CIBSE Hong Kong Branch
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The role of green roofs in sustainable development of urban cities

1911-2011

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- Green roof systems
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Urban cities

- World urbanization
  - Will increase from 50% in 2009 to 69% in 2050
  - By 2050, urban dwellers will account for 86% of the population in the more developed regions and for 66% of that in the less developed regions
- Problems of urban cities
  - Urban heat island (UHI)
  - Lack of greenery space
  - Large ecological footprint

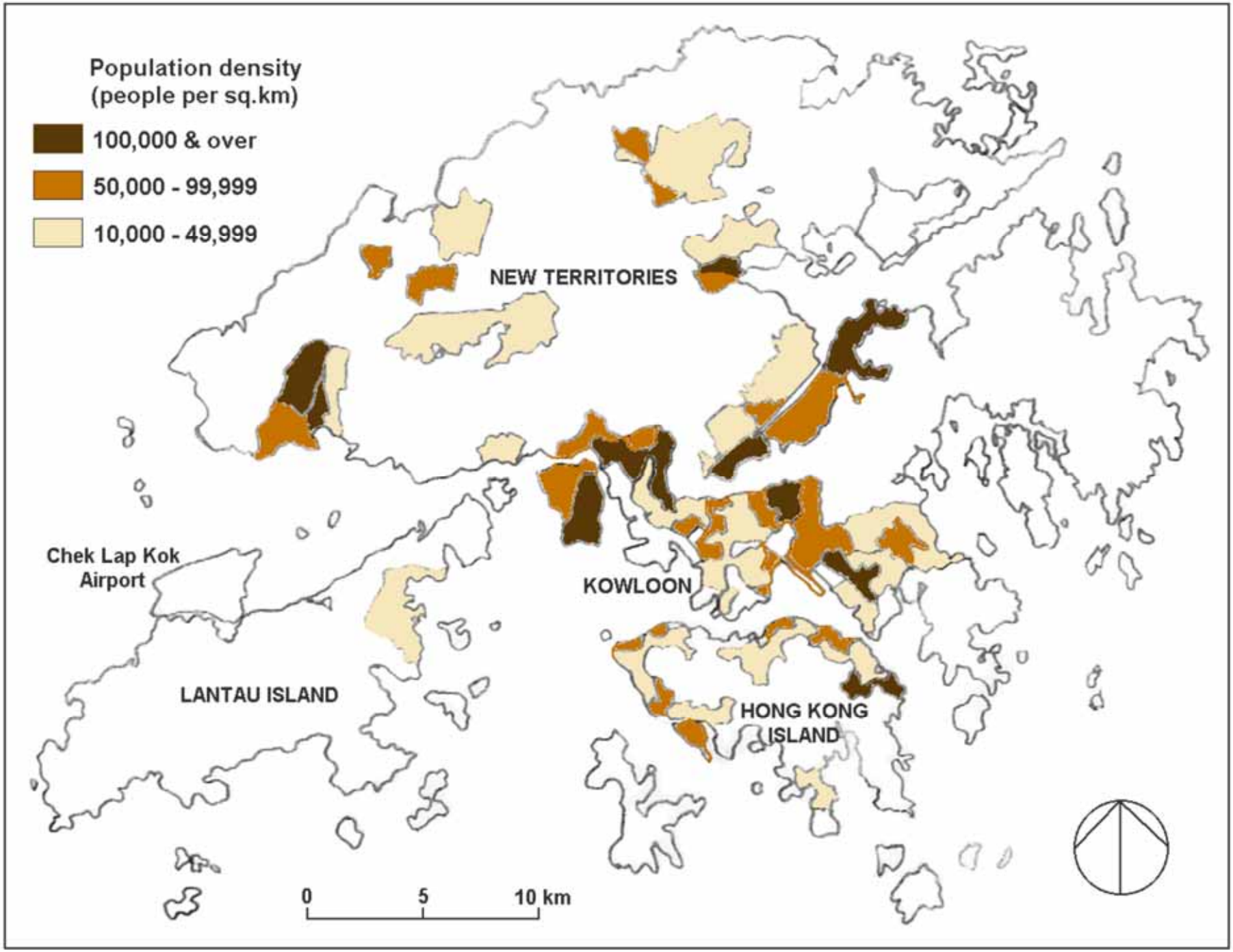
Urban cities

- Examples:
  - Hong Kong
  - London
  - New York
  - Shanghai
  - Taipei
  - Tokyo

Hong Kong

Satellite image from Dr. Gabor Remetey-Fülöpp, Hungarian Association for Geo-information (HUNAGI)

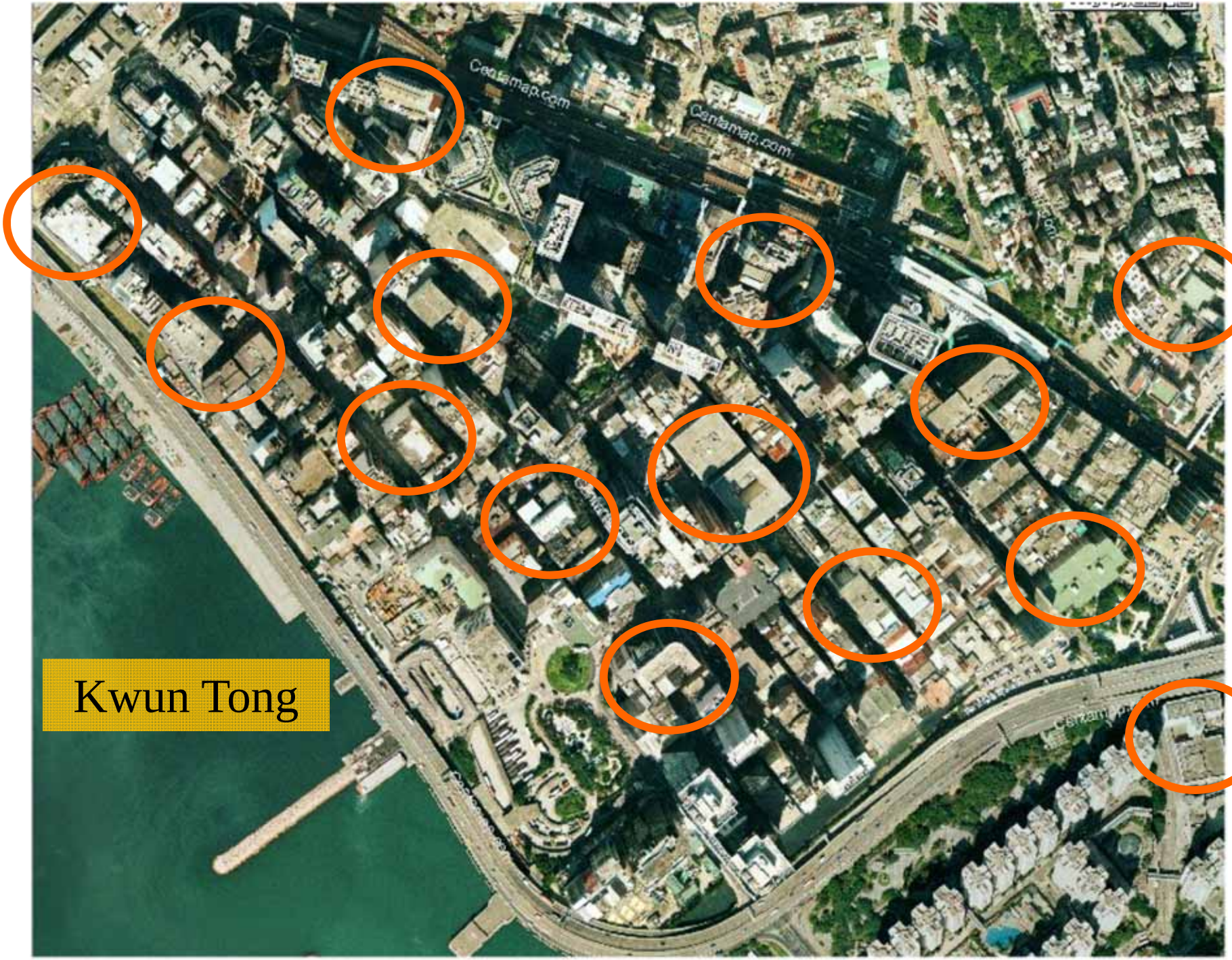
Areas in Hong Kong with high population density



