Sustainability & Sustainable Development

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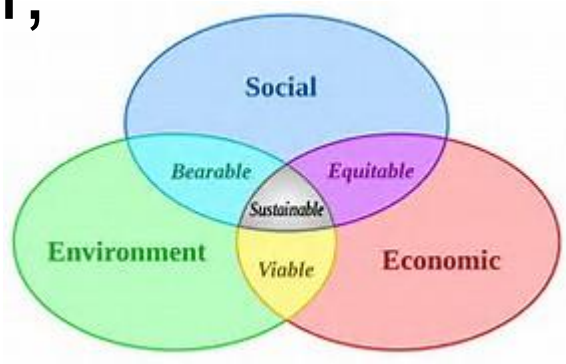
Introduction

Sustainability: The ability to ”sustain”, or, the capacity to ”endure”

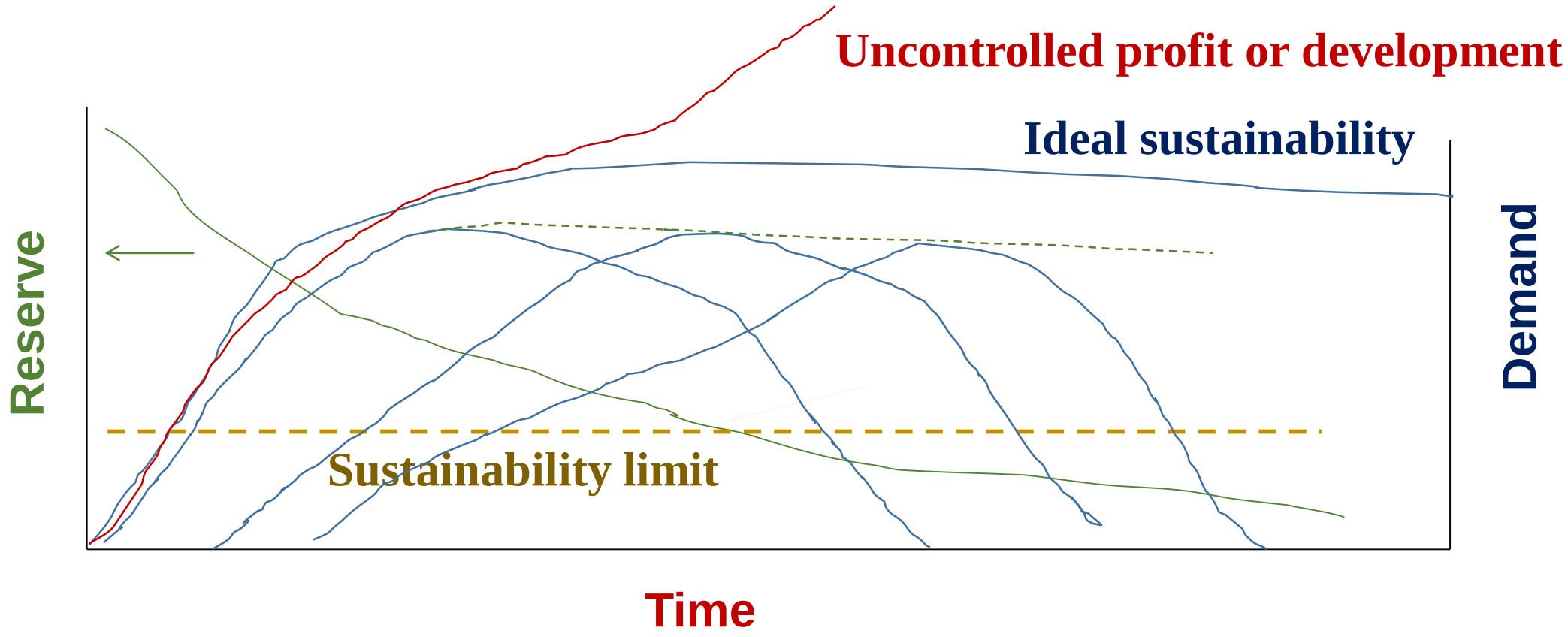
By who? By what?



