Regenerative Cities: Making cities work for people and planet

Herbert Girardet

Presentation outline

- Thinking local, regional and global
- Agropolis: the town set in its local landscape
- Petropolis: the city of the 'Anthropocene'
- I-P-A-T: Population growth, affluence and technology
- Cities in the anthropocene: New challenge for city leaders
- Cities as spatial, technical, economic & ecological systems
- Ecopolis: the regenerative city
- The metabolism of cities: From liner to circular
- New horizons: Integrating local and global issues
- The Adelaide case study


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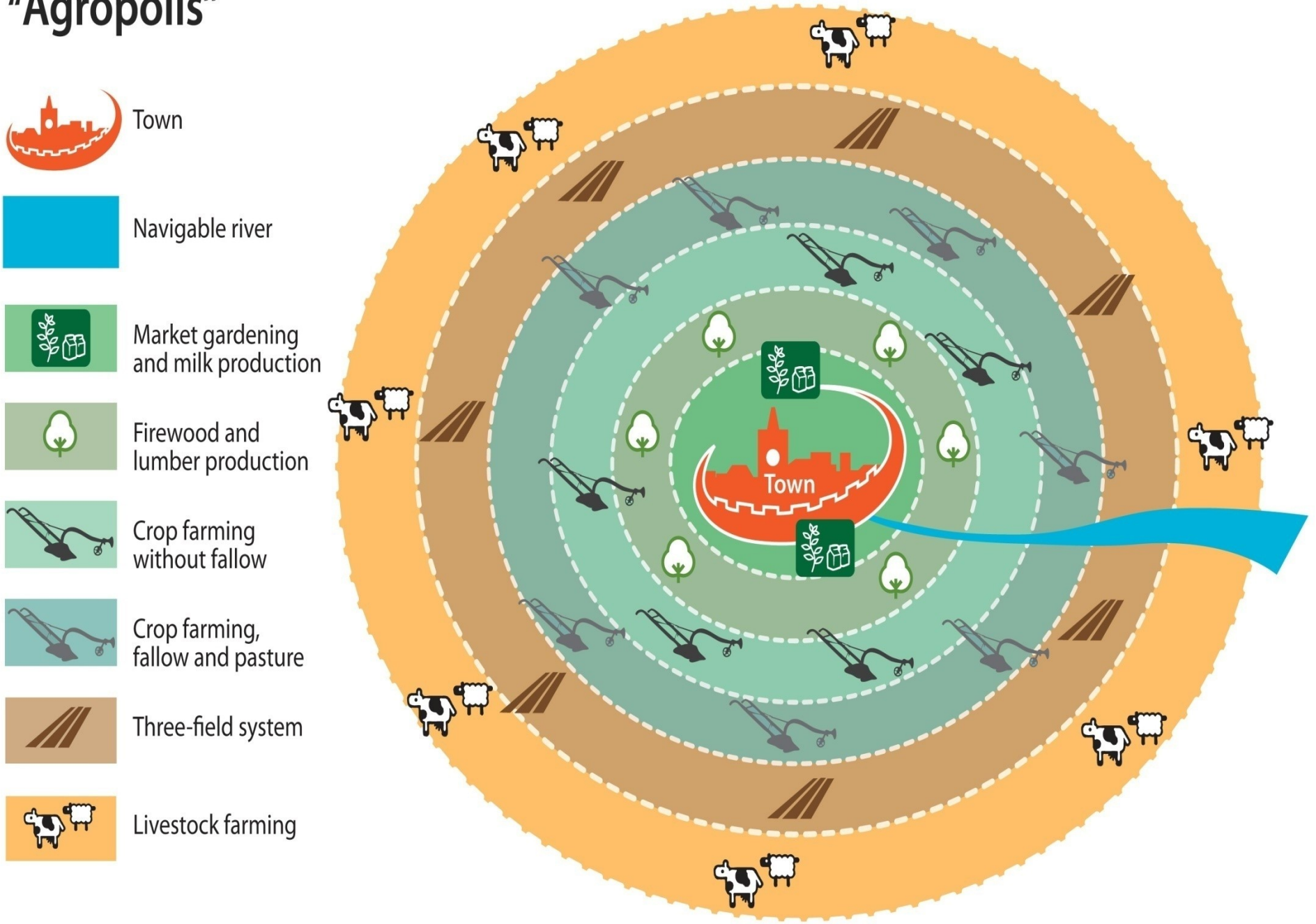
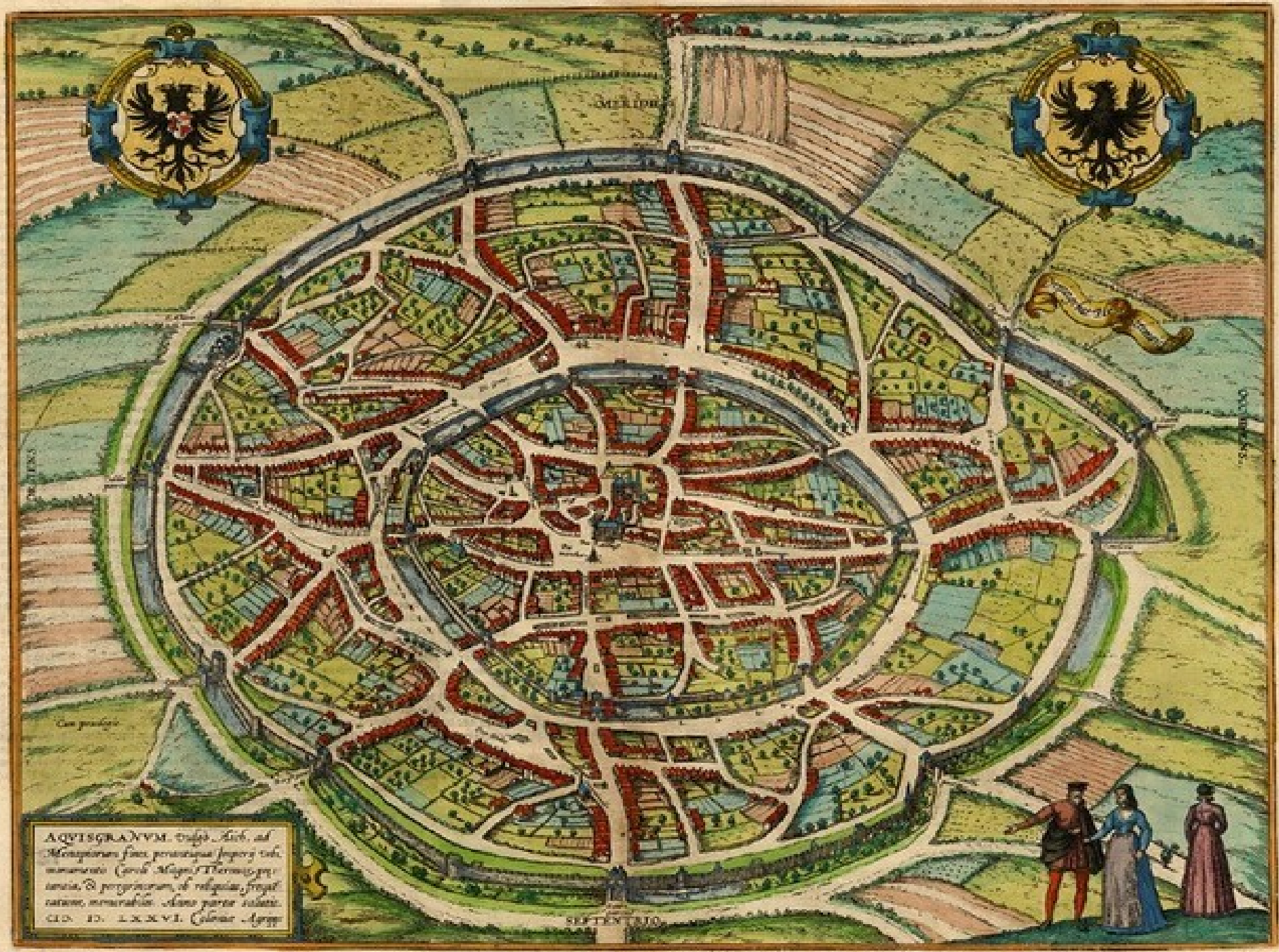
The age of the city

- Cities define human existence in the 21st century
- They are the heartland of national economies, financial systems and cultural life
- Cities tend to see themselves as 'centres of the universe' around which the world revolves
- But: the require vast resource flows, including 80% of world fossil energy, from ever more distant places
- In an age of climate change, we need to address the full impacts of these *global* urban systems
- City leaders need to find new ways to combine local responsibilities with long term, global perspectives

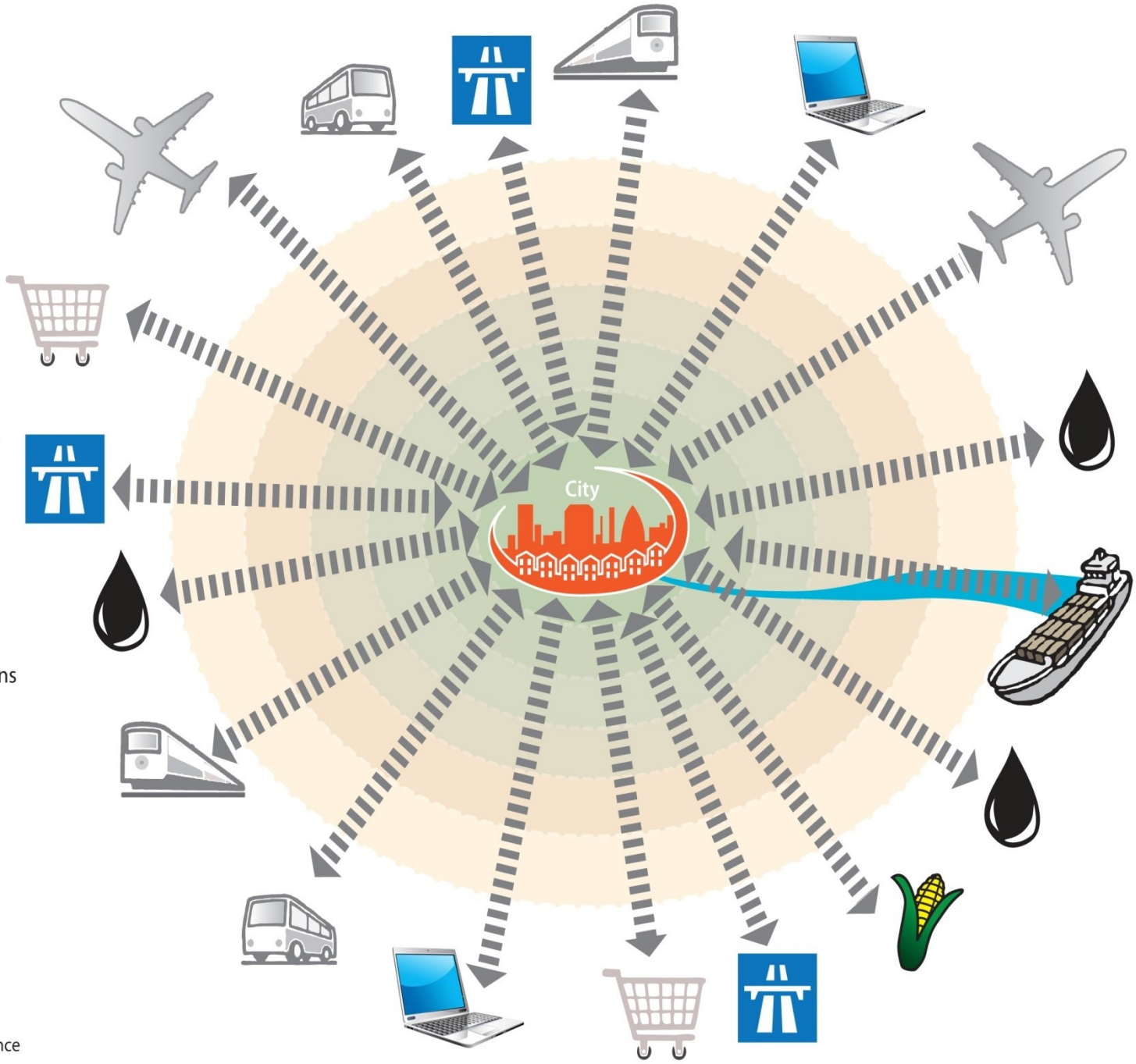
"Agropolis"