Kwun Tong area in Hong Kong

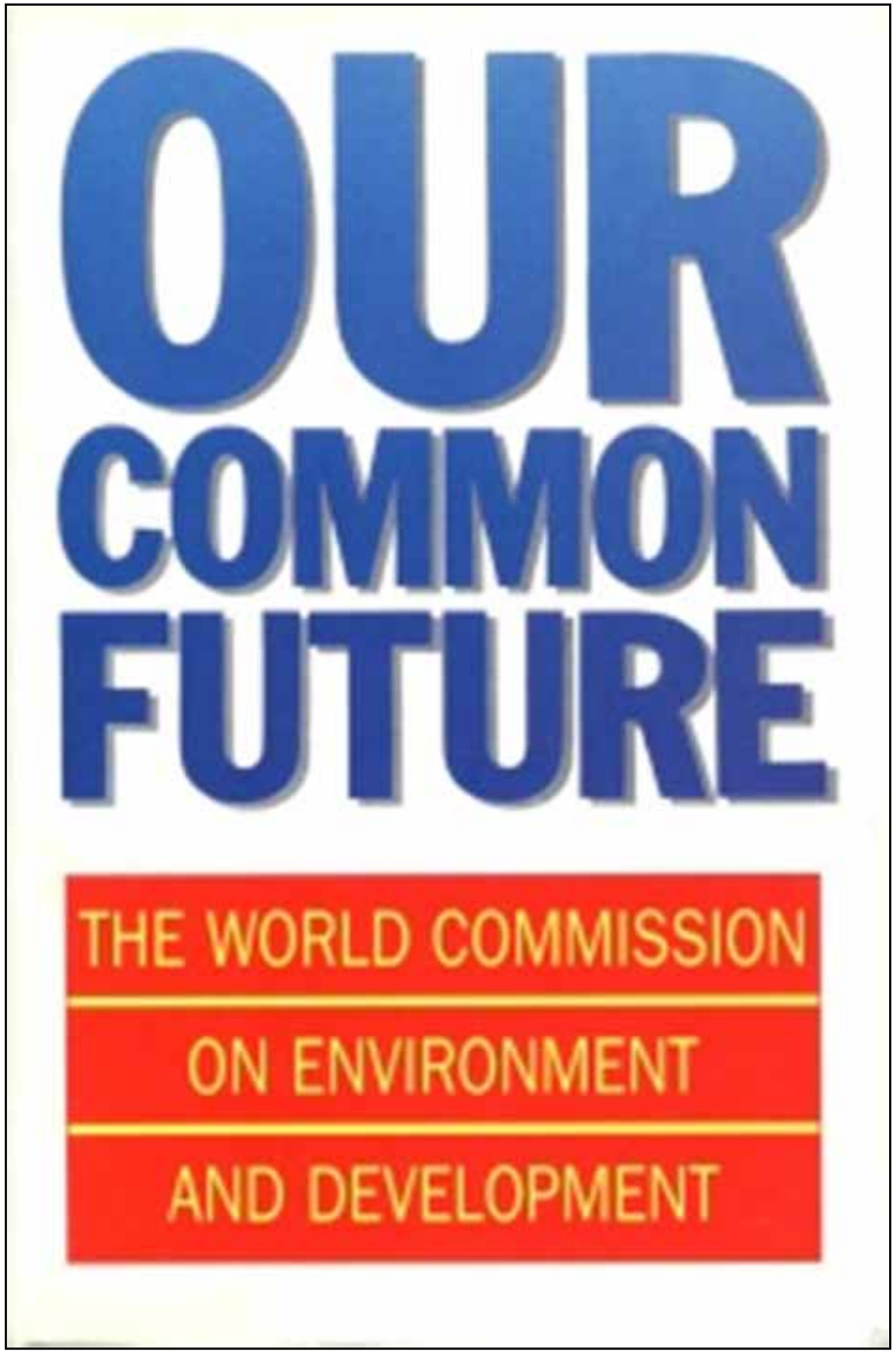
(Source: www.centamap.com)

Potential of promoting green roofs in urban areas



(Source: http://hk.centamap.com)


SUSTAINABLE
DEVELOPMENT
可持續發展



The Brundtland Report defines "Sustainable Development" (S.D.)

Full text of the report:
http://www.un-documents.net/wced-ocf.htm
http://www.worldinbalance.net/agreements/1987-brundtland.html

Sustainable development

- The Brundtland Report (*Our Common Future)*
  - “ S.D. is development which meets the needs of the present without compromising the ability of future generation to meet their own needs.” – World Commission on Environment and Development.