Sustainable Development: “development that meets the needs and aspirations of the present without compromising the ability of future generations to meet their own needs”

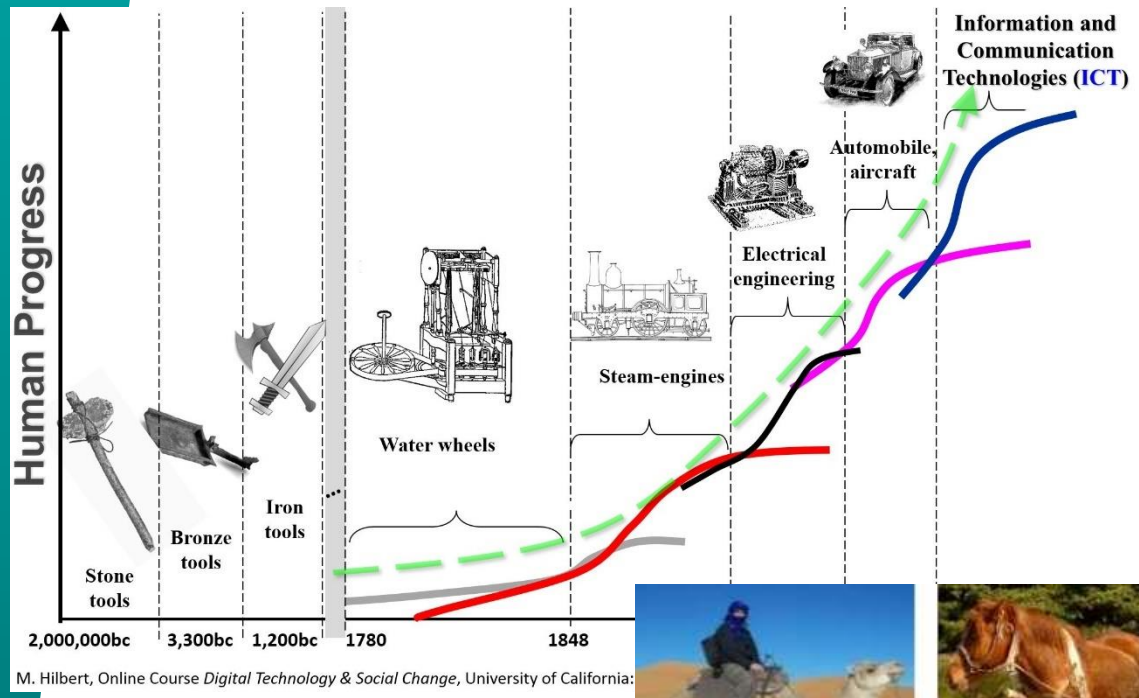
Brundtland Report, UN, 1989

Capacity to endure & ability to sustain

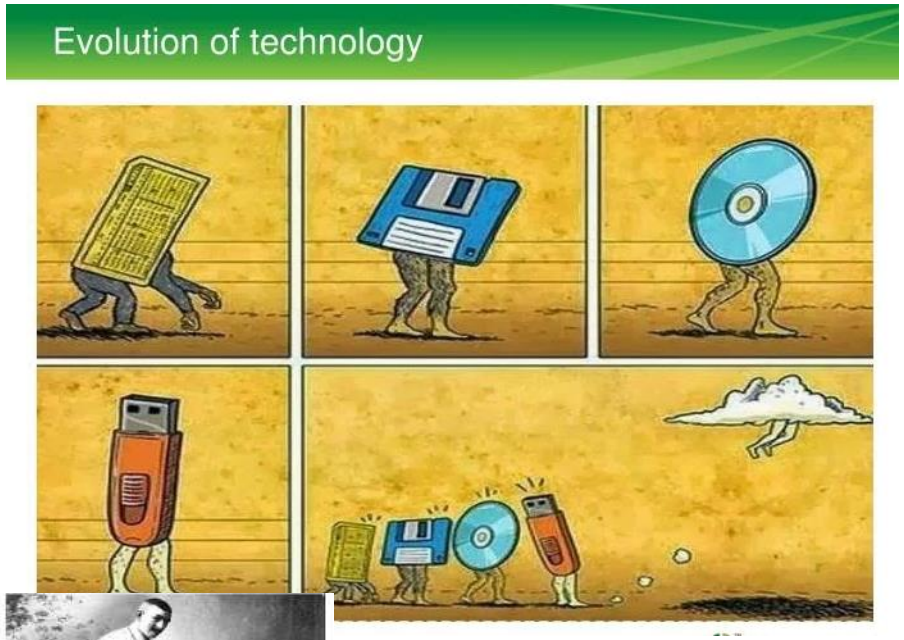


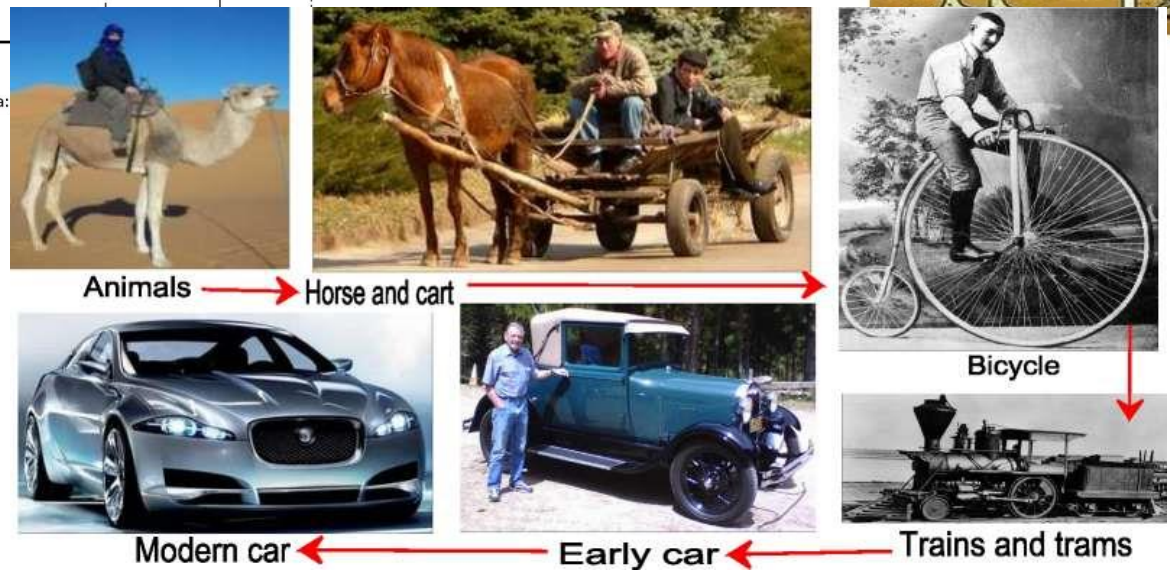
Sustainability of the total system and sub-systems are measured in terms of demand and reserve (of resources) with respect to time (in the human scale of time)

Need leads to sustainability!



M. Hilbert, Online Course *Digital Technology & Social Change*, University of California:

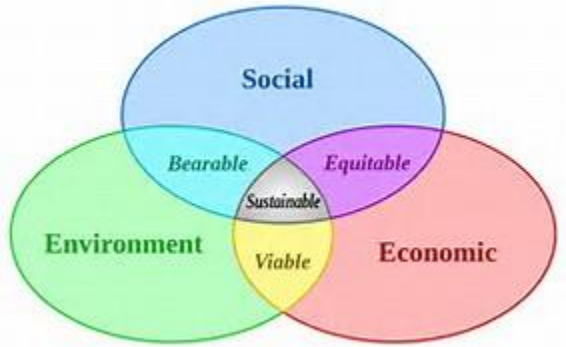




Why is sustainable development important?

Sustainable development defines the actions we need to achieve sustainability!

What is sustainable development.mp4
(video not incuded)



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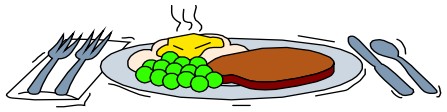
Our status on planet earth: we are the master!

