SBS5222 Indoor Environmental Engineering

http://ibse.hk/SBS5222/

Environmental issues

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- Hong Kong situation
- Climate change
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- Waste

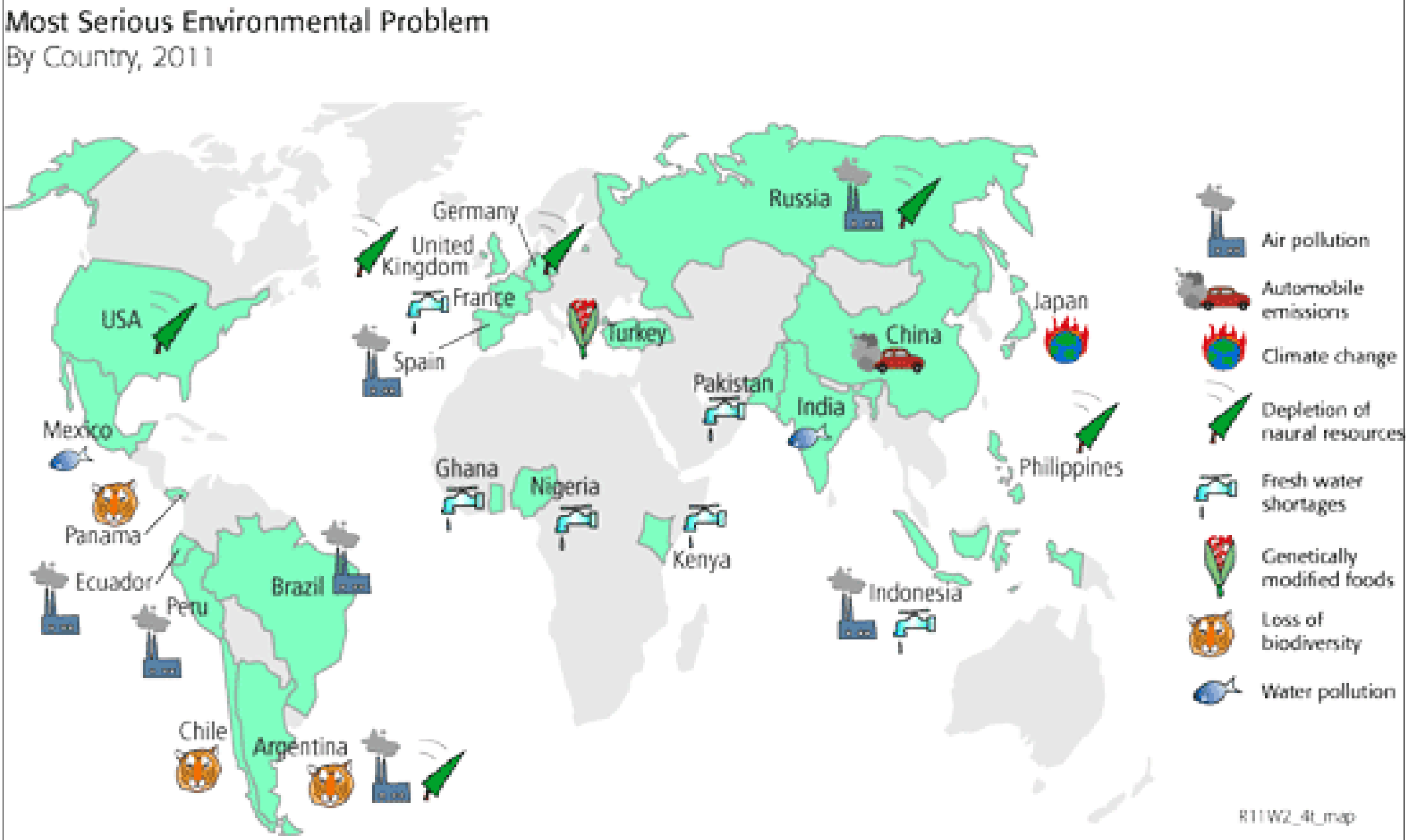
Introduction

- Environmental issues in the world:
  - Pollution of air, water and land
  - Hazardous chemicals and wastes
  - Land degradation
  - Loss of biodiversity
  - Ozone depletion
  - Climate change
  - Loss of natural and cultural resources
  - ……

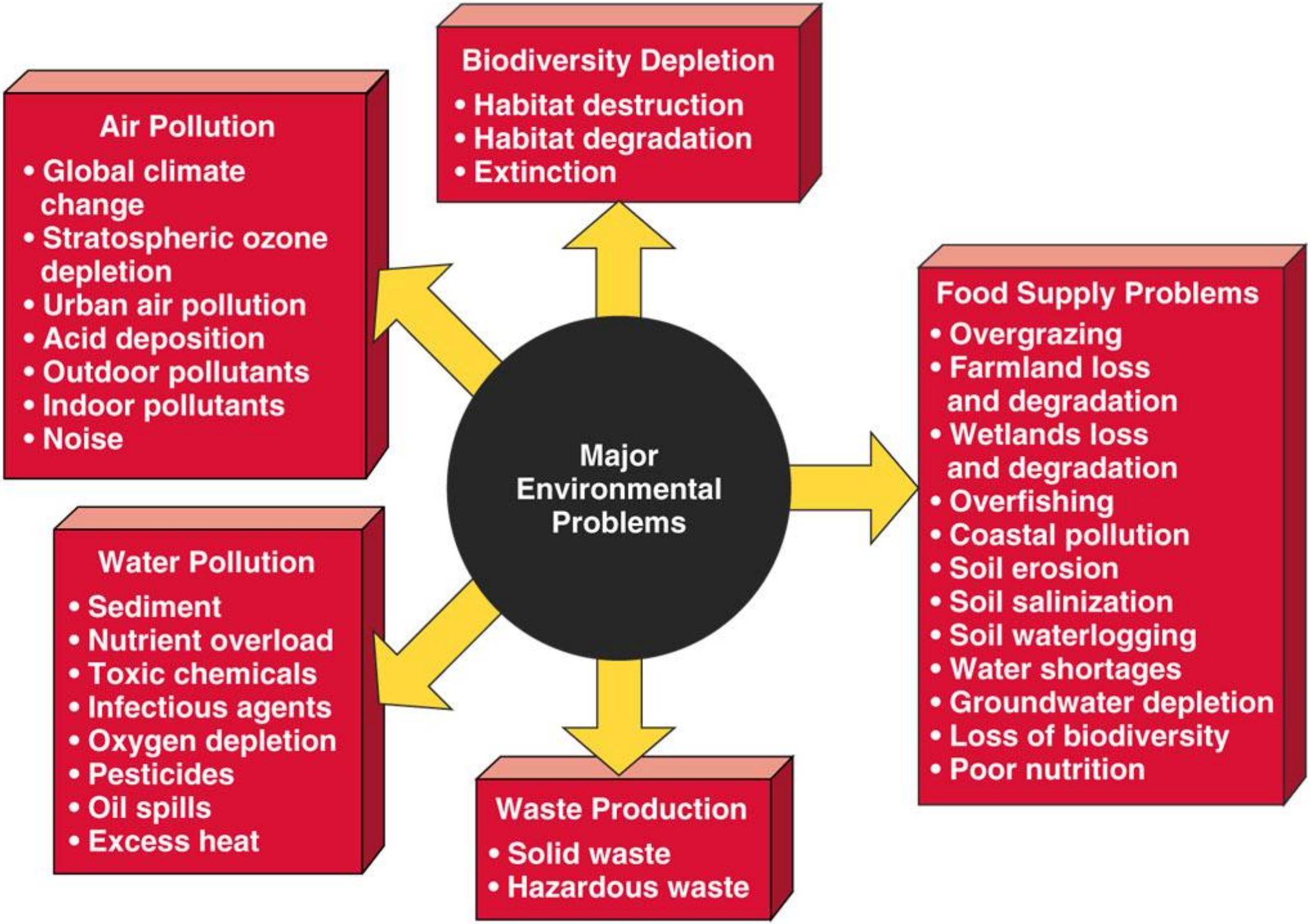
World environmental issues map

(Source: http://www.mapsnworld.com/world-environmental-issues--map.html)

Environmental problems vary from place to place



(Source: http://www.globescan.com/news-and-analysis/blog/entry/natural-resource-depletion-emerges-as-dominant-environmental-concern-in-global-north.html)

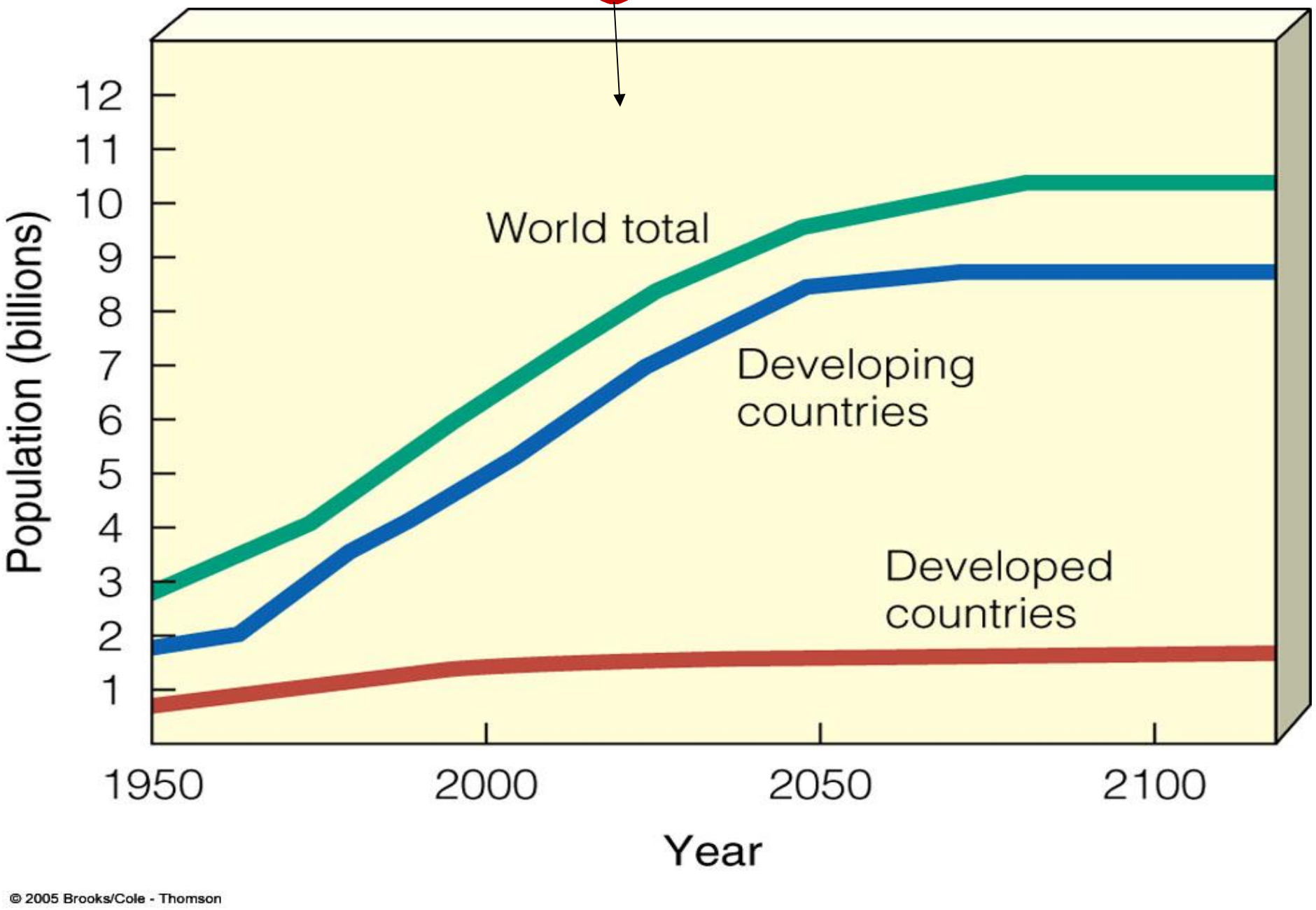


Causes of Environmental Problems

- Rapid population growth
- Unsustainable resource use
- Poverty
- Not including the environmental costs of economic goods and services in their market prices
- Trying to manage and simplify nature with too little knowledge about how it works