「無後為大」– 孔子
“Most important is the future generation” - Confucius

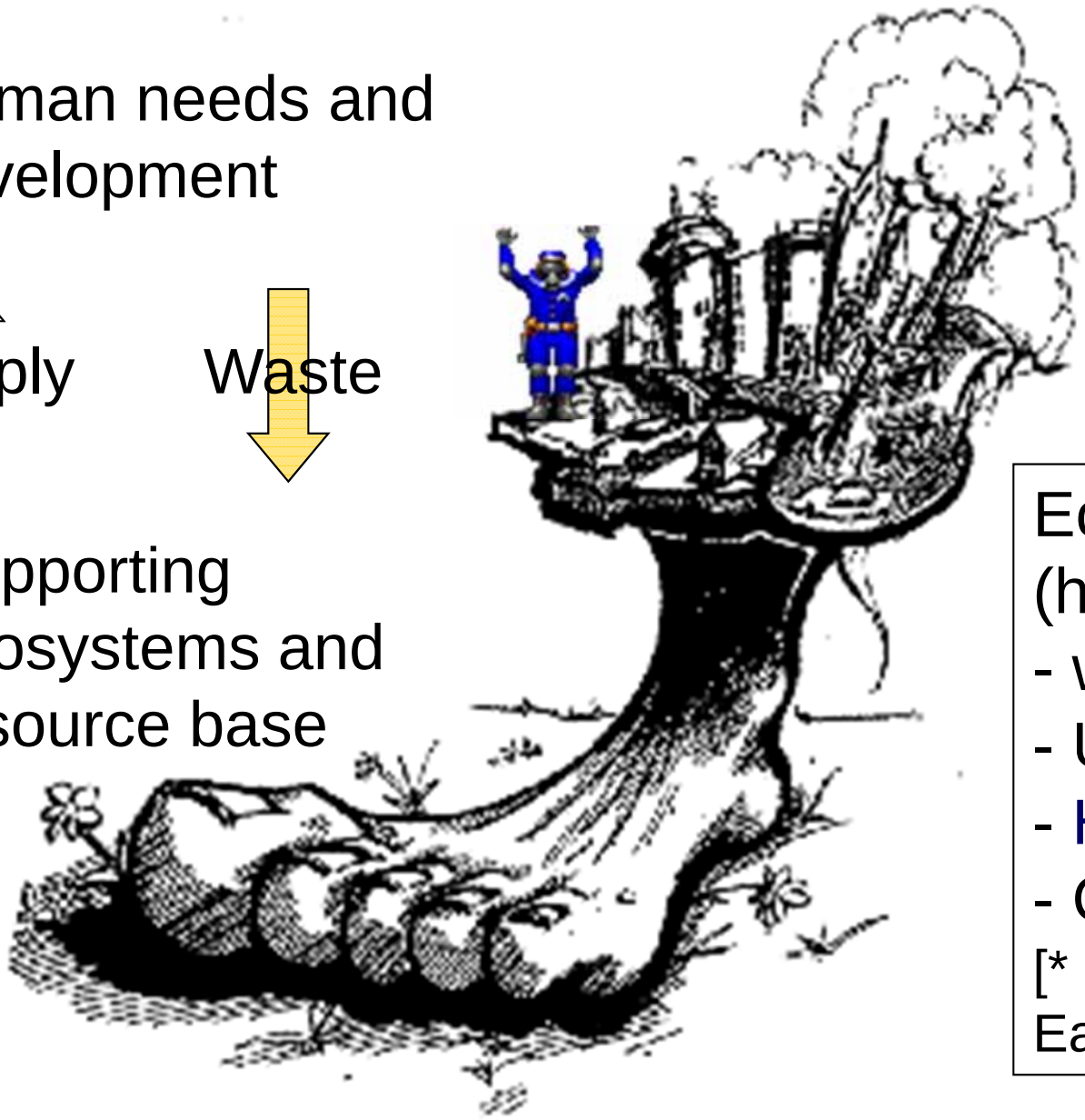
- Two important concepts
  - Needs – maintain an acceptable life standard
  - Limits – within the carrying capacity of supporting ecosystems and resource base

