

SBS5222 Indoor Environmental Engineering

<http://ibse.hk/SBS5222/>



Sustainability

The*i*

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WHAT DOES
SUSTAINABILITY
MEAN TO YOU?



Sustainability is ...

- **Sustainability** is ...
 - A set of conditions and trends in a given system that can *continue indefinitely*
- **Sustainable development (SD)** is ...
 - A strategic process of continuous change in the direction of sustainability
- At its core, sustainability is about being **responsible** with resources – people, land, energy, water, materials and capital



Sustainability is ...

- **Sustainability** is:
 - the capacity of the earth's natural systems and human cultural systems to survive, flourish, and adapt into the very long-term future
 - thinking about tomorrow TODAY
- It requires:
 - a transition in human attitudes toward the environment, and a shift in behaviour, can lead to a much better future for the planet in the future (i.e. paradigm change/shift)



Sustainability is ...

- **Sustainability** is:
 - “A way of life that safeguards and enhances our resources, prevents harm to the natural environment and human health, and sustains and benefits the community and local economy – for the sake of current and future generations.” (Santa Monica Sustainable City Program)
 - Use sustainability to bridge the gulf between development and environment

Development vs Environment

Sustainability is ...



- Sustainability science:
 - One of the initial attempts to express human impact mathematically:
 - $I = P \times A \times T$
 - where
 - I = Environmental impact
 - P = Population
 - A = Affluence (levels of consumption)
 - T = Technology (impact per unit of resource use)

(See also: Video: I=PAT - ENGN2226 Online Classroom (3:25) <http://www.youtube.com/watch?v=fU9SP5hL2XA>)

I = PAT – Wikipedia http://en.wikipedia.org/wiki/I_%3D_PAT)



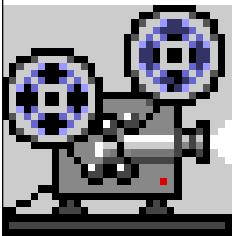
Sustainability is ...

- The three core drivers of un-sustainability:
 - **1. Consumption:** Use of resources beyond the reasonable limits set by nature
 - **2. Production:** Gross inefficiencies in production
 - **3. Distribution:** Inequitable distribution e.g. distribution of global income between rich and poor
- To break the vicious cycle!



Sustainability is ...

- **Sustainability** (可持續性, 永續性)
 - The endurance of systems and processes
 - Improves the quality of human life while living within the carrying capacity of supporting eco-systems
- Video Presentation:
 - Sustainability in 2minutes - GMIC (2:01), <http://youtu.be/Doeb6QWJ5kA>
 - What is Sustainability? (1:51) <http://youtu.be/hH109q5kk0k>







Sustainable development

- **Sustain** - to keep in existence without diminishing, to provide sustenance and nourishment
- **Develop** - to bring out the capabilities or possibilities of, to bring to a more advanced or effective state
- **Community** - a group of any size whose members reside in a specific locality and share resources needed to survive

Sustainable development



- Historical evolution

- Stockholm Conference on Human Environment (1970)
- World Conservation Strategy and Natural Step (1980s)
- World Commission on Environment and Development's 'Our Common Future' (1987)
- UN (Rio) Conference on Environment and Development (UNCED) (1992)
- UN Session on Agenda 21 (1997)
- UN Johannesburg Conference (2002)
- Early focus on environmental issues; now expanding to social and economic concerns

《我們的共同未來》

OUR COMMON FUTURE

THE WORLD COMMISSION
ON ENVIRONMENT
AND DEVELOPMENT

Have you heard of this report before?

The Brundtland Report
defines
“Sustainable Development”



Full text of the report:

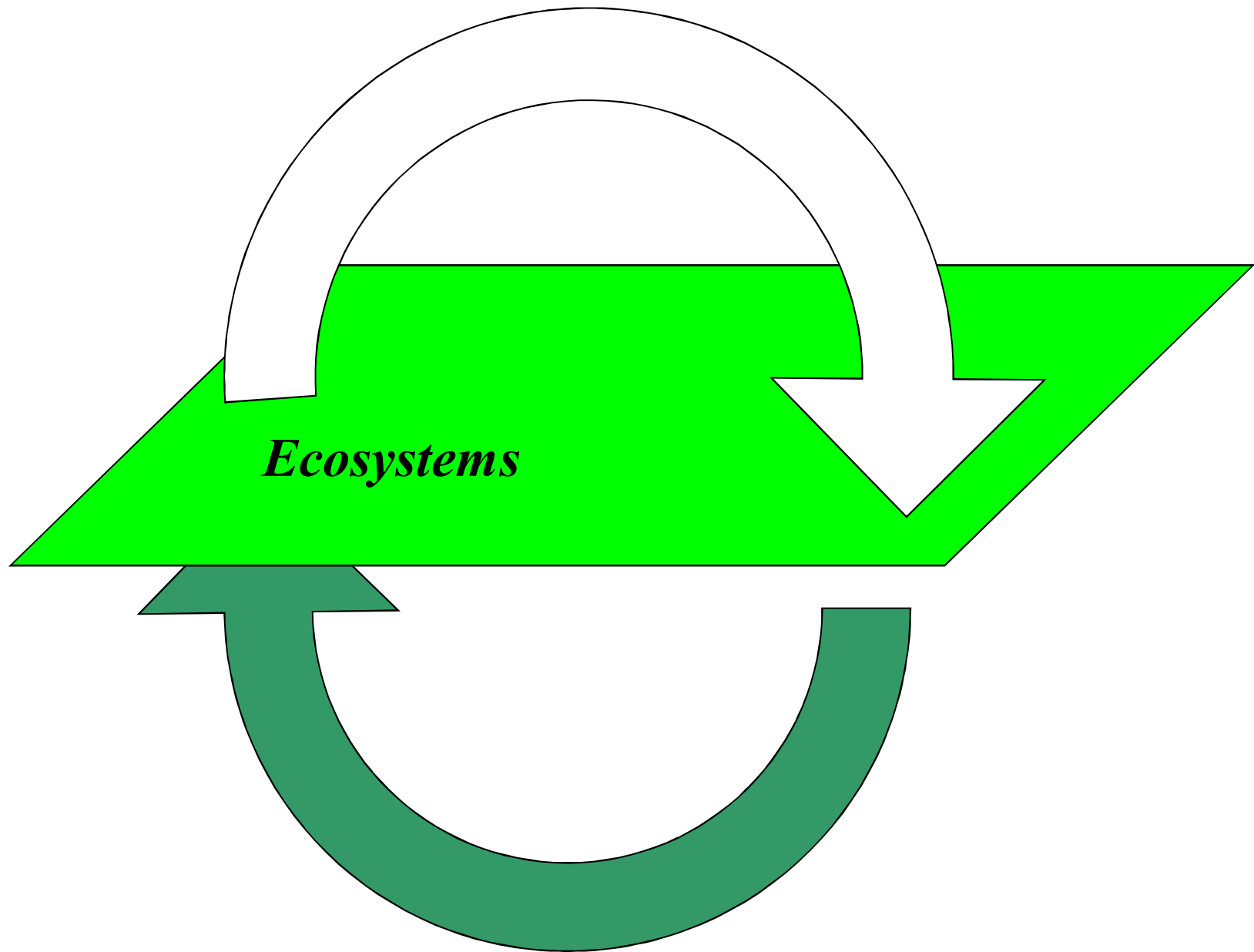
<http://www.un-documents.net/wced-ocf.htm>