Population growth and overpopulation

$$I = P \times A \times T$$



(See also: Overpopulation: Causes, Effects and Solutions http://www.conserve-energy-future.com/causes-effects-solutions-of-overpopulation.php)

Environmental impacts in developing and developed countries

Developing Countries

X

X

=

Population (**P**) X Consumption per person (affluence, **A**) X Technological impact per unit of consumption (**T**) = Environmental impact of population (**I**)

X

X

=

Developed Countries

Introduction

- Major concerns of environmental problems
  - Cause illness and death
  - Damage to habitat and ecosystems
  - Loss of plant and animal life
  - Loss of natural resources
  - Economic consequences
  - Trans-boundary impacts (acid rain, haze, water pollution, nuclear fallout)
  - Peace and security

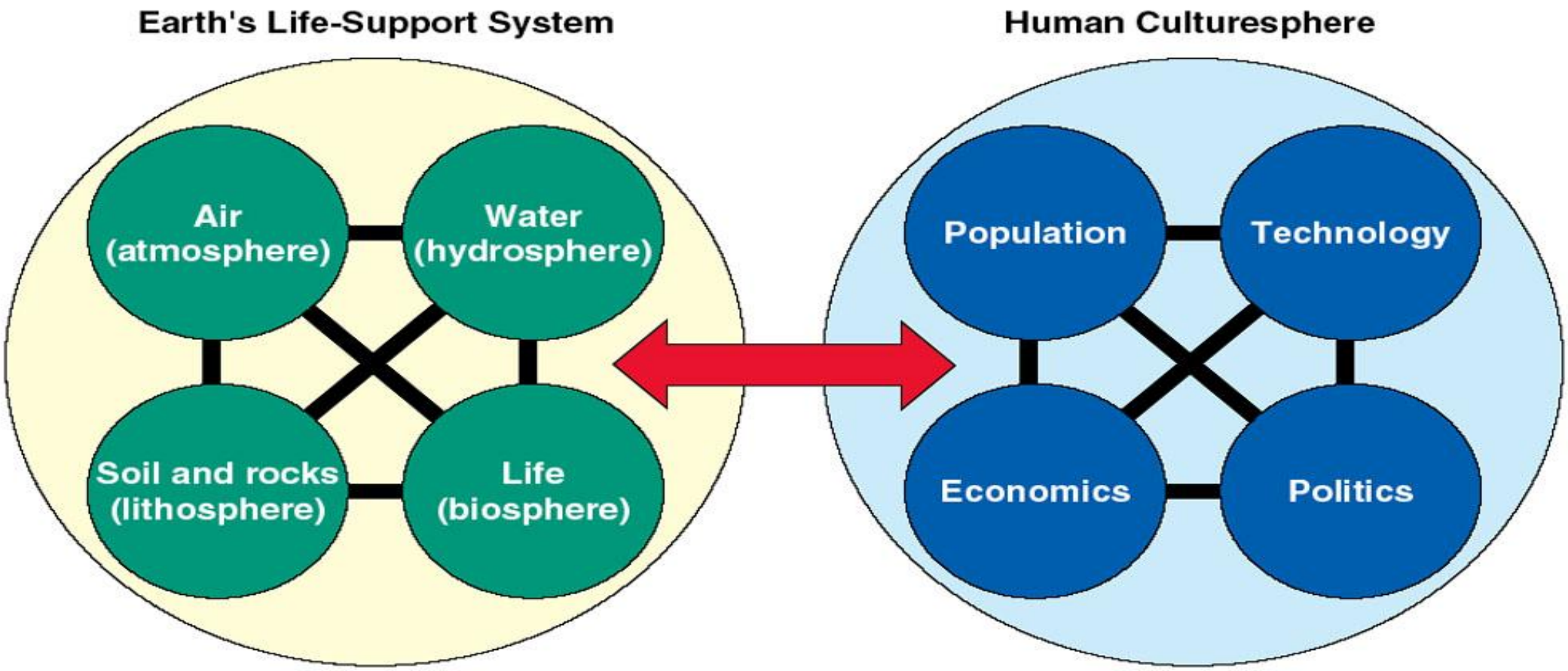
Introduction

- Remedial measures
  - Ambient standards (e.g. on clean air/water)
  - Discharge standards (e.g. for industries, sewage)
  - Cleaner production (e.g. for energy and factories)
  - Technology transfer (e.g. in developing countries)
- Scope of work
  - Global: international actions and protocols
  - Local: legislation, standards, guidelines

Complex environmental interactions

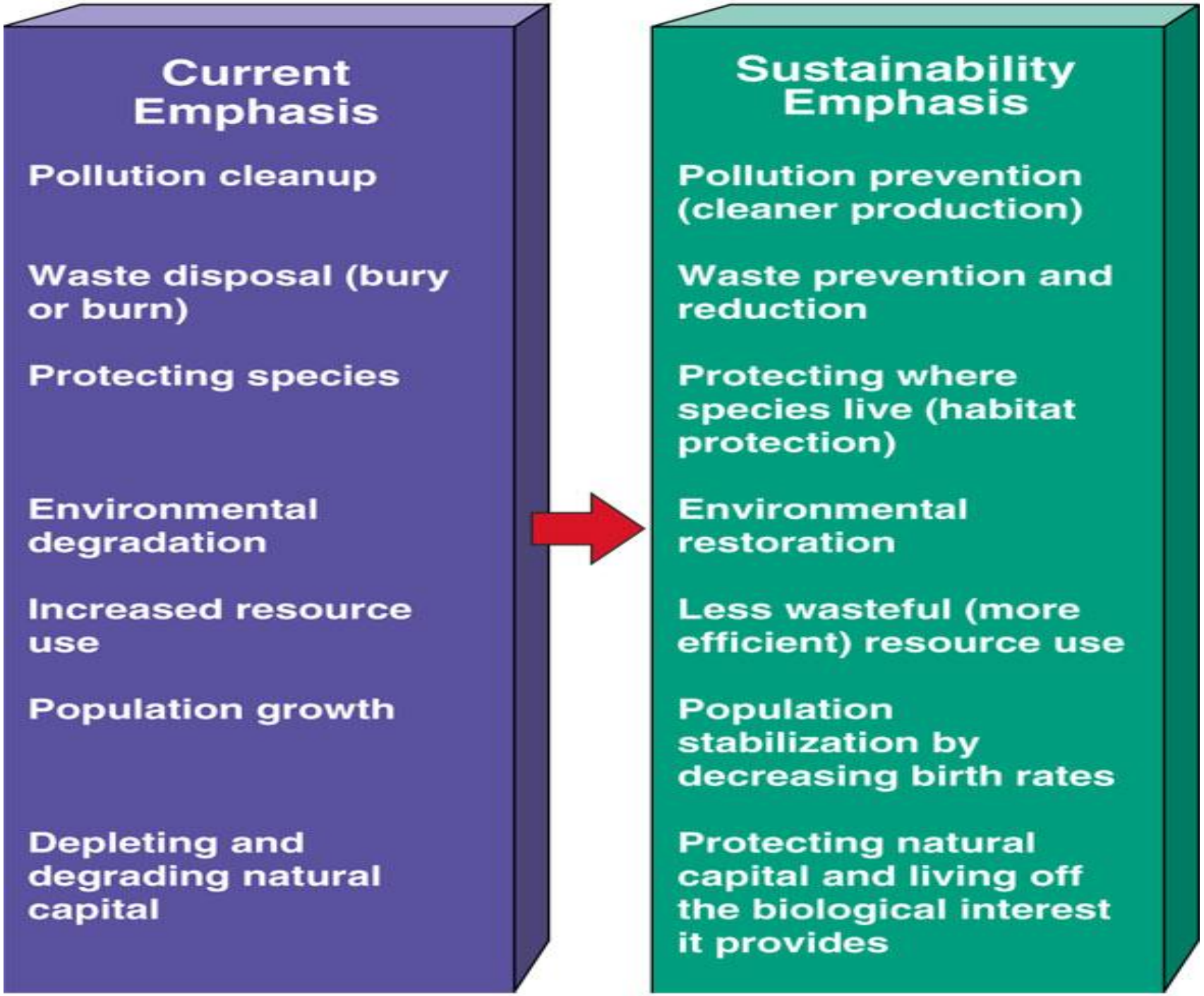
The Nature

The Human



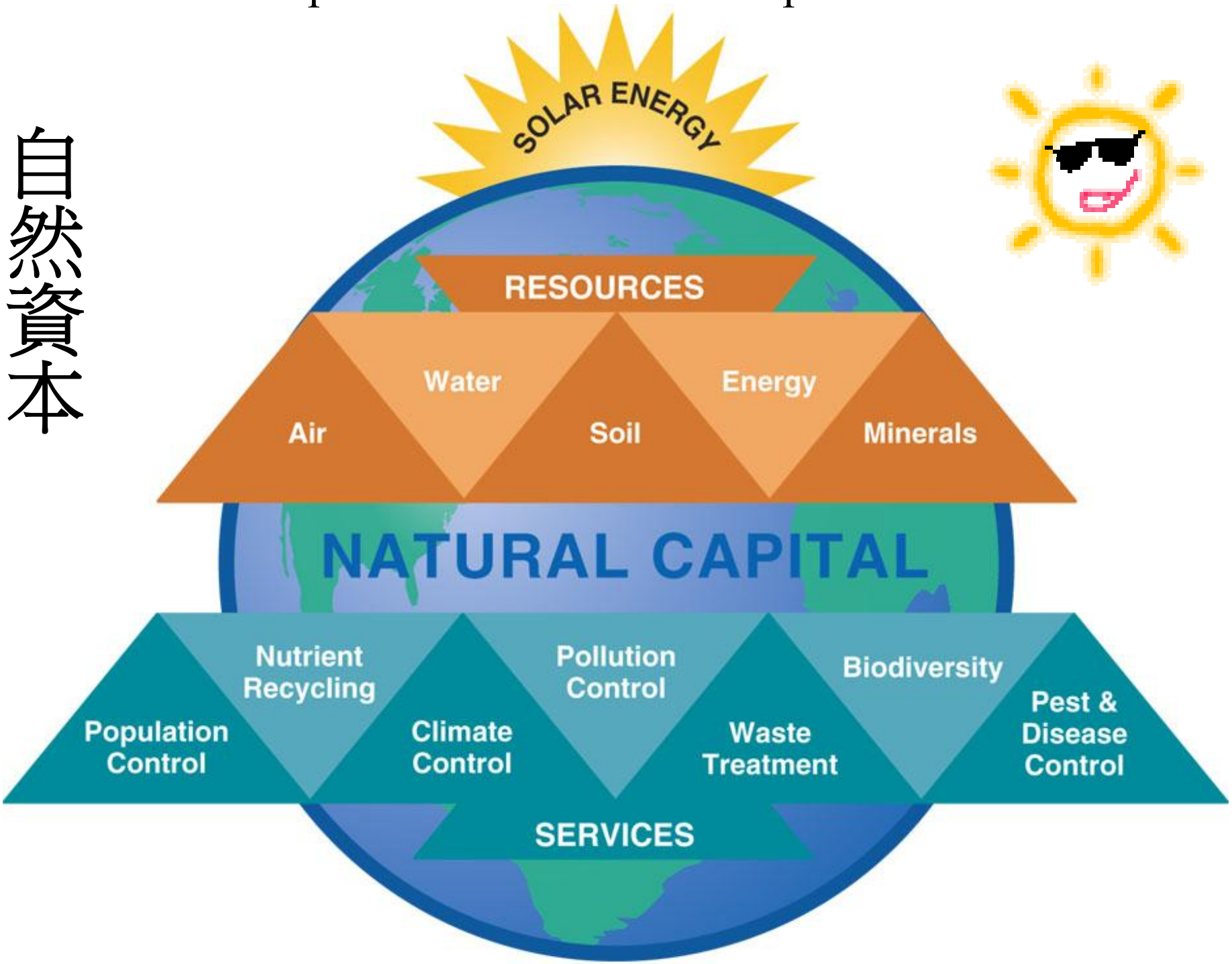
"Everything is connected to everything else."