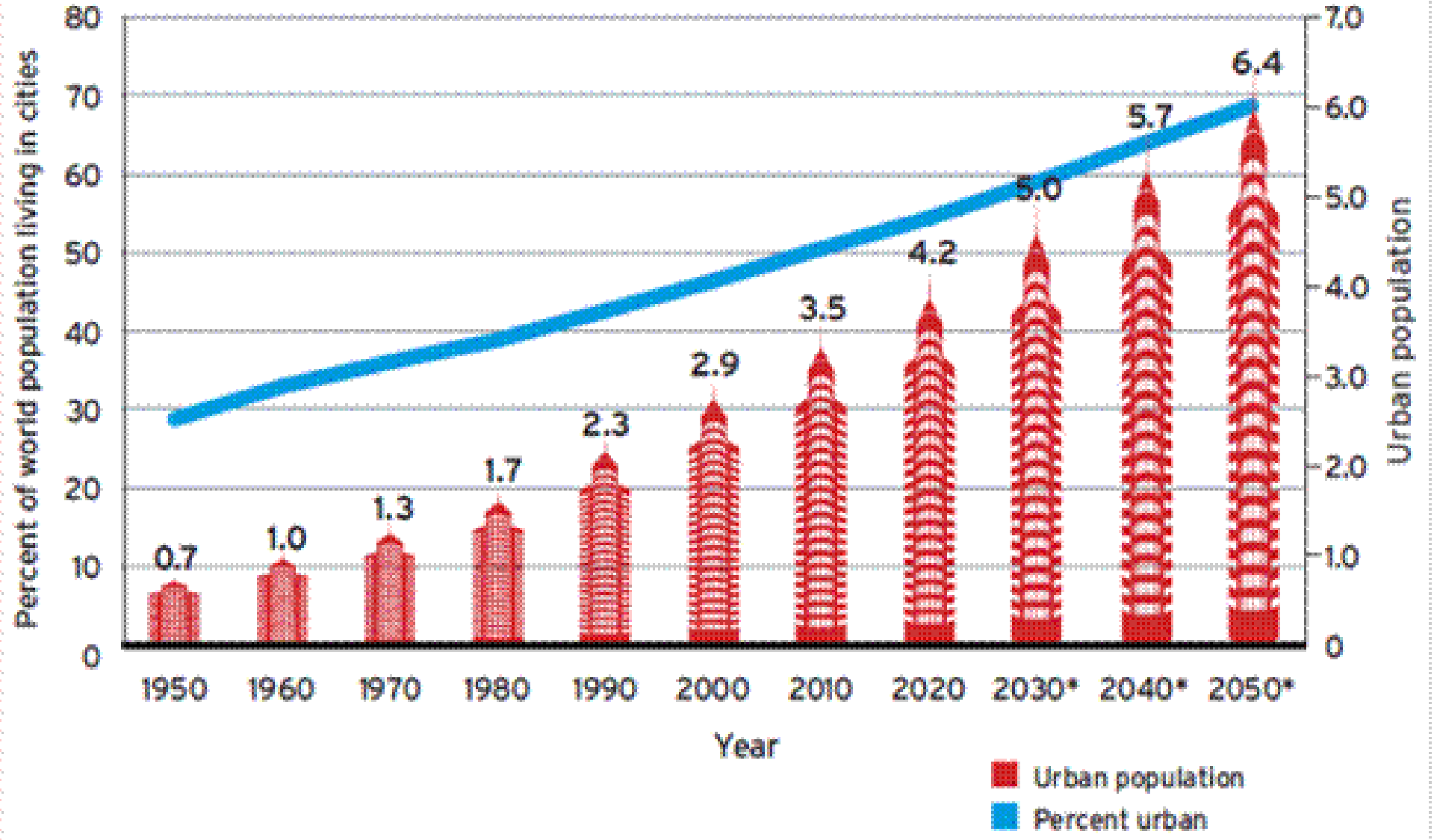


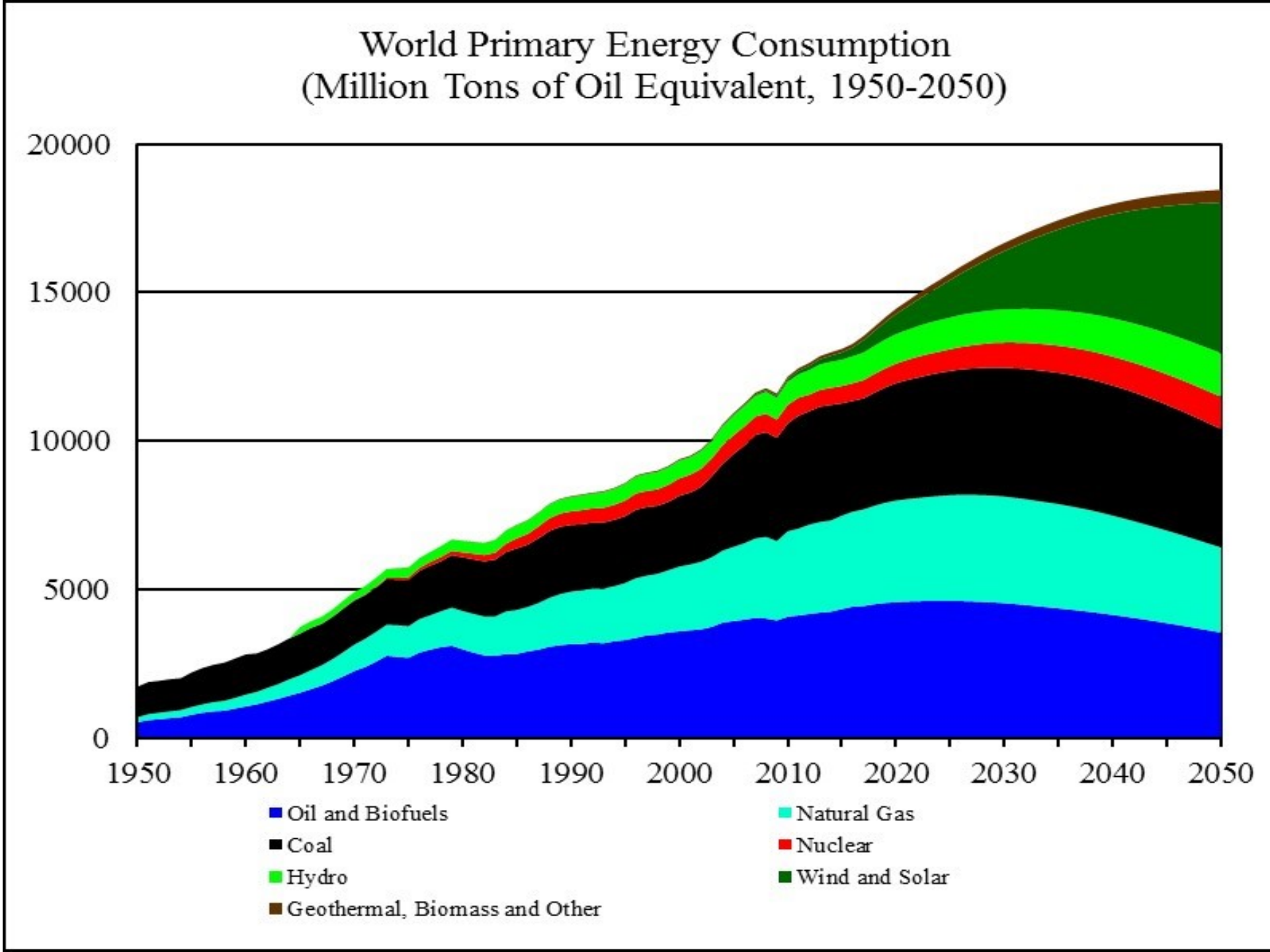

AQVISGRANVM
SEPTENTRIO

Montereggioni, Tuscany

"Petropolis"