Sustainable development



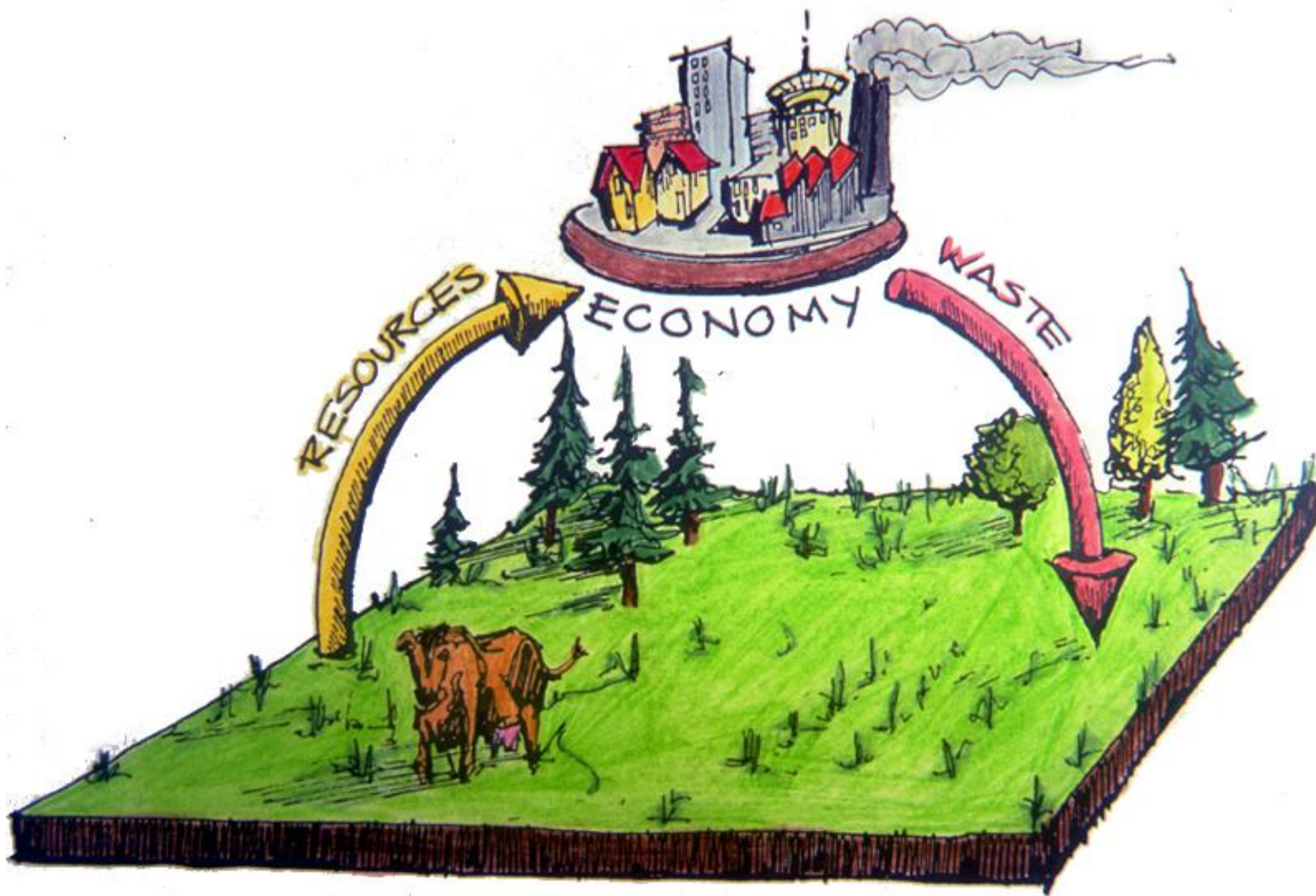
- The Brundtland Report (*Our Common Future*)
 - “...is development which meets the **needs of the present** without compromising the ability of **future generation** to meet their own needs.” – World Commission on Environment and Development.
- Two important concepts 「無後為大」 – 孔子
 - Needs – maintain an acceptable life standard
 - Limits – within the carrying capacity of supporting ecosystems and resource base

Organism's metabolism: food in, waste out.



Nature turns waste back into food

If too many of us use resources inefficiently or generate waste too quickly for the environment to absorb and process, future generations obviously won't be able to meet their needs.