Solutions: from current emphasis to sustainability emphasis



What keeps us alive? – Natural Capital and the Sun

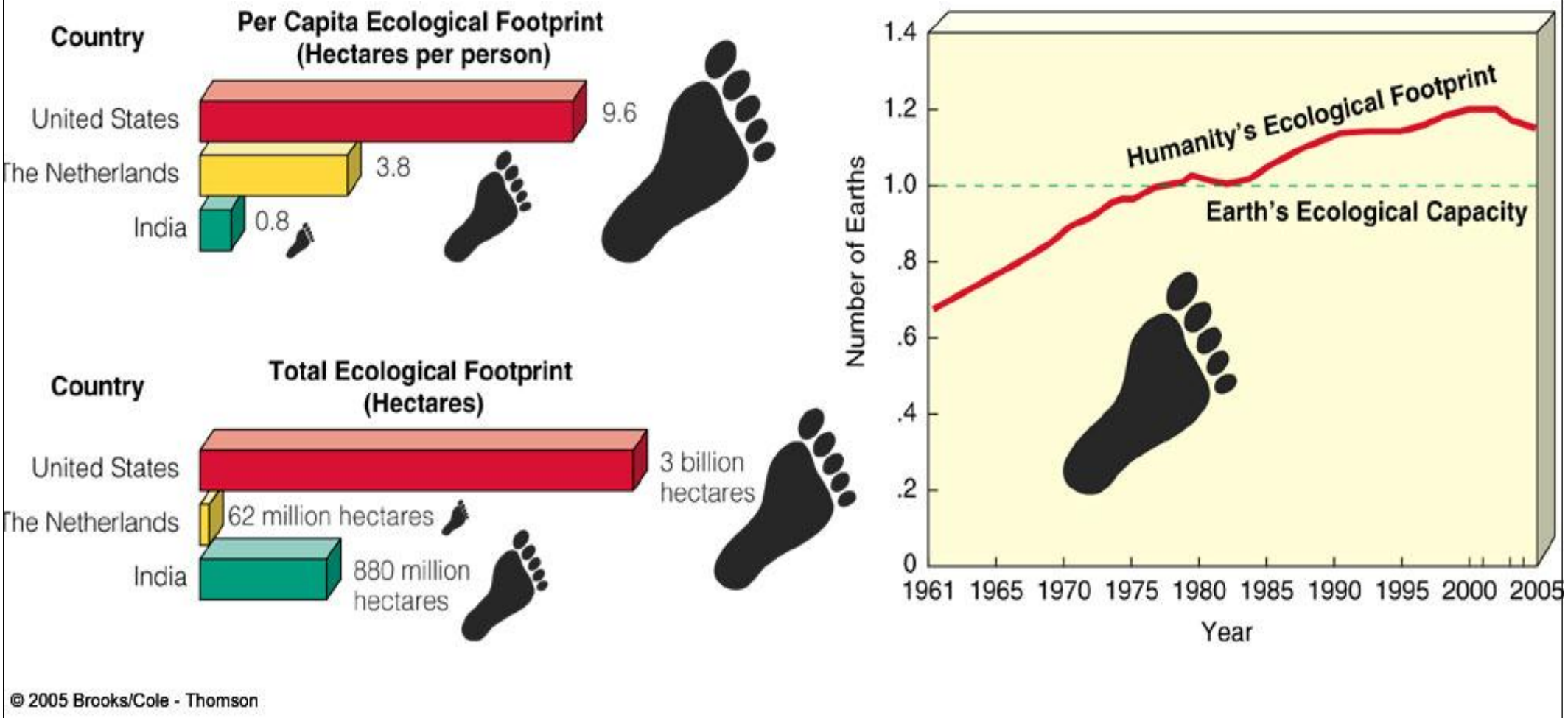
自然資本



(See also: Natural capital - Wikipedia http://en.wikipedia.org/wiki/Natural_capital)

Ecological footprint: Measure of the biologically productive land and water needed to support each person

生態足跡



1 hectare = 100 acres or 10,000 square meters (about 100 football fields)

(See also: Ecological footprint - Wikipedia http://en.wikipedia.org/wiki/Ecological_footprint)

Hong Kong situation

- Government bodies (policies & measures)
  - Environment Bureau (EnB) (www.enb.gov.hk)
  - Environmental Protection Department (EPD) (www.epd.gov.hk)
- Environmental protection issues
  - Hong Kong: The Facts: Environmental Protection
    - http://www.gov.hk/en/about/abouthk/factsheets/docs/environmental_protection.pdf
  - Hong Kong's Wild Places – Edward Stokes
    - http://www.greencouncil.org/db_images/publication/111/

Major environmental problems in Hong Kong

Air pollution

- Street-level pollution (many cars on roads in high-density city)
- Regional smog problem (emissions from Guangdong areas and factories)
- Pollutants from motor vehicles, marine vessels, industry and power plants
- Ozone layer protection
- Indoor air quality management

Water pollution

- Rubbish being thrown to the harbour, beaches, and river streams
- Effluents from buildings and factories
- Restaurants and companies emit waste water improperly
- Sewage collection and treatment
- Regional water quality management

Noise pollution

- Too many cars and traffic noise
- High population density
- Construction works, commercial and industrial activities causing noise
- Aircraft noise

Solid waste problem

- Growing population and waste loads
- Construction and municipal wastes
- Food waste and chemical waste
- People purchase a lot and materials used to pack a product are too much
- Difficulties in waste sorting & recycling

Further information (from EPD):

- Air http://www.epd.gov.hk/epd/english/environmentinhk/air/air_maincontent.html
- Water http://wqrc.epd.gov.hk/en/overview/index.aspx
- Noise http://www.epd.gov.hk/epd/english/environmentinhk/noise/noise_maincontent.html
- Waste http://www.epd.gov.hk/epd/english/environmentinhk/waste/waste_maincontent.html

Hong Kong situation

- Example in HK: Air pollution - definition
  - The emission of any impurity into the air, such as smoke (including tobacco smoke), dust, cinders, solid particles, gases, mists, fumes, odours and radioactive substances.

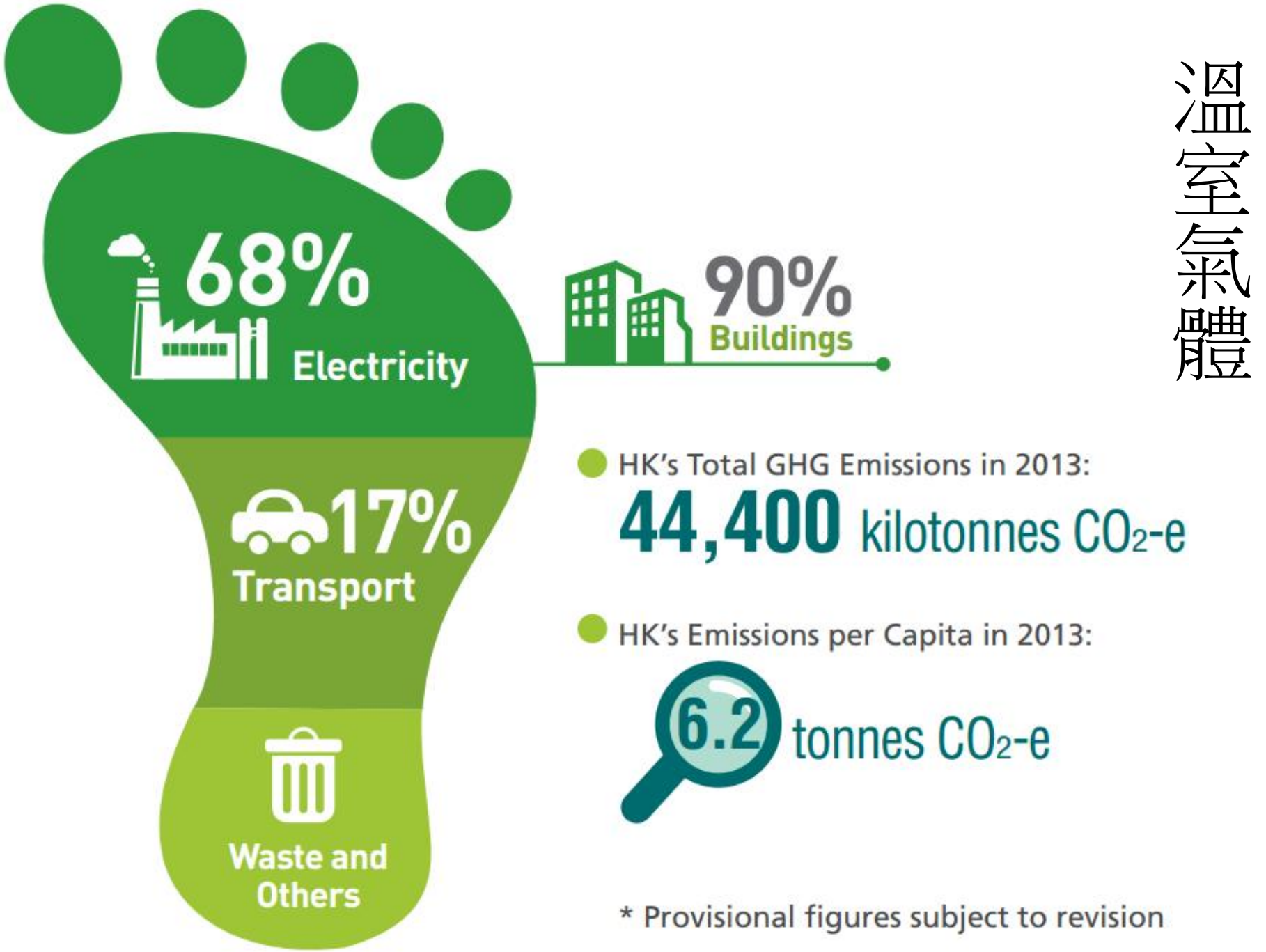
(Image source: SCMP http://www.scmp.com/topics/hong-kong-air-pollution)

HONG KONG'S ECOLOGICAL FOOTPRINT

* Local emission and CO_2 generated during production and transportation of imported products

(Source: WWF Sustainable City & Ecological Footprint
http://www.wwf.org.hk/en/whatwedo/biodiversity_and_sustainability_in_hong_kong/sustainable_city_ecological_footprint/)