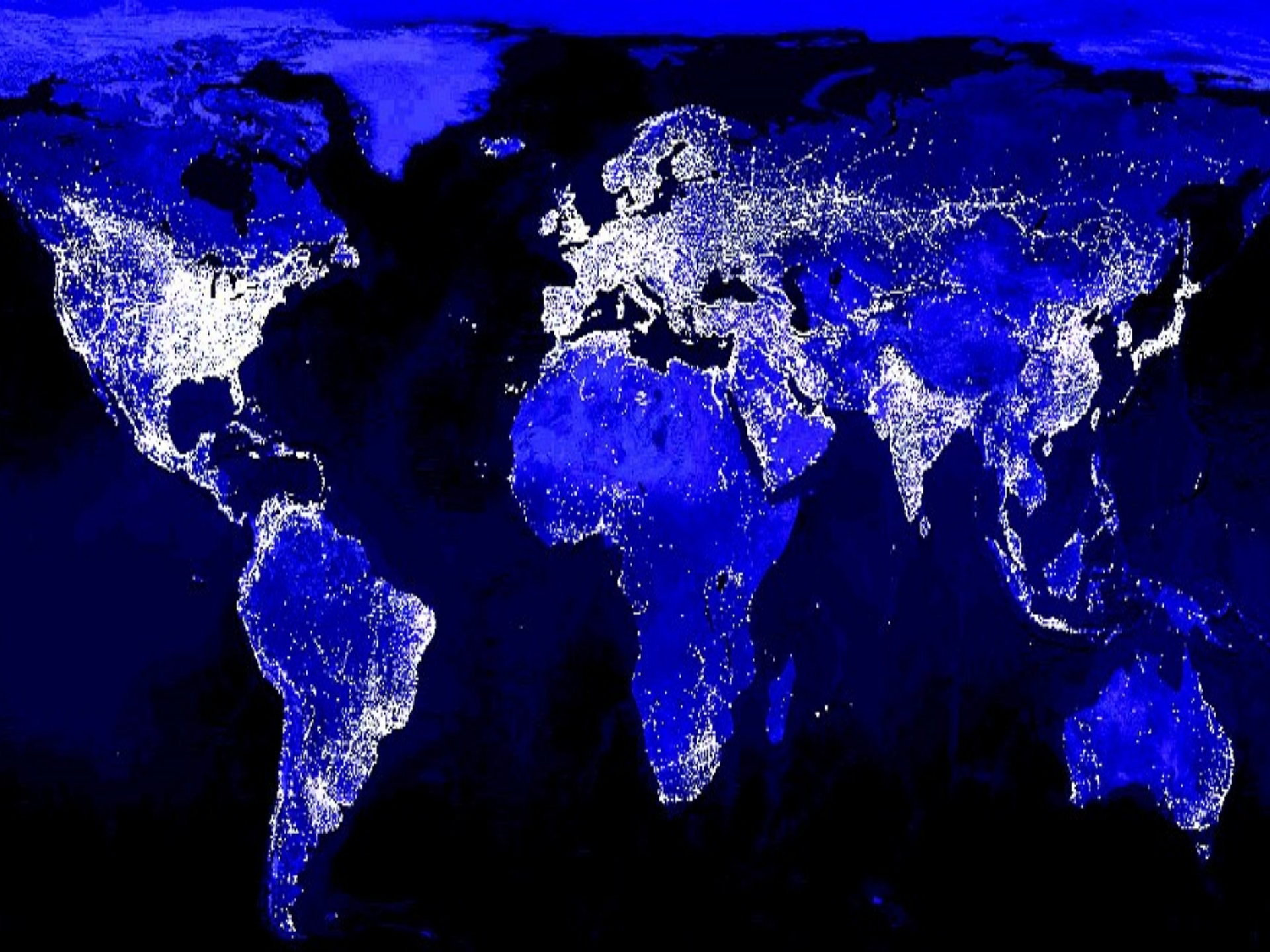



Percent of world population living in cities
80
70
60
50
40
30
20
10
0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
Urban population
0.7
1.0
1.3
1.7
2.3
2.9
3.5
4.2
5.0
5.7
6.4
1950
1960
1970
1980
1990
2000
2010
2020
2030*
2040*
2050*
Year
Urban population
Percent urban


World Primary Energy Consumption
(Million Tons of Oil Equivalent, 1950-2050)
20000
15000
10000
5000
0
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
Oil and Biofuels
Natural Gas
Coal
Nuclear
Hydro
Wind and Solar
Geothermal, Biomass and Other

Urban growth and its impacts

- **In 120 years, human numbers have increased five fold – from 1.5 to 7.5 billion people**
- **By 2030, 4.8 billion people, or 60% of the world population (8 billion), could be living in urban areas**
- **Urban growth as multiplier of human impacts**
- **I-P-A-T: Human impacts = numbers of People x level of Affluence x uses of Technology**
- **In developing countries, as villagers move to the city, per capita resource use typically increases fourfold**
- **Cities increase living standards as well as impacts**
- ***Cities, located on 3-4% of the land surface of the earth, use 80% of its resources, and discharge the bulk of solid, liquid and gaseous wastes***



Atlanta


CARPOOL IS 2 OR MORE PERSONS PER VEHICLE
PACIFIC TANK LINES

The Built-up Area of Atlanta and Barcelona Represented at the Same Scale

10 km of metro line

Atlanta:
2.5 million people (1990)
4,280 km2 (built-up area)

Transit in Atlanta VS Barcelona	Barcelona	Atlanta
Length of metro lines (km)	99	74
% of population within 600 m from a metro station	60%	4%
% of trips using metro	30%	4.50%
Length of metro line that would be required to serve 60% of atlanta ppopulation (km) :		3400
Number of station required		2800

Barcelona:
2.8 million people (1990)
162 km2 (built-up area)

Barcelona

Barcelona: the vibrant city

Structures and processes

- City planners are primarily concerned with urban *structures* as a way of assessing urban impacts
- But arguably the *metabolic processes* that define cities are even more important in understanding these impacts
- The *metabolism of cities* is not confined to the intra-urban realm:
- It reaches across the planet – biosphere, aqua-sphere, lithosphere, atmosphere – as never before


Changing The Way You HIRE

London

London's metabolism - inputs

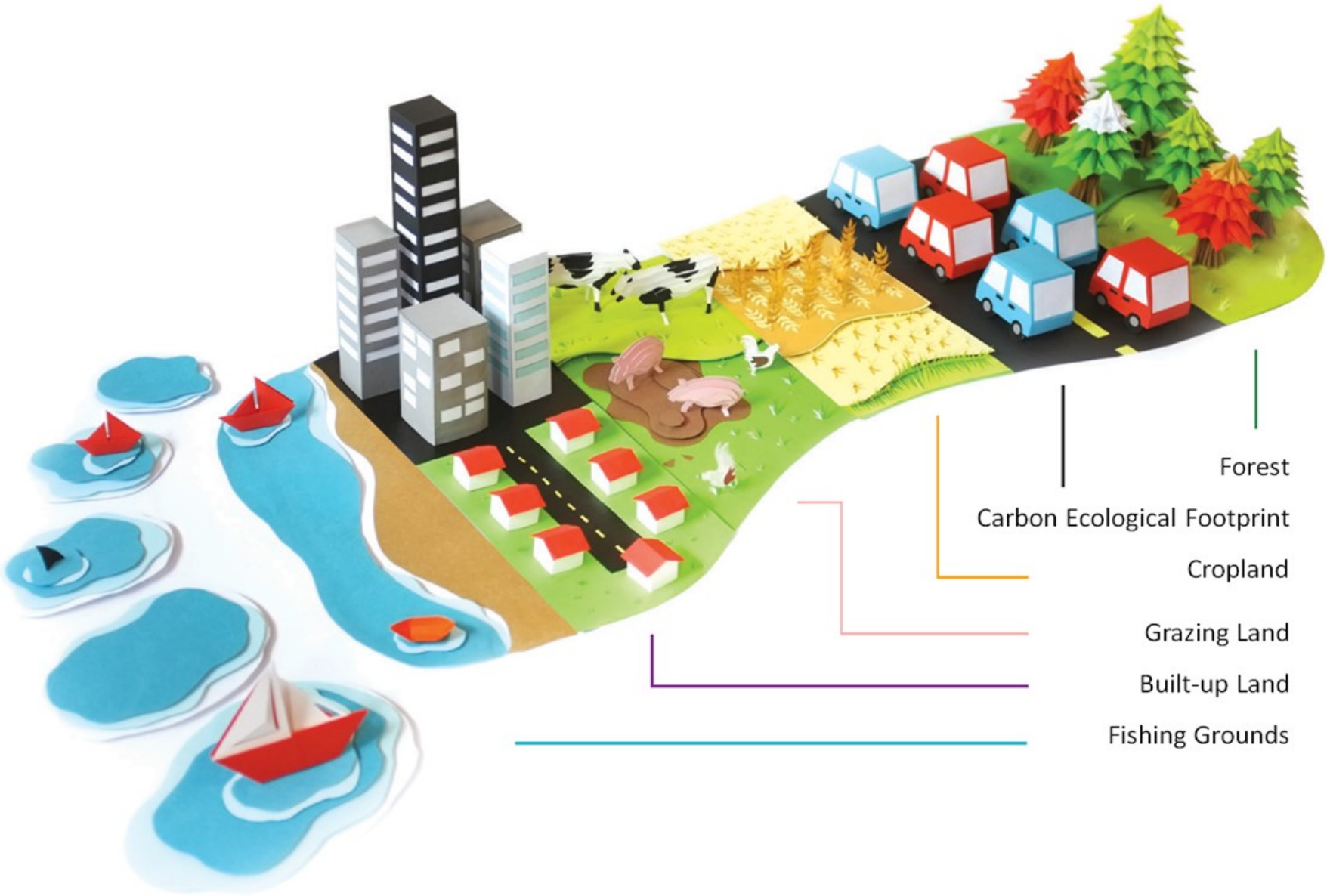
	(tonnes per year)
• Total tonnes of fuel, oil equivalent	20,000,000
• Oxygen	40,000,000
• Water	1,002,000,000
• Food	2,400,000
• Timber	1,200,000
• Paper	2,200,000
• Plastics	2,100,000
• Glass	360,000
• Cement	1,940,000
• Bricks, blocks, sand and tarmac	36,000,000
• All Metals	1,200,000

London's metabolism - wastes

	(tonnes per year)
• CO2	60,000,000
• SO2	400,000
• NOX	280,000
• Wet, digested sewage sludge	7,500,000
• Industrial and demolition wastes	11,400,000
• Household, civic and commercial wastes	3,900,000

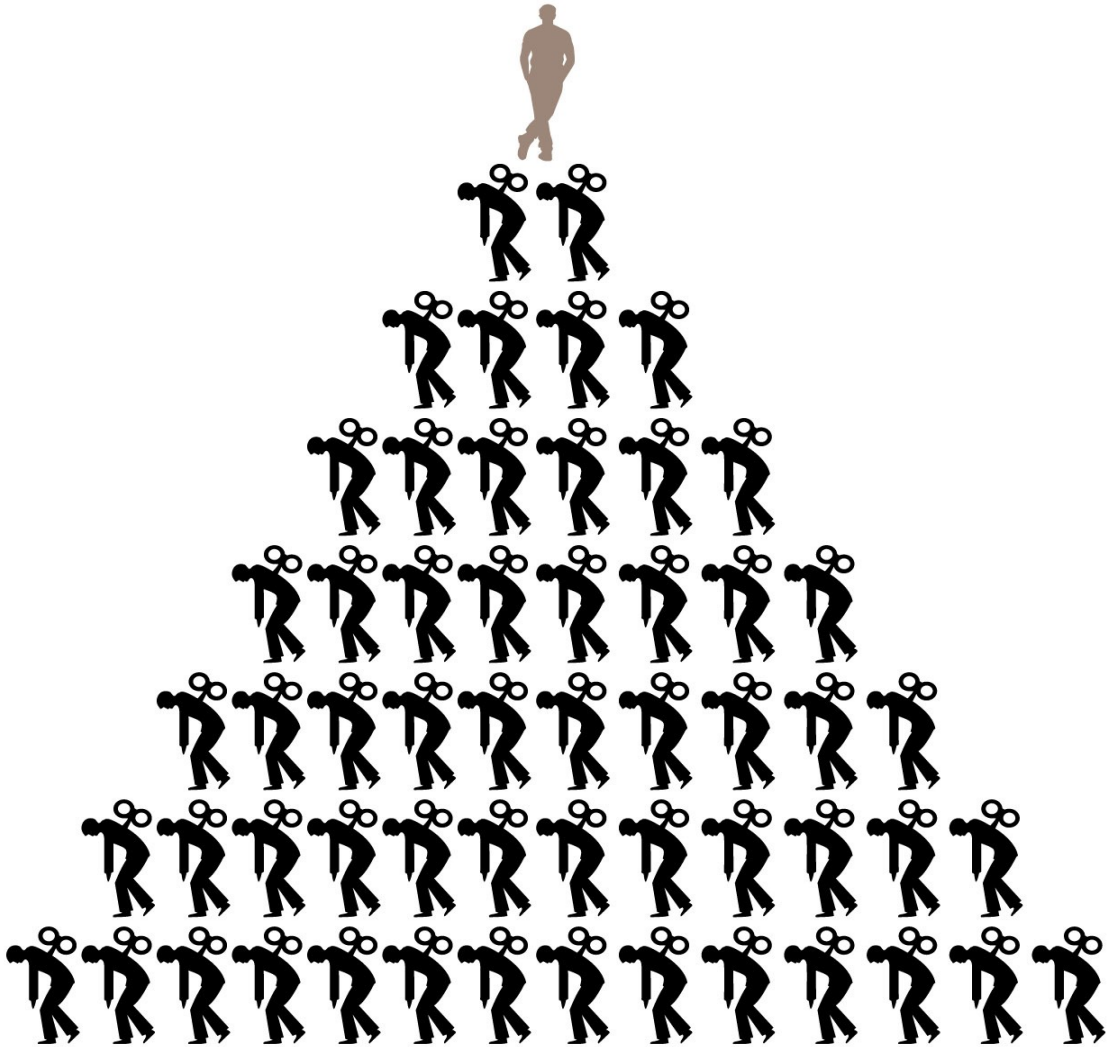
London's Ecological Footprint

- Population: 8,500,000 people
- Surface area: 158,000 ha
- Area required for food production: 1.2 ha per person: 8,400,000 ha
- Forest area required for wood products: 768,000 ha
- Land area required for carbon sequestration
- = bio-fuel production: 1.5 ha per person: 10,500,000 ha
- **London's footprint: 19,700,000 ha = 125 times London's surface area**
- Britain's productive land: 21,000,000 ha
- Britain's surface area: 24,400,000 ha