Human needs and development

Supply

Waste

Supporting ecosystems and resource base

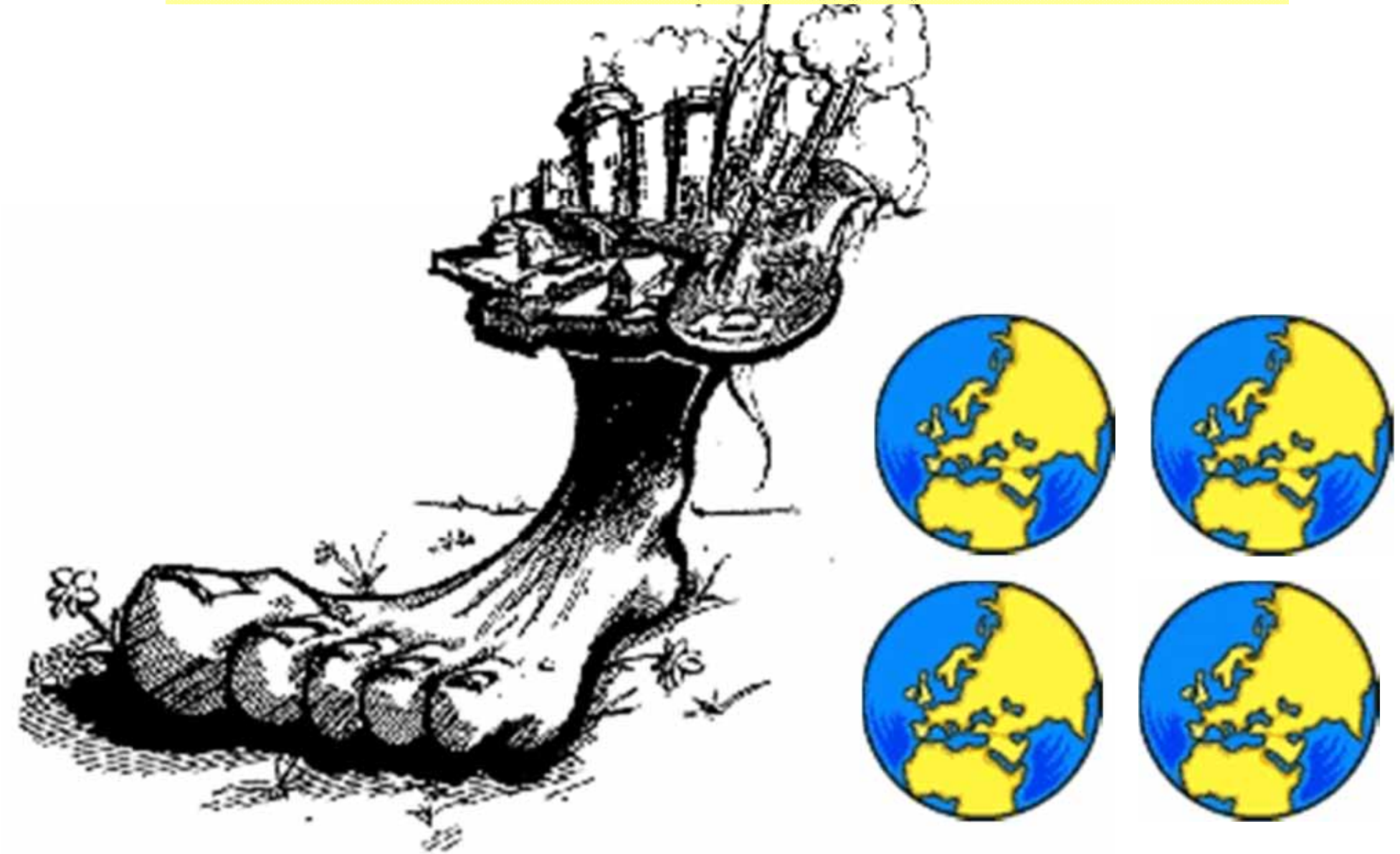


Ecological footprint (hectares/person) *:
- world average = 2.3
- USA = 10.3
- Hong Kong = 6.0
- China = 1.2

[* Source: Friends of the Earth (HK)]

Carrying capacity and ecological footprint

Sustain-able Future?

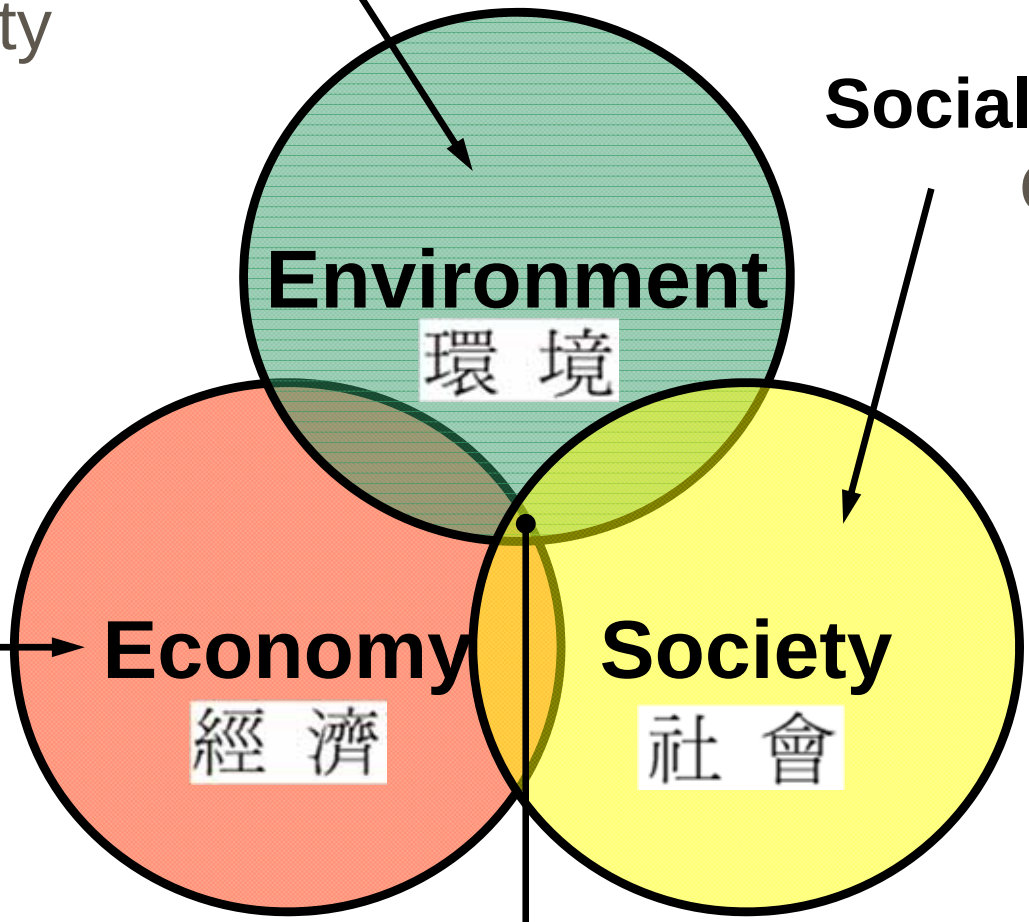


Environmental Sustainability

Ecosystem integrity
Carrying capacity
Biodiversity

Social Sustainability

Cultural Identity
Empowerment
Accessibility
Stability
Equity



Economic Sustainability

Growth
Development
Productivity
Trickle-down

Three dimensions of sustainability

Green roof systems

- **Green Roofs**: roofs bearing vegetation – FLL
  - "Living vegetation installed on the roofs"
  - "Vegetated roof"
- **Green Roof System** – Definition
  - "A roof area of plantings/landscape installed above a waterproofed substrate at any building level that is separated from the ground beneath it by a man-made structure." – *NRCA Green Roof System Manual 2007*
- Other terms: Eco-roof, Living roof

Examples of green roofs in Hong Kong

Ocean Park Hong Kong

EMSD Headquarters

Parklane, Tsimshatsui

A school in San Po Kwong

(Photos taken by Dr Sam C M Hui)

Green roof systems from Germany (left) and Japan (right)

