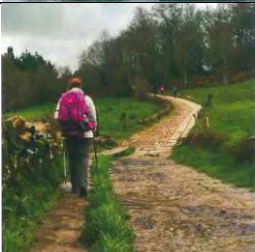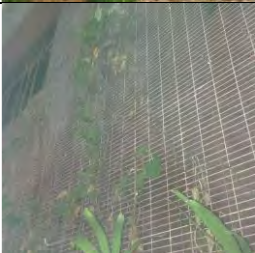
(D)H-56		Urban parks improve neighbourhood and social interaction by creating spacious, scenic entertaining and safe green areas. They allow intimate exposure to greenery in daily life.
(D)H-57		Greeneries are planted alongside the carpark, which does not only make the building more aesthetically appealing, but also improve air quality and absorb carbon emissions from automobiles, which provides a better living environment for people who work and live nearby.
(D)H-58		Decks of the original pie, where people can get closer to the sea were designed to as a playground for people, especially children, with grass to further enhance people's interaction with nature.
(D)H-59		The pavilion in the Statue Square was an intended resting place for people work in central as well as tourists. It's a thoughtful infrastructure with a view, a shade from rain and solar radiation. In order to bring people closer to nature, trees were invited in through the openings on top which also improves air quality.
(D)H-60		A solar shading façade is designed to reduce direct solar radiation.

Appendix 5   Photo-Elicitation Survey – Design for Human vs Design for Nature
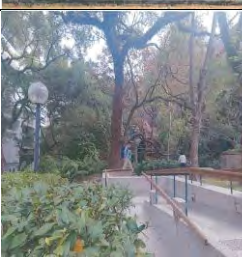
Design for Nature

No.	Photo	Description
(D)N-1. Ge		A fish ladder made of places cobbles and boulders randomly placed in the river is designed to facilitate the natural mitigation of diadromous fish in the urban river system.
(D)N-2.		The bottom part of the bridge is designed to allow birds comfortably resting and acts as a shading device for them.
(D)N-3.		Zig-zag elevated footbridge was designed to preserve the trees for fruit bats to inhabit.
(D)N-4.		The artificially built stone retaining wall is an infrastructure that is carefully considering the nature, with the pre-designed holes for planting the trees and for the roots to hold on to.
(D)N-5.		The slope is filled with soil for planting trees along the slope topography. The slope is designed to let plants to grow on it.
(D)N-6.		Ground is reshaped, nature operates in the infrastructural system, growth is uncontrolled.

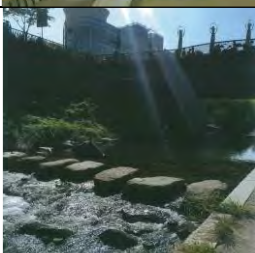| (D)N-7.		The people cut and trim the barricades to avoid displacing the ancient trees.
(D)N-8.		Instead of having a particular design for the nature, it is better to co-habitat with them and keep wherever they are.
(D)N-9.		Harbour with floating trees as an avant-garde green space provoking human's reflection on environmental issues.
(D)N-10.		In the other hand, this path is prioritizing nature over humans; giving the chance to relate and interact with the natural landscape in a free-way.
(D)N-11.		Wire grid attached to building façade not only provides framework for vines and other plants to grow on naturally, but also for better climate control on the interior of the building (absorbs heat from sunlight), as well as for a more visually pleasant exterior.
(D)N-12.		A steel wire frame is hung on the wall next to the main library to allow vine plants to climb up vertically.
(D)N-13.		Courtyard space in a building is helpful not only for its beneficial effects on micro-climate but also because it introduces a public space into the building. Nature does not necessarily need to be completely excluded from the interior of buildings. On the contrary, buildings should somehow strive to accommodate nature within them.
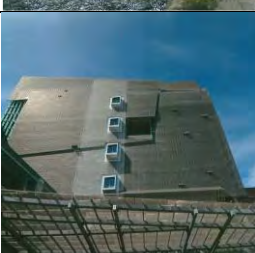
(D)N-14.		This is part of the rainwater harvesting system, located on top of the estate for collecting rainwater which would be recycled for irrigation of vegetation in the estate area.
(D)N-15.		In some cases, elevated walkways are designed across the jungle to not disrupt the wildlife habitat below, but also allow people to enjoy and situate inside the greenery.
(D)N-16.		Even though it is a man-made open garden podium, the spacious garden is completely under sunlight and well ventilated, planted with different plantations species provide an opportunity of a small-scale ecosystem of plants, insects and a place for the birds in between the dense concrete buildings setting.
(D)N-17.		The priority is given to maintaining the original landscape and keeping the diversity of nature (greenery, water bodies, birds and fish)
(D)N-18.		The old warehouse frame acts as a support for the climbing plants and there is one example how the human infrastructure can benefit the nature.
(D)N-19.		The bird labels alert birds to the transparent noise barriers so that bird collisions can be avoided.
(D)N-20.		Wire mesh fence structure in favour of the trailing or climbing stems of flowering vines.

(D)N-21.		Recovering the highways back to streams and greenery natural environment, adaptable for lots of birds and ducks and some other urban creatures who have a difficult time living among buildings.
(D)N-22.		Drainage system designed for planters on the sides of footbridges.
(D)N-23.		This is exposed structure of the green house at Hong Kong Zoological and Botanical Gardens is designed to favour the extensive growth of climber plants, thus naturally forms an arch- shape "green façade" for the green house.
(D)N-24.		The green roof provides a rainwater buffer, purifies the air, reduces the ambient temperature, saves energy and encourages biodiversity in the city. It reduces the heat flux through the roof, and less energy for cooling or heating can translate into fewer greenhouse gas emissions.
(D)N-25.		The glass roof along the pedestrian walkway does not cover the greenery, so that rainfall can irrigate the plants. The use of glass roof also allow more sunlight to pass through and reach the plants.
(D)N-26.		This bio-diverse rooftop incorporates pesticide-free growing beds for greens, herbs and flowers, providing habitat for birds and insects and improves air quality and sewage storm water runoff; and also contains wind turbines installed during summer periods to promote use of renewable sources of energy, reducing electricity usage and waste.
(D)N-27.		The stone wall is used to protect the Banyan Trees from foaling or landslides.
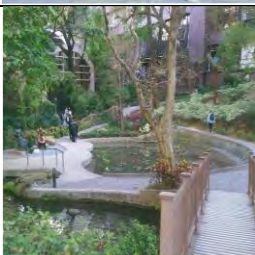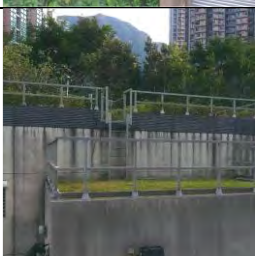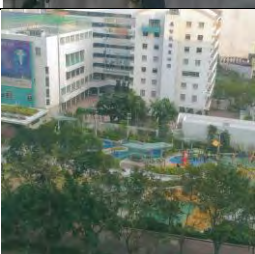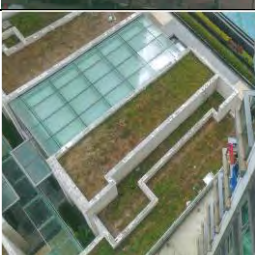
(D)N-28.		This is an example of an individual utilized their own fencing system as a barrier, but also a platform for the vegetation to grow on naturally.
(D)N-29.		Space made for nature generates pocket spaces also can be utilized by residents as a gathering space.
(D)N-30.		This building makes use of natural ventilation for the covered plaza in order to minimise the reliance of air-conditioning which reduces energy consumption of the entire space hence understanding how this strategy was adopted in order to create a positive impact on the environment and nature.
(D)N-31.		This picture is of a revitalised river stream to conserve and preserve the natural habitat and flow of an ancient river, it stands in between the industrial hustle and bustle, the passages allow the stream to follow its path and also help it maintain its integrity.
(D)N-32.		Through the use of automated screening system, the San Francisco Federal building is not only able to self-regulate indoor lighting and temperature without the use of an air-conditioner, but also able to be bird friendly by limiting the amount of exposed glass which may blind birds and the amount of artificial lighting emanating from within which may attract birds.
(D)N-33.		Trees and plants are planted on an artificial topography for animals around to adapt the urban built environment.
(D)N-34.		Design made for nature should be green, designs which generate positive impact to the natural environment, this is a part of the Jordon Valley Box Culvert Pumping Station, which has carbon emission measures and photovoltaic panels on the roofs. Etc, to achieve the aim of being environmental considerate.

(D)N-35.		The suspended podium is raised up above the ground by four towers, which allows unobstructed wind penetration through the building.
(D)N-36.		A pond surrounded by rocks, soil grasses and trees are designed within the estate for birds, butterflies, turtles, etc. to inhabit there.
(D)N-37.		There is a green area in between Festival Walk and Kowloon Tong MTR RAILWAY. The landscape serves a buffering in the urban living environment. The stream of SiuSaiWu is reserved as the nature with trees and bushes planted. Not only is it a leisure area for people, it is also a habitat for the wild birds. The design has taken nature into consideration.
(D)N-38.		The garden outside Lung Fu Shan Environmental Education Centre has a more open view with less obstructions and a greater variety of plantations that is more welcoming for birds and other animals to also share the space.
(D)N-39.		Weep holes and water channels are included to direct rainwater during typhoon seasons to protect trees and plants from excessive irrigation. Minimal interference allows vegetations o flourish, and create a micro-ecosystem that provides shelter for animals and birds.
(D)N-40.		The planning of this exit took in consideration t preserve the whole row of cliff with long history, which gave example to urban design that protect nature rather than wipe out everything for construction.
(D)N-41.		This Botanical garden is a case of Design for nature that the ground is even not hardened to provide a better living environment for plants.
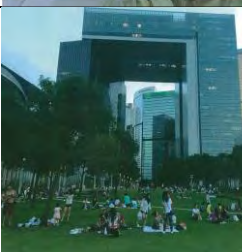
(D)N-42.		The photo features the entrance of a hotel encircled by plants, soil and rocks removed in the excavation and construction process, exemplifying such transplantation enables nature to reclaim its own ground and co-exist with human amidst urban development.
(D)N-43.		The giant opening in the middle took the natural factor into consideration, enabling hot wind from the mountain and from the sea to pass through and giving more chance of releasing heat than from a solid building block.
(D)N-44.		This photo shows the design of traditional pitched roofs, which could effectively guide rainwater towards surrounding greenery.
(D)N-45.		Although beautification of a general area could make this completely designed for human enjoyment, the lily pond; water host and ecospecies of fish and turtles as well as plants and trees.
(D)N-46.		The brown roof and insets can be seen on top of the building where human access is limited.
(D)N-47.		Natural energy sources of wind, light and water are utilized through green facilities as the main power source for the park, providing a natural environment for plantation and small animals.
(D)N-48.		Greenery is grown on the roof of the clubhouse, along with a ladder, opening up the possibility for birds and flying animals to utilize the space that is meant for humans.