Nutrition

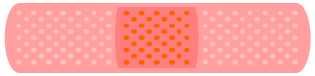
Fertilizers



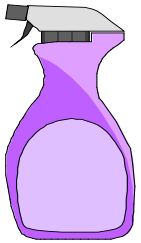
Vitamins

Pharmaceuticals

Healthcare



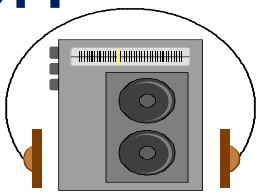
Detergents



Colorants and coatings

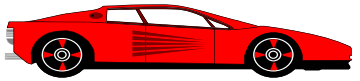
Clothing

Electronics

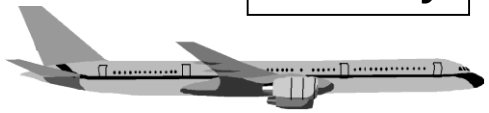


Communications, Entertainment

Fuel



Mobility



Plastics

Housing

But, how did we get there and is our dominance or survival threatened?

Sustainability Issues: Question of our survival

World population is expected to reach 11 billions by 2050

Increase in water, energy & commodities demand

6-7 x  Global GDP growth over next ~50 years (in constant dollars)

5-6 x  Production capacity for most commodities (steel, chemicals, lumber, etc.)