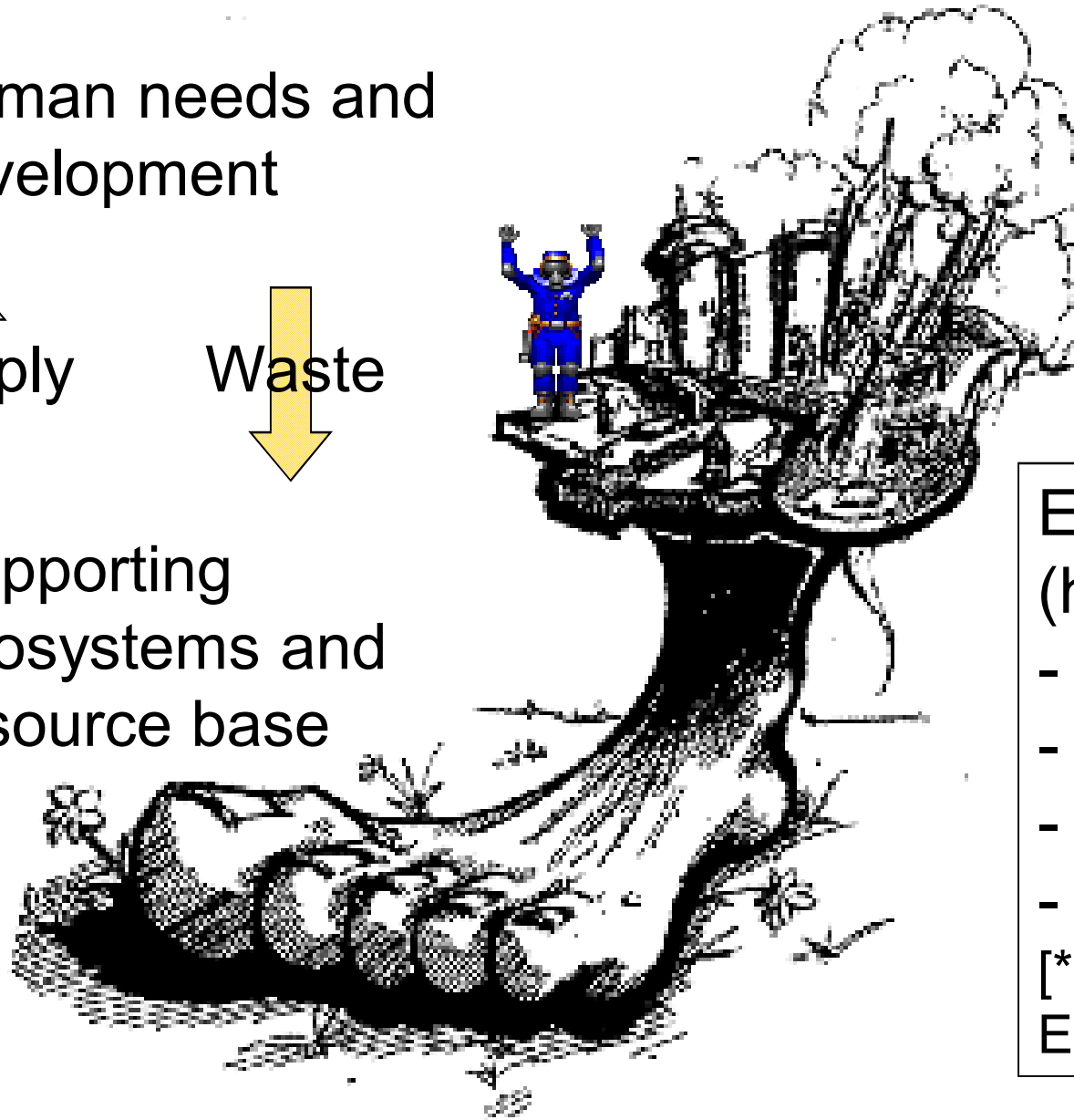
Carrying capacity and ecological footprint

Human needs and development

Supply

Waste

Supporting ecosystems and resource base

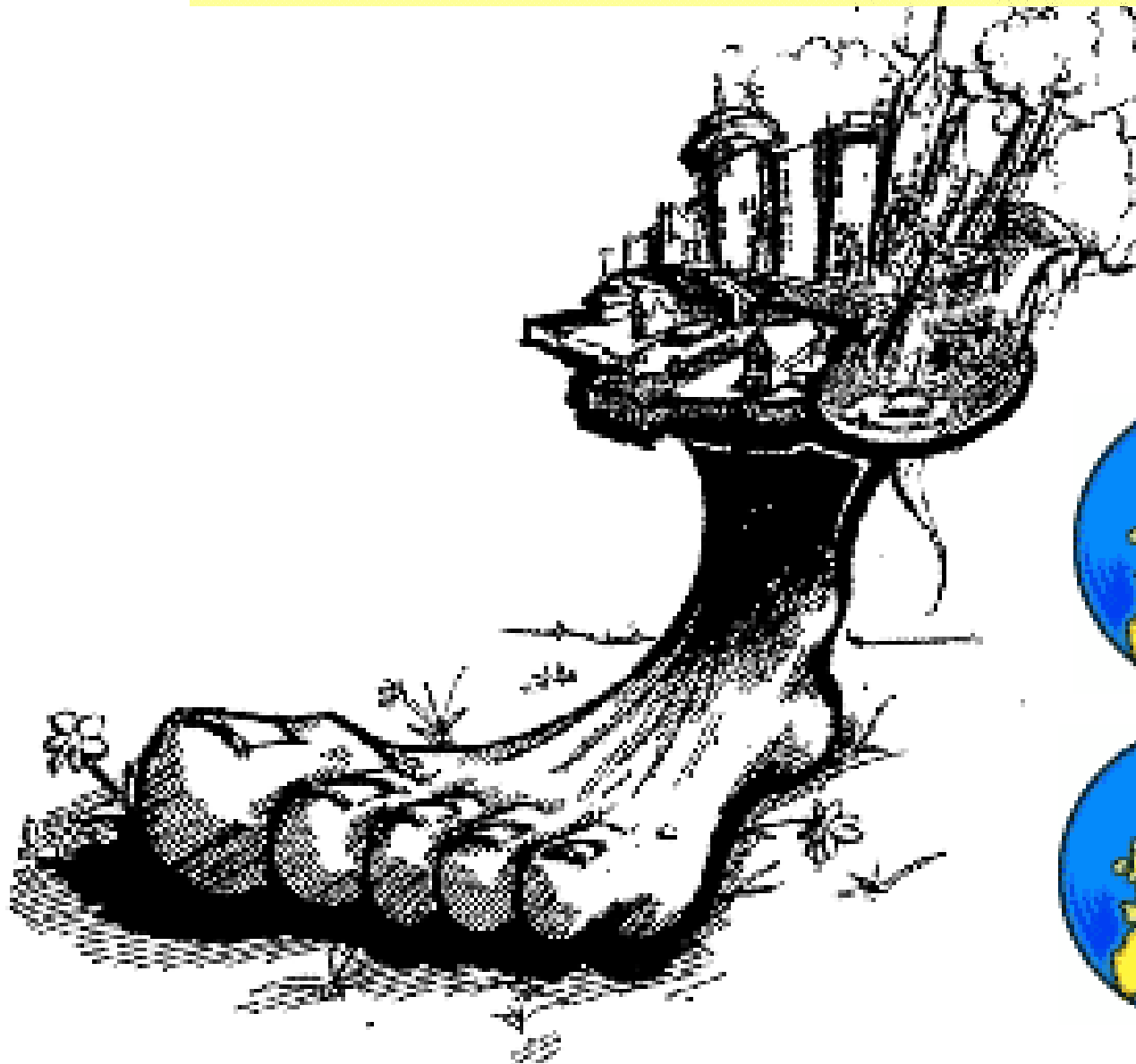


Ecological footprint (hectares/person) *:

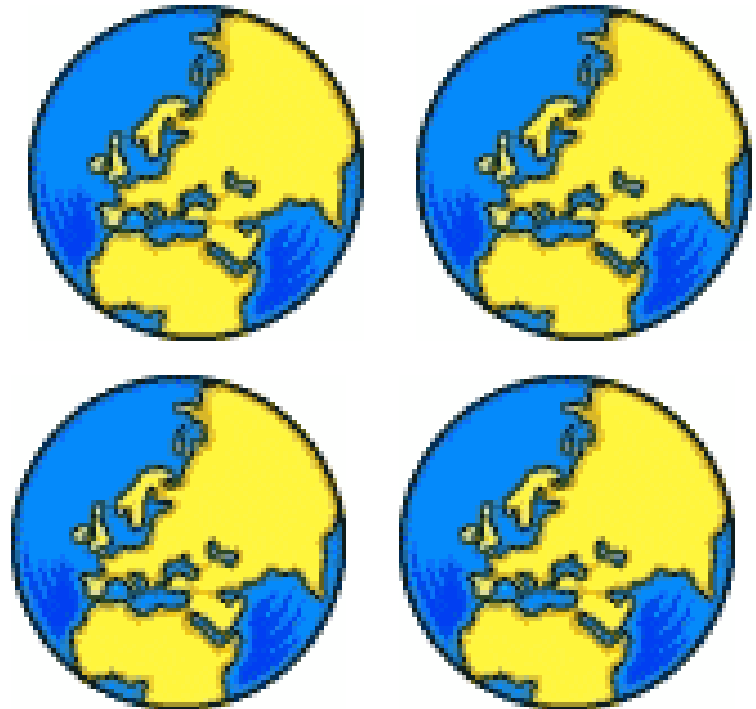
- world average = 2.3
- USA = 10.3
- **Hong Kong = 6.0**
- China = 1.2

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

Sustain-able Future?



The Factor Four concept*



(*See also <http://www.gdrc.org/sustdev/concepts/12-f4.html>)



Key concepts

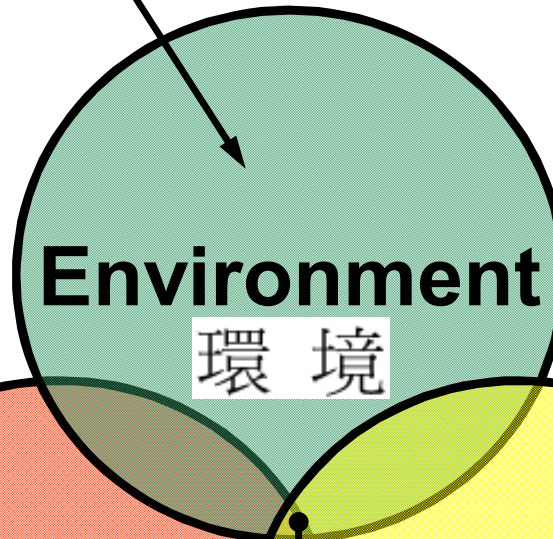
Triple bottom line

- Three components of sustainability:
 - Environment – maintaining the earth’s life support system (e.g., ecosystem services such as pollution filtering) [PLANET]
 - Social – maintaining community (civic) capacity that fosters effective participation and ‘equitable’ treatment of all stakeholders [PEOPLE]
 - Economic – maintaining an economic system that provides a non-declining standard of living for this and future generations [PROFIT]