(D)N-49.		The Park is installed with solar panels and recycled materials as a way of advocating sustainable development, while the park as a program is the secondary use of the park.
(D)N-50.		Ecological element, such as fish caves and diversion stones were added on both sides and bottom of the Kai Tak nullah to support the growth of aquatic organisms. Inspired by Cheonggyecheon in Seoul, greenery and plants were added on both sides of the river, providing spaces in urban for birds and insect to stay.
(D)N-51.		To respect the living things (animal and plants) to co-exist with basic living rights for them within the urban environment.
(D)N-52.		As the protective fence, restricts passengers to approach to the residential units for privacy as well as security, which showcases how nature could work for human.
(D)N-53.		A metal frame in the building façade for plant life to freely grow and entangle upon
(D)N-54.		Natural drainage system can help vegetation, for example, this prevents water-logging in soil which is bad for plants, thus nurturing more greenies along the street. Also, it can collect water for nearby wildflowers and livestock.
(D)N-55.		Courtyard spaces area also designed for nature. Canals are constructed in the courtyard to collect rainwater, which runs to different parts of the Tulou for plantations, animal etc. The construction of pitched roofs also serves to bring rainwater into the courtyard space
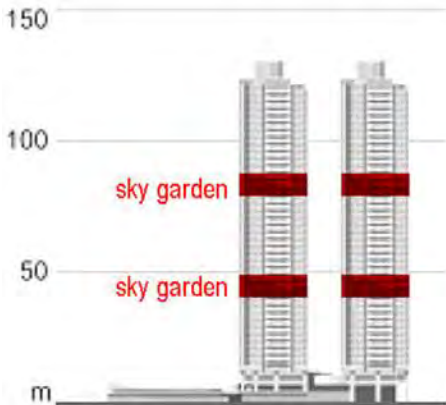
(D)N-56.		Biodiversity is promoted in urban green spaces without causing nuisances to city-dwellers. It regulates human-nature relationship by providing comfortable barrier between two.
(D)N-57.		The rooftop of the kindergarten grown with plants are habitats to animals such as birds and butterflies, and at the same time help to improve air quality and sewage storm water runoff.
(D)N-58.		Steel gate was painted as wood and the lattice on it protects the inside from being intruded as well as provides space for liana to grow on it.
(D)N-59.		The grassland in tamar park creates a green oasis among the soaring buildings in central district, opening up to the sea, the expansive open space helps sea breeze to permeate through in summer which generates natural ventilation and regulates surrounding microclimate. The greeneries also improve surrounding air quality. The lawn is friendly to both human and animals.
(D)N-60.		This is a rooftop space of a garbage disposal station near my site. It was turned into a rooftop garden from empty and useless rooftop. Now it provides habitat for insects and helps improve air quality nearby.

Appendix 6 Communal Green Spaces in Residential High-rises

Appendix to Chapter 8.3

Case Studies – Communal Green Spaces in Residential High-rises

To exemplify the benefits to promote health and well-being in urban living, case studies of forty residential high-rises in Hong Kong and Singapore map out diverse functions, configurations, connectivity and amenities of sky gardens. Details of case studies forty residential high-rises in Hong Kong and Singapore are delineated as follows.

	Development	No. of storeys (residential floors)	Nos. of sky gardens	Sky garden location	Separate floor	Refuge floor	Doorstep from units	Near podium clubhouse	Near sky clubhouse	At roof level	Connect different blocks	Amenities, except seating
Hong Kong	The Orchard (2003)	38	2	17, 32/F		●						
	The Arch (2005)	50-51 (5-82/F)	1	62/F		●			●		●	
	Centre Place (2006)	27	1	25/F	●				●			●
	Grand Promenade (2006)	55-58 (7-73/F)	1	47/F		●						●
	Indi Home (2006)	55	1	45R/F		●						●
	31 Robinson Road (2007)	30 (8-42/F)	1	7/F	●			●				
	Manhattan Hill (2007)	40-42	1	25-26/F		●						
	The Apex (2007)	44 (2-50/F)	1	R/F	●					●	●	
	SOHO38 (2008)	26 (5-38/F)	1	27/F	●							
	The Forest Hills (2008)	48 (8/F-51/F)	1	29/F		●						●
	The Sparkle (2008)	37 (7-49/F)	1	45/F	●				●			●
	i-home (2009)	37	1	20/F		●						●
	Shining Heights (2009)	48 (5-60/F)	2	27, 50/F		●			●			
	The Masterpiece (2009)	38	2	9, 47/F	●	●		●				●
	Aria (2010)	30 (5-39/F)	1	37/F	●				●		●	●
	Island Crest (2010)	36 (2-50/F)	1	29/F		●						
	Larvotto (2011)	25-28 (7-39/F)	1	20-24/F		●					●	
	Lime Stardom (2011)	36 (5-45/F)	1	18R/F		●						
	Harbour One (2012)	29 (9-42/F)	2	7, 32/F		●		●				
	De Novo (2015)	23 (1-23/F)	1	23/F	●				●	●	●	●
Singapore	Newton Suites (2007)	36	7	every 4 floors			●					
	Central Horizon (2008)	11/40	1	12/F		●				●	●	
	Pinnacle at Duxton (2009)	50	2	26, 50/F	●				●	●	●	●
	RiverGate (2009)	43	20+	every 2-3 floors			●					
	Skypark at Somerset (2010)	32	15	every 2 floors			●					
	Reflections at Keppel Bay (2011)	24/41	4	8, 15, 22, R/F	●		●			●	●	
	Martin Place Residences (2011)	33	1	14/F	●						●	●
	Soleil @ Sinaran (2011)	33	1	14/F	●						●	●
	Parc Seabreeze (2012)	20	1	14/F	●							●
	Ascentia Sky (2014)	45	10	every 5 floors			●		●	●		●
	Novel 18 (2014)	36	8	11-26/F	●				●			
	Lincoln Suites (2014)	30	1	24/F	●				●		●	●
	Spottiswoode Residence (2014)	36	3	2, 10, 22/F	●			●			●	●
	Spottiswoode 18 (2015)	36	2	14, 24/F	●							●
	Skyville @ Dawson (2015)	40-43	2	19,33/F	●		●				●	
	Sky Habitat (2015)	38	3	14,26,38/F	●				●	●	●	●
	Robinson Suite (2016)	42	2	7, 19/F	●		●					●
	Scotts Tower (2016)	31	1	25/F	●							●
	The Tembusu Kovan (2017)	18	3	6,12,18/F			●		●	●	●	●
	City Gate (2019)	30	2	6,24/F	●			●	●		●	●

Case Study No.:	HK-1
Development Name:	The Orchard
City:	Hong Kong
Location:	3 Greig Road, Quarry Bay
Developer:	Swire Properties Ltd.
Architect:	Wong & Ouyang (HK) Ltd.
Completion Year:	2003
Site Area / GFA:	5,714m^2 / 36,729m^2
Units:	442
No. of Towers:	2
No. of Storeys (residential floors):	38
No. of Sky Garden(s) per Tower:	2
Sky Garden Location(s):	17/F, 32/F
	Refuge floor
Greeneries:	Trees, planters at edges
Description:	It is one of the earliest private residential developments with provision of sky gardens after implementation of government incentives to sky gardens. Two sky gardens are located on the 17/F and the 32/F that serve as refuge floors. Japanese Garden and British Garden are themes of these two gardens respectively. Sitting area, strolling paths, sculptures and plants are provided.

17/F & 32/F Sky Gardens

Reference:	PBGC, 2006, Green Building Award booklet

Appendix 6   Communal Green Spaces in Residential High-rises

Case Study No.:	HK-2
Development Name:	The Arch
City:	Hong Kong
Location:	Union Square, 1 Austin Road West
Developer:	Sun Hung Kai Properties Ltd.
Architect:	Sun Hung Kai Properties Ltd.
Completion Year:	2006
Site Area / GFA:	- / 105,131m^2
Units:	1054
No. of Towers:	4
No. of Storeys (residential floors):	50-51
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	62/F
	Refuge floor; near clubhouse; connecting different blocks
Greeneries:	Planters at edges
Description:	A sky garden on the 62/F connects 4 tower blocks and serves as a refuge floor and main access path to the sky clubhouse on the 59/F-61/F.
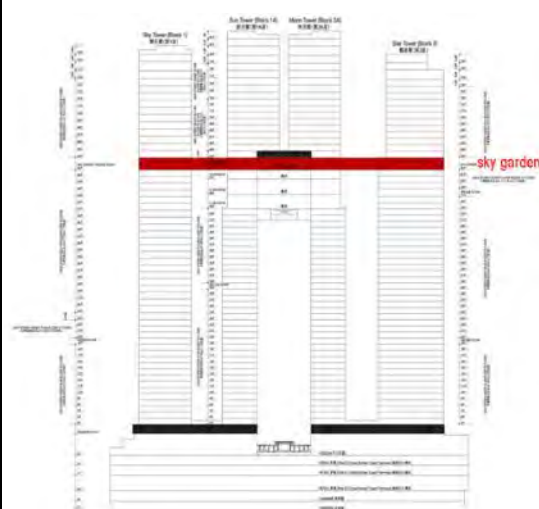
Reference:	Sun Hung Kai Properties Ltd, 2005, The Arch Sales Brochure

Appendix 6   Communal Green Spaces in Residential High-rises

Case Study No.:	HK-3
Development Name:	Centre Place
City:	Hong Kong
Location:	1 High Street, Mid-levels
Developer:	Henderson Land Development Co. Ltd.
Architect:	-
Completion Year:	2006
Site Area / GFA:	- / 5,915m^2
Units:	95
No. of Towers:	1
No. of Storeys (residential floors):	27
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	25/F
	Separate floor; near clubhouse
Greeneries:	Planters at edges
Description:	A sky garden is located on the 25/F and serves as an extension of a sky clubhouse, accommodating landscape area, yoga area, leisure walk, barbeque party zone and chess corner,

25/F Sky Garden

1. Gym
2. Jacuzzi
3. Sun bath deck
4-7. Changing rooms
8. Lift lobby
9. Planter
10. Yoga zone
11. Toilet
12. Strolling path
13. Barbecue
14. Lounge

Reference:	https://hk.centanet.com/estate/en/Centre%20Place/2-SSPPWWPOWE

Case Study No.:	HK-4
Development Name:	Grand Promenade
City:	Hong Kong
Location:	38 Tai Hong Street, Quarry Bay
Developer:	Henderson Land Development Co. Ltd. & Towngas Ltd.
Architect:	WCWP International Ltd.
Completion Year:	2006
Site Area / GFA:	- / 133,555m^2
Units:	2020
No. of Towers:	5
No. of Storeys (residential floors):	55-58
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	47/F
	Refuge floor
Greeneries:	Trees, planters at edges
Description:	A sky garden on the 47/F serves as a refuge floor and an observation deck for harbour view as well. Four themes are created, namely Art Garden, Sound Garden, Tea Garden and Scent Garden, with provision of various arts and sculptures, sound effects, amenities for tea, chess and bonsai, flowers and greenery.