*Biocapacity, Ecological Footprint, and land area are usually measured in gha (global hectares)

Each European has about 60 energy slaves, each American about 110 energy slaves. That is the energy equivalent of a strong man working 10 hours a day six days a week represented by the energy output of the motors and engines, powered by fossil fuel energy, working on our behalf. In a sustainable world this figure would have to come down to a quarter or less.



Moscow

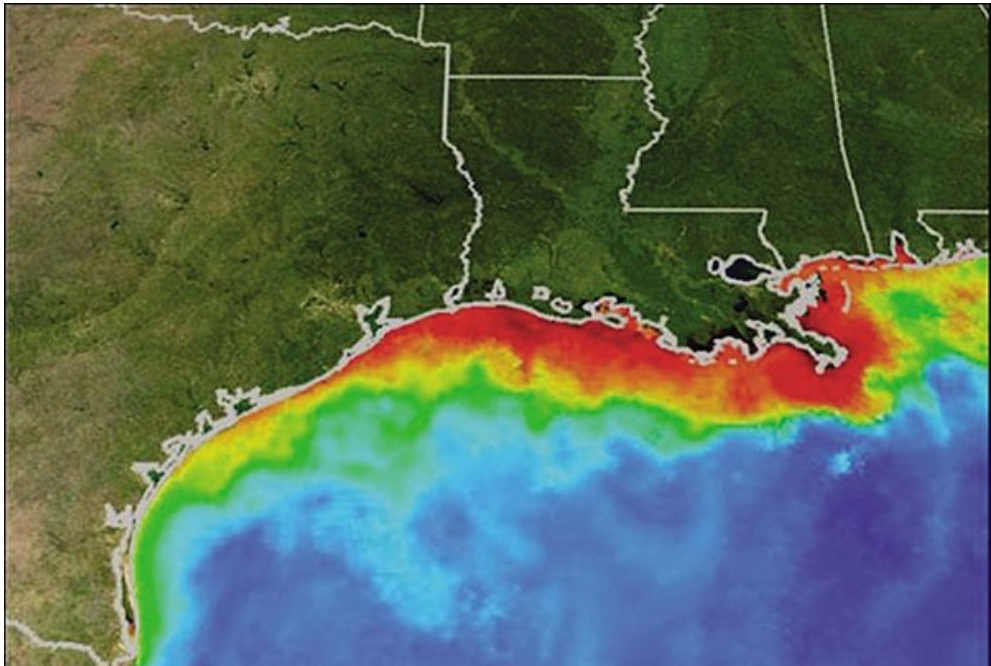

Чемпионы по Trade-in
730 3434
RANGE ROVER SPORT
ИГРА НА ПОБЕДУ
АВТОМОБИЛЬ С ХАРАКТЕРОМ -
ПАКЕТ ОПЦИЙ STORMER
MUSA MOTORS
785-1111
ЗДАНИЕ свободного назначения
пр-т Мира
2500 м²
ПРОДАЖА
(495)229-35-26

Shanghai Pudong 1978

Shanghai Pudong 2013

Shenzhen: from 30,000 to 14 million in 40 years


MAERSK
SEALAND



Who is feeding urban China?

- It takes about 2 acres to feed the average U.S. consumer. China only has about 0.2 acres of arable land per citizen, including fields degraded by pollution
- Almost one-sixth of China's has been affected by soil contamination due to toxic runoff and air pollution
- Since 1978, some 250 million farmers in China had to give up their land for urban, industrial and transport development
- From 2005 to 2015, China's food imports have increased from $6 million in 2005 to $300 million, meeting ever increasing demand for 'better food'

What is China eating?

- China has massively increased its meat consumption, from 7 million tons in 1975, to 75 million tons last year. China now consumes some 50 kg of meat per capita (US: 97 kg)
- China's food companies scour the planet for everything from soy beans and corn, to bacon and beef, to palm oil and bananas to meet the appetite of its 1.4 billion people
- China as become the world's largest vegetable importer, with soybeans constituting 64 % of its vegetable imports in 2014
- In 2017, 50 million tonnes of soy were imported from Brazil, requiring around 15 million ha of land, mainly Mato Grosso…
- What are the climate implications of this global food dependence?

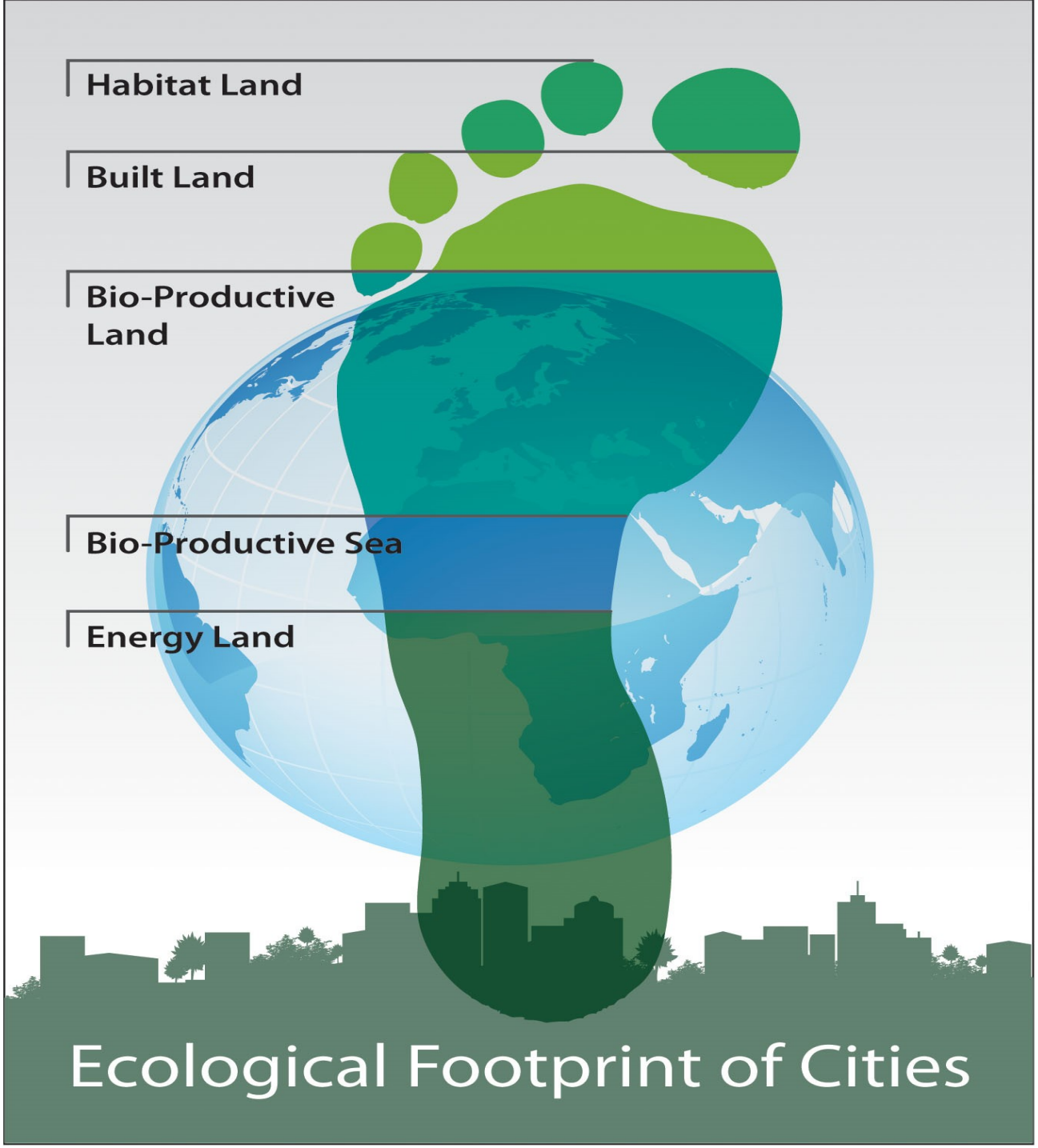
An Ecological Civilization?

‘We need to move towards an ecological civilization. It is an ethical morality and ideology which realizes harmonious co-existence and sustainable development both among people and between them and nature and society, reflecting the progress of civilization.’