3.5 x  Energy demand

7 x  Electricity demand

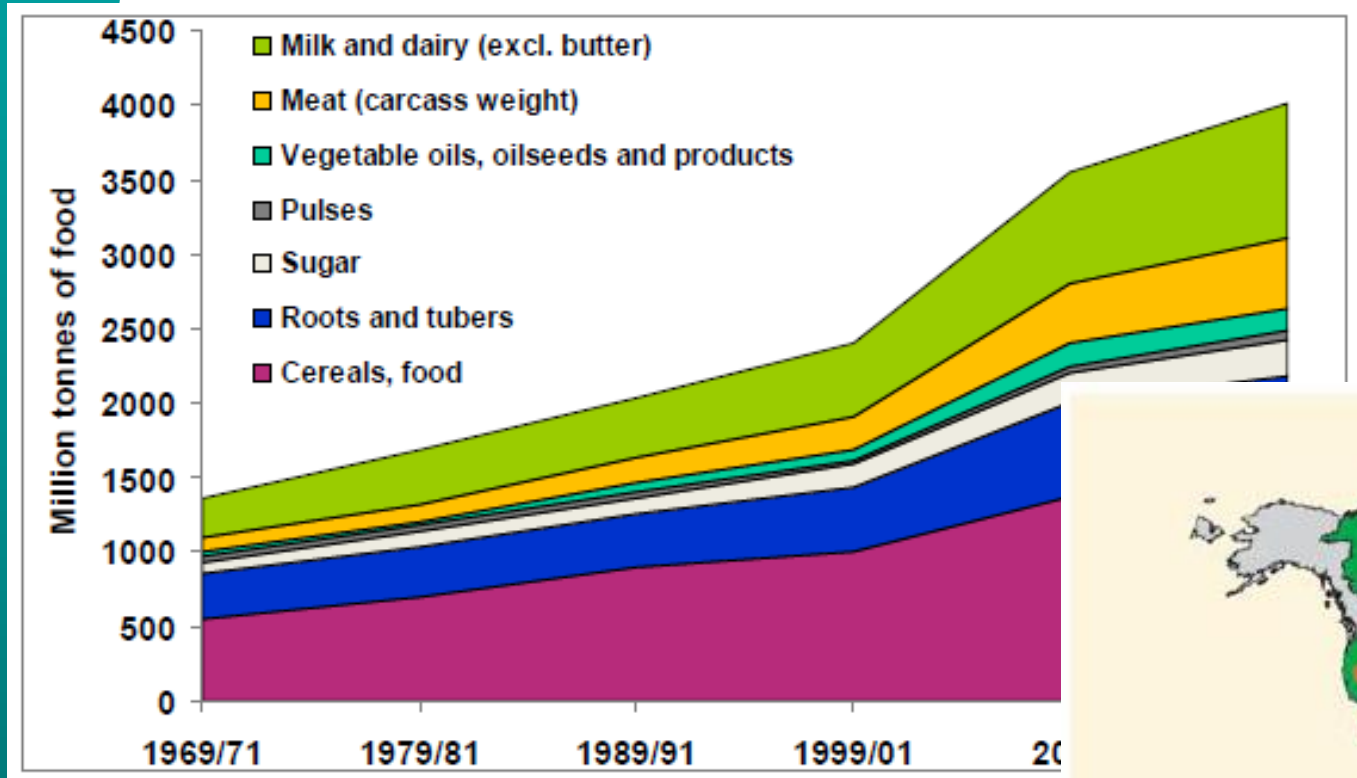
Increase  Water demand

Increase 

GHG emissions

Adopted from Siirola, PSE-2012

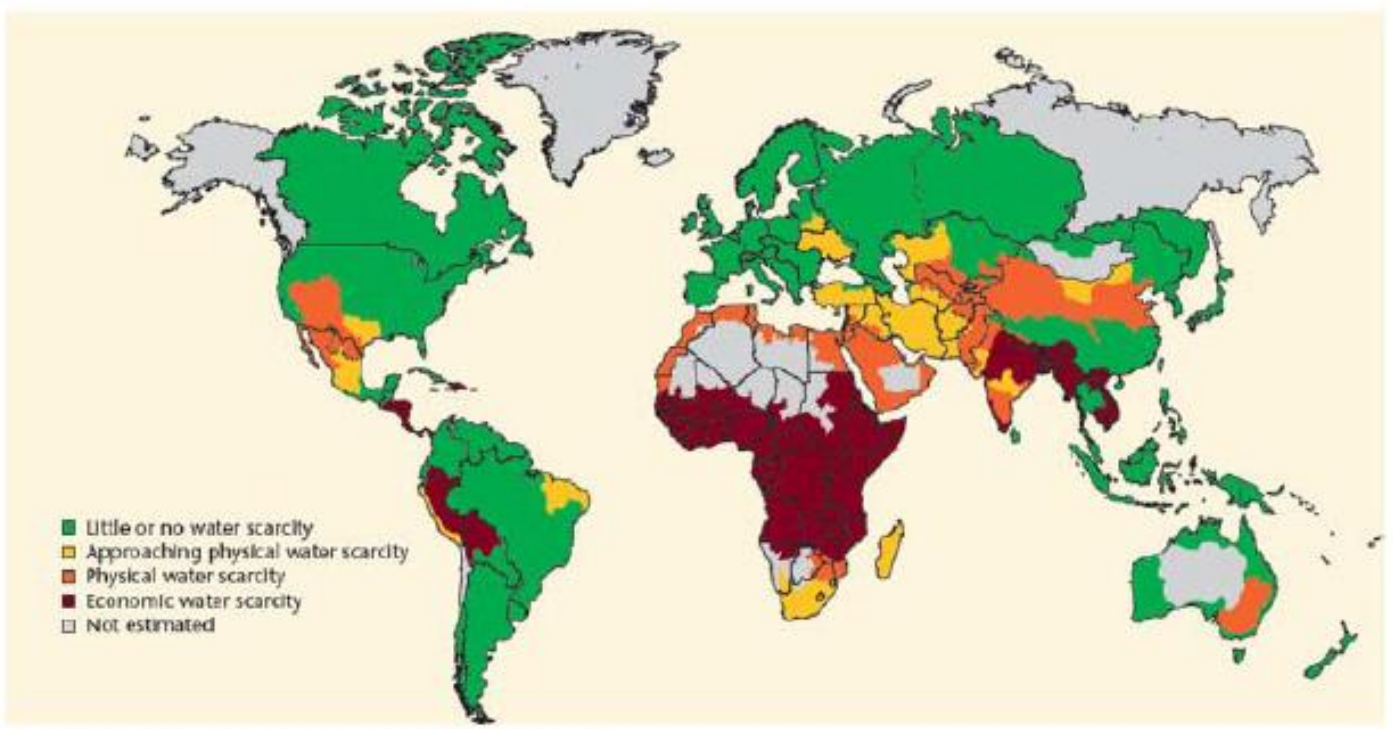
The problems (Issues)