Reference:	Henderson Land Development Co. Ltd & Towngas Ltd, 2005, Grand Promenade Sales Brochure

Appendix 6   Communal Green Spaces in Residential High-rises

Case Study No.:	HK-5
Development Name:	Indi Home
City:	Hong Kong
Location:	138 Yeung Uk Road, Tsuen Wan
Developer:	Kwong Sang Hong International Ltd. & Chinese Estates Holdings. Ltd.
Architect:	-
Completion Year:	2006
Site Area / GFA:	- / 54,000m^2
Units:	960
No. of Towers:	1
No. of Storeys (residential floors):	50
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	45R/F
	Refuge floor
Greeneries:	Planters at edges
Description:	A sky garden of 1,000m^2 is located on the 45/F and serves as a refuge floor. With discrete structural walls and columns, segmented spaces are found to accommodate basic amenities for children play, sitting, strolling and fitness.

45R/F Sky Garden

Reference:	Kwong Sang Hong International Ltd& Chinese Estates, 2005, Indi Home Sales Brochure

Case Study No.:	HK-6
Development Name:	31 Robinson Road
City:	Hong Kong
Location:	31 Robinson Road
Developer:	Kowloon Development Ltd.
Architect:	MLA Architects (HK) Ltd.
Completion Year:	2007
Site Area / GFA:	- / -
Units:	84
No. of Towers:	1
No. of Storeys (residential floors):	30
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	7/F
	Separate floor; near clubhouse
Greeneries:	Planters at edges
Description:	A sky garden of 421m^2 is located on the 7/F above podium clubhouse and accommodates tea leisure and lounge areas.

31 Robinson Road

Sky Garden Plan   Ⓜ Tea Leisure and Lounge Area

Reference:	Kowloon Development Co. Ltd, 2007, 31 Robinson Road Sales Brochure

Appendix 6   Communal Green Spaces in Residential High-rises

Case Study No.:	HK-7
Development Name:	Manhattan Hill
City:	Hong Kong
Location:	1 Po Lun Street, Lai Chi Kok
Developer:	Sun Hung Kai Properties Ltd. & Kowloon Motor Bus Ltd.
Architect:	Ronald Lu & Partners (HK) Ltd.
Completion Year:	2007
Site Area / GFA:	10,585m^2 / -
Units:	1115
No. of Towers:	5
No. of Storeys (residential floors):	40-42
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	25-26/F
	Refuge floor
Greeneries:	Planters at edges
Description:	A 6m high sky garden of 338m^2 serves as a refuge floor between the 25/F and 26/F. Flushing and fire services water pump rooms and tanks, light wells and pipe ducts occupy one-third of sky garden area. In addition to discrete structural walls, segmented spaces are resulted there. So, it is mainly used for recreational ground and as an observation deck for viewing fireworks during festivals.

sky garden

Sky Garden - Towers 1 and 2

Reference:	Sun Hung Kai Properties Ltd & Kowloon Molor Bus Ltd, 2007, Manhattan Hill Sales Brochure

Appendix 6   Communal Green Spaces in Residential High-rises

Case Study No.:	HK-8
Development Name:	The Apex
City:	Hong Kong
Location:	33 Wo Yi Hop Raod, Kwai Chung
Developer:	Cheung Kong (Holdings) Ltd.
Architect:	A&T Design International Ltd.
Completion Year:	2007
Site Area / GFA:	- / -
Units:	924
No. of Towers:	2
No. of Storeys (residential floors):	42
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	R/F
	Separate floor; connecting different blocks
Greeneries:	Planters at edges
Description:	A sky garden on the roof level connects roofs of 2 nos. of 46-storey tower blocks and offers recreational areas of 882m^2. It accommodates sun deck, observation deck, children play areas, reading spaces and sky sitting lounge.

Reference:	Cheung Kong (Holdings) Ltd, 2007, The Apex Sales Brochure

Appendix 6   Communal Green Spaces in Residential High-rises

Case Study No.:	HK-9
Development Name:	SOHO38
City:	Hong Kong
Location:	38 Shelleey Street, Central
Developer:	Kerry Properties Ltd.
Architect:	Archiplus International Ltd.
Completion Year:	2008
Site Area / GFA:	- / -
Units:	75
No. of Towers:	1
No. of Storeys (residential floors):	26
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	27/F
	Separate floor
Greeneries:	Planters at edges
Description:	A 6m high sky garden of 96m^2 is located on the 27/F and solely serves the purpose of sky garden without any connection to neither clubhouse nor refuge floor. It accommodates sitting areas and a barbeque party zone.
Reference:	Kerry Properties Ltd, 2008, SOHO 38 Sales Brochure
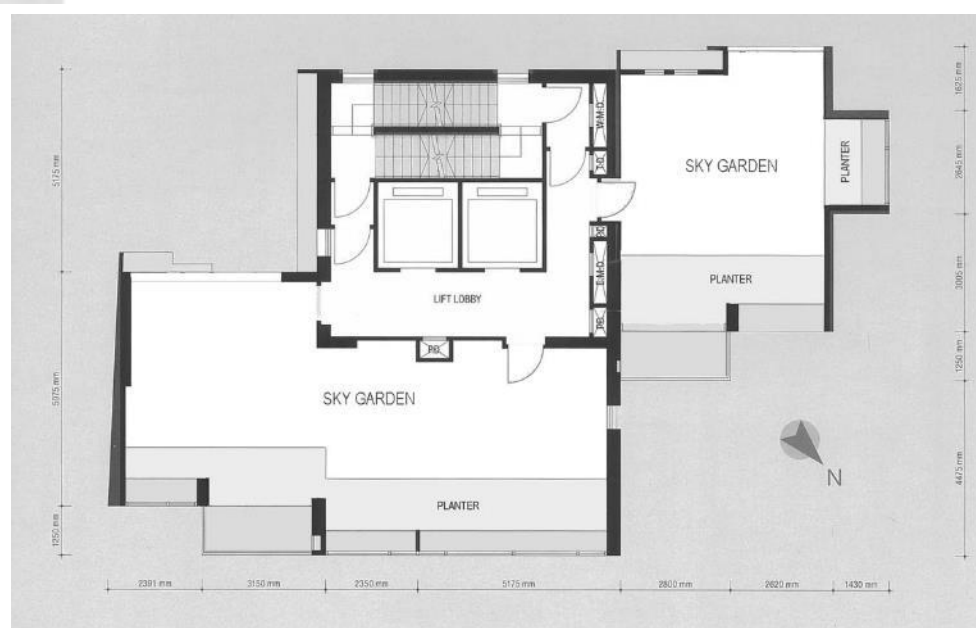
Appendix 6   Communal Green Spaces in Residential High-rises

Case Study No.:	HK-10
Development Name:	The Forest Hills
City:	Hong Kong
Location:	99 Po Kong Village Road, Kowloon
Developer:	SEA Holdings Ltd.
Architect:	Lu Tang Lai Architects Ltd.
Completion Year:	2008
Site Area / GFA:	2,250m^2 / 18,825m^2
Units:	304
No. of Towers:	1
No. of Storeys (residential floors):	40
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	19/F
	Refuge floor
Greeneries:	Planters at edges
Description:	A sky garden of 300m^2 is located on the 29/F and serves as a refuge floor. Various amenities at sky garden comprise yoga zone, café, foot massage trail, sky aerobic, chess zone, Taichi square and meditation studio.

Forest in the Sky 平面圖

Forest in the Sky - Amenities
- (A) Yoga zone
- (B) Indoor cafe
- (C) Foot massage trail
- (D) Sky aerobic
- (E) Chess zone
- (F) Taichi square
- (G) Meditation studio

Reference:	SEA Holdings Ltd, 2008, The Forest Hills Sales Brochure

Case Study No.:	HK-11
Development Name:	The Sparkle
City:	Hong Kong
Location:	500 Tung Chau Street, Cheung Sha Wan
Developer:	Henderson Land Development Co. Ltd.
Architect:	Simon Kwan & Associates Ltd.
Completion Year:	2008
Site Area / GFA:	- / -
Units:	400
No. of Towers:	2
No. of Storeys (residential floors):	37
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	45/F
	Separate floor; near clubhouse
Greeneries:	Trees, planters at edges
Description:	A sky garden is located on the 45/F immediately below the clubhouse on the uppermost floors. Distant city and harbour views can be observed. "Soothing Green" and "Dancing Light" are design themes in sky garden, with features of music, lush greenery and floor lights.