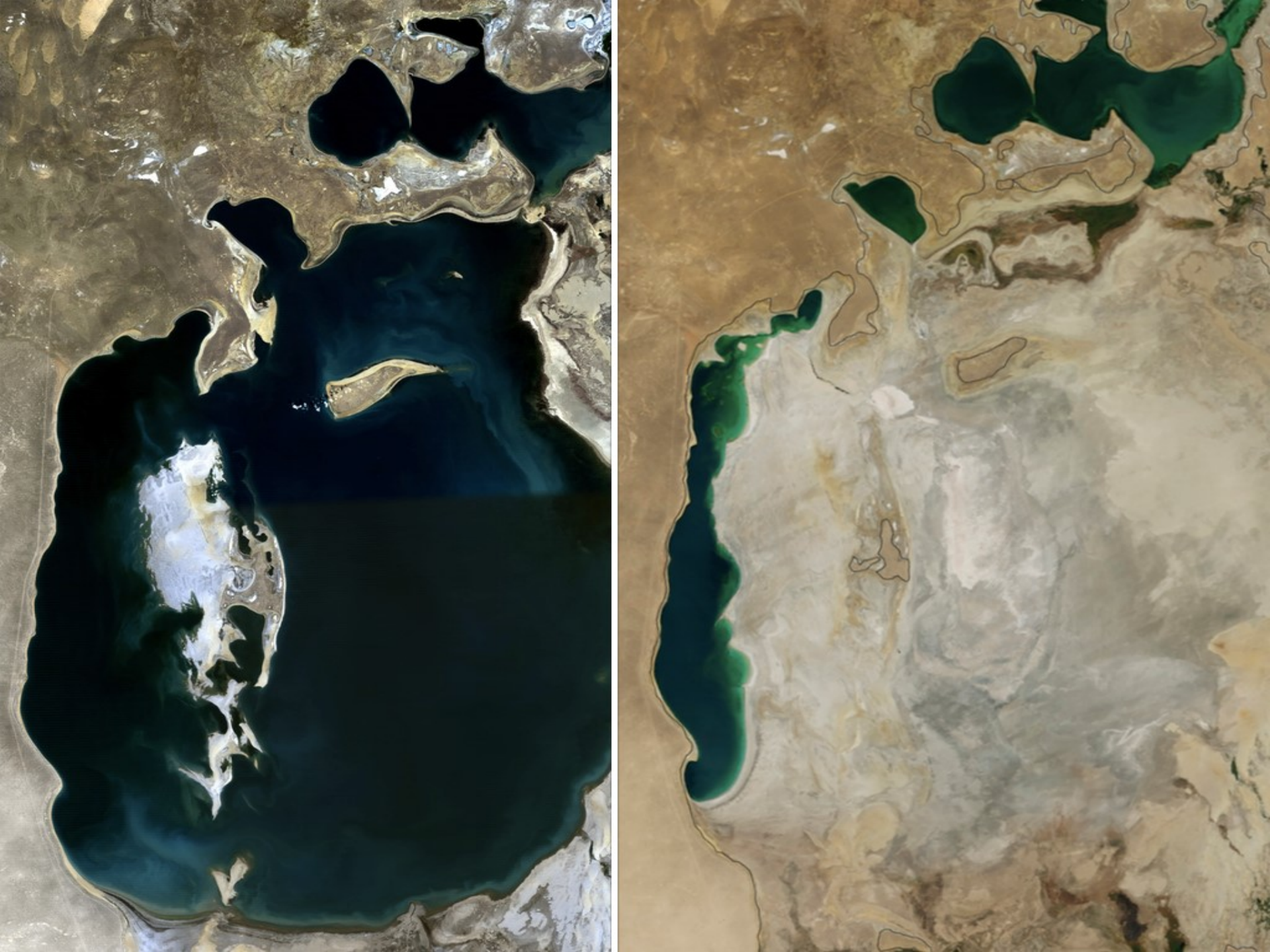
President Xi JinPing, 2017

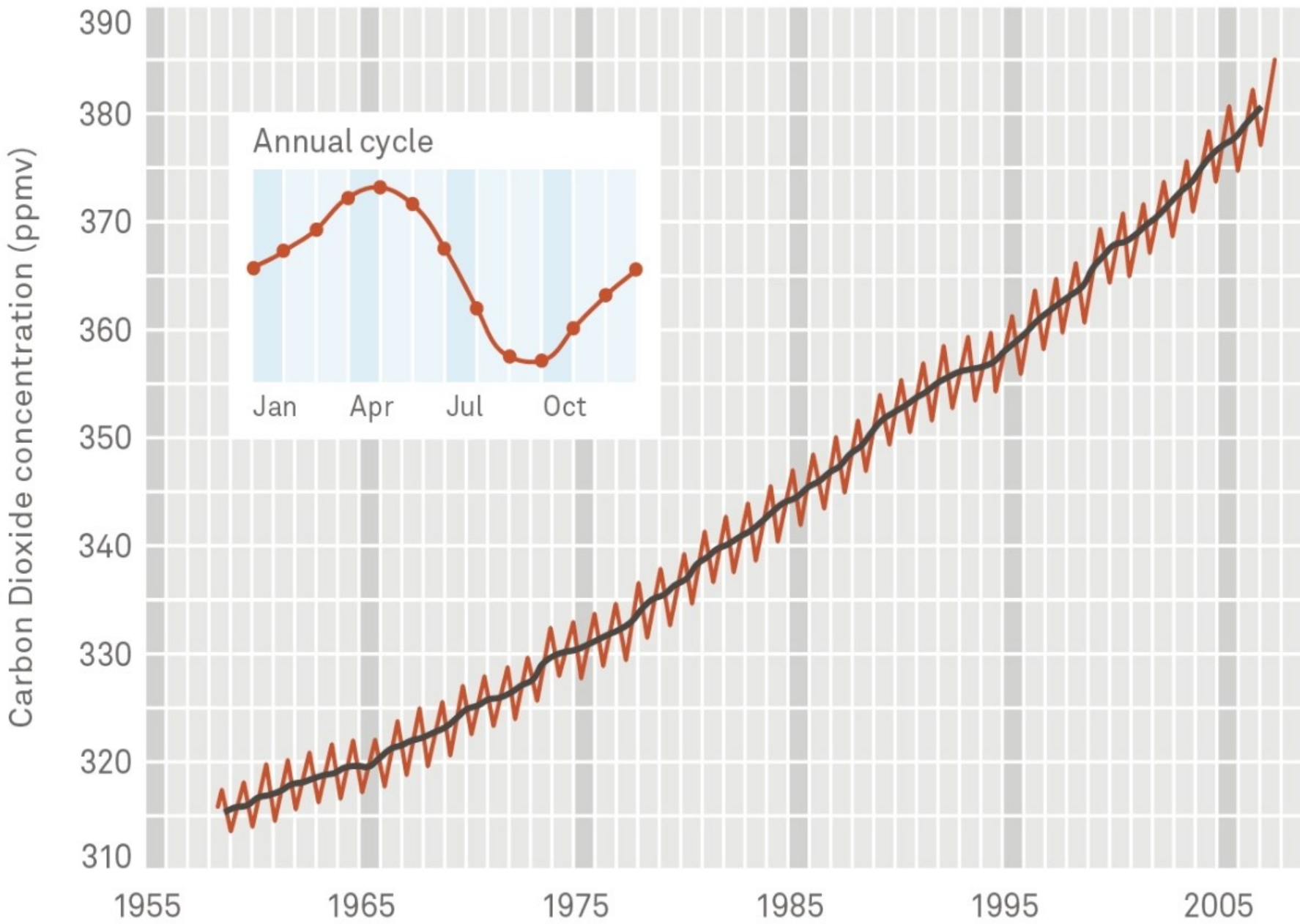
Who will feed India's cities?

- India's population is expected to grow from 1.3 billion in 2018 to 1.7 billion by 2050, probably eliminating food self-sufficiency
- With a 50% in the use of fertilizers, expansion of irrigation and other technical improvements, cereal production could rise to 260 million tons or more. But at what environmental cost?
- By 2020, demand for meat and eggs is expected be four times greater for meat and eggs, and five times greater for milk products, as compared to 1990
- Given current rates of population and income growth, India will need a 4.2% annual growth in cereal production until 2020, instead of the less than 2% it achieved in the previous decade
- Where will India's future food supplies come from?

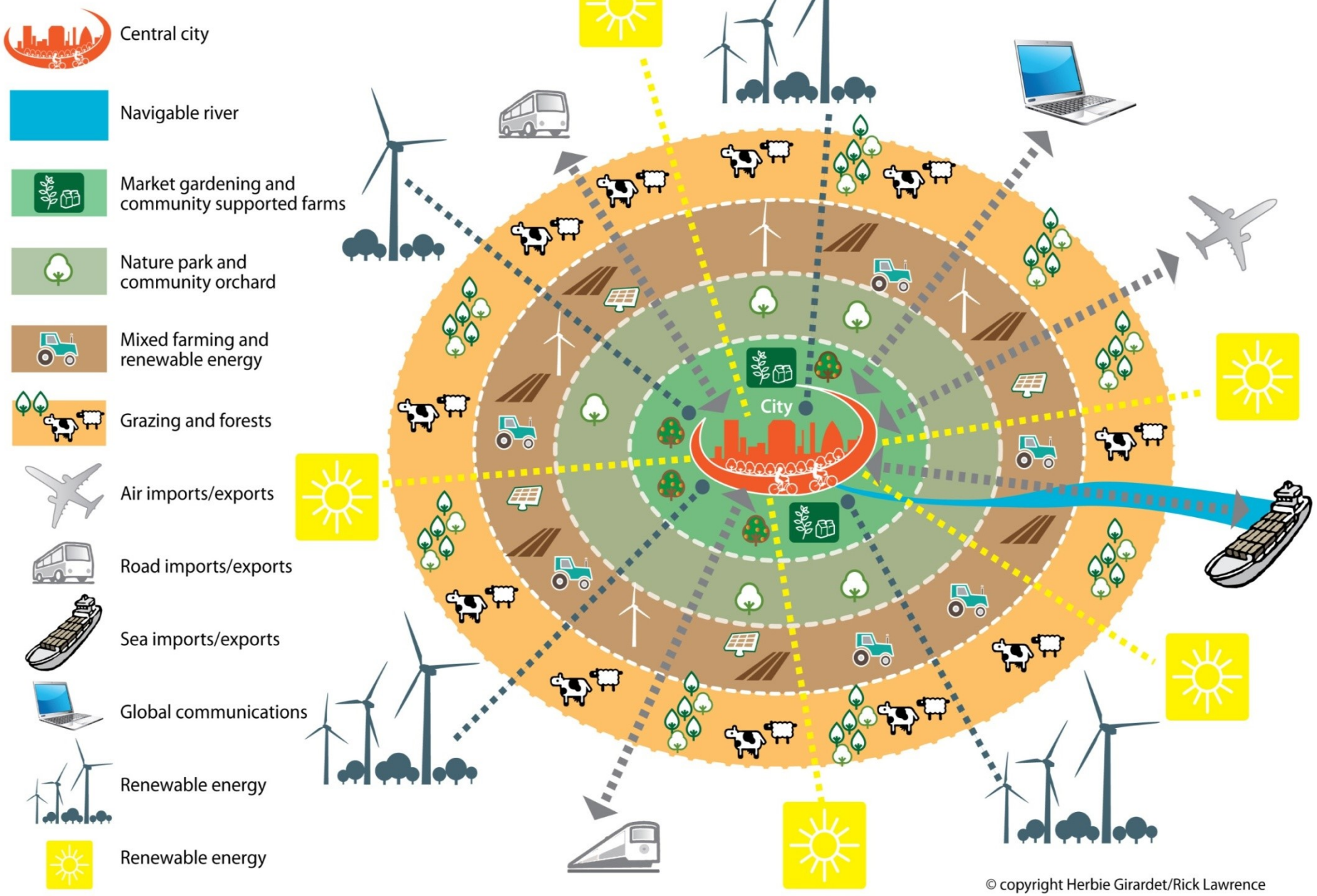

Habitat Land
Built Land
Bio-Productive Land
Bio-Productive Sea
Energy Land
Ecological Footprint of Cities

Kayapo village, Para, Amazonia




Atmospheric Carbon Dioxide
Measured at Mauna Loa, Hawaii
Carbon Dioxide concentration (ppmv)
390
380
370
360
350
340
330
320
310
1955
1965
1975
1985
1995
2005
Annual cycle
Jan
Apr
Jul
Oct