Typical structure of extensive green roof

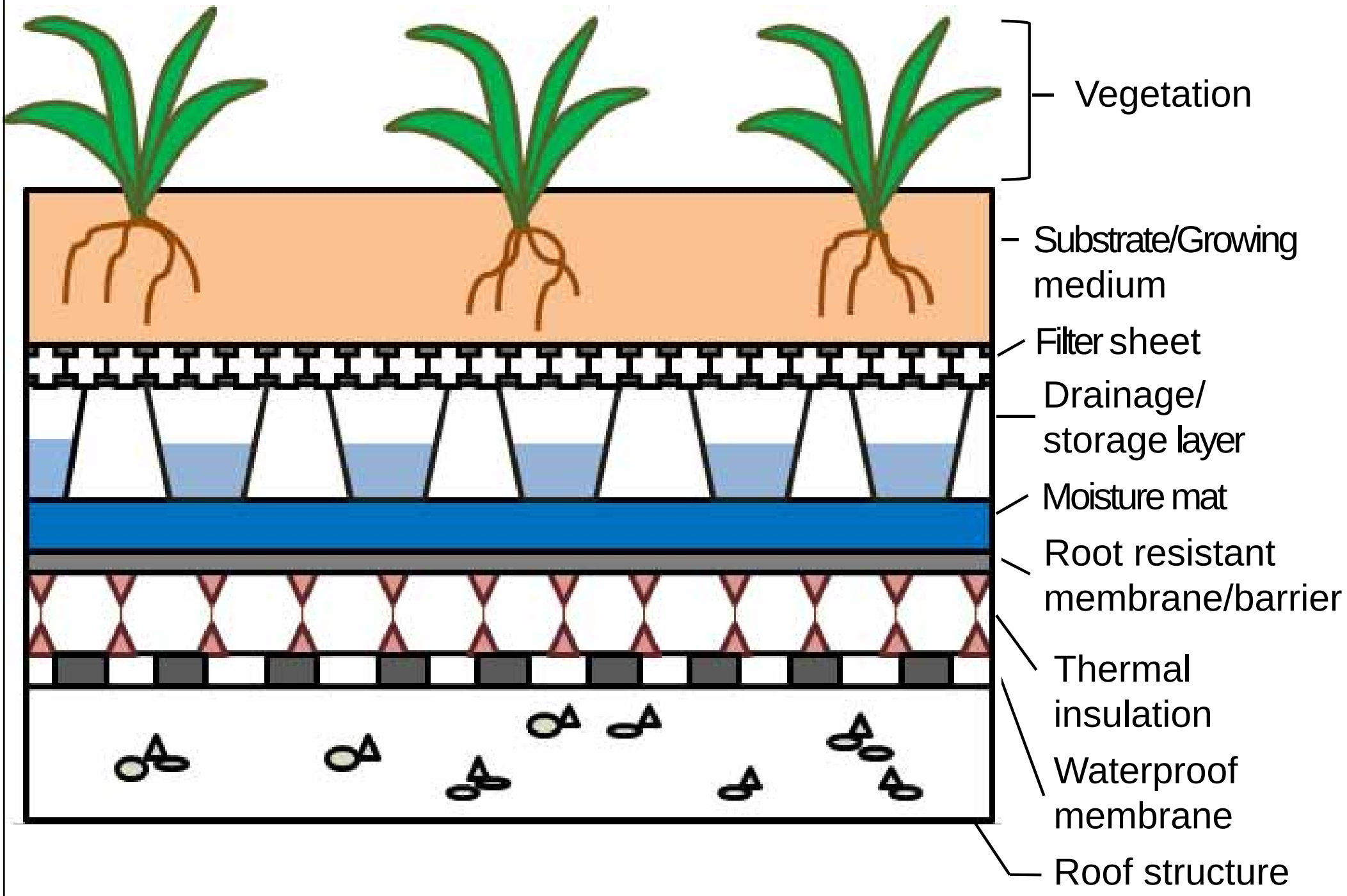


Table 1. Major types of green roofs and their characteristics

Characteristics	Extensive	Semi-intensive	Intensive
Depth of material	150 mm or less	Above and below 150 mm	More than 150 mm
Accessibility	Often inaccessible	May be partially accessible	Usually accessible
Fully saturated weight	Low (70-170 kg/m^2)	Varies (170-290 kg/m^2)	High (290-970 kg/m^2)
Plant diversity	Low	Greater	Greatest
Plant communities	Moss-sedum-herbs and grasses	Grass-herbs and shrubs	Lawn or perennials, shrubs and trees
Use	Ecological protection layer	Designed green roof	Park like garden
Cost	Low	Varies	Highest
Maintenance	Minimal	Varies	Highest

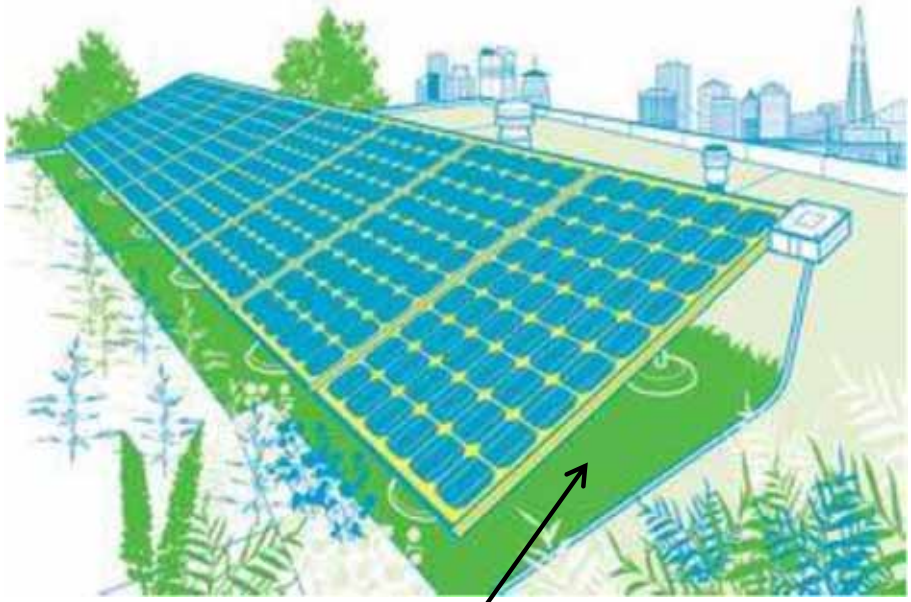
Table 2. Public and private benefits of green roof systems

Public benefits:	**Private benefits:**
- Aesthetic value - Mitigate urban heat island - Stormwater retention - Create natural habitat - Functional open space - Agricultural space - Filter dust and pollutants - Filter rainwater	- Increase roof life span - Reduce cooling loads - Contribute to green building rating credit points - Better use of space - Reduce noise levels - Reduce risk of glare for surrounding buildings