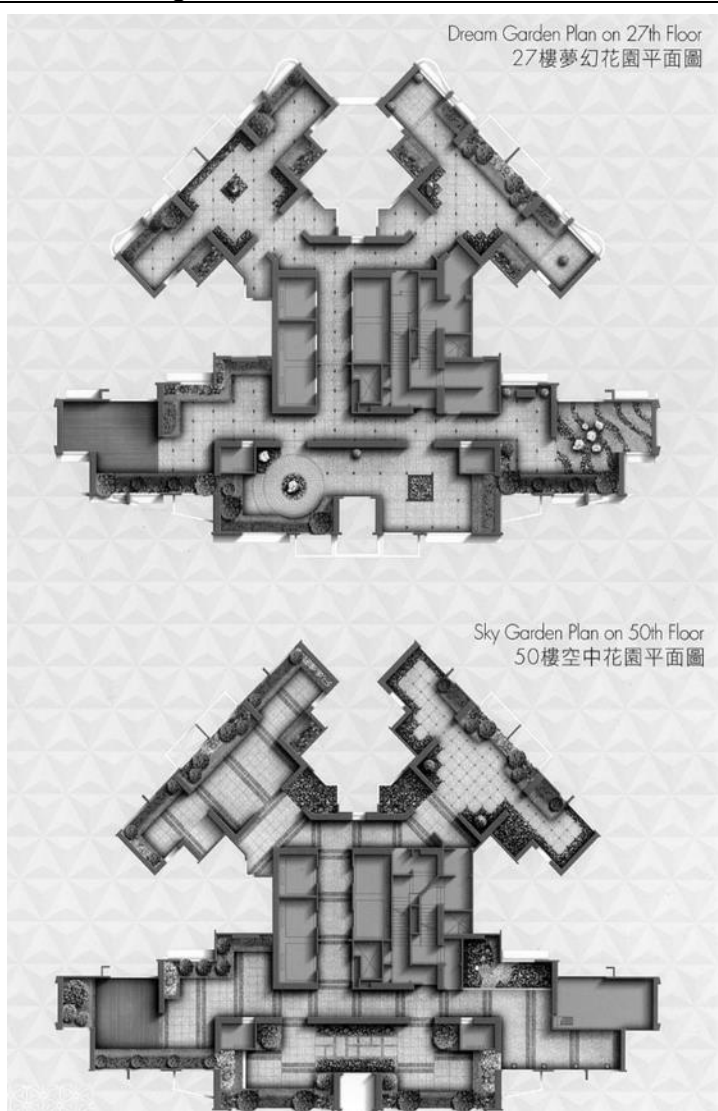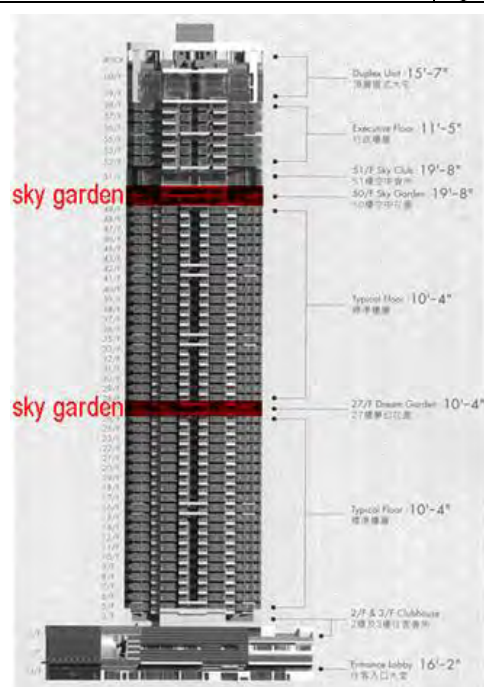|	
Reference:	Henderson Land Development Co. Ltd, 2008, The Sparkle Sales Brochure

Case Study No.:	HK-12
Development Name:	i-home
City:	Hong Kong
Location:	38 Larch Street, Tai Kok Tsui
Developer:	Urban Renewal Authority & Chinese Estates Holdings Ltd.
Architect:	LWK & Partners (HK) Ltd.
Completion Year:	2009
Site Area / GFA:	1,229m^2 / -
Units:	182
No. of Towers:	1
No. of Storeys (residential floors):	37
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	20/F
	Refuge floor
Greeneries:	Planters at edges & inner parts
Description:	A sky garden on the 20/F serves as a refuge floor and features activity areas including chessboard zone, qualiwalk area, leisure path, teahut park, greenish court and trove zone.

Reference:	Urban Renewal Authority + Chinese Estates Holdings Ltd, 2009, I-Home Sales Brochure

Appendix 6   Communal Green Spaces in Residential High-rises

Case Study No.:	HK-13
Development Name:	Shining Heights
City:	Hong Kong
Location:	83 Sycamore Street, Kowloon
Developer:	Hong Kong Ferry (Holdings) Co. Ltd.
Architect:	Andrew Lee King Fun & Associates Ltd.
Completion Year:	2009
Site Area / GFA:	- / -
Units:	348
No. of Towers:	1
No. of Storeys (residential floors):	48
No. of Sky Garden(s) per Tower:	2
Sky Garden Location(s):	27/F, 50/F
	Refuge floor; near clubhouse
Greeneries:	Planters at edges
Description:	Two sky gardens of 242m^2 are located on the 27/F and 50/F and parts of the areas are reserved for the purpose of refuge floors. The heights of the 27/F and 50/F are 3.15m and 6m respectively. The 50/F sky garden is immediately below the sky club and floors of special units in larger size.

Reference:	Hong Kong Ferry (Holdings) Co. Ltd, 2015, Shining Heights Sales Brochure

Case Study No.:	HK-14
Development Name:	The Masterpiece
City:	Hong Kong
Location:	18 Hanoi Road, Tsim Sha Tsui
Developer:	New World Development Co. Ltd.
Architect:	Dennis Lau & Ng Chun Man Architects & Engineers (HK) Ltd.
Completion Year:	2009
Site Area / GFA:	8,299m² / -
Units:	345
No. of Towers:	1
No. of Storeys (residential floors):	36
No. of Sky Garden(s) per Tower:	2
Sky Garden Location(s):	9/F, 47/F
	Refuge floor; near clubhouse
Greeneries:	Planters at edges & inner parts
Description:	Two sky gardens are located on the 9/F and 47/F. The 9/F sky garden is immediately above clubhouse floor with amenities of sitting area, feature planting, foot massage paths and viewing corridor. The 47/F sky garden is reserved for the purpose of refuge floor with provision of Taichi area, sitting area and feature paving.
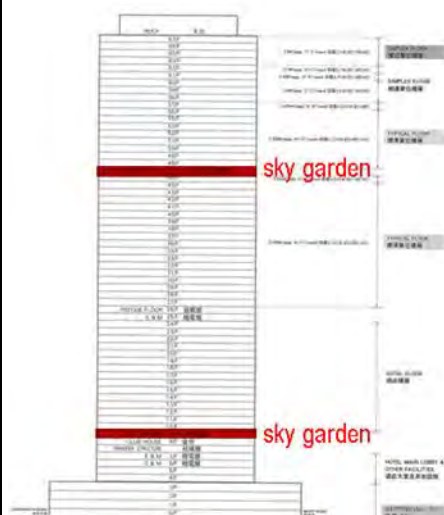
9/F Sky Garden (Hotel/Residential Common Areas)
空中花園9樓平面圖（酒店及住宅公用地方）

① Lift Lobby 電梯大堂　④ Feature Planting 特色園藝
② Lift 電梯　⑤ Viewing Corridor 觀景長廊
③ Sitting Area 休憩區　⑥ Foot Massage 足底按摩徑

47/F Sky Garden/ Refuge Floor (Residential Common Areas)
47樓空中花園/ 避難層平面圖 （住宅公用地方）

① Lift Lobby 電梯大堂　④ Sitting Area 休憩區
② Lift 電梯　⑤ Feature Paving 特色小徑
③ Taichi Area 太極展運區

Reference:	New World Development Co. Ltd, 2014, The Masterpiece Sales Brochure

Appendix 6   Communal Green Spaces in Residential High-rises

Case Study No.:	HK-15
Development Name:	Aria
City:	Hong Kong
Location:	51 Fung Shing Road, Ngau Chi Wan
Developer:	Sun Hung Kai Properties Ltd.
Architect:	P&T Architects & Engineers Ltd.
Completion Year:	2010
Site Area / GFA:	14,459m^2 / -
Units:	723
No. of Towers:	5
No. of Storeys (residential floors):	30
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	37/F
	Separate floor; near clubhouse; connecting different blocks
Greeneries:	Planters at inner parts
Description:	A sky garden of 1,391m^2 bridges 5 separate tower blocks on the 37/F and serves as the main access path to the sky clubhouse for the two uppermost floors and above sky garden. It accommodates 340m sky promenade, sky deck, chess garden, sky gym, golf putting green, water crescendo, fitness station, swinging beds and lifts to sky clubs.