"Ecopolis"

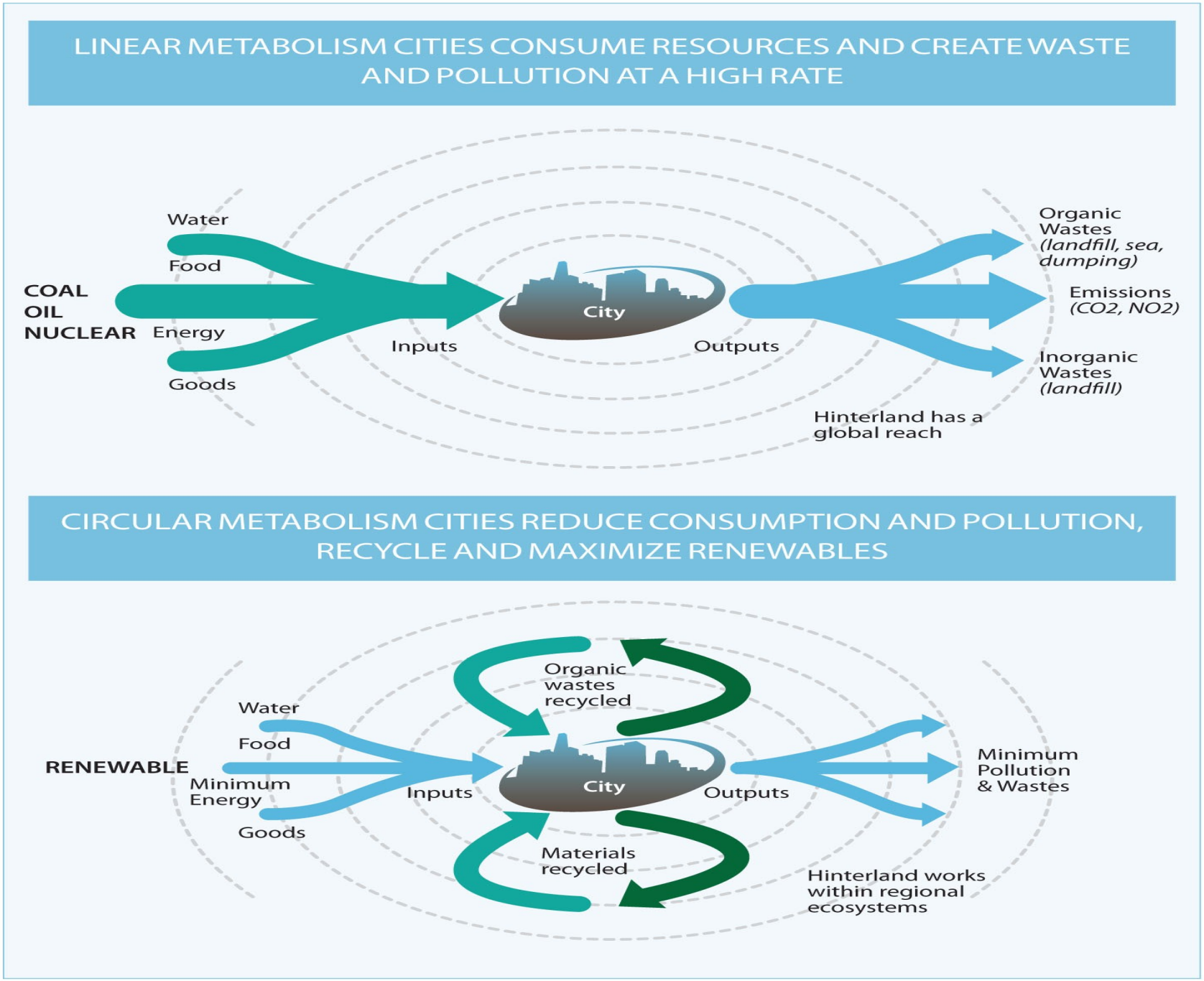


Definitions

- **Resilient city: the capacity of an urban system to absorb a range of disturbances and still retain its basic function and structure**
- **Liveable city: affordable housing and living; high quality of education, cultural amenities and green spaces; minimal pollution, ease of movement**
- **Smart city: has digital technology embedded across all its functions to enhance performance, wellbeing and communication, and to reduce costs & resource consumption**
- **Sustainable city: should meet the needs of the present without sacrificing the ability of future generations to meet their own needs**

Regenerative, Symbiotic Cities - criteria

- An environmentally enhancing, restorative relationship between cities and the natural systems they depend on;
- The mainstreaming of efficient, renewable energy systems for human settlements across the world; and
- New lifestyle choices and economic opportunities which will encourage people to participate in this transformation process

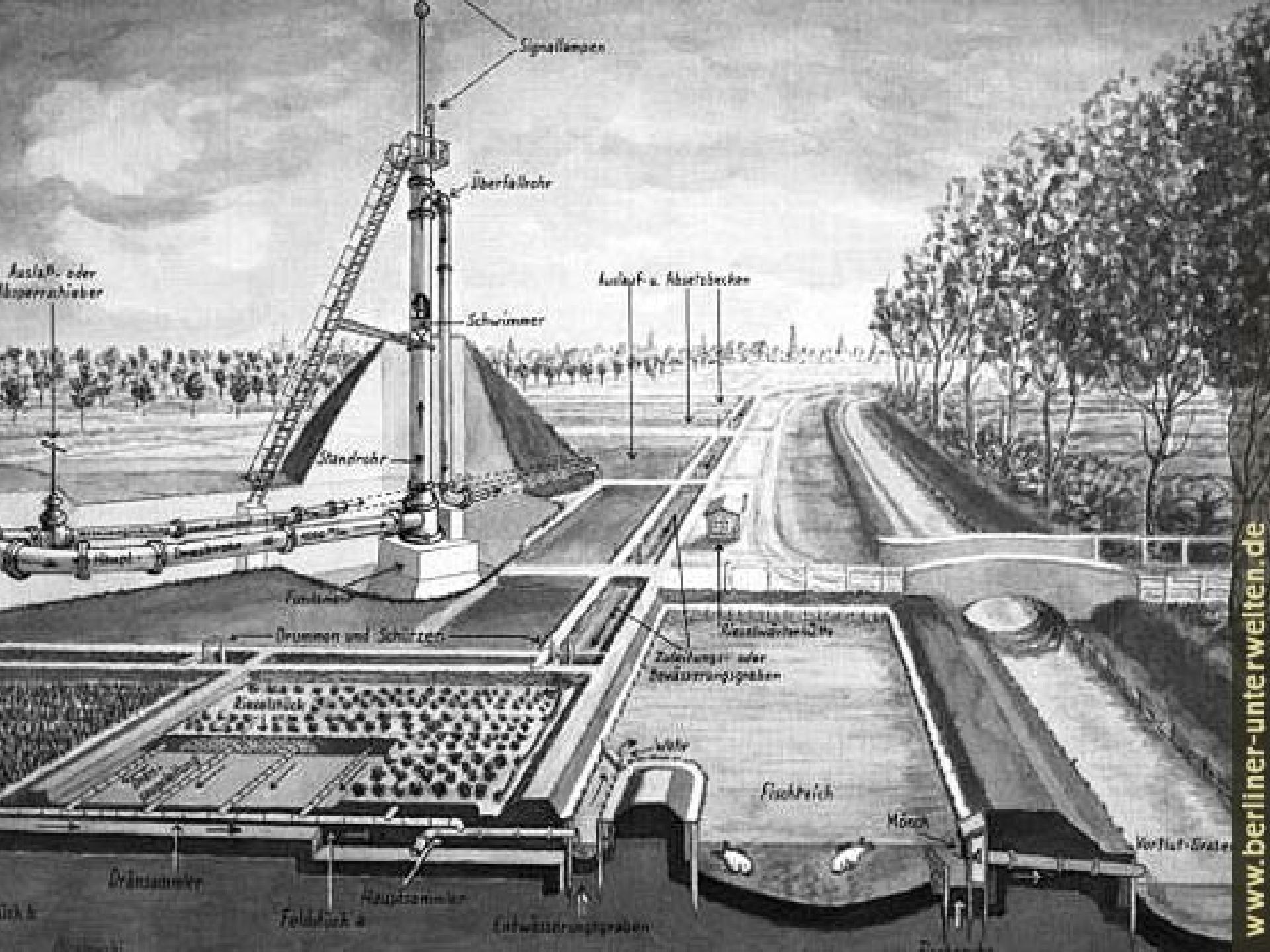


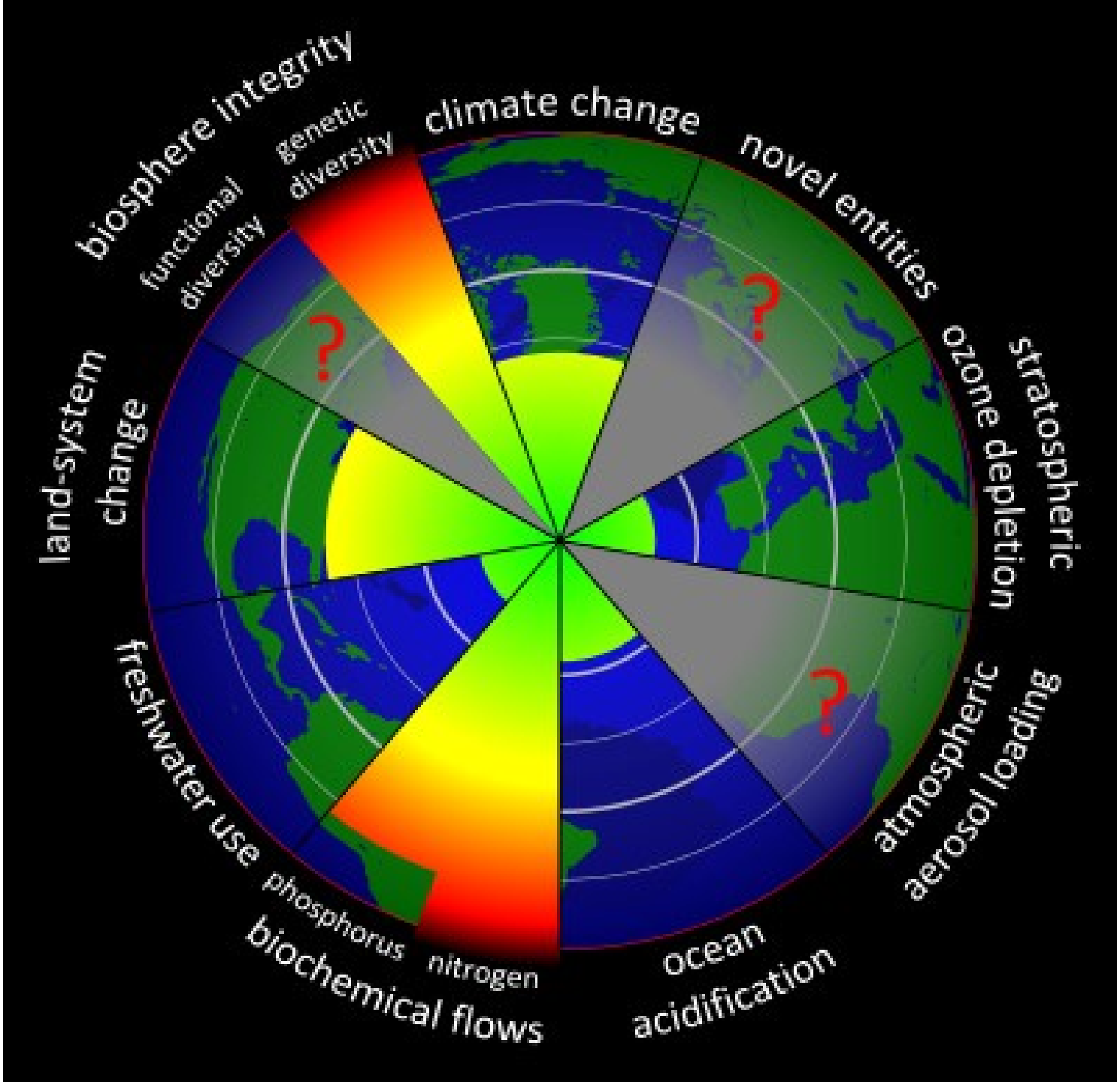
Credit: Herbert Girardet.