FAO, 2011

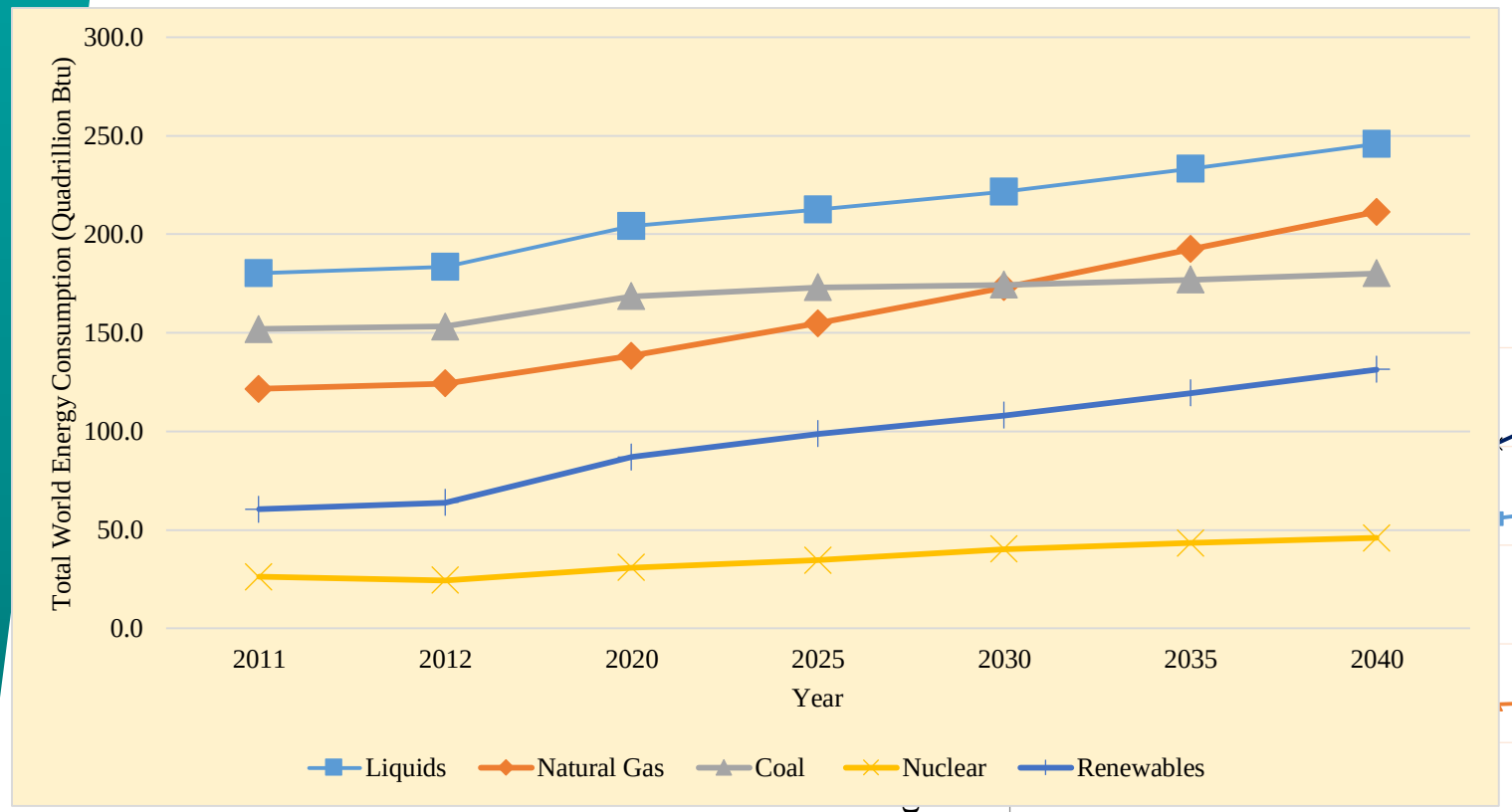
Food supply is increasing but is it enough for the population!