SKY PROMENADE 37/F

Reference:	Sun Hung Kai Properties Ltd, 2010, Aria Sales Brochure
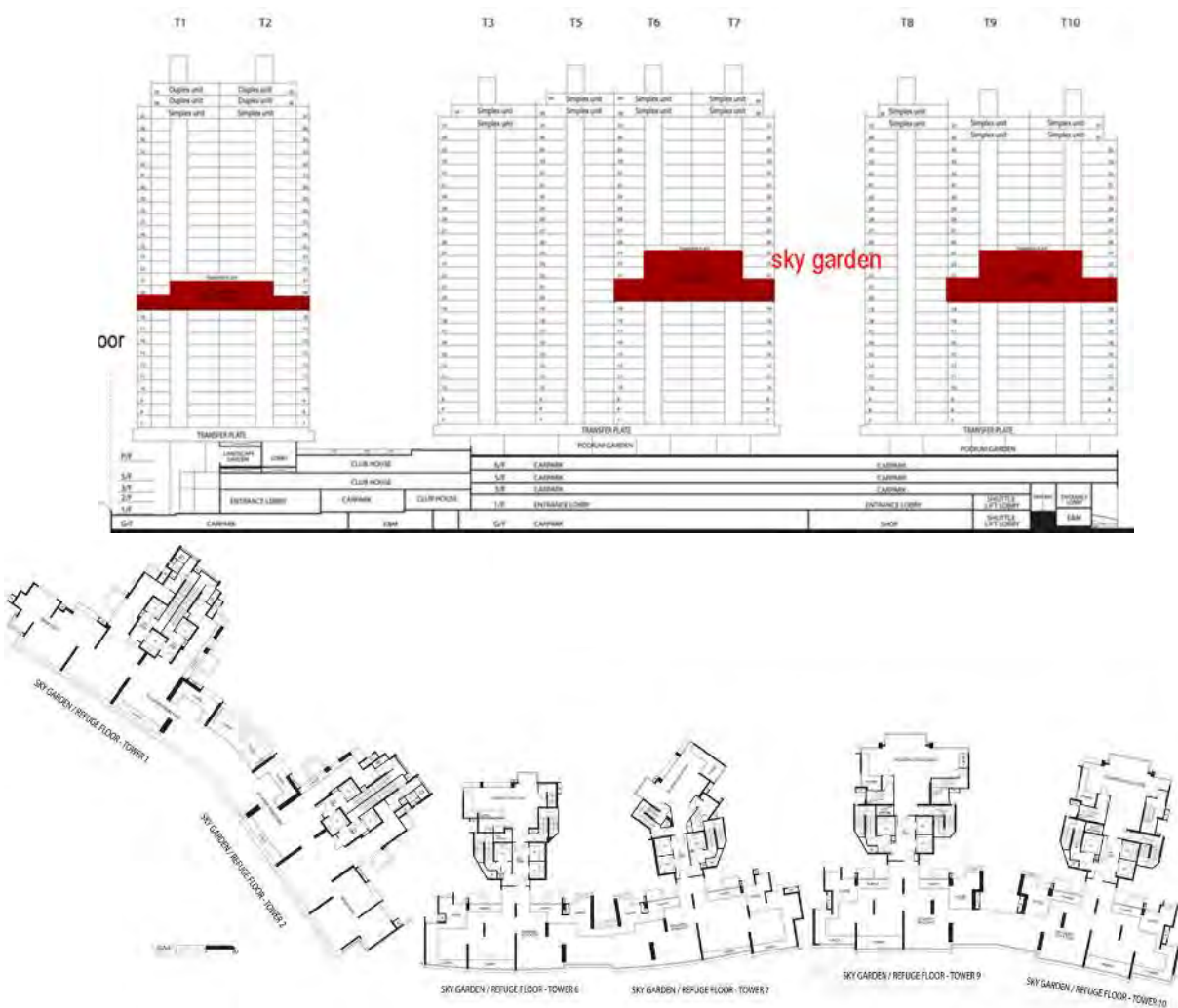
Case Study No.:	HK-16
Development Name:	Island Crest
City:	Hong Kong
Location:	8 First Street
Developer:	Urban Renewal Authority & Kerry Properties Ltd.
Architect:	CYS Associates (HK) Ltd.
Completion Year:	2010
Site Area / GFA:	3,234m² / -
Units:	488
No. of Towers:	2
No. of Storeys (residential floors):	36
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	29/F
	Refuge floor
Greeneries:	Planters at edges
Description:	A sky garden at mid-level of a 42-storey residential building serves as a refuge floor and provides leisure paths and sitting areas.

29/F FLOOR PLAN (Sky Garden & Refuge Floor)

TOWER 1 29/F

TOWER 2 29/F
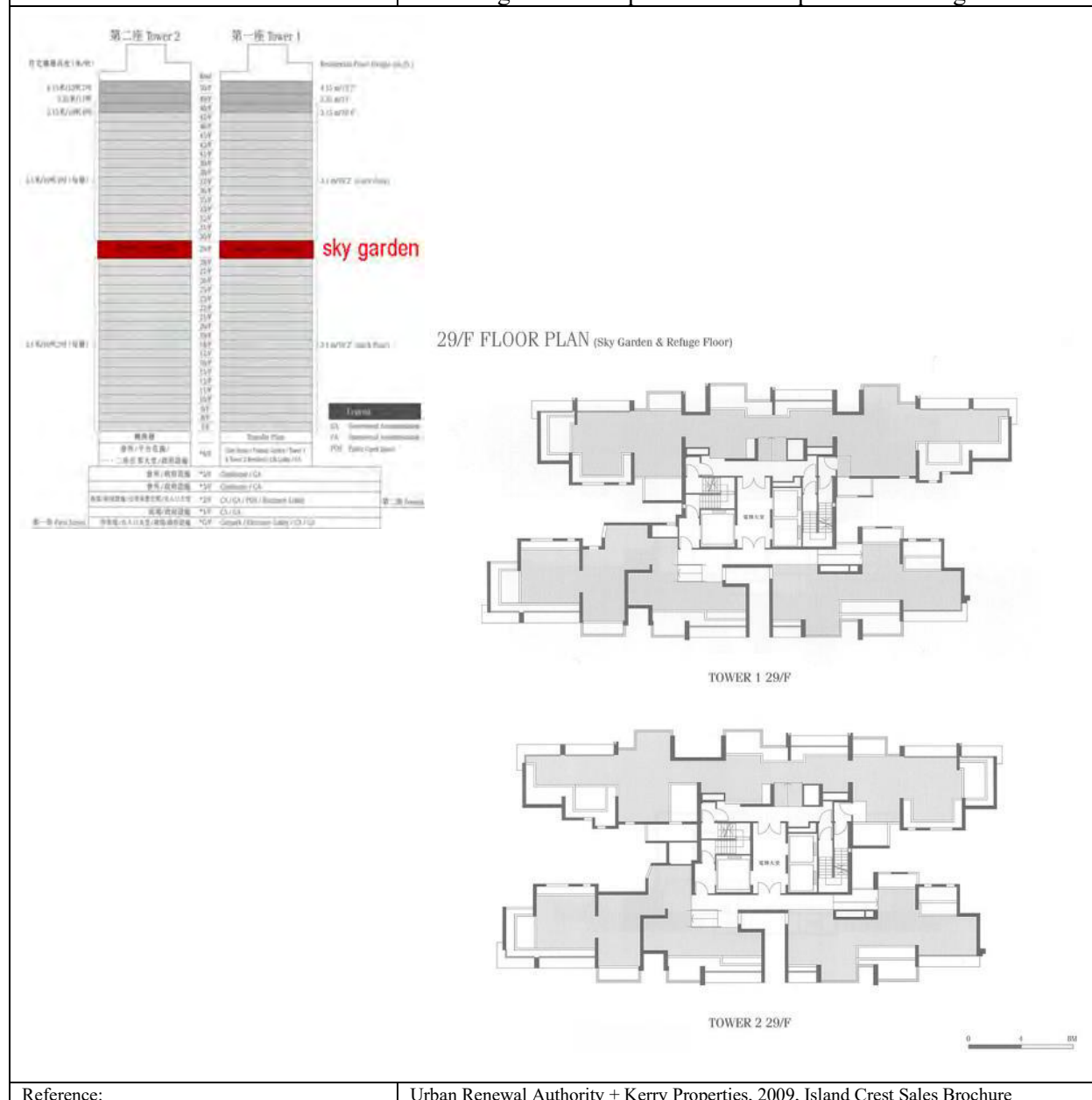
Reference:	Urban Renewal Authority + Kerry Properties, 2009, Island Crest Sales Brochure

Appendix 6   Communal Green Spaces in Residential High-rises

Case Study No.:	HK-17
Development Name:	Larvotto
City:	Hong Kong
Location:	8 Ap Lei Chau Praya Road
Developer:	Sun Hung Kai Properties Ltd., Kerry Properties Ltd. & Paliburg Holdings Ltd.
Architect:	Ronald Lu & Partners (HK) Ltd.
Completion Year:	2011
Site Area / GFA:	16,770m^2 / -
Units:	715
No. of Towers:	9
No. of Storeys (residential floors):	25-28
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	20-24/F
	Refuge floor; connecting different blocks
Greeneries:	Planters at edges
Description:	Sky gardens of 1,180 sq.m on the 19/F-24/F with heights of 7m-14m serve as refuge floors for 6 tower blocks and facilitate air ventilation passing through the development site. Transfer structures are created for 16m-20m wide covered landscaped spaces at sky gardens.

Reference:	Sun Hung Kai Properties Ltd + Kerry Properties Ltd + Paliburg Holdings Ltd, 2017, Larvotto Sales Brochure

Appendix 6   Communal Green Spaces in Residential High-rises

Case Study No.:	HK-18
Development Name:	Lime Stardom
City:	Hong Kong
Location:	1 Larch Street, Tai Kok Tsui
Developer:	Urban Renewal Authority & Shun Hung Kai Properties Ltd.
Architect:	Simon Kwan & Associates Ltd.
Completion Year:	2011
Site Area / GFA:	2,195m² / -
Units:	377
No. of Towers:	1
No. of Storeys (residential floors):	36
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	18/F
	Refuge floor
Greeneries:	Planters at edges
Description:	A 6m high sky garden of 197 sq.m is located on the 19/F and serves as a refuge floor. Without structural transfer of upper living units, discrete spaces are resulted in the sky garden.

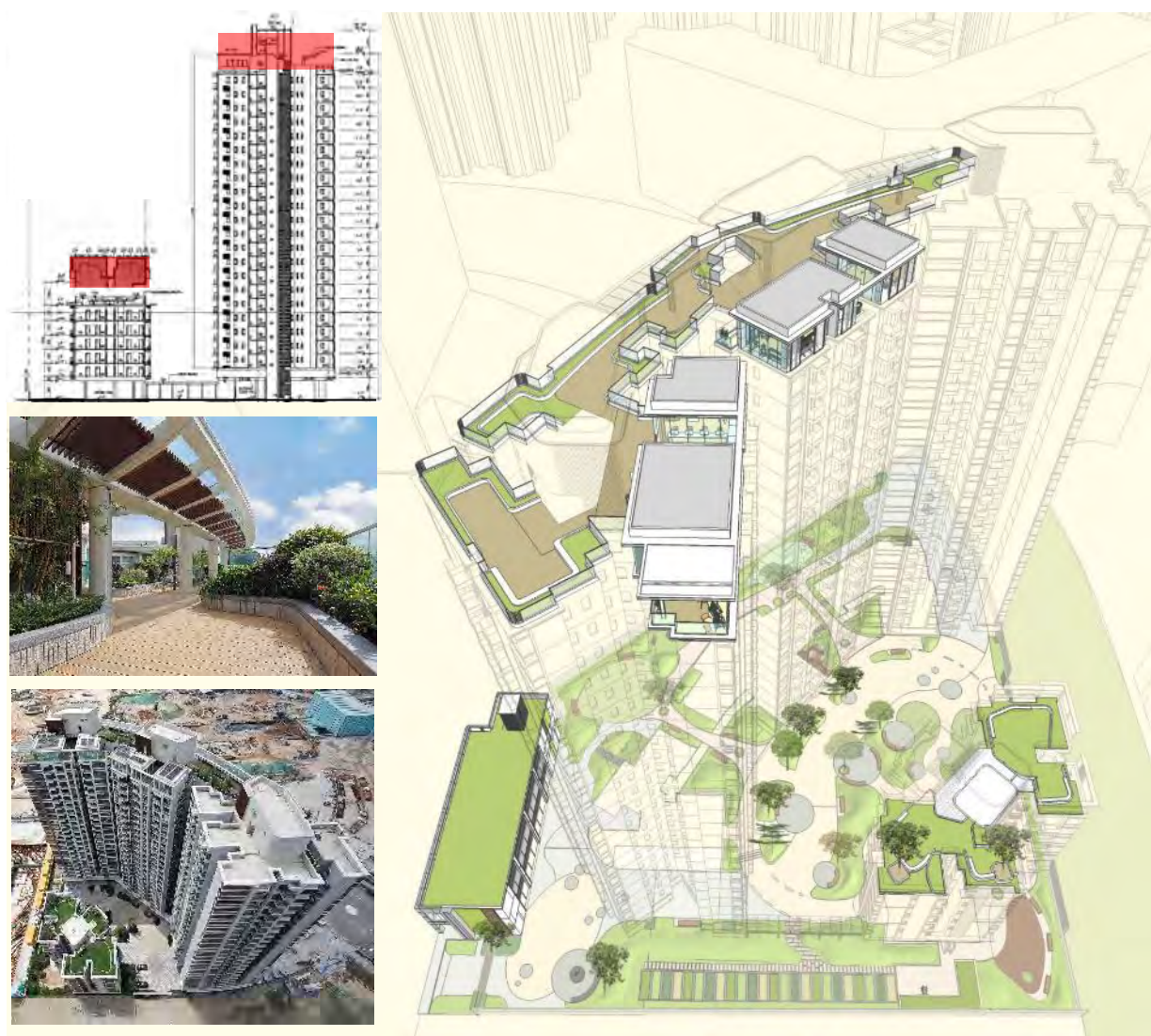SKY GARDEN FLOOR PLAN [AT REFUGE FLOOR]