The four laws of ecology

1. Everything is connected to everything else. There is one ecosphere for all living organisms and what affects one affects all;
2. Everything must go somewhere. There is no 'waste' in nature and there is no 'away' to which it can be thrown;
3. Nature knows best. The absence of a particular substance from nature is often a sign that it is incompatible with the chemistry of life;
4. Nothing comes from nothing. Exploitation of nature always carries ecological costs and these costs are significant.

(Adapted from Barry Commoner, The Closing Circle, 1971)

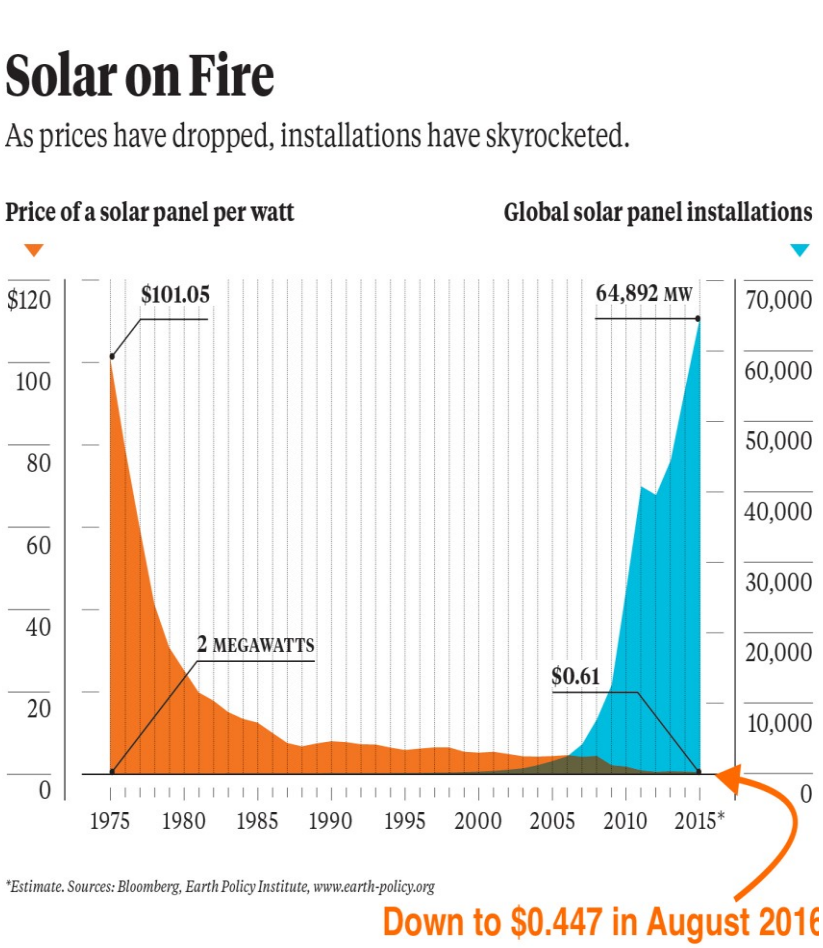


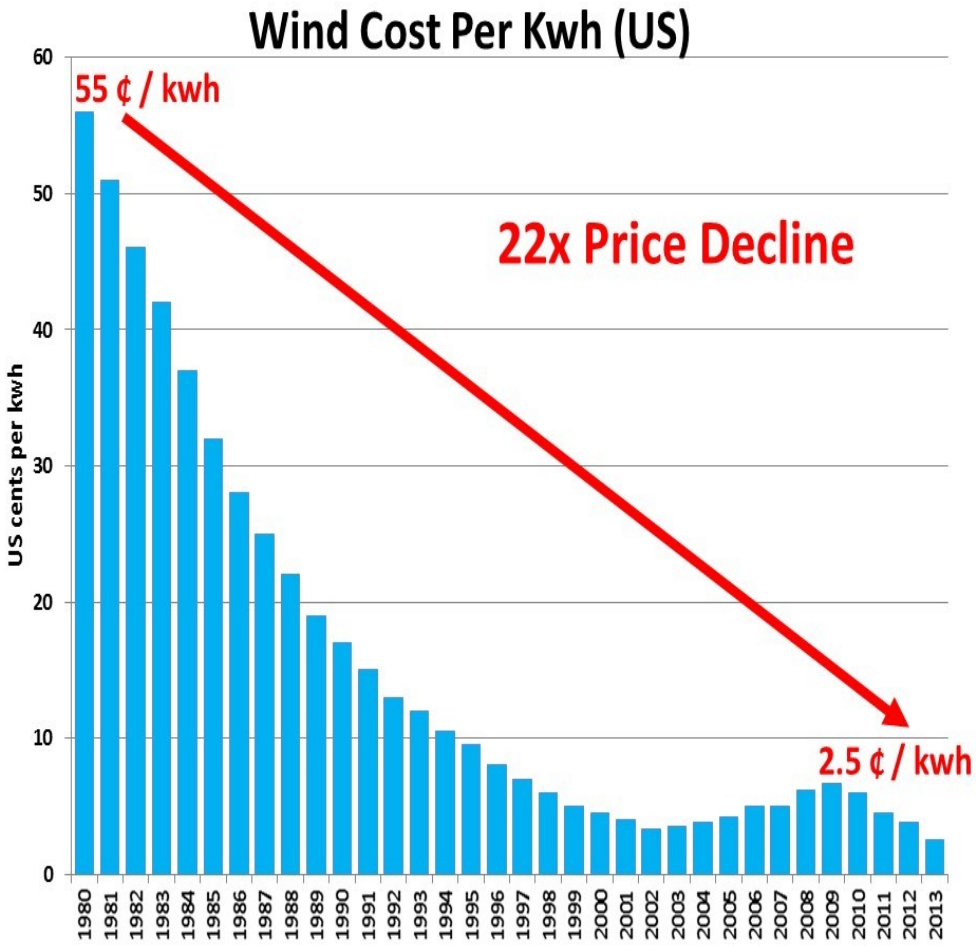

biosphere integrity
genetic diversity
functional diversity
climate change
novel entities
ozone depletion
stratospheric aerosol loading
atmospheric aerosol loading
ocean acidification
biochemical flows
nitrogen
phosphorus
freshwater use
land-system change
?
?
?

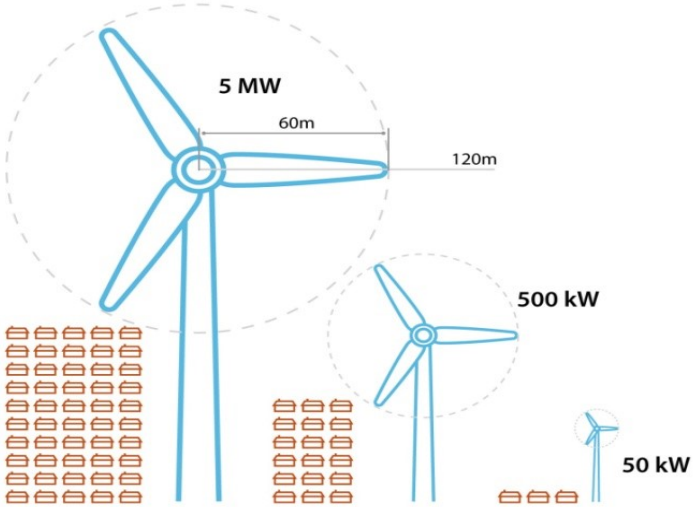
Full scale phosphate recovery (as calcium phosphates) from sewage : DHV Crystalactor® at Geestmerambacht sewage works, near Edam, Holland (230,000 pe.)


AFP

Renewable Energy price drop



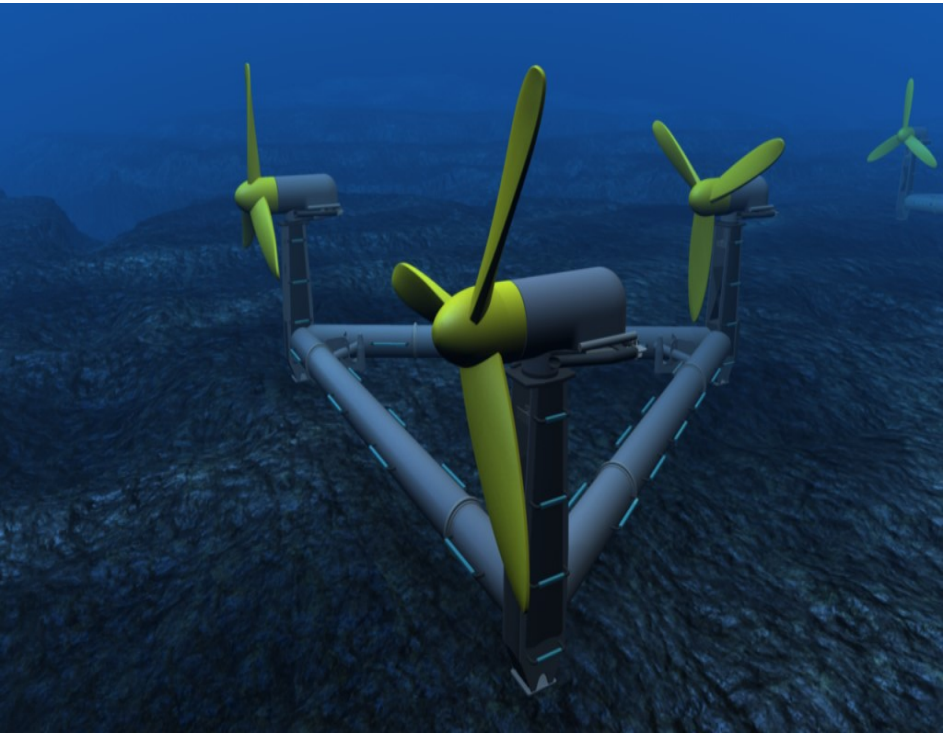




With good wind, this turbine could generate enough electricity for 1250 homes.

With good wind, this turbine could generate enough electricity for 50 homes.

With good wind, this turbine could generate enough electricity for 12 homes.