Three dimensions of sustainability

Environmental Sustainability

Ecosystem integrity
Carrying capacity
Biodiversity

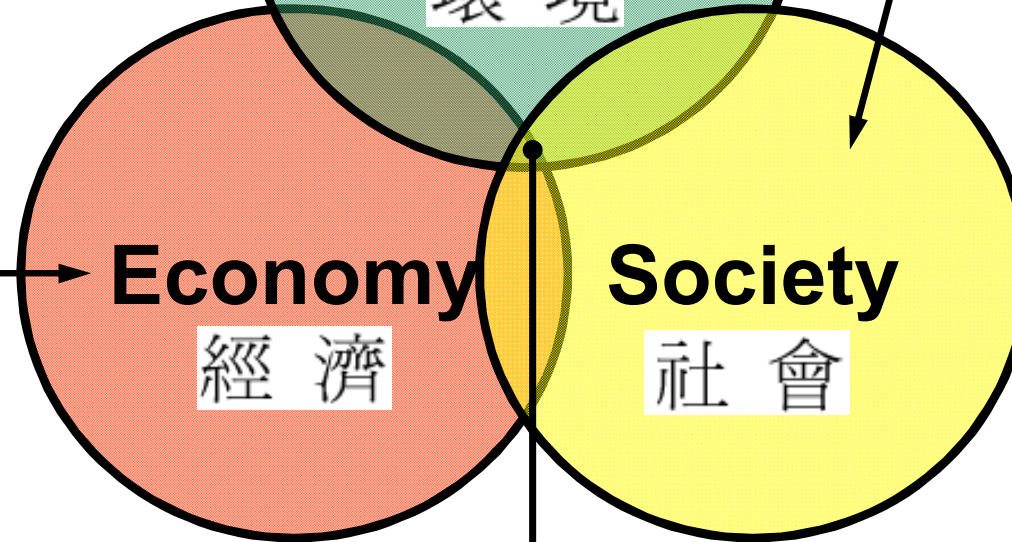


Social Sustainability

Cultural Identity
Empowerment
Accessibility
Stability
Equity

Economic Sustainability

Growth
Development
Productivity
Trickle-down



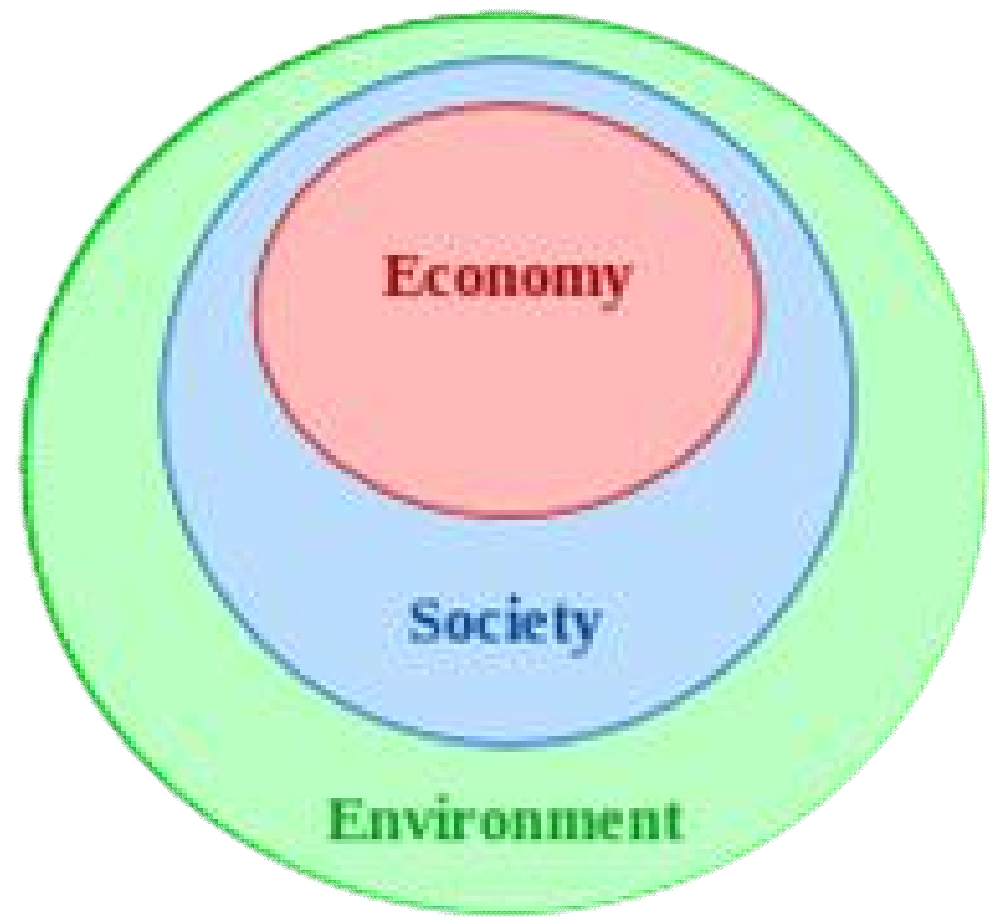
Human Well Being



Sustainable view of community to bring three elements into

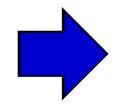
harmony

和諧

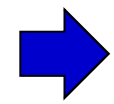


Different scales of environment:

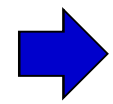
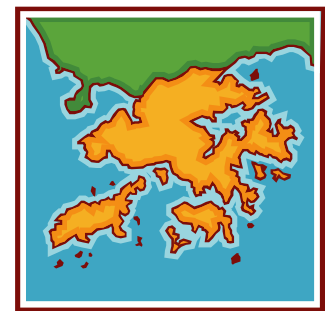
Global



Regional



Local



Internal





Key concepts

- Major issues:
 - **Long-term balance** between economic, social and environmental goals (look ahead 20-50 years, understand the connections)
 - **Limits** to natural, social, and built systems (live off the interest of community capital, don't degrade or use it up)
 - **Inter- and intra- generational equity** (share with future generations and current inhabitants, local sustainability in harmony with global sustainability rather than at expense of others)



Key concepts

- Related terms:
 - *Ecosystem stability and resilience* – magnitude of disturbance that can be absorbed before the system changes structure
 - *Systems theory* – suggests that ecological, social, and economic systems are a group of interrelated, interacting or interdependent constituents forming a complex whole



Key concepts

- Related terms: (cont'd)
 - Capital – natural, manmade, financial, human, and social assets that deliver services into the future
 - Equity – intra-generational, i.e., current groups, and inter-generational, i.e., over generations
 - Economic viability – maintaining firm profitability and government solvency



Key concepts

- Important principles:
 - Maintain **sufficient stocks of capital** (natural, manmade, human and social) through use and investment such that future generations can achieve at least the same **quality of life** as current generations
 - Assure **equitable** distributions of capital forms across contemporary groups and countries and across generations

Hong Kong context

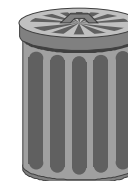
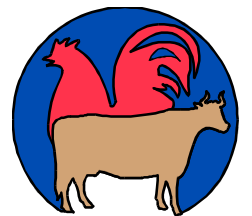


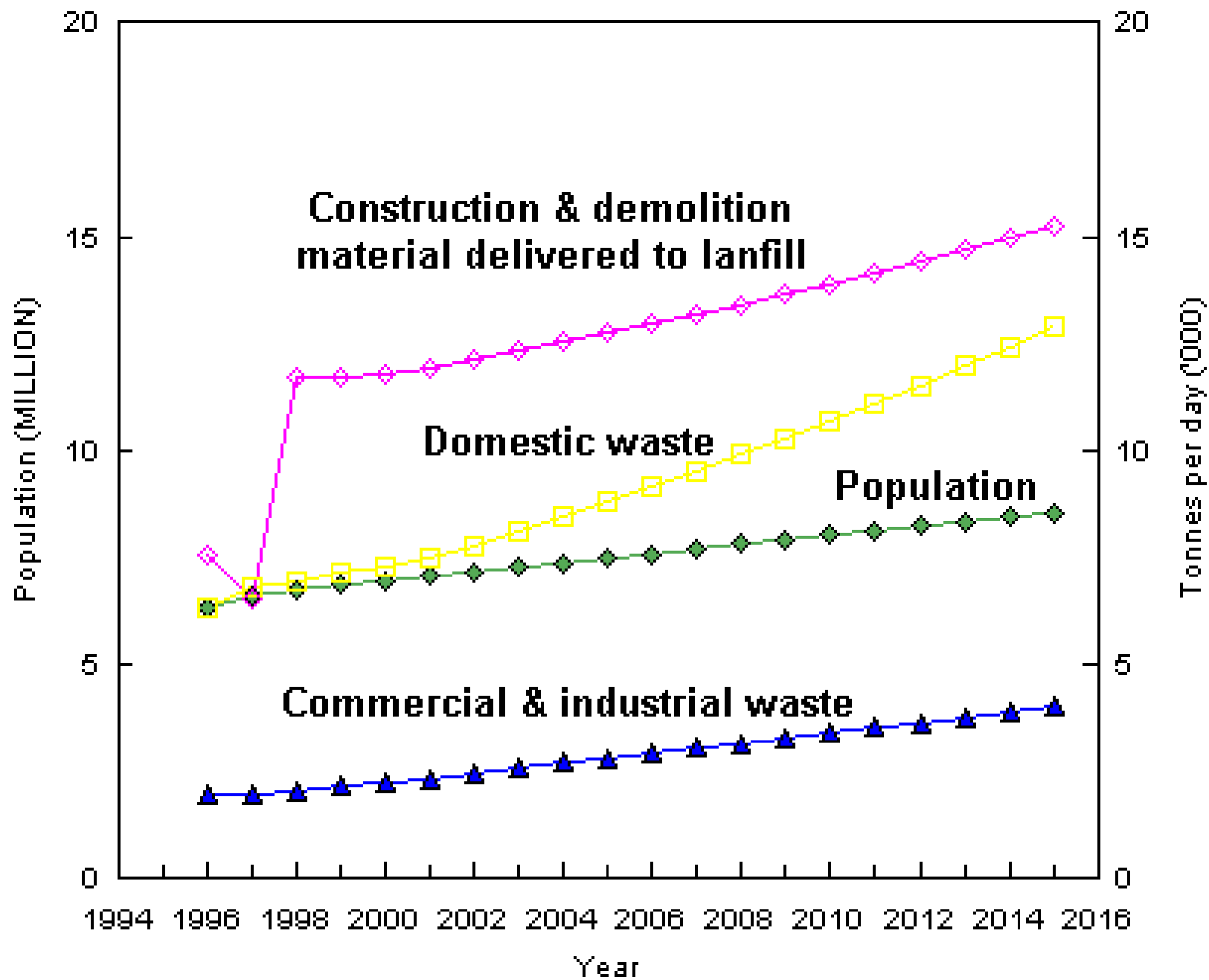
- Sustainability is about: [Mei Ng, FoE(HK)]
 - System thinking (harmonize human & living)
 - Value judgment (importance of natural capital)
 - Efficiency (resources & eco-efficiency)
 - Fair share (inter- & intra-generational equity)
 - Making informed choices
 - Quality people & quality life
 - Self-reliance (self-help & regeneration)