Reference:	Urban Renewal Authority + Sun Hung Kai Properties Ltd, 2011, Lime Stardom Sales brochure

Appendix 6   Communal Green Spaces in Residential High-rises

Case Study No.:	HK-19
Development Name:	Harbour One
City:	Hong Kong
Location:	458 des Voeux Road West
Developer:	Emperor International Holdings Ltd.
Architect:	Design Consultants Ltd.
Completion Year:	2012
Site Area / GFA:	- / -
Units:	103
No. of Towers:	1
No. of Storeys (residential floors):	29
No. of Sky Garden(s) per Tower:	2
Sky Garden Location(s):	7/F, 32/F
	Refuge floor
Greeneries:	Planters at edges
Description:	Two sky gardens of 923 sq.m are located on the 7/F and 32/F and both serve as refuge floors. The sky garden on the 7/F is immediately below the podium clubhouse. Panoramic harbour view is offered on the 32/F sky garden.

7/F (Refuge Floor)

32/F (Refuge Floor)

| Reference: | Emperor International Holdings Ltd, 2012, Harbour One Sales Brochure |

Appendix 6   Communal Green Spaces in Residential High-rises

Case Study No.:	HK-20
Development Name:	De Novo
City:	Hong Kong
Location:	3 Muk Chui Street, Kai Tak
Developer:	Urban Renewal Authority
Architect:	Ronald Lu & Partners (HK) Ltd.
Completion Year:	2016
Site Area / GFA:	- / -
Units:	484
No. of Towers:	3
No. of Storeys (residential floors):	23
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	R/F
	Separate floor; near clubhouse; connecting different blocks
Greeneries:	Trees, planters at edges
Description:	Three 23-storey residential towers, an elderly-friendly low-rise block and a retail block. Rooftop garden at the low-rise block offers green spaces for leisure and pleasant view to higher units; sky garden at the rooftop of the towers is integrated with a jogging track, barbecue area and multi-purpose pavilions.

Reference:	http://the-sun.on.cc/cnt/news/20120228/00407_080.htm l

Appendix 6   Communal Green Spaces in Residential High-rises

Case Study No.:	SG-1
Development Name:	Newton Suites
City:	Singapore
Location:	60 Newton Road
Developer:	-
Architect:	WOHA
Completion Year:	2007
Site Area / GFA:	- / -
Units:	-
No. of Towers:	1
No. of Storeys (residential floors):	36
No. of Sky Garden(s) per Tower:	7
Sky Garden Location(s):	Every 4 floors
	Doorstep form units
Greeneries:	Trees, planters at edges, vertical green
Description:	Cantilevered sky gardens seamlessly integrated with the lift lobbies at every 4 levels of a 36-storey residential building. With most available horizontal and vertical surfaces being vegetated, the sky gardens serve as a natural retreat for residences.

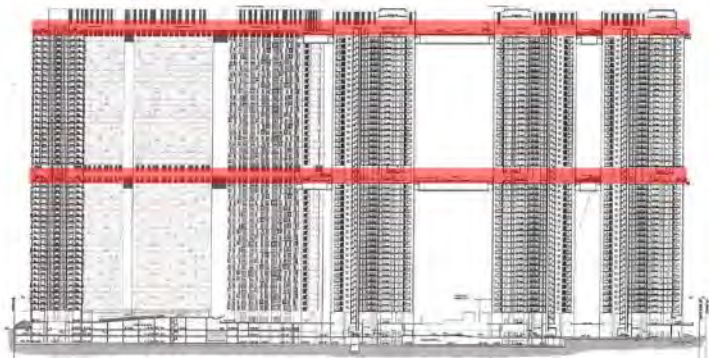|	
Reference:	http://ifd-arch.blogspot.hk/2011/04/architecture-design-newton-suites.html

Appendix 6   Communal Green Spaces in Residential High-rises

Case Study No.:	SG-2
Development Name:	Central Horizon
City:	Singapore
Location:	D12, 78A Toa Payoh Central
Developer:	Housing & Development Board
Architect:	Surbana International Consultants
Completion Year:	2009
Site Area / GFA:	- / -
Units:	1158
No. of Towers:	5
No. of Storeys (residential floors):	40
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	12/F
	Refuge floor; connecting different blocks
Greeneries:	Trees, planters at edges & inner parts, grass/turf areas
Description:	A long sky garden of 4,600 m^2 elevated green spaces connects the 12/F of five 40-storey residential towers and rooftop gardens of an 11-storey high podium slab block and a 7-storey multi-storey carpark. It also serves as a refuge in the event of a fire.

Reference:	https://www.worldarchitecturenews.com/article/1504408/new-horizon

Case Study No.:	SG-3
Development Name:	Pinnacle at Duxton
City:	Singapore
Location:	1G Cantonmet Road
Developer:	Housing & Development Board
Architect:	ARC Studio Architecture + Urbanism & RSP Architects, Planners & Engineers (Pte) Ltd.
Completion Year:	2009
Site Area / GFA:	- / -
Units:	1848
No. of Towers:	7
No. of Storeys (residential floors):	50
No. of Sky Garden(s) per Tower:	2
Sky Garden Location(s):	26/F, 50/F
	Separate floor; near clubhouse; connecting different blocks
Greeneries:	Trees, planters at inner parts, grass/turf areas
Description:	Two longest sky gardens over the world connect seven numbers of 50-storey public housing blocks. These two sky gardens are located on 26th and 50th floors. The 26th is exclusively for residents only while the 50th opens to public as an observation deck for visitors viewing cityscape and skyline of Singapore. The 26th sky garden accommodate jogging tracks, children play area, gym room, residents' committee centre and others. It offers over 5,000 residents a social interaction place.

Reference:	https://divisare.com/projects/150328-arc-studio-architecture-urbanism-pinnacle-duxton

Appendix 6   Communal Green Spaces in Residential High-rises

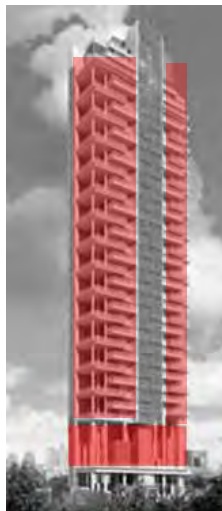|	
Case Study No.:	SG-4
Development Name:	RiverGate
City:	Singapore
Location:	Robertson Quay, Orchard
Developer:	Riverwalk Promenade Pte Ltd.
Architect:	Image Creative Design
Completion Year:	2009
Site Area / GFA:	- / -
Units:	545
No. of Towers:	3
No. of Storeys (residential floors):	43
No. of Sky Garden(s) per Tower:	20+
Sky Garden Location(s):	Every 2-3 floors
	Doorstep from units
Greeneries:	Trees, planters at edges
Description:	Three 43-storey residential blocks at the edge of the Singapore River incorporate 45 sky gardens which are a mixture of communal and private garden spaces distributed every two to three storeys on different sides of the building blocks.

Reference:	https://www.srx.com.sg/condo/rivergate-108/floor-plans

Case Study No.:	SG-5
Development Name:	Skypark at Somerset
City:	Singapore
Location:	22 Saint Thomas Walk
Developer:	TG Development Pte Ltd.
Architect:	MKPL Architects
Completion Year:	2010
Site Area / GFA:	- / -
Units:	56
No. of Towers:	2
No. of Storeys (residential floors):	32
No. of Sky Garden(s) per Tower:	15
Sky Garden Location(s):	Every 2 floors
	Doorstep from units
Greeneries:	Trees, planters at edges, grass/turf areas
Description:	Double volume, large and lush sky gardens at a 32-storey building serve as the garden gate before arriving at the front door of individual units.

Reference:	https://propertypacrim.wordpress.com/2007/04/01/skypark-somerset/

|	
Case Study No.:	SG-6
Development Name:	Reflections at Keppel Bay
City:	Singapore
Location:	Keppel Bay View
Developer:	Keppel Bay Pte Ltd.
Architect:	DCA Architects Pte Ltd.
Completion Year:	2013
Site Area / GFA:	- / -
Units:	1129
No. of Towers:	6
No. of Storeys (residential floors):	24-41
No. of Sky Garden(s) per Tower:	4
Sky Garden Location(s):	8/F, 15/F, 22/F, R/F
	Separate floor; doorstep from units; connecting different blocks
Greeneries:	Trees, planters at inner parts
Description:	Each pair of the six residential towers is connected by landscaped decks on three separate floors. Terraced gardens are created at each roof of the towers.