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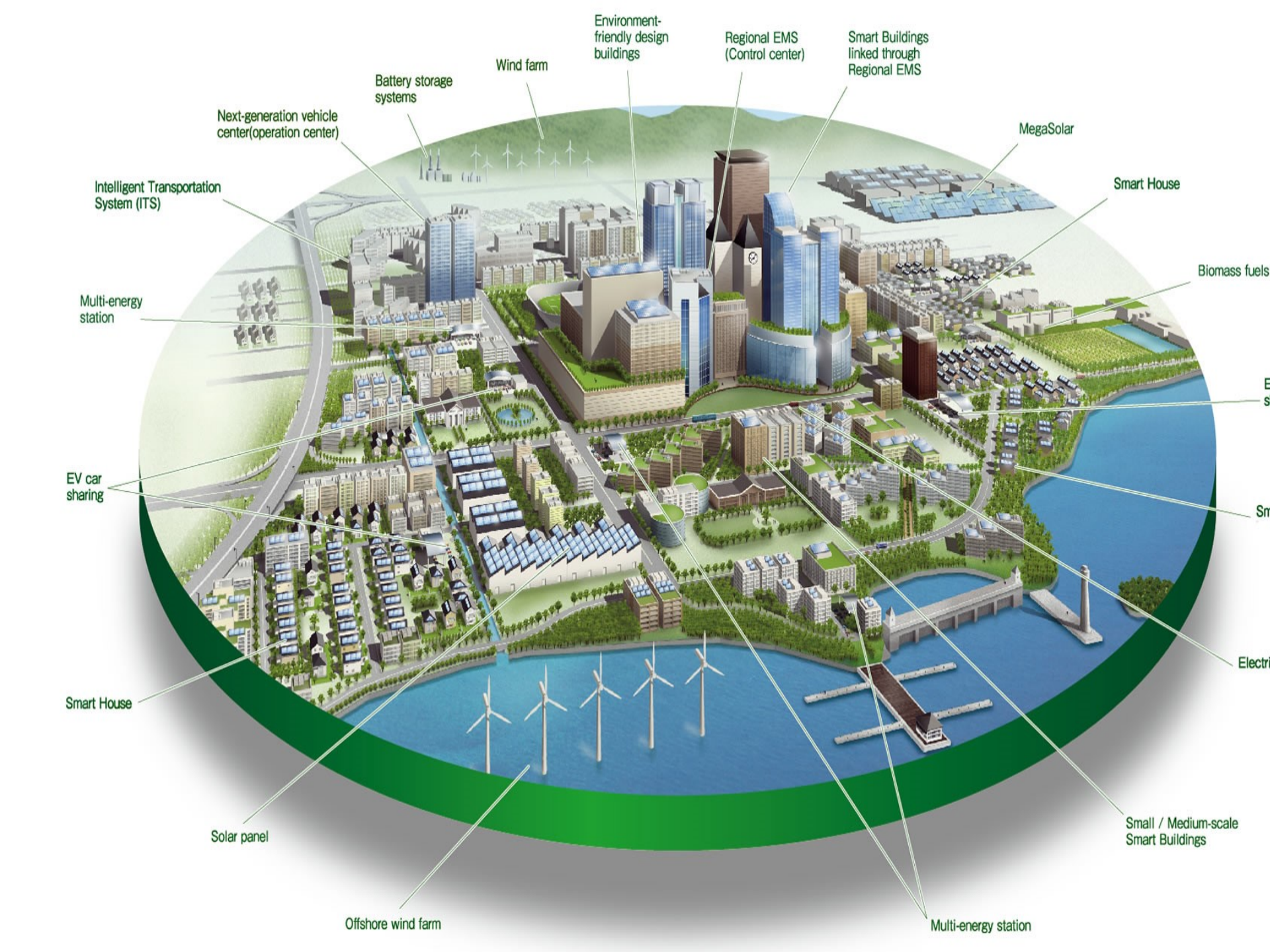
Sprite
Taste it!

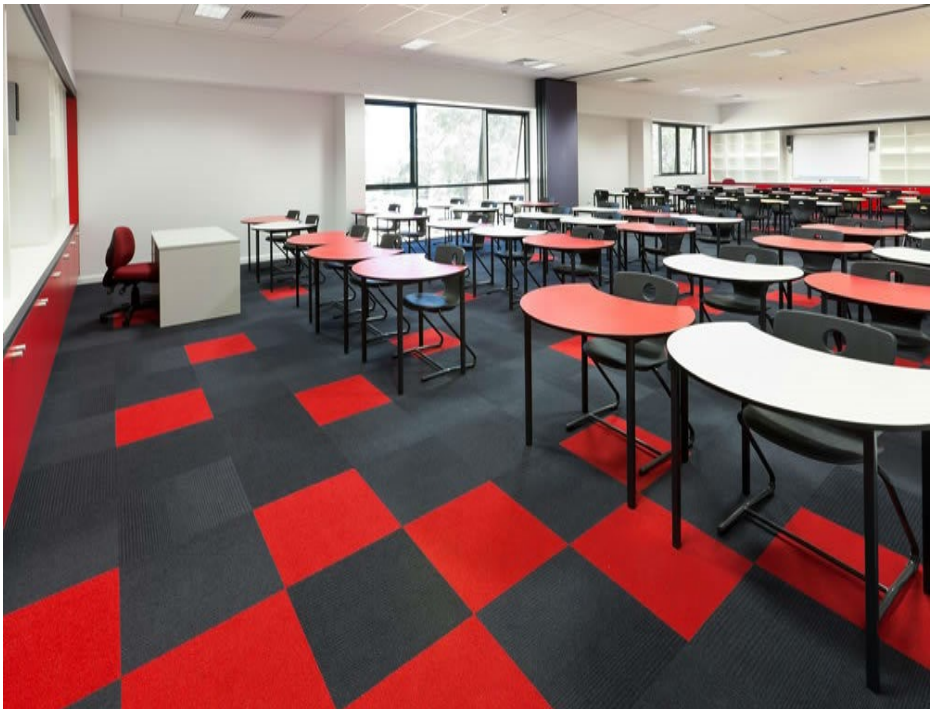

BUDGET
Today
71.54kWh
5.23kWh
next
usage
menu
£
kW


Environment-friendly design buildings
Regional EMS (Control center)
Smart Buildings linked through Regional EMS
Wind farm
Battery storage systems
Next-generation vehicle center(operation center)
MegaSolar
Intelligent Transportation System (ITS)
Smart House
Biomass fuels
Multi-energy station
EV car sharing
Smart House
Solar panel
Offshore wind farm
Multi-energy station
Small / Medium-scale Smart Buildings

The solar suburb


Connecticut
AN·37437
Constitution State

What to do with waste plastics?



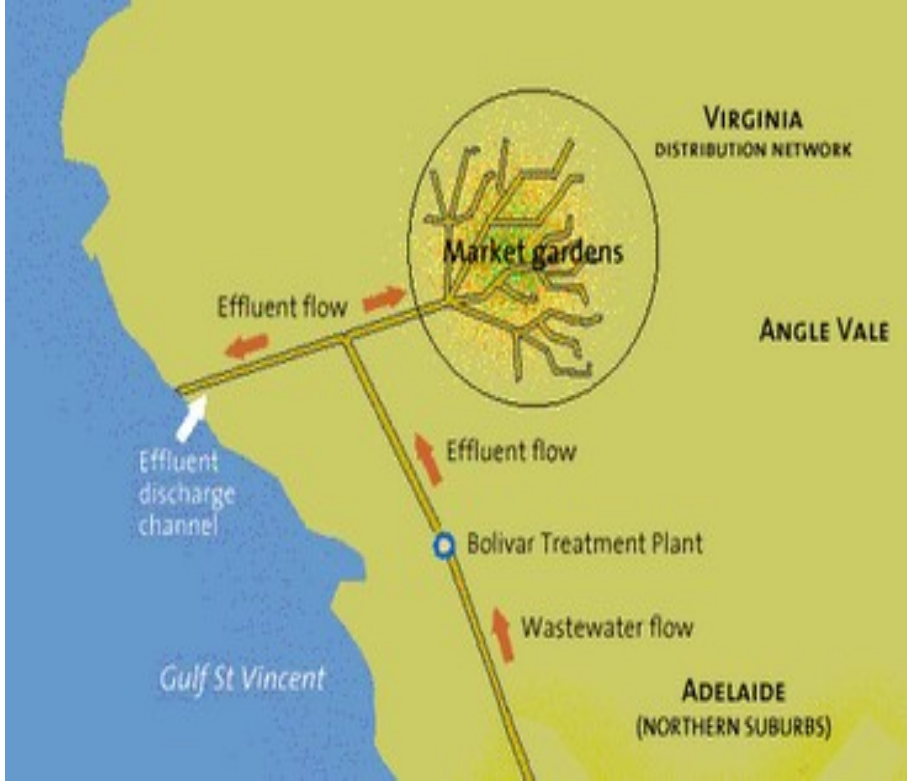
Plastic Roads

Adelaide


SA Water
ngarrindjeri
peramangk
ngarkat
ngarrindjeri
kaurna


Tindo
Tindo


TESLA
TESLA
TESLA
TESLA
TESLA
TESLA


VIRGINIA
DISTRIBUTION NETWORK
Market gardens
Effluent flow
ANGLE VALE
Effluent flow
Effluent discharge channel
Bolivar Treatment Plant
Wastewater flow
Gulf St Vincent
ADELAIDE
(NORTHERN SUBURBS)


551
5820
Nicaragua
ORGANIC
CARROTS
Selected
Potatoes
POTATOES


QUALITY FRUIT
eftpos
available here
eftpos
available here
GOLD
PINEAPPLE
$3.95
$4.50
$2.99
$3.99

‘Regenerative’ Adelaide 2018

- **48% electricity supply from wind and solar**
- 200,000 PV roofs on 600,000 houses = 350 MW peak
- PV roofs on most public buildings
- 100 MW battery storage
- Solar hot water systems mandated for new buildings
- 3 million trees planted on 2000 ha for C02 absorption and biodiversity
- 15% reduction of C02 emissions since 2000
- Water sensitive urban development
- 180,000 tonnes of compost made from urban organic waste
- 20,000 ha of peri-urban land used for vegetable and fruit crops
- Reclaimed waste water and urban compost used to cultivate this land
- Large scale-building tune-up programmes across the city region
- 60% carbon emissions reduction by municipal buildings
- Construction of Lochiel Park Solar Village with 106 eco-homes
- **Thousands of new green jobs**


BOERI
STEFANO
BOERI
ARCHITETTI

Submarine view of aquaculture fields and biologic farms

Herbert Girardet - recent reports and books:

Reports:

- Regenerative *Adelaide,* 2011
http://thesolutionsjournal.anu.edu.au/node/1153

- *Towards the Regenerative City*, 2013
www.worldfuturecouncil.org

Books:

- *Cities, People, Planet – Urban Development and Climate Change,* Wiley, London, 2004 and 2008
- *A Renewable World,* Green Books, 2012
- *Creating Regenerative Cities,* Routledge, 2015

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Creating Regenerative Cities

Herbert Girardet

ROUTLEDGE