Hong Kong context



- One day in HK (population = 7 million) [2007]
 - Fresh water consumption = 374 litre/person
 - Electricity consumption = 17.4 kWh/person
 - Food consumption:
 - Vegetables 1,780 tonnes; fruits 1,460 tonnes
 - Live pigs 4,860 heads; live cattle 120 heads
 - Live poultry 80 tonnes; fresh eggs 230 tonnes
 - Freshwater fish 100 tonnes; marine fish 210 tonnes
 - Solid waste production = 13,901 tonnes





Projection of waste requiring disposal and population in HK
 (source: Waste Reduction Framework Plan)

Hong Kong context



- Definition of SD in Hong Kong: *
 - Sustainable development in Hong Kong balances social, economic, environmental and resource needs, both for present and future generations, simultaneously achieving a vibrant economy, social progress and a high quality environment, locally, nationally and internationally, through the efforts of the community and the Government
- Three core elements: economic growth, social inclusion and environmental protection

[* From Study on Sustainable Development for the 21st Century in Hong Kong (SUSDEV 21) in 1997, further information:

<http://www.enb.gov.hk/en/susdev/sd/>]

Hong Kong context



- Eight guiding principles of the key sustainable development issues in Hong Kong: **

Economy 經濟	Biodiversity 生物多樣化
Health and Hygiene 健康與衛生	Leisure and Cultural Vibrancy 消閒及文化活動
Natural Resources 自然資源	Environmental Quality 環境質素
Society and Social Infrastructure 社會及基礎設施	Mobility 交通運輸

Hong Kong



High-density urban city



A satellite photograph of a coastal city, likely San Francisco, showing a dense urban area with a grid street pattern, a large bay, and surrounding hills. A semi-transparent green rectangular box is overlaid on the center of the image, containing a quote in green text.

**"We shape our buildings and
thereafter they shape us."
(Winston Churchill)**

Satellite picture from Dr. Remetey Gabor (Hungarian Association for Geo-information)

Hong Kong context



- Built environment is everything that has been made by humans to modify the spaces in which we live and work
 - Ranges from the large-scale civic surroundings to the personal places
 - May be residential, commercial, industrial, schools, parks, roads and highways
 - Include architectural design, building engineering, interior design, landscape design, town planning and urban design

Hong Kong context



- Scope of the built environment
 - Economy
 - Environment
 - Social
- Possible impacts, such as on
 - Quality of life, economic goals
 - Climate, bio-sphere, global resources
 - Air quality, water and ground pollution
 - Land use, waste, local resources





Take action

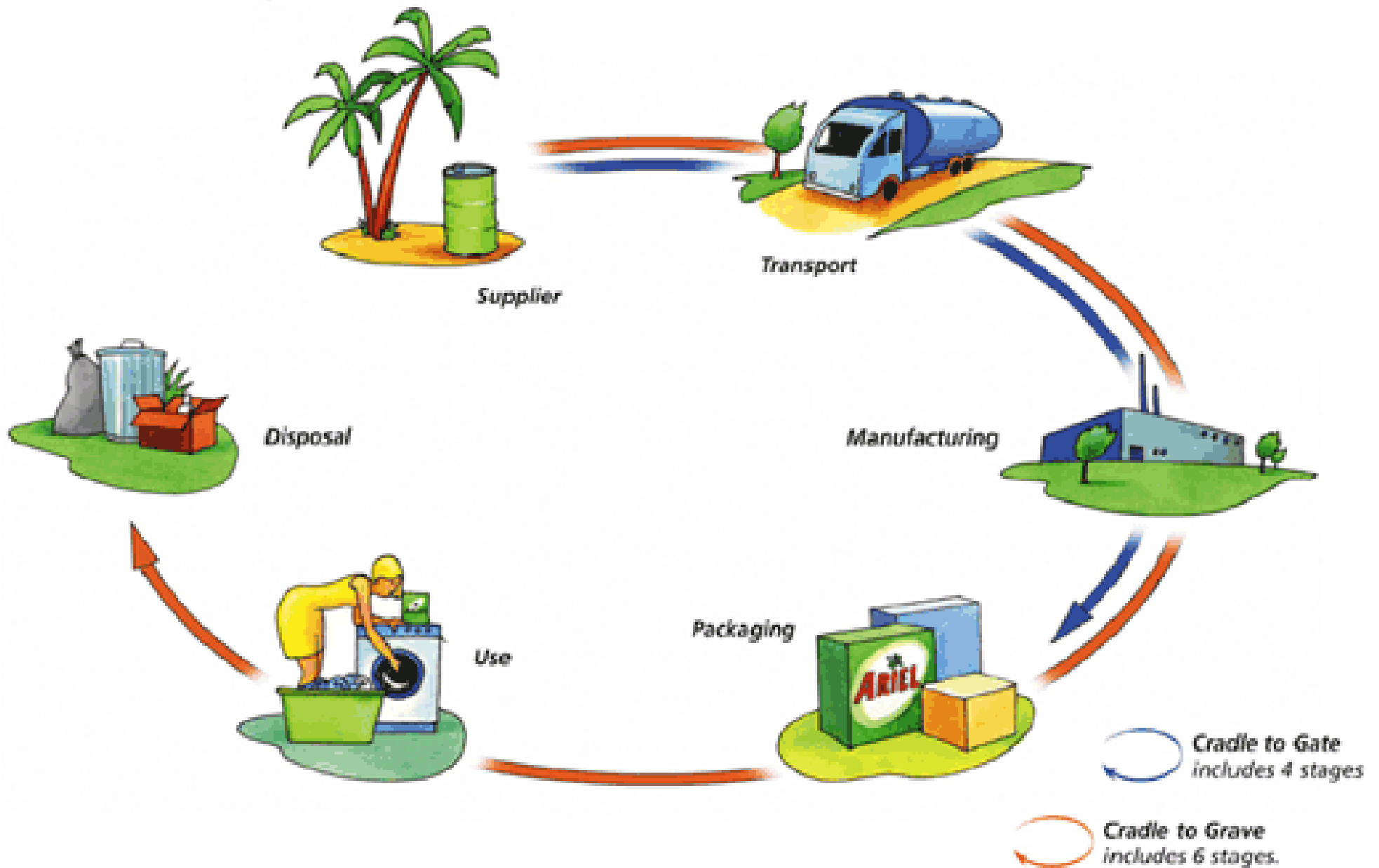
- A total plan for sustainability requires (from the Institution of Structural Engineers):
 - Reduction of emission of greenhouse gases
 - More efficient use (and reuse) of resources
 - Minimisation and constructive reuse of waste
 - Reduction of harmful effects from construction activities and building occupation
- Life cycle assessment to evaluate environmental impacts: [cradle to grave](#)