Sustainable rooftops

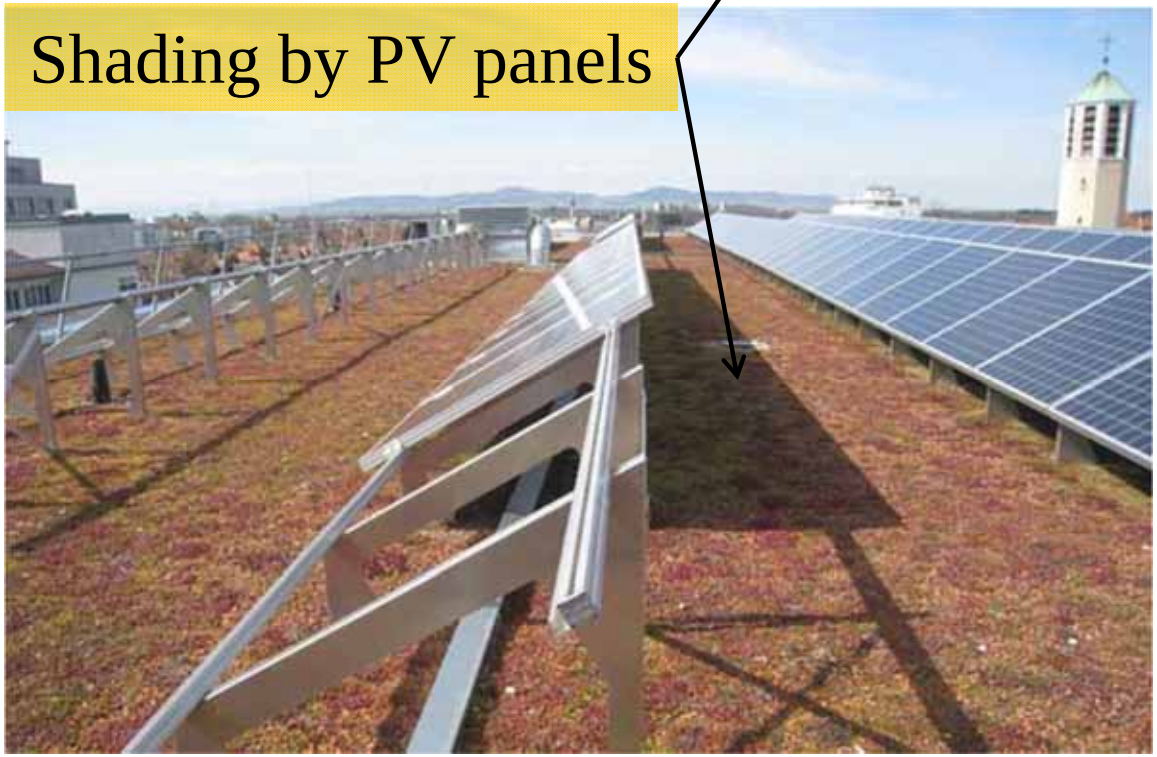
- Environmental sustainability
  - Mitigate urban heat island, manage stormwater, enhance biodiversity, reduce air pollution
- Economic sustainability
  - Extend roof life, reduce costs (energy and maintenance), enhance property value
- Social sustainability
  - Useful roof space, civil education, local job creation, food production