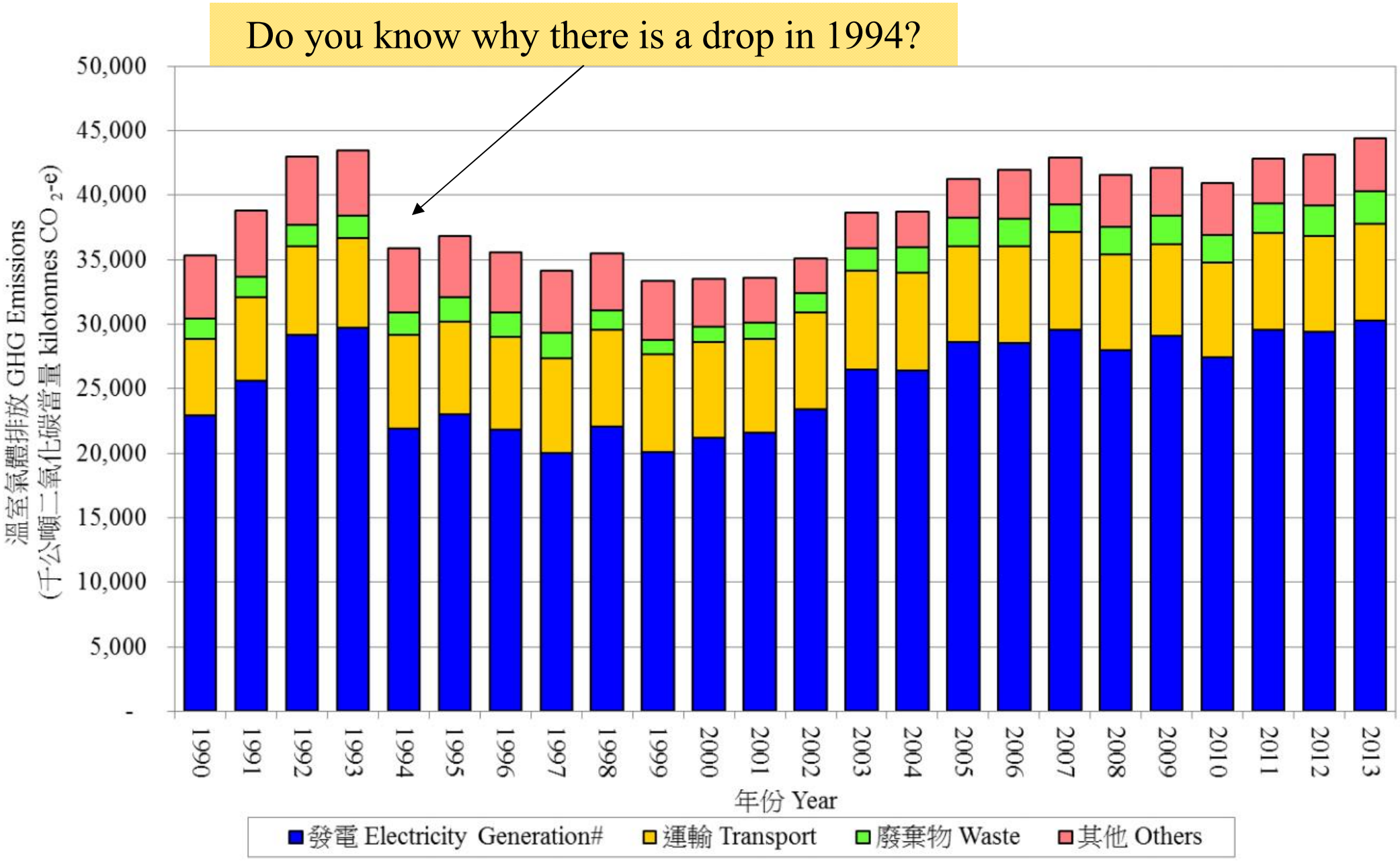
Hong Kong's greenhouse gas emissions by sector in 2013



溫室氣體

(Source: Environmental Protection Department)

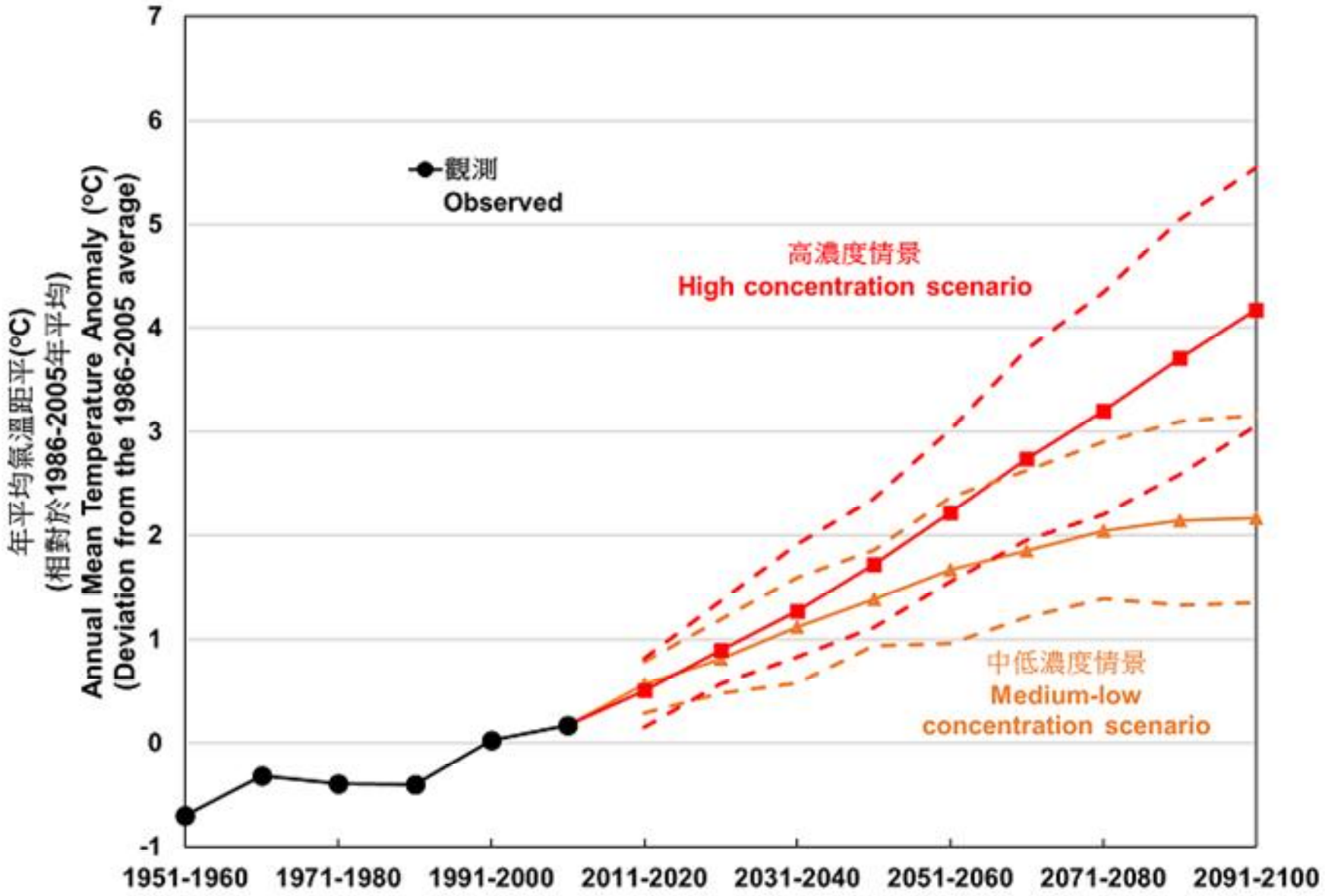
Greenhouse gas emission trends of Hong Kong 1990-2013



Including GHG emissions arising from Towngas production which accounts for about 0.69% of total GHG emissions in Hong Kong.

(Source: Environmental Protection Department)

Past and projected change in annual mean temperature for Hong Kong



(Source: Hong Kong Observatory)

Global warming 全球暖化

Arctic sea ice drops to its lowest level since modern recording began

Scientists call event “tipping point" in global warming.

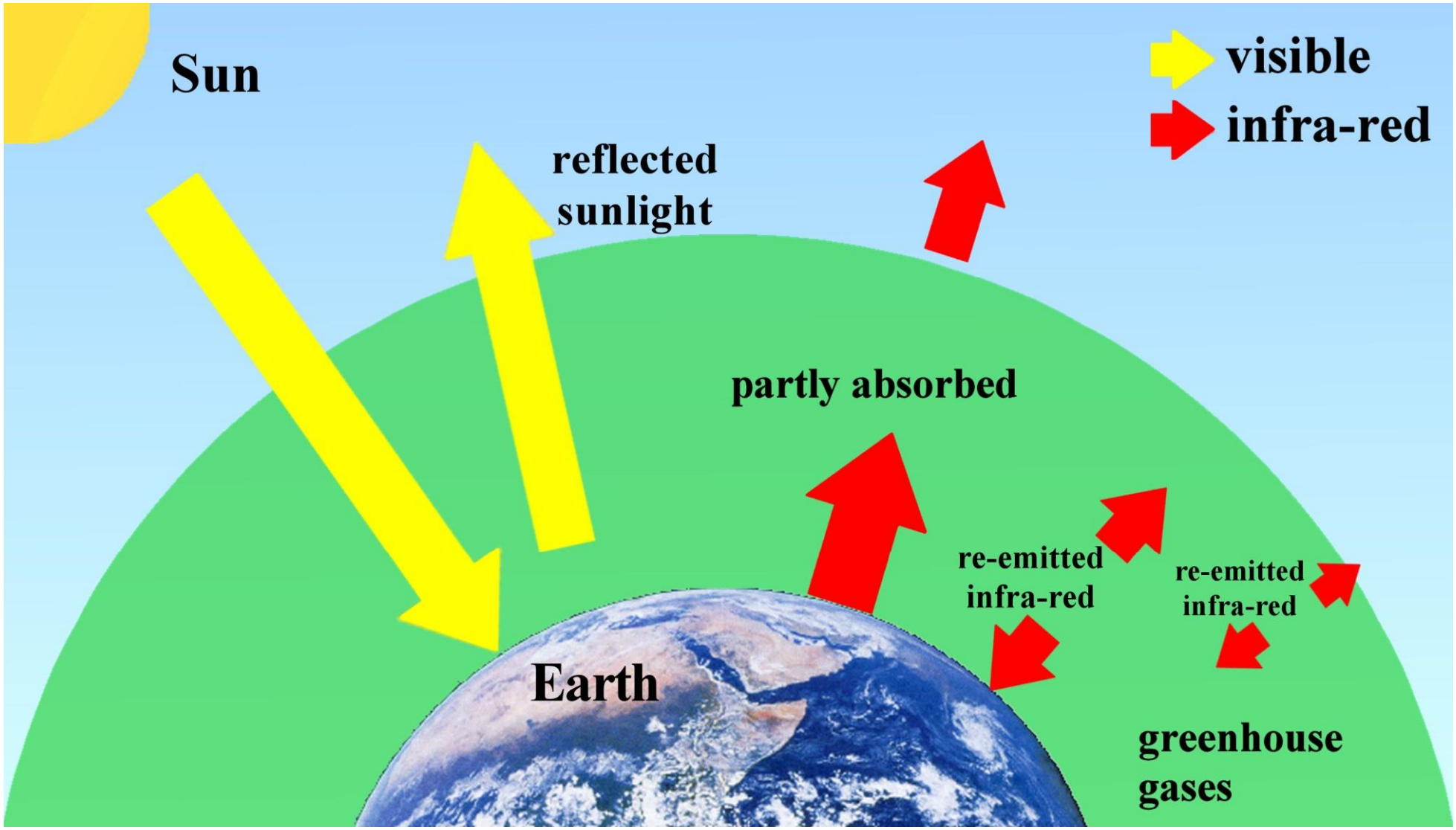
-*National Sea Ice and Data Center* (09/16/12)