Reference:	https://www.edgeprop.sg/

Appendix 6   Communal Green Spaces in Residential High-rises

Case Study No.:	SG-7
Development Name:	Martin Place Residences
City:	Singapore
Location:	2 Martin P1
Developer:	FCL Land Pte Ltd.
Architect:	Design Link Architects
Completion Year:	20
Site Area / GFA:	- / -
Units:	302
No. of Towers:	2
No. of Storeys (residential floors):	33
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	14/F
	Separate floor; connecting different blocks
Greeneries:	Trees, planters at edges & inner parts
Description:	Two towers of 33-storey residential high-rises with 302 units has a sky garden at the 14th floor with outdoor gym, water garden, yoga corner, lounge areas, barbeque areas and jacuzzi.
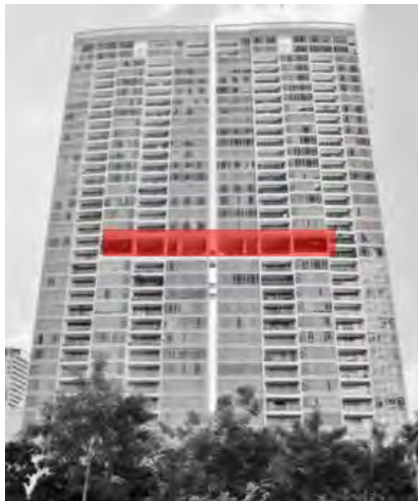
Sky Terrace Site Plan
(14th Storey)

Legend

A	Outdoor Gym	C	Work Loft	E	Sky Lounge
B	Yoga Corner	D	Water Garden	F	Reading Lounge

Reference:	https://vincentongvirtualhomes.com/martin-place-residences/

Appendix 6   Communal Green Spaces in Residential High-rises

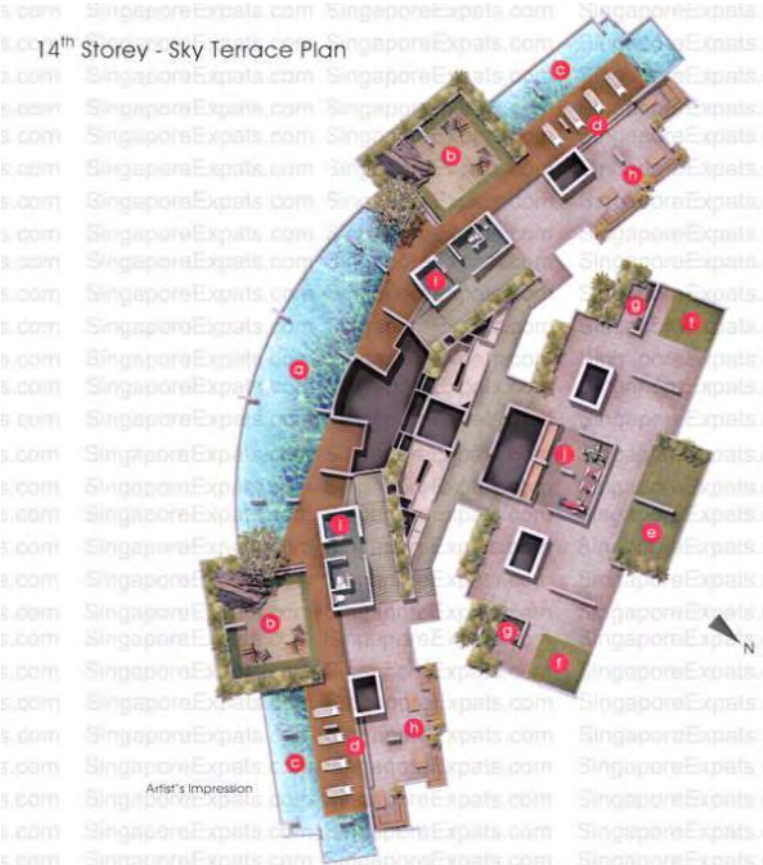|	
Case Study No.:	SG-8
Development Name:	Solei @ Sinaran
City:	Singapore
Location:	2, 6 Sinaran Drive in District 11
Developer:	Riverside Investments Pte Ltd.
Architect:	Architects 61
Completion Year:	2012
Site Area / GFA:	- / -
Units:	417
No. of Towers:	2
No. of Storeys (residential floors):	38-40
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	20/F
	Separate floor
Greeneries:	Trees, planters at edges
Description:	Two blocks of 38 and 40-storey residential buildings with 417 units has a sky garden at the 20th floor.

Reference:	https://www.srx.com.sg/condo/soleil-sinaran-4711

Appendix 6   Communal Green Spaces in Residential High-rises

Case Study No.:	SG-9
Development Name:	Parc Seabreeze
City:	Singapore
Location:	532 Joo Chiat Road in District 15
Developer:	Grovehill Pte Ltd.
Architect:	Park + Associates Pte Ltd.
Completion Year:	2012
Site Area / GFA:	- / -
Units:	91
No. of Towers:	20
No. of Storeys (residential floors):	1
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	14/F
	Separate floor
Greeneries:	Trees, planters at edges
Description:	A 20-storey residential building with 91 units has a sky garden with spa & social pools, gym, lounge, sauna & steam room and multi-purpose deck at the 14th floor.

14th Storey - Sky Terrace Plan

Artist's Impression

- a Spa / Social Pool
- b Multi-purpose Deck
- c Spa / Social Pool
- d Pool Deck
- e Lawn
- f Dining Area
- g Kitchenette
- h Lounge Areas
- i Sauna / Steam Room
- j Gym

Reference:	http://parcseabreeze.com/index.html

Case Study No.:	SG-10
Development Name:	Ascentia Sky
City:	Singapore
Location:	1 Alexandra View in District 3
Developer:	Wing Tai Holdings Ltd.
Architect:	P&T Group
Completion Year:	2014
Site Area / GFA:	- / -
Units:	373
No. of Towers:	1
No. of Storeys (residential floors):	45
No. of Sky Garden(s) per Tower:	10
Sky Garden Location(s):	Every 5 floors
	Doorstep from units; near clubhouse
Greeneries:	Trees, planters at edges
Description:	Ten sky gardens opened to south and north facing elevations are spread over a 45-storey residential building. Almost every 5 storeys have a sky garden. There are multi-levels of themed sky gardens. For instance, 22/F with fitness facilities, 26/F for self-retreat, 31/F as a tea garden and etc.
Reference:	https://www.land.plus/listings/853753/ascentia-sky-tiong-bahru-condominium-for-sale

Case Study No.:	SG-11
Development Name:	Nouvel 18
City:	Singapore
Location:	18 Anderson Road
Developer:	City Development Ltd.
Architect:	The Ateliers Jean Nouvel
Completion Year:	2014
Site Area / GFA:	- / -
Units:	156
No. of Towers:	2
No. of Storeys (residential floors):	36
No. of Sky Garden(s) per Tower:	8
Sky Garden Location(s):	11-26/F
	Separate floor; near clubhouse
Greeneries:	Trees, planters at edges & inner, grass/turf areas, vertical green
Description:	8 sky gardens with various design themes and recreational facilities are scattered at two 36-storey high-end luxurious residential apartments. 8 themes comprise therapeutic patio, forest conservatory, fitness arena, wellness terrace, gourmet pavilion, aqua veranda, sky botanique and meditation garden.

Reference:	https://nouvel18.com/

Appendix 6   Communal Green Spaces in Residential High-rises

Case Study No.:	SG-12
Development Name:	Lincoln Suites
City:	Singapore
Location:	3 Khiang Guan Ave
Developer:	Phileap Pte Ltd.
Architect:	-
Completion Year:	2014
Site Area / GFA:	- / -
Units:	175
No. of Towers:	2
No. of Storeys (residential floors):	30
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	24/F
	Separate floor; near clubhouse; connecting different blocks
Greeneries:	Trees, planters at edges
Description:	Twin 30-storey residential towers with 175 units has a sky clubhouse at the 24th floor with spa massage zone, sky gymnasium, sky lounge, wine and cigar lounge and the sky dining pavilion with 24-hour security.

Club Wing   Wellness Wing

Legend:

Club Wing		Wellness Wing	
23	Alfresco Dining	31	Sky Gym
24	The Italian Dining	32	Outdoor Gym
25	Gourmet Kitchen	33	Meditation Corner
26	The Intimate Booth	34	Yoga Corner
27	The Wine Room	35	Changing Room
28	Recreation Corner	36	Steam Room
29	The Garden	37	Thermal Spa with Hot & Cold Jacuzzis
30	The Living Room	38	Massage/Aroma Therapeutic Deck

Reference:	https://www.propertyguru.com.sg/project/lincoln-suites-2145

Appendix 6   Communal Green Spaces in Residential High-rises

Case Study No.:	SG-13
Development Name:	Spottiswoode Residences
City:	Singapore
Location:	48 Spottiswoode Park Road
Developer:	UOL Development Pte Ltd
Architect:	Eco – ID
Completion Year:	2014
Site Area / GFA:	- / -
Units:	351
No. of Towers:	3
No. of Storeys (residential floors):	36
No. of Sky Garden(s) per Tower:	3
Sky Garden Location(s):	2/F, 10/F, 22/F
	Separate floor; near clubhouse; connecting different blocks
Greeneries:	Trees, planters at edges
Description:	A 36-stoery residential apartment with 351 units has three sky gardens at 2nd, 10th and 22th floors.

LEISURE TERRACE @ LEVEL 2

15 Teppanyaki Dining Area
16 Folding Lawn Reading Corner
17 Laundromat and Lounge
18 Sports Bar and Billiard Table *
19 Games Machines
20 Swing in the Forest

ENTERTAINMENT TERRACE @ LEVEL 10

WELLNESS TERRACE @ LEVEL 22

21 Private Dining Area *
22 Tea Garden
23 Massage Pavilion
24 Rainforest Shower *
25 Jacuzzi *
26 Sky Gym
27 Yoga/Meditation Corner
28 Outdoor Fitness Area with Equipment

Reference:	https://keylocation.sg/condos/spottiswoode-residences

Appendix 6   Communal Green Spaces in Residential High-rises

Case Study No.:	SG-14
Development Name:	Spottiswoode 18
City:	Singapore
Location:	18 Spottiswoode Park Road
Developer:	R1 Development Pte Ltd.
Architect:	Ronny Chun Architecture Pte Ltd.
Completion Year:	2015
Site Area / GFA:	- / -
Units:	251
No. of Towers:	1
No. of Storeys (residential floors):	36
No. of Sky Garden(s) per Tower:	2
Sky Garden Location(s):	14/F, 24/F
	Separate floor
Greeneries:	Trees, planters at edges & inner parts, grass/turf areas
Description:	A 36 storey residential apartment with 251 units has two sky gardens at 14th and 24th floors.