Examples of green roof and solar PV integration



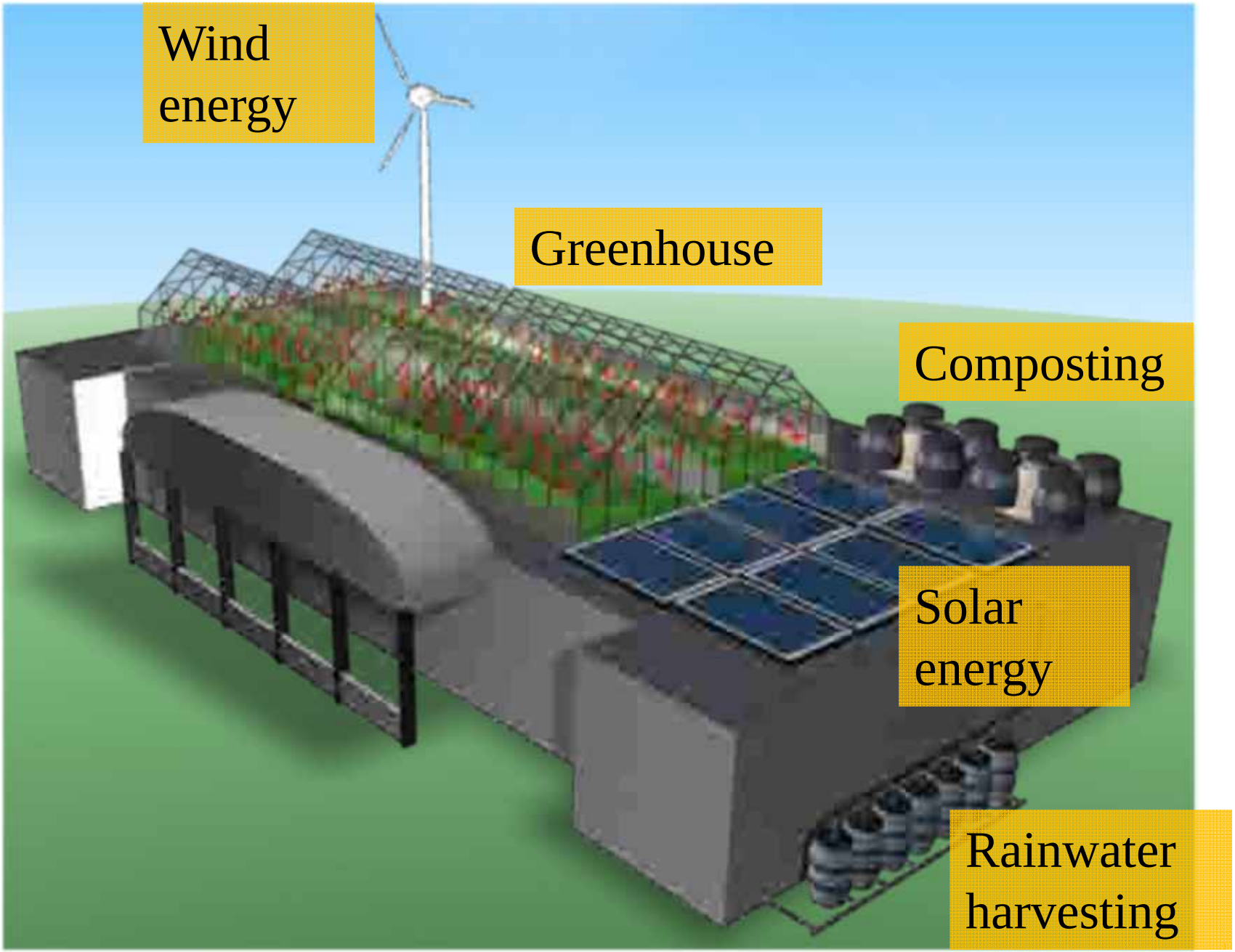
Cooling by vegetation

Shading by PV panels

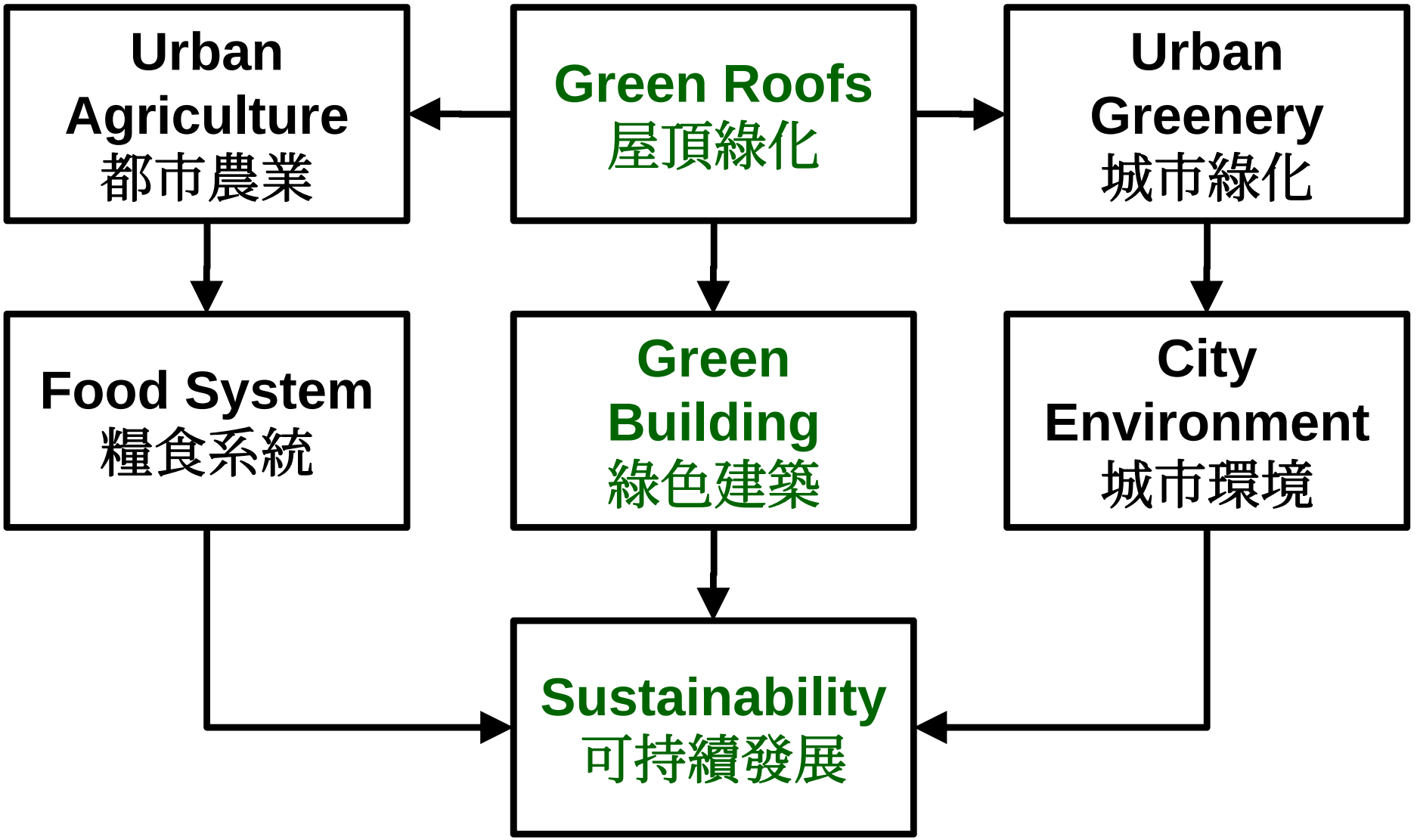


(Source: (Peck and van der Linde, 2010); www.livingroofs.org; www.igra-world.com)