Climate change

- Climate change as a natural phenomenon
- Human contributions
  - Such as greenhouse gases (GHG) emissions
  - Affect global warming
- Impacts of climate change
  - Changes to ecosystems & damage to infrastructure brought about by extreme weather events, e.g. heat waves and droughts, extreme storms, pressure on water resources and crop yields, damage to corals, sea level rise

氣候變化

Greenhouse effect



Condition for greenhouse gases in the atmosphere; greenhouse gases include carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), chlorofluorcarbons (CFCs) , ozone (O_3) and water vapour (H_2O)

(Source: Hong Kong Observatory)

(Video: An introduction to climate change in 60 seconds (1:39)
http://www.youtube.com/watch?v=n4e5UPu1co0)

Human activities produce greenhouse gases

energy production, industry:carbon dioxide(CO_2)

waste landfill: nitrous oxide(N_2O)

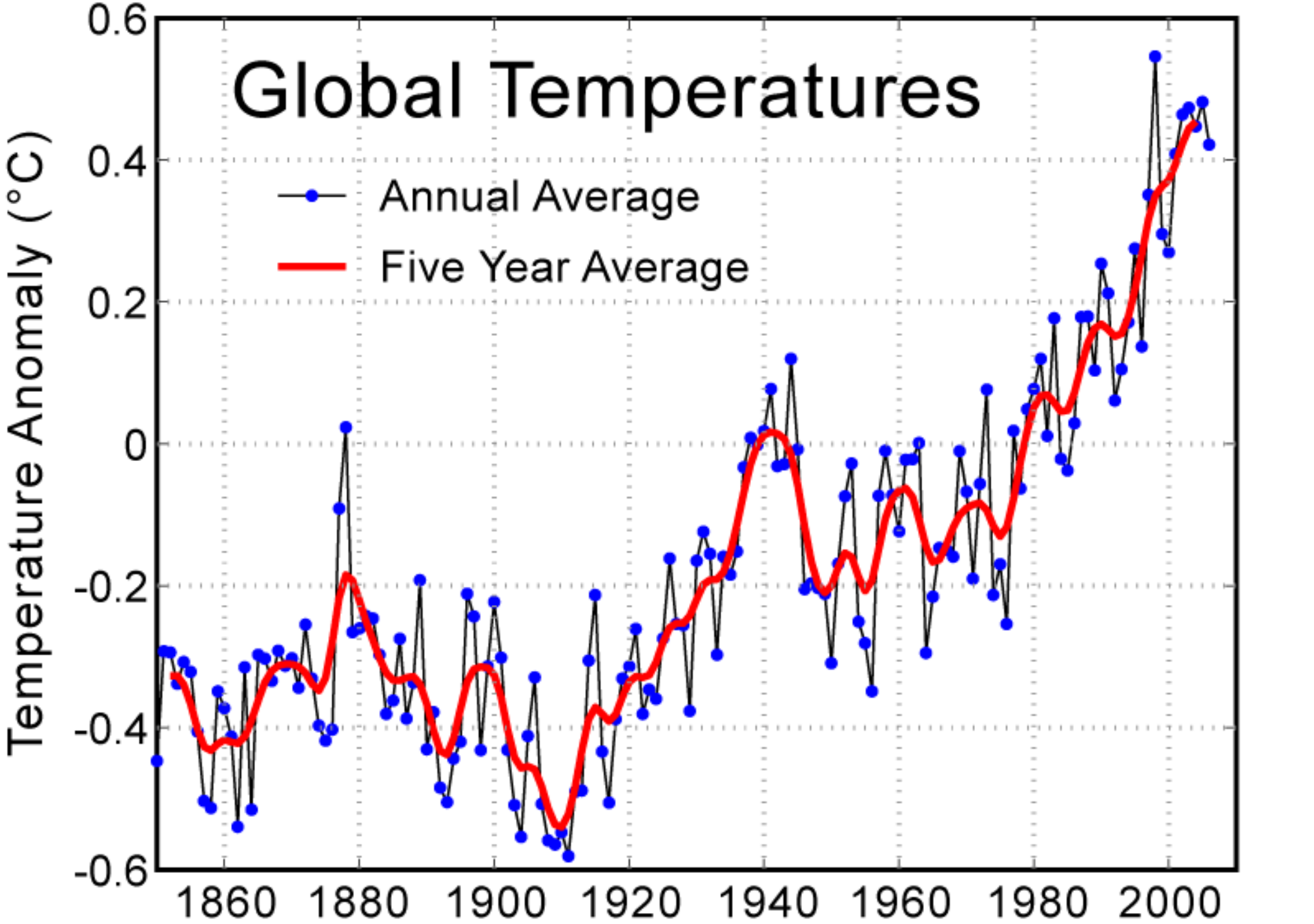
husbandry: methane(CH_4)

freezer, aerosol spray: chlorofluorcarbons(CFCs)

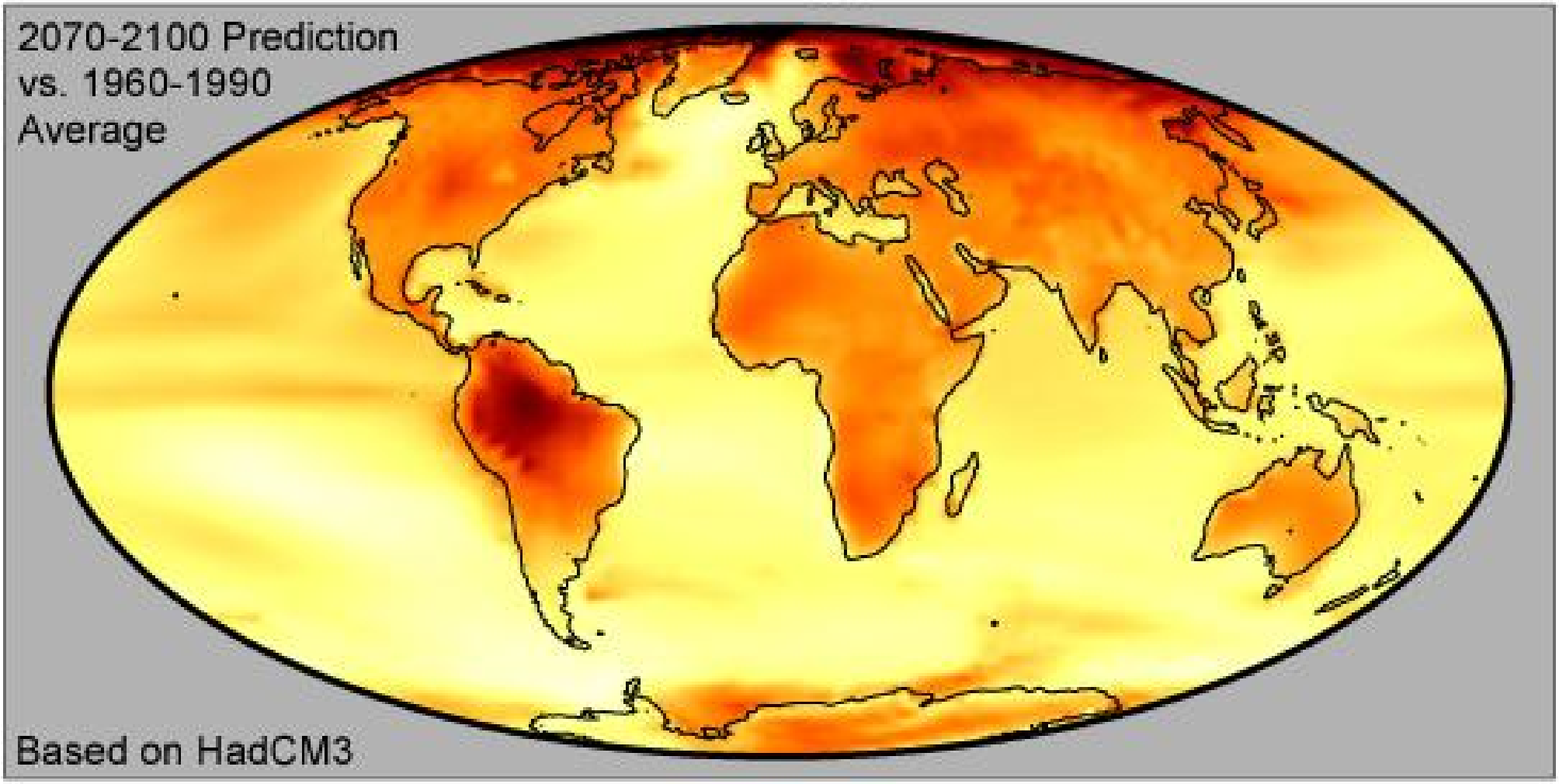
vehicle exhaust : ozone(O_3)

(Source: Hong Kong Observatory)

(Video: Climate Change Explained (5:49) http://www.youtube.com/watch?v=ifrHogDujXw)


Global Temperatures
Annual Average
Five Year Average
Temperature Anomaly (°C)
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
1860
1880
1900
1920
1940
1960
1980
2000

Global Warming Predictions



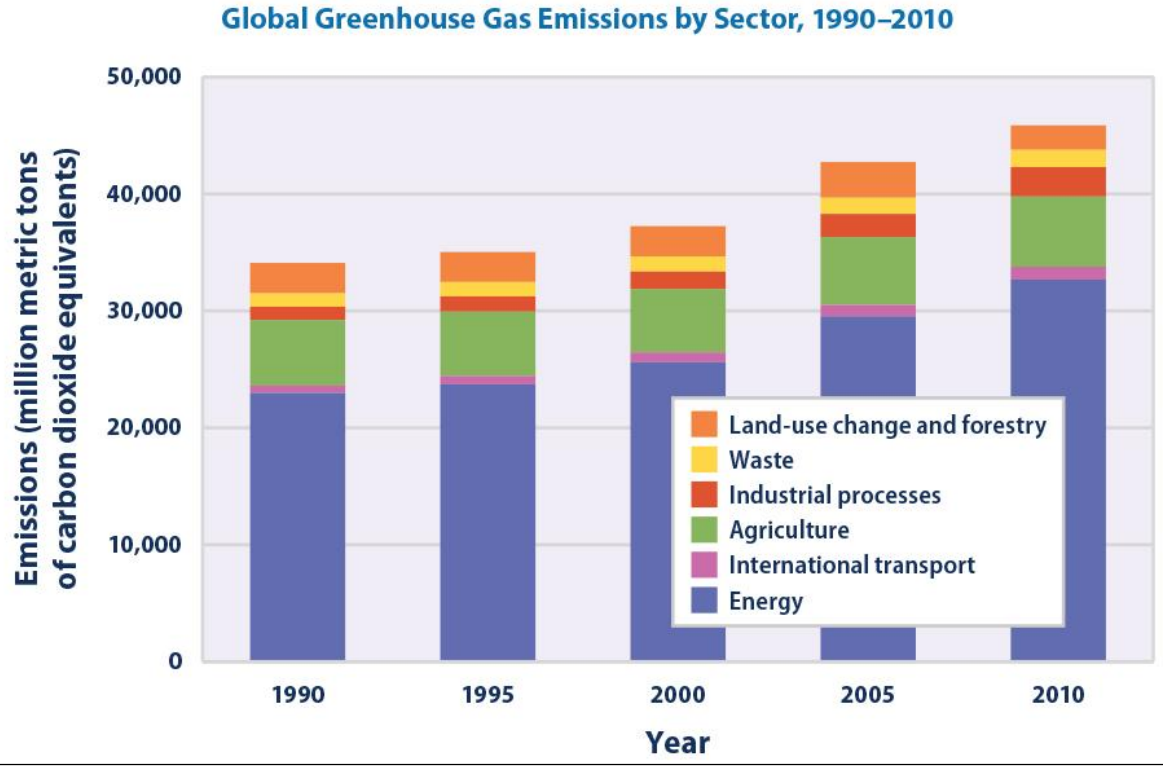
Climate change

- A brief history of global climate change action
  - 1988 - Intergovernmental Panel on Climate Change (IPCC) formed to assess evidence
  - 1992 - United Nations Framework Convention on Climate Change (UNFCCC)
  - 1997 - Kyoto Protocol to Climate Change Convention (average 5% emissions reduction)
  - 2009 - Copenhagen Accord (global temperature increase to be kept below 2˚C)
  - 2015 - Conference of the Parties (COP) in Paris