Legend
A Observation Deck – CITYVIEW@14
B Meditation Corner – BALANCE@14
C Gymnasium – GYM@14
D Waiting Area
E Reflective Pool – POOL@14
F Yoga Space – STRETCH@14
G Scented Spa Pots – SPA@14
  • G1 Spa Plumeria
  • G2 Spa Muraya
  • G3 Spa Michelia
  • G4 Massage Slab
H Toilet
J Reflexology Walk

LEVEL 14

LEVEL 24

Legend
A Observation Deck – CITYVIEW@24
B Landscaped Gardens – RETREAT@24
  • B1 Tea Garden
  • B2 Zen Garden
  • B3 Lush Garden
C Observation Lounge – SEAVIEW@24
D Reflective Pool – POOL@24
E Family and Friends' Lounge – ENTERTAIN@24
F Toilet

Reference:	Http://condo.singaporeexpats.com/condo/3273/SPOTTISWOODE-18

Case Study No.:	SG-15
Development Name:	Skyville @ Dawson
City:	Singapore
Location:	85-88 Dawson Road
Developer:	Housing & Development Board
Architect:	WOHA
Completion Year:	2015
Site Area / GFA:	29,392m^2 / 113,960m^2
Units:	960
No. of Towers:	3
No. of Storeys (residential floors):	47
No. of Sky Garden(s) per Tower:	4
Sky Garden Location(s):	12/F, 24/F, 36/F, 48/F
	Separate floor; doorstep from units; connecting different blocks
Greeneries:	Trees, planters at edges & inner parts
Description:	Each home is part of a Sky Village comprising 80 homes sharing a sheltered community garden terrace. The rooftop public skypark, open 24 hours, incorporates a 400m jogging track under pavilions capped by a photovoltaic array.

Reference:	https://www.world-architects.com/en/woha-singapore/project/skyville-dawson https://www.archdaily.com/800832/skyville-woha/58453a18e58ece8fdb0003c4-skyville-woha-section

Case Study No.:	SG-16
Development Name:	Sky Habitat
City:	Singapore
Location:	7 Bishan Street
Developer:	Capitaland & Mitsubishi Estate Asia Pte Ltd.
Architect:	Safdie Architects
Completion Year:	2015
Site Area / GFA:	- / -
Units:	509
No. of Towers:	2
No. of Storeys (residential floors):	38
No. of Sky Garden(s) per Tower:	3
Sky Garden Location(s):	14/F, 26/F, 38/F
	Separate floor; near clubhouse; connecting different blocks
Greeneries:	Trees, planters at edges
Description:	Three sky gardens offer community garden and recreational amenities including a swimming pool at the upmost storey, and bridge two 38-storey residential towers.

1 Karaoke Room   4 Sky Bridge   7 Screening Room
2 Reading/Games Lounge 5 Outdoor Exercise Area 8 Function Room
3 Party Room   6 Gym   9 Roof Top Lap Pool

Level 14   Level 26   Level 38

SKY BRIDGES

Reference:	https://www.designboom.com/architecture/moshe-safdie-designs-fractal-based-sky-habitat-for-singapore /

Case Study No.:	SG-17
Development Name:	Robinson Suite
City:	Singapore
Location:	50 Robinson Road
Developer:	50 Robinson Pte Ltd.
Architect:	Ronny Chin Architecture Pte Ltd.
Completion Year:	2016
Site Area / GFA:	- / -
Units:	167
No. of Towers:	1
No. of Storeys (residential floors):	42
No. of Sky Garden(s) per Tower:	2
Sky Garden Location(s):	7/F, 19/F
	Separate floor; doorstep from units
Greeneries:	Trees, planters at edges & inner parts, grass/turf areas
Description:	In a 42 storey residential building with 167 units, the 19/F sky garden accommodates a 24 meter lap pool, jacuzzi, aqua gym, gymnasium, outdoor fitness corner, sky lounge, outdoor kitchen, outdoor dining and the spa room. Another sky garden is at the 7th floor with a swimming pool.

19/F

Legend
a Play Pool   g Sky Lounge
b Jacuzzi   h Changing Room
c Yoga Corner   i Outdoor Fitness Corner
d Spa Room   j Outdoor Kitchen
e Pool Deck   k Outdoor Dining
f Gym

7/F

Legend
a 30 metres lap swimming pool   f Sky Garden
b Wet Deck   g Private 10 metres lap pool
c Pool Deck   h Private Terrace
d Barbecue Deck   j Shower Area
e Garden Suites   k Changing Room
  #07-01
  #07-05

Reference:	https://condo.singaporeexpats.com/condo/3265/ROBINSON-SUITES

Appendix 6   Communal Green Spaces in Residential High-rises

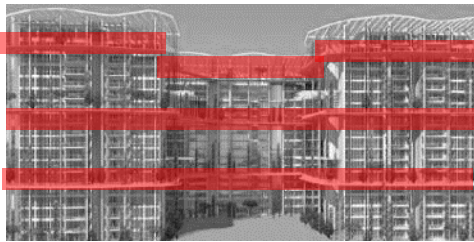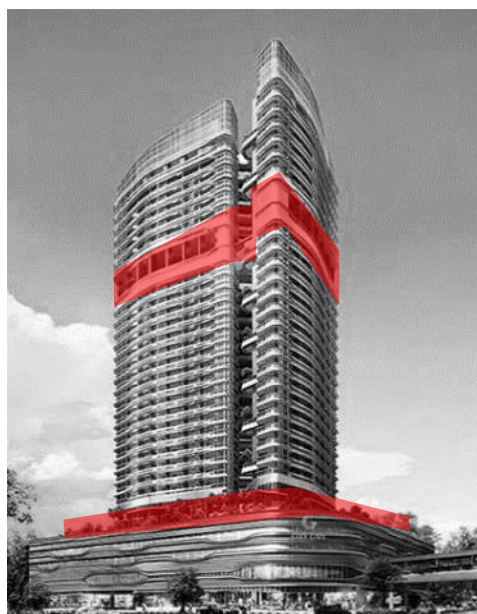| Case Study No.:	SG-18
Development Name:	Scotts Tower
City:	Singapore
Location:	38 Scotts Road
Developer:	Far East Organization
Architect:	UN Studio
Completion Year:	2017
Site Area / GFA:	- / -
Units:	231
No. of Towers:	1
No. of Storeys (residential floors):	31
No. of Sky Garden(s) per Tower:	1
Sky Garden Location(s):	25/F
	Separate floor
Greeneries:	Trees, planters at inner parts
Description:	A 31 storey residential tower has a sky garden at the 25th floor which offers public accessibility to enjoy this public green at the sky-high level.

Reference:	http://new.rushi.net/Home/Works/detail/id/36742.html

Case Study No.:	SG-19
Development Name:	The Tembusu Kovan
City:	Singapore
Location:	105 Tampines Road
Developer:	Winsmart Investment Pte Ltd.
Architect:	Arc Studio Architecture + Urbanism Pte Ltd.
Completion Year:	2017
Site Area / GFA:	- / -
Units:	337
No. of Towers:	3
No. of Storeys (residential floors):	18
No. of Sky Garden(s) per Tower:	2
Sky Garden Location(s):	6/F, 12/F, 18/F
	Doorstep from units; near clubhouse; connecting different blocks
Greeneries:	Trees, planters at inner parts, vertical green
Description:	Three levels of sky garden facilities are spread over 18-storey building blocks for 337 residential units. It demonstrates how extensively and seamlessly integrated with greenery at communal spaces as much as possible. For instance, at intermediate levels, the nominal circulation corridors are enlarged to be lush vegetation decks with a variety of social interaction spaces and plantation, such as fitness corner, reading corner, lounge, dining area and leisure farm corner.

Sky Link
LEVEL 6
24. Sky Club (Play Zone)
25. Fitness Corner (Kids)
26. Relaxation Alcove
27. Art Deck
28. Reading Corner
29. Recreation Corner

Sky Link
LEVEL 12
30. Entertainment Deck
31. Fitness Corner (Adults)
32. Art Deck
33. Lounge Deck
34. I Deck
35. Observatory Deck

Sky Terrace
LEVEL 18
36. Leisure Farm Corner
37. Lounge Corner
38. Roof Top Dining

Reference:	https://www.newlaunch.sg/the-tembusu/

Appendix 6   Communal Green Spaces in Residential High-rises

Case Study No.:	SG-20
Development Name:	City Gate
City:	Singapore
Location:	371 Beach Road
Developer:	Bayfront Ventures Pte Ltd.
Architect:	Westfourth Architecture
Completion Year:	2019
Site Area / GFA:	- / -
Units:	311
No. of Towers:	1
No. of Storeys (residential floors):	25
No. of Sky Garden(s) per Tower:	2
Sky Garden Location(s):	6/F, 24/F
	Separate floor; near clubhouse
Greeneries:	Trees, planters at edges, grass/turf areas
Description:	A 30 storey mix-used development comprises 3 storey commercial podium, 3 storey podium carpark and 25 storey residential tower with sky gardens on the 6th and 24th floors.

LEGEND   The plans and ilustrations are subject to changes as may be approved by relevant authorities. Plans and ilustrations are not drawn to scale.

1 CHILDREN'S PLAYPEN	5 TOILET	9 RELAXATION DECK	13 GOURMET DINING	17 CHILL OUT PAVILION
2 WATER TERRACE	6 FITNESS CORNER	10 MEDITATION DECK	14 TEPPANYAKI GRILL	18 CITY VIEW PAVILION
3 COMMUNAL OUTDOOR GYM	7 GYMNASIUM	11 YOGA DECK	15 LOBBY LOUNGE	19 COMMUNAL SKY PAVILION
4 FLORAL SANCTUARY	8 PUTTING GREEN	12 LANDSCAPED GARDEN	16 LANDSCAPE POOL	20 SCREENING LOUNGE

Reference:	https://www.srx.com.sg/condo/city-gate-37032

END