Cradle-to-Grave



Cradle-to-grave is the full Life Cycle Assessment from resource extraction ('cradle') to use phase and disposal phase ('grave').

Cradle-to-Gate and Cradle-to-Grave





Take action

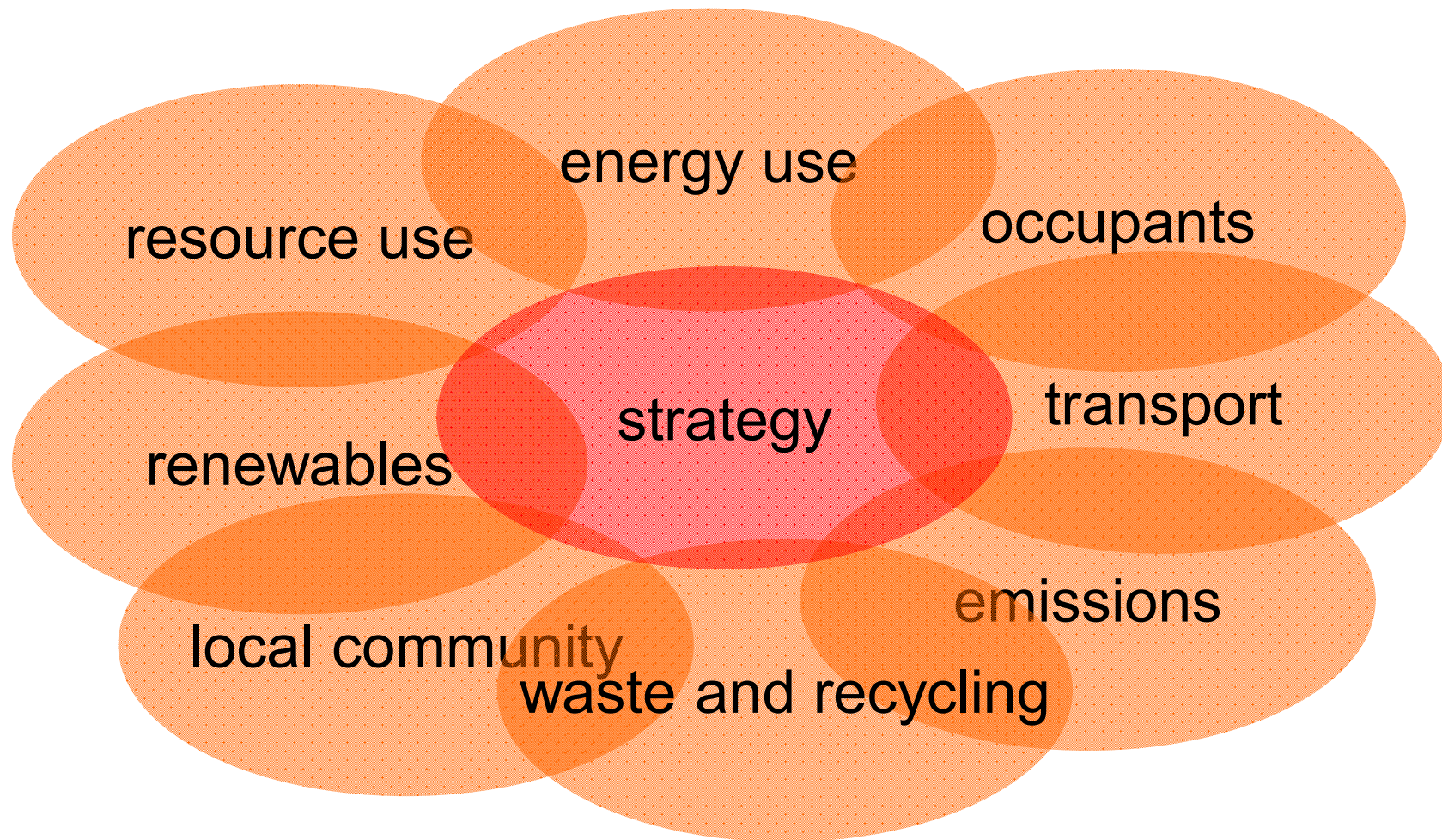
- Sustainable design
 - It is the way of doing things or making things such that the result of the design meets the **three pillars of sustainability** – it should **NOT** cause irreversible change to the environment – locally and globally, should be functional, practical, and economically viable, and should benefit society. Sustainable design uses a holistic approach that optimizes the **overall system performance**, not just the product or service itself.