(See also: A brief history of climate change (BBC News) http://www.bbc.com/news/science-environment-15874560)

Climate change

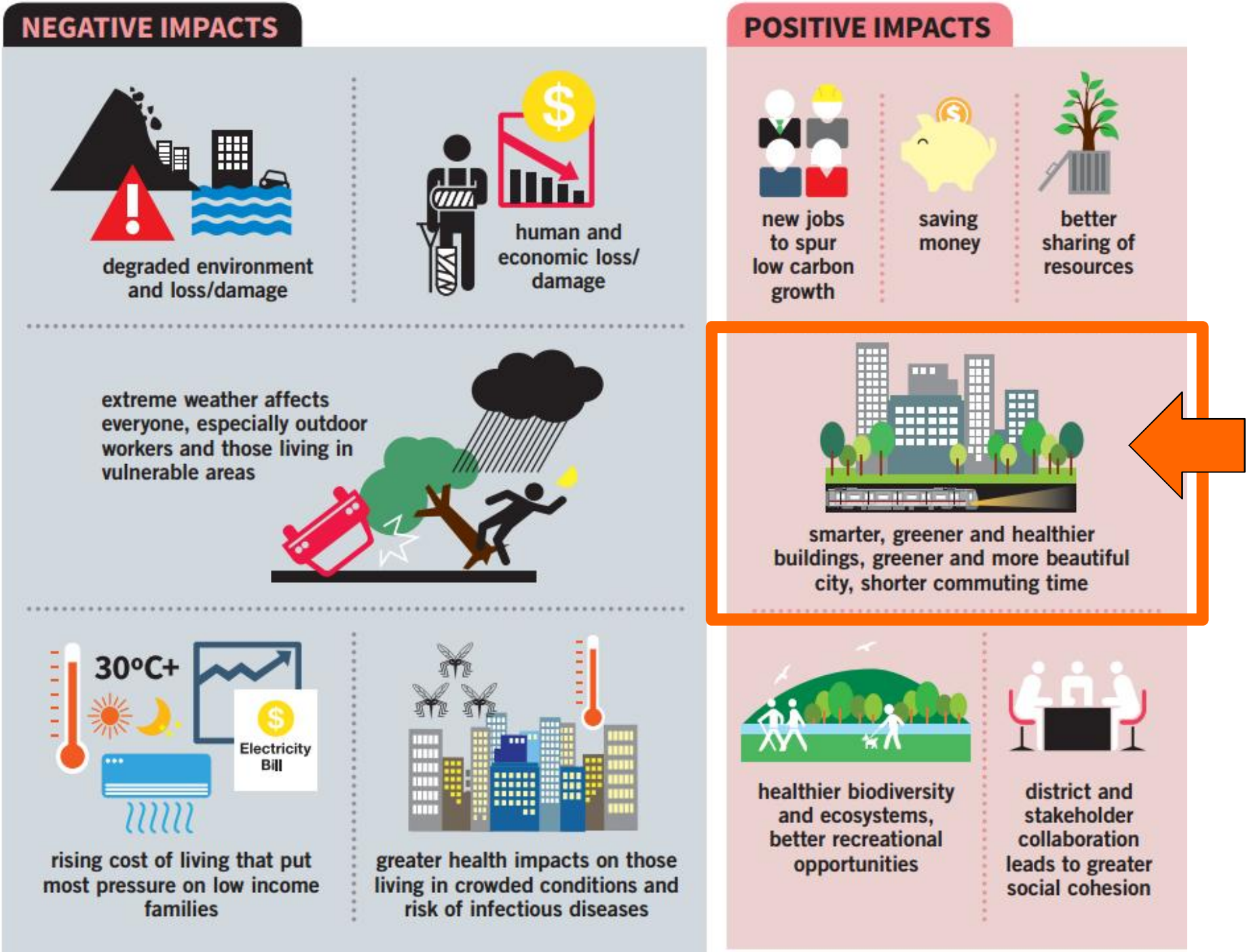
- Major sources of greenhouse gases
  - Natural causes
  - Land use and animal husbandry
  - Energy production
  - Industry
  - Transport
  - Domestic sources



Climate change

- Three approaches to tackle climate change
  - **1. Mitigation 緩和**
    - Efforts to reduce or prevent emission of GHG
    - Using low-carbon and clean-energy strategies
  - **2. Adaptation 適應**
    - Anticipate the adverse effects and take appropriate actions to prevent or minimise the damage they may cause, or take advantage of opportunities that may arise
  - **3. Resilience 恢復**
    - Capacity to absorb stress and maintain function, and adapt and evolve to get better prepared

Challenge and opportunities of climate change in Hong Kong



(Source: Hong Kong Climate Change Report 2015 http://www.enb.gov.hk/sites/default/files/pdf/ClimateChangeEng.pdf)

Climate change

- Climate change action in Hong Kong
  - Target: reduce the carbon intensity by 50-60% from the 2005 level by 2020
  - Energy saving becomes a core activity
  - Major mitigation measures:
    - Practicing energy saving in buildings
    - Revamping electricity fuel mix
    - Greening transportation (e.g. rail & public transport)
    - Greening the city (e.g. landscape, green infrastructure)
    - Turning waste to resources

(See also: Hong Kong Climate Change Report 2015 http://www.enb.gov.hk/sites/default/files/pdf/ClimateChangeEng.pdf)

Pollution

- Pollution is the presence of substances at high enough levels in air, water, soil or food to threaten humans or other living organisms
  - Pollution on air, water, soil, food + noise pollution
  - Most pollution are unintended by products of useful activities, e.g. cars gives off pollutant

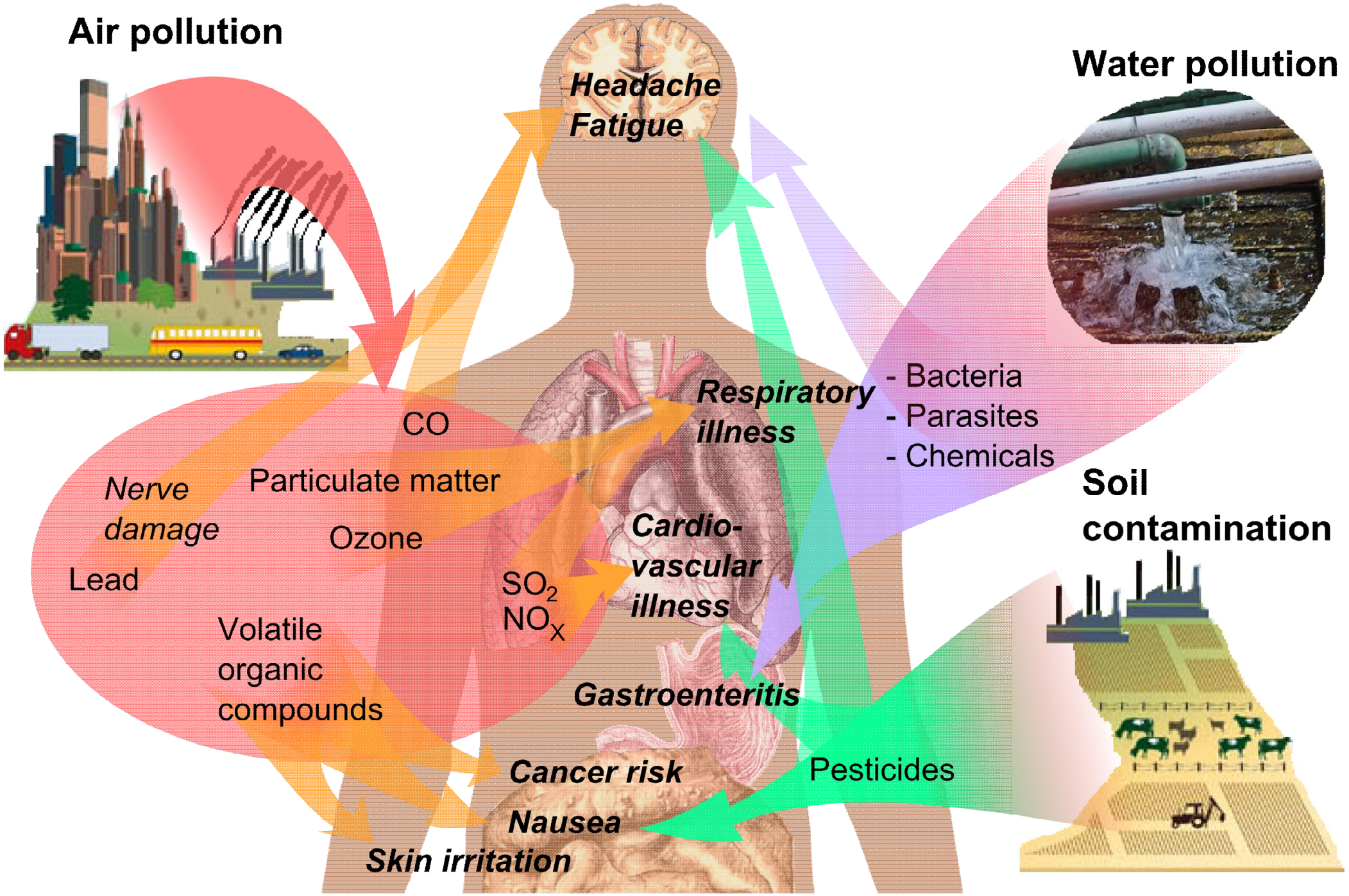
Pollution

- Major causes of pollution
  - Overpopulation and industrialisation
  - Emissions/discharges from industry, transport and energy production
  - Agricultural run offs
  - Unclean technology
  - Inadequate policies and legal regimes
  - Non-implementation of ambient quality standards
  - ……

Pollution

- Effects of pollution
  - Disrupt or degrade life-supporting systems for humans or other species
  - Can damage wildlife, human health or property
  - Can be a nuisance e.g. noise, smell, sights