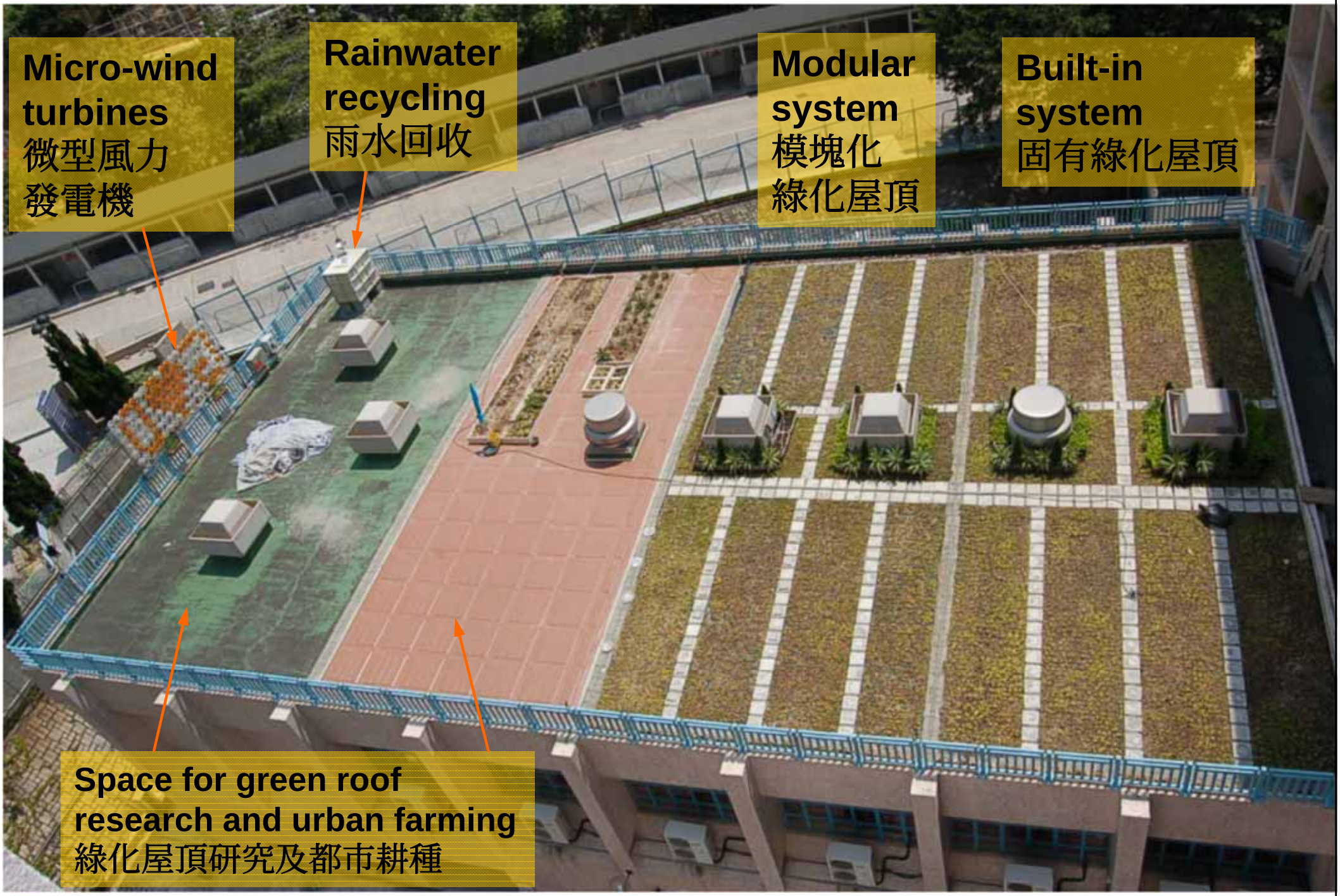
Sustainable rooftop farming



(Source: www.skyvegetables.com)


Urban Agriculture
都市農業
Green Roofs
屋頂綠化
Urban Greenery
城市綠化
Food System
糧食系統
Green Building
綠色建築
City Environment
城市環境
Sustainability
可持續發展

A green roof project with integrated systems



Urban farming on green roofs

Farming on the roof

Vegetables and herbal plants

Water melon

Green beans

(Photos taken by Dr Sam C M Hui; Acknowledgement: St. Bonaventure Catholic Primary School)

Rooftop urban farming in the world

Bangkok, Thailand (fruits, rice)

Tokyo, Japan (greenhouse)

London, UK (with bee keeping)

San Francisco, USA (kitchen)

(Source: www.time.com)

Eagle Street Rooftop Farm in NYC
(Source: http://blog.anandaharvest.org)

Rice paddy and vegetable plot at Roppongi Hills in Tokyo, Japan

(Source: www.greenroofs.com)

Modern green roofs in Osaka, Japan (Namba Parks) (2003)

(Source: www.treehugger.com & www.toho-leo.co.jp)

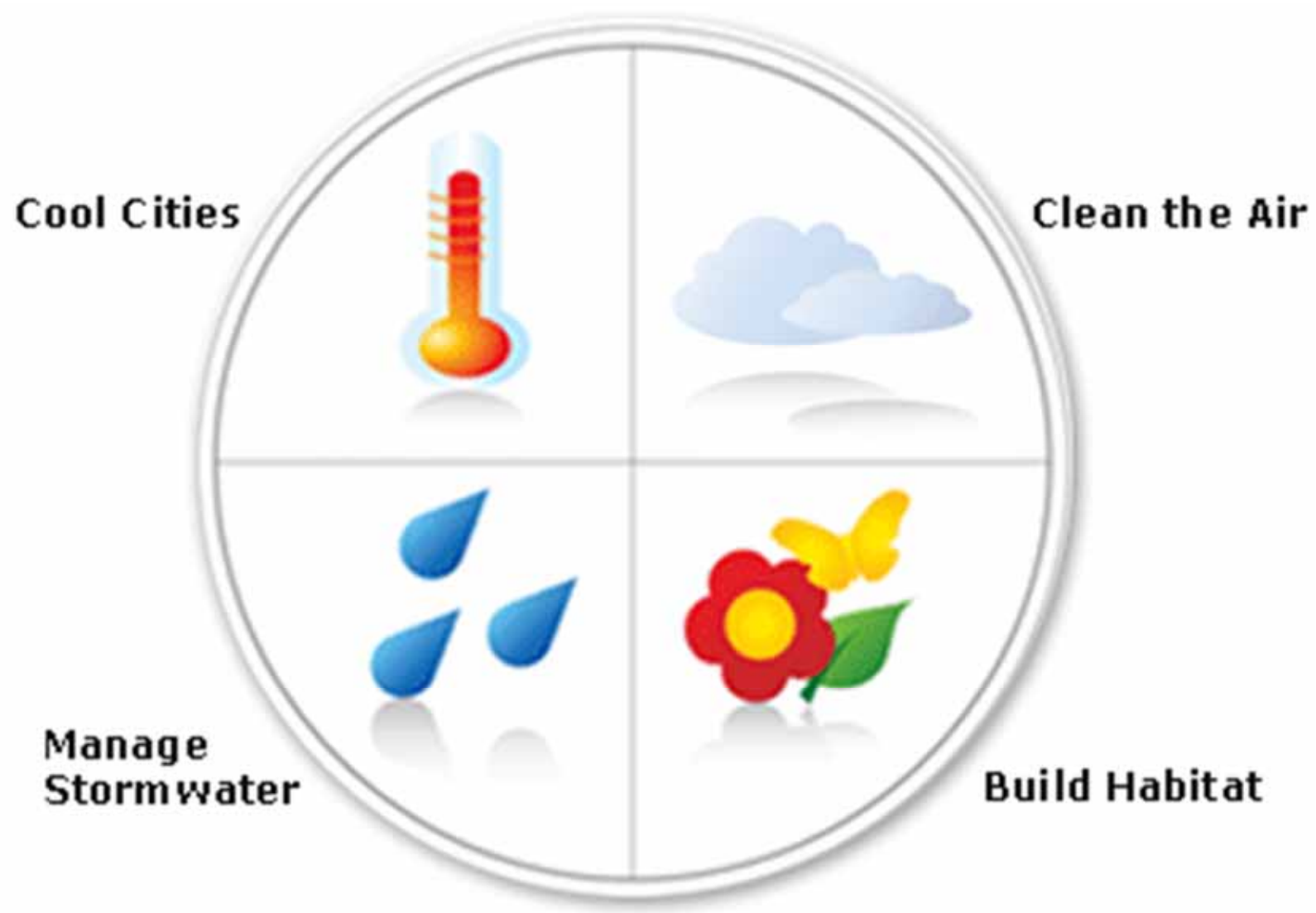
Container garden in Taiwan

(Source: http://yiu.com.tw/green.htm)

Conclusions

- Green roofs are important for sustainability and for achieving green performance development in urban cities
- New buildings
  - Green roofs can be accommodated easily
- Existing buildings
  - Through retrofit projects
  - Age & condition of the roof will affect feasibility
  - May use light-weight green roof systems

THANK YOU 謝謝 !!



Green roofs help cool cities, manage storm water, clean the air, and build habitat.

(More information: www.hku.hk/bse/greenroof/)