Take action

- Principles of sustainable design:
 - Holistic approach to environmental, social, and economic issues
 - Minimize environmental impacts (pollution, waste, disruption, etc.)
 - Use renewable energy and resources efficiently
 - Design for reuse, recycling, and emotionally and functionally durability
- Integrated thinking in design (Win-Win-Win)

To maximise sustainability in a building design
a global strategy is required





Take action

- Sustainability in buildings
 - “Sustainable building design should aim to provide a **balanced solution**, offering optimum working/living conditions, alongside **reduced environmental impact**, both now and in the future. Taking the complete **building lifecycle** into consideration, there are many factors involved, from the location of the building, its design, subsequent operation and maintenance, to the construction materials and practices used, and how any future changes of use are addressed.”
--- D. McLean (IET)

Application of Sustainability in Buildings

Pre-Design

- Material Selection
- Building Program
- Project Budget
- Team Selection
- Partnering
- Project Schedule
- Laws, Codes & Standards
- Research
- Site Selection

On-Site

- Site Analysis & Assessment
- Site Development & Layout
- Watershed Management & Conservation
- Site Material & Equipment

Design

- Passive Solar Design
- Materials & Specification
- Indoor Air Quality

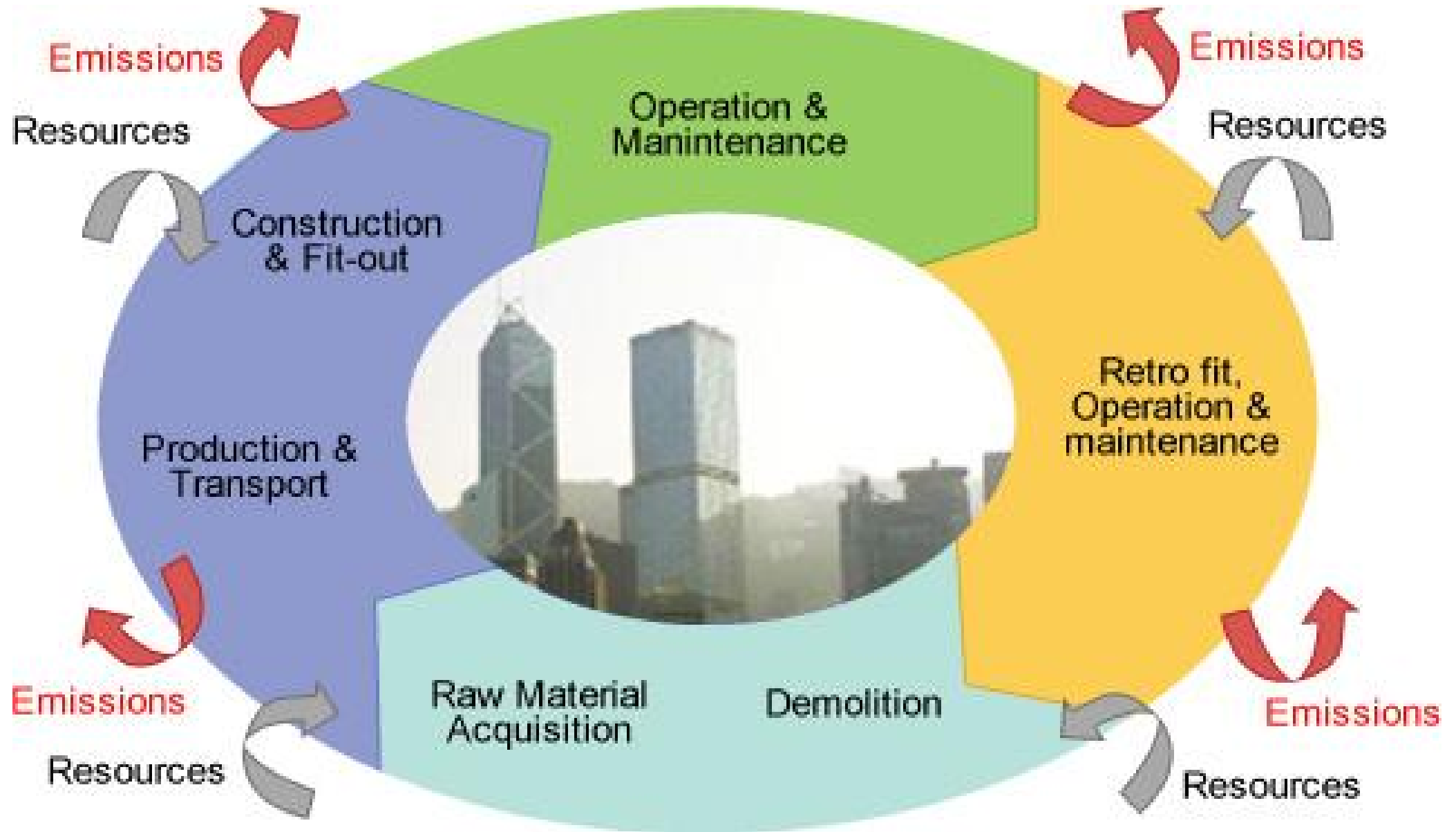
Construction

- Environmentally Conscious Construction
- Preservation of Features & Vegetation
- Waste Mgmt
- IAQ Issues
- Source Control Practices

O&M

- Maintenance Plans
 - Indoor Quality
 - Energy Efficiency
 - Resource Efficiency
 - Renovation
 - Housekeeping & Custodial Practices
- (O&M: operation and maintenance)

Life cycle of buildings





Take action

- Common terms:
 - Sustainable building
 - Green building
 - Green/environmental architecture
 - Green/sustainable construction
 - Environmentally friendly building
 - Environmentally sustainable building
 - Sustainable city/urbanism
- Different interpretations and criteria ?!

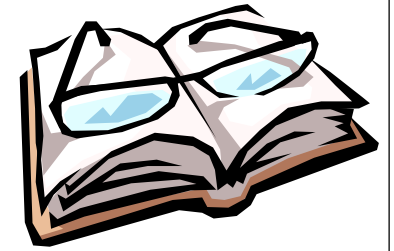




Take action

- Sustainable building design strategies:
 - Urban and site design
 - Energy efficiency
 - Renewable energy
 - Building materials
 - Water issues
 - Indoor environment
 - Integrated building design





Further reading

- Sustainability – Wikipedia
 - <http://en.wikipedia.org/wiki/Sustainability>
- I = PAT – Wikipedia
 - http://en.wikipedia.org/wiki/I_%3D_PAT
- What is Sustainable Development? (EnB)
 - <http://www.enb.gov.hk/en/susdev/sd/>
- History of SD
 - http://www.sd-commission.org.uk/pages/history_sd.html

Playing games

~~Further reading~~



- On-line games for learning sustainability:

- Fish Game Online

- <http://cloudinstitute.org/fish-game>

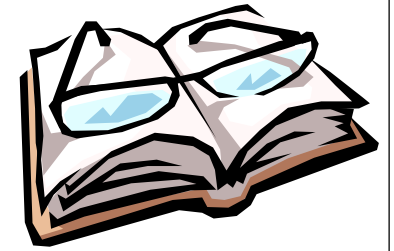
- MySustHouse games

- <http://www.mysusthouse.org/game.html>

- Stop Disasters!

- <http://www.stopdisastersgame.org/>





Further reading

- Teaching Kit: Sustainable Design for Buildings (ArchSD)
 - <http://www.archsd.gov.hk/archsd/html/teachingkits/tk1/>
 - Sustainable planning
 - Sustainable building design
 - Green procurement
 - Green construction management
 - Sustainable maintenance