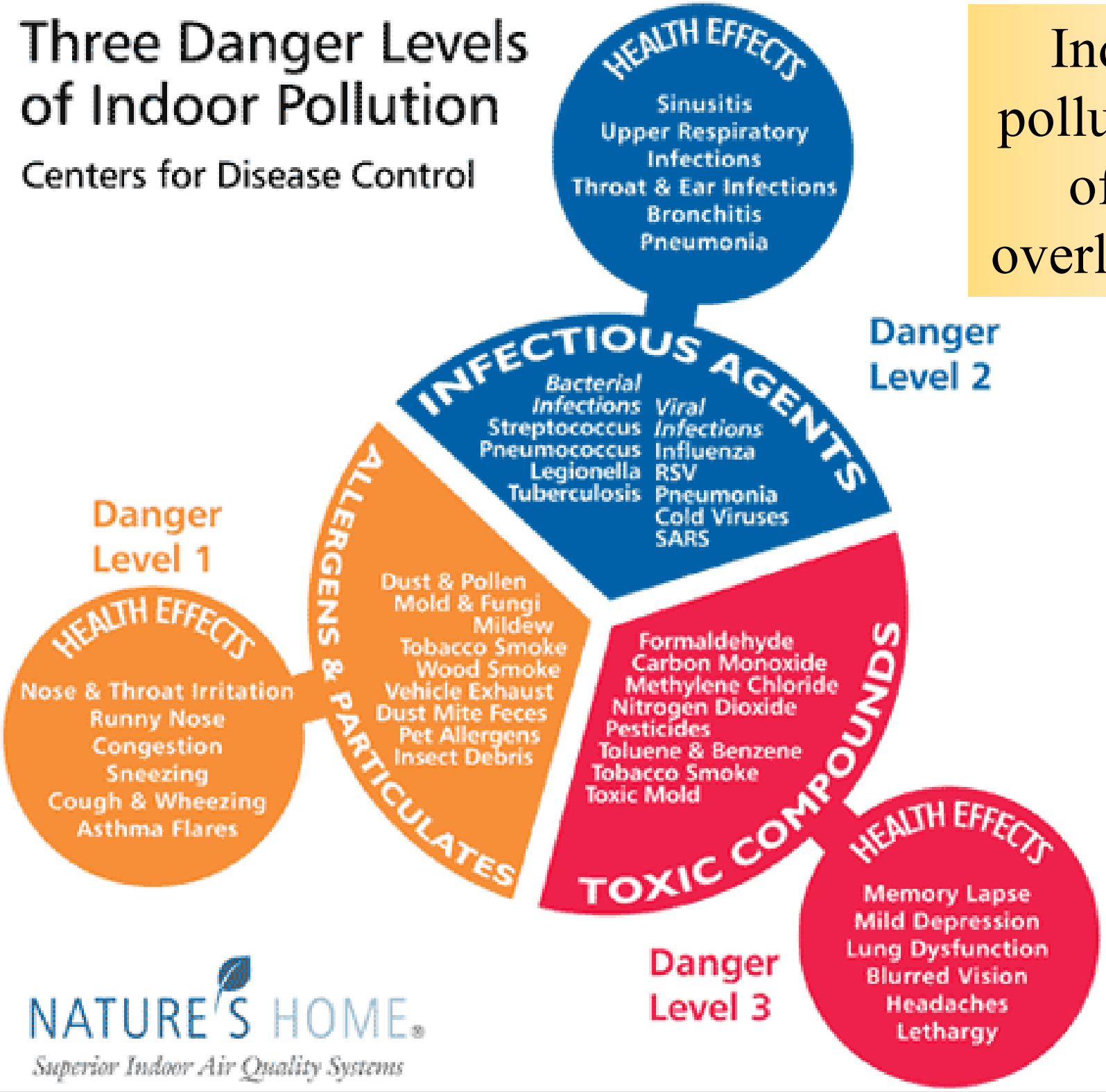
Health effects of pollution



(Image source: http://commons.wikimedia.org)

Three Danger Levels of Indoor Pollution

Centers for Disease Control



Indoor pollution is often overlooked.

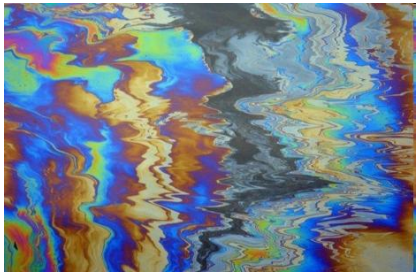
NATURE'S HOME®

Superior Indoor Air Quality Systems

Pollution

- Water pollution sources
  - 1. Point sources
    - Discharge directly into receiving waters
    - Easier to characterize and regulate

  - 2. Non-point sources
    - Pollutants from diffuse sources (e.g. agricultural waste)
    - May vary regionally and seasonally
    - May be difficult to distinguish anthropogenic from natural effects



Pollution

- Dealing with pollution
  - Prevention (input control): reduce or eliminate pollutants from production e.g. using clean energy, more fuel efficient cars and equipment
  - Pollution clean-up (output control): clean up or dilute pollution once in the environment
- What are the problems with pollution clean-up?

Resource depletion

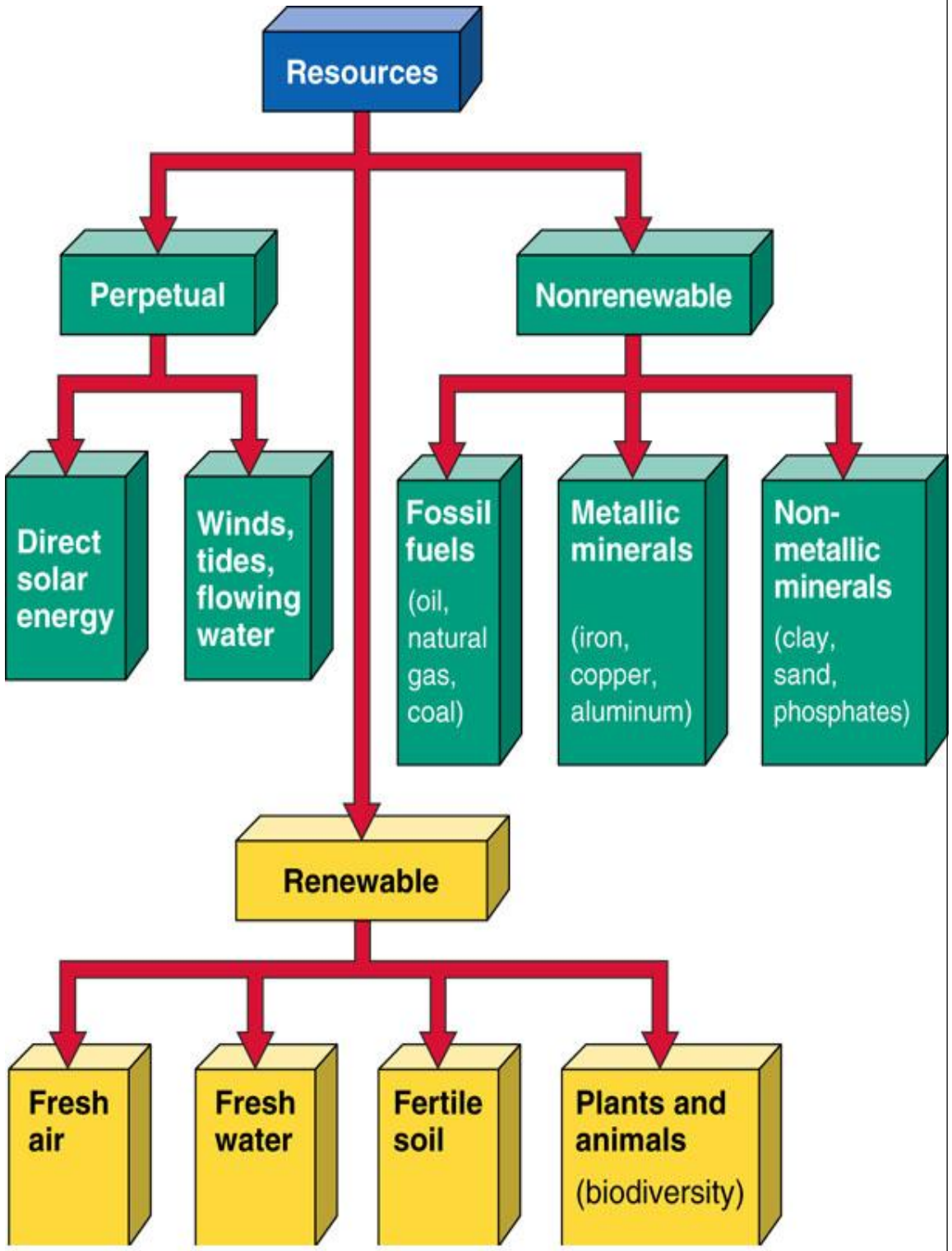
- Consumption of a resource faster than it can be replenished (i.e. overconsumption)
  - The risk of using up the resources
  - Fossil fuels (oil), minerals (mining), forests (trees), drinking water, food (farming, fishing)
- The causes of resource depletion
  - Overpopulation, industrial development, erosion, deforestation, over-fishing, irrigation, mining, pollution, and non-equitable distribution

Types of resources:

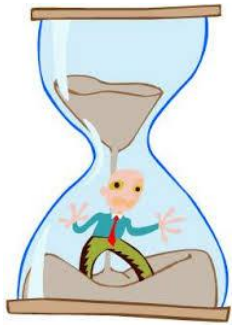
1. Perpetual: renewed continuously on a human scale.

2. Renewable: can be replenished fairly quickly.

3. Non-renewable: exist only in fixed quantities. (once they are gone they are gone.)

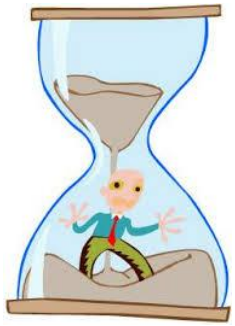


Resource depletion

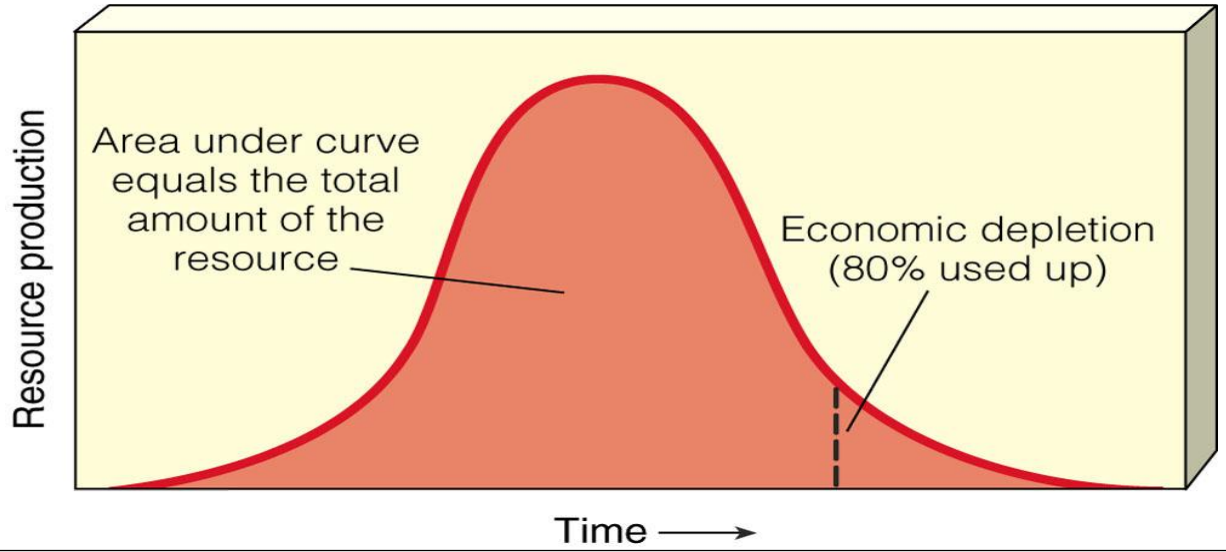


- Renewable resources can be depleted or degraded
  - Sustainable Yield: the highest rate at which a renewable resource can be used without reducing its supply. Example: over-farming the land leading to soil erosion, clear-cutting forests.
  - Environmental Degradation: when we exceed the natural replacement rate of the resource. Example: groundwater depletion, water pollution.

Resource depletion



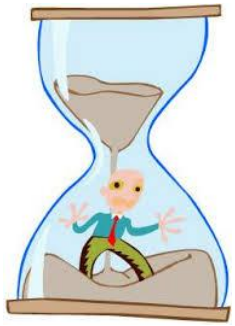
- Non-renewable resources exist only in fixed quantities on earth
  - Energy resources: e.g. coal, oil and natural gas
  - Metallic resources: e.g. iron, copper, aluminium
  - Non-metallic resources: e.g. salt, clay, sand



Economic Depletion

When 80% is gone it may be too costly to get the last 20%.

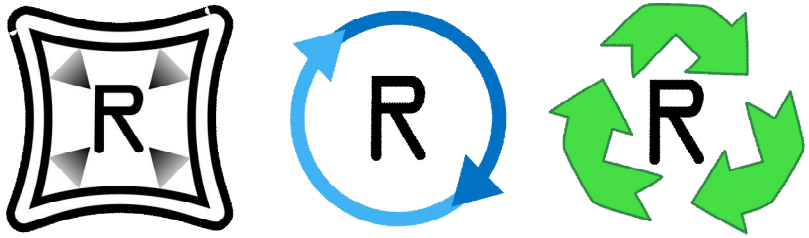
Resource depletion



- Technical solutions:
  - Alternative resources (e.g. alternative energy)
  - Best use of recyclable products
  - Forestation (planting trees)
  - Avoid over-exploitation (e.g. fisheries, mining)
  - Resource levelling (get the resource from other places that are still abundant supply)
  - Control over pollution

Resource depletion

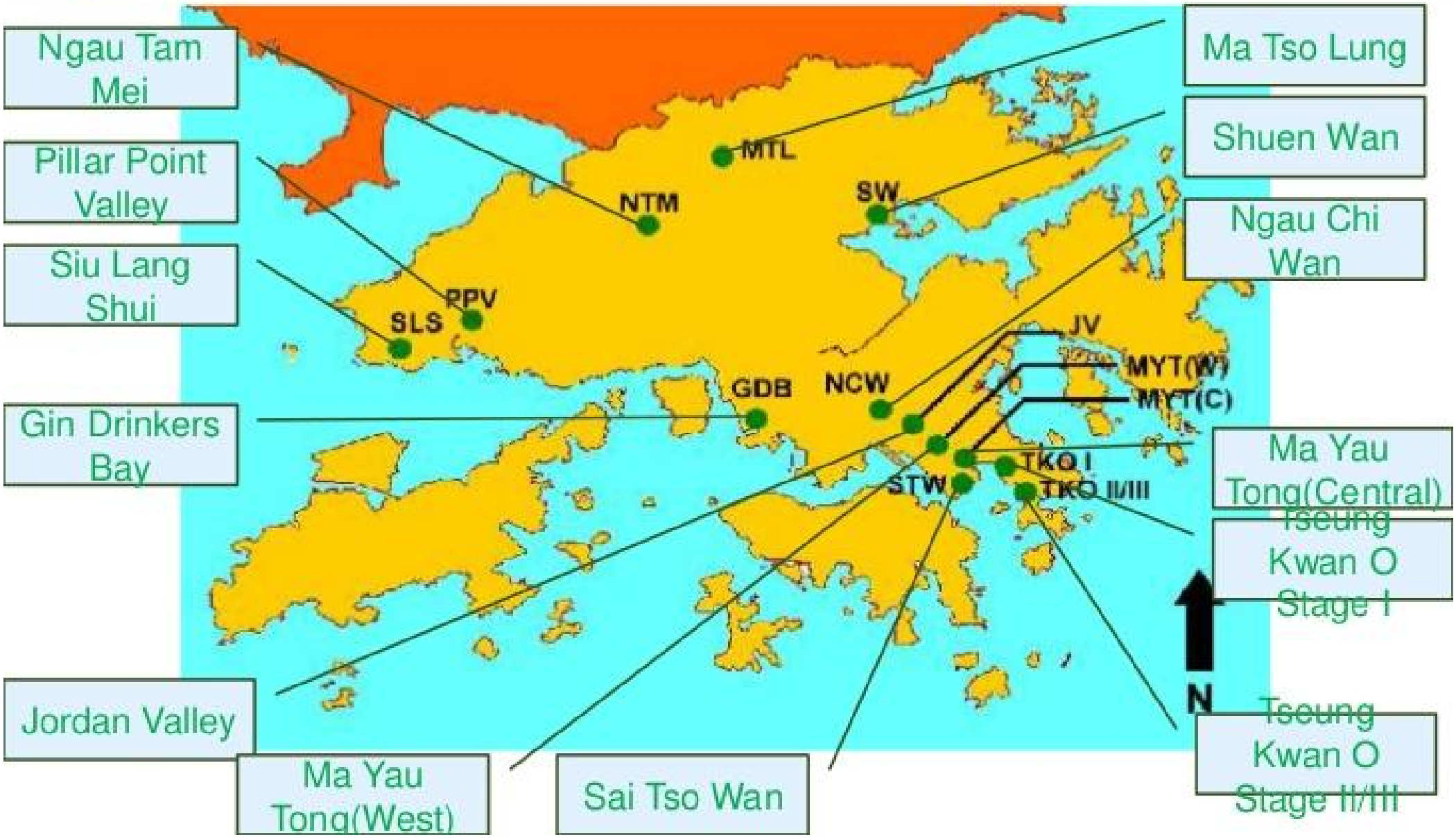
- Reduce, Reuse and Recycle: Saving non-renewable resources
  - Reduce: Use less resource
  - Reuse: Use the resource more than once to conserve
  - Recycle: Collect resource, process it into new products



Waste

- We produce too much waste
  - Solid waste, chemical/toxic waste, food waste
- Waste facilities
  - Landfills, incinerators and waste transfer stations
- Waste management and elimination
  - Move towards "Zero Waste"
  - Connect the front end (production and design) and the back end (reuse and reprocessing) of material flow

Closed landfills in Hong Kong

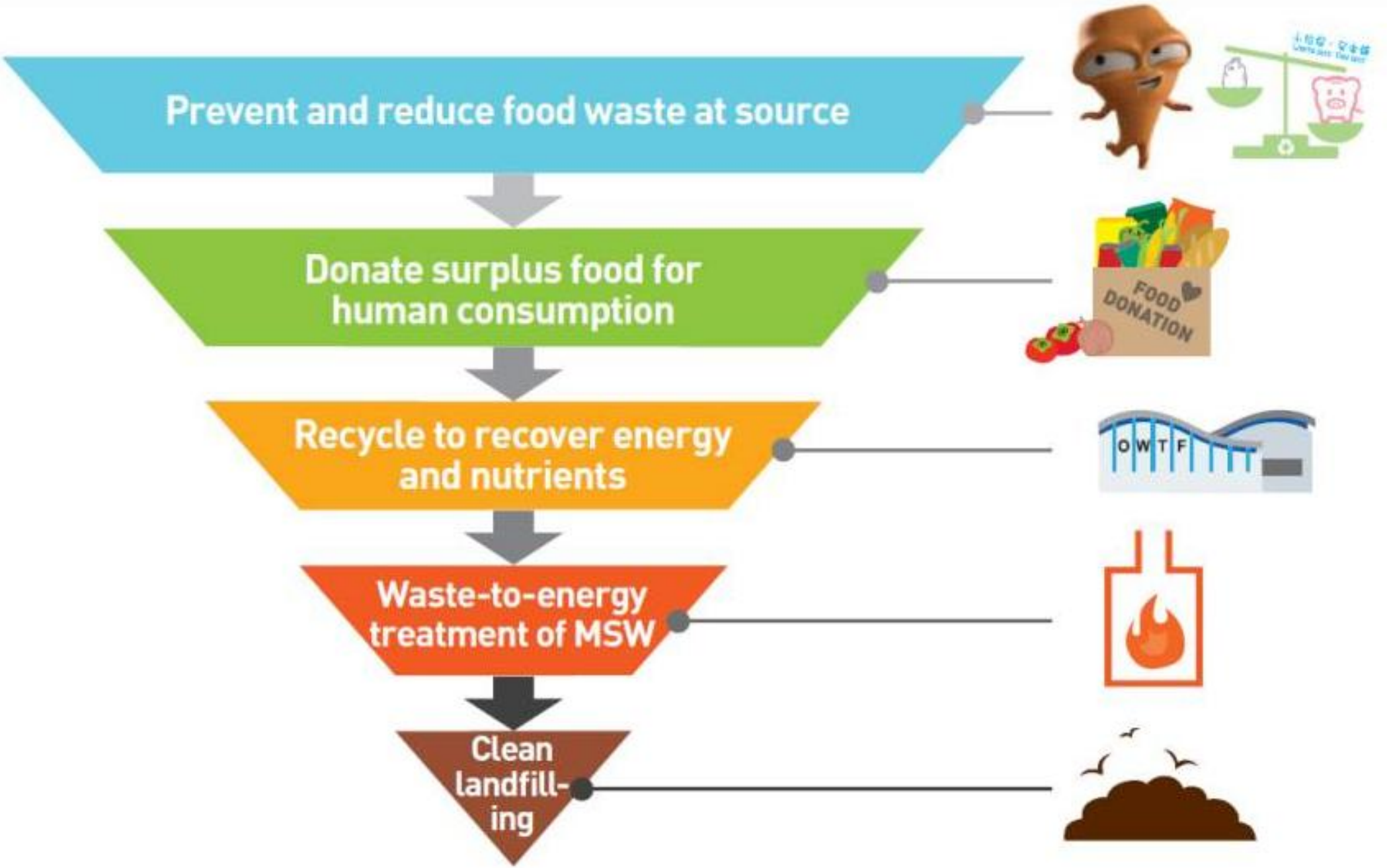


(Source: Environmental Protection Department)

Hong Kong Blueprint for Sustainable Use of Resources 2013-2022

(Source: Environmental Protection Department and http://www.enb.gov.hk/en/files/WastePlan-E.pdf)

Food waste management strategy in Hong Kong



(Source: Environmental Protection Department http://www.epd.gov.hk/epd/english/environmentinhk/waste/prob_solutions/food_waste_challenge.html)

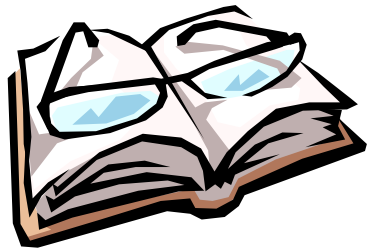
Waste

- Zero Waste approach:
  - Reduce needless consumption
  - Minimize waste
  - Maximize reuse and recycling
  - Incentivize the manufacturing of products that can be intentionally reused, repaired, or recycled back into the marketplace

零廢棄

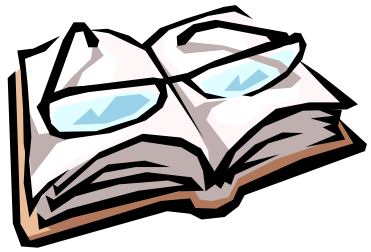
(Source: Zero Waste http://upstreampolicy.org/solutions/recycling-and-zero-waste/)

Further reading

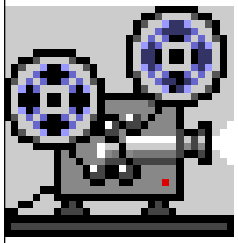


- Environmental issues in Hong Kong, China and around the world
  - http://www.opentextbooks.org.hk/ditatopic/10008
- HK: The Facts: Environmental Protection
  - http://www.gov.hk/en/about/abouthk/factsheets/docs/environmental_protection.pdf
- Hong Kong Climate Change Report 2015
  - http://www.enb.gov.hk/sites/default/files/pdf/ClimateChangeEng.pdf

Further reading



- Videos:



  - Treasure our Planet, Make a Better Choice (4:00)
    - http://www.youtube.com/watch?v=EVv4H4fneS4
  - Climate Change Explained (5:49)
    - http://www.youtube.com/watch?v=ifrHogDujXw
- Academic visit:
  - CUHK the Jockey Club Museum of Climate Change 香港中文大學賽馬會氣候變化博物
    - http://www.gaia.cuhk.edu.hk/