Around 2 billion people will be soon living in water scarce areas

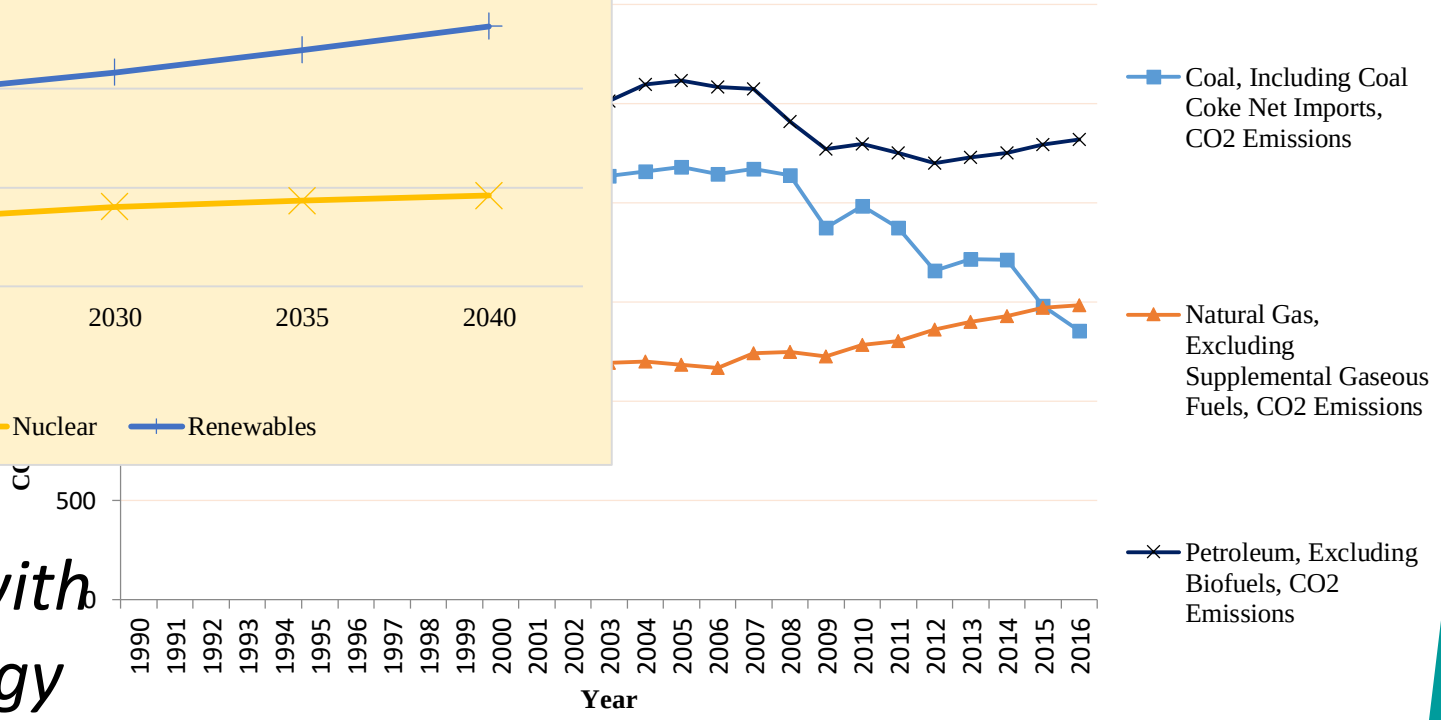


CAWMA, 2007. Earthscan, and Colombo, London.

The problems (Issues)



Use of other forms (not fossil) of energy needs to increase significantly



Emissions of CO2 increases with use of fossil fuel based energy

Is our future sustainable? The challenge facing us

We convert resources to products we need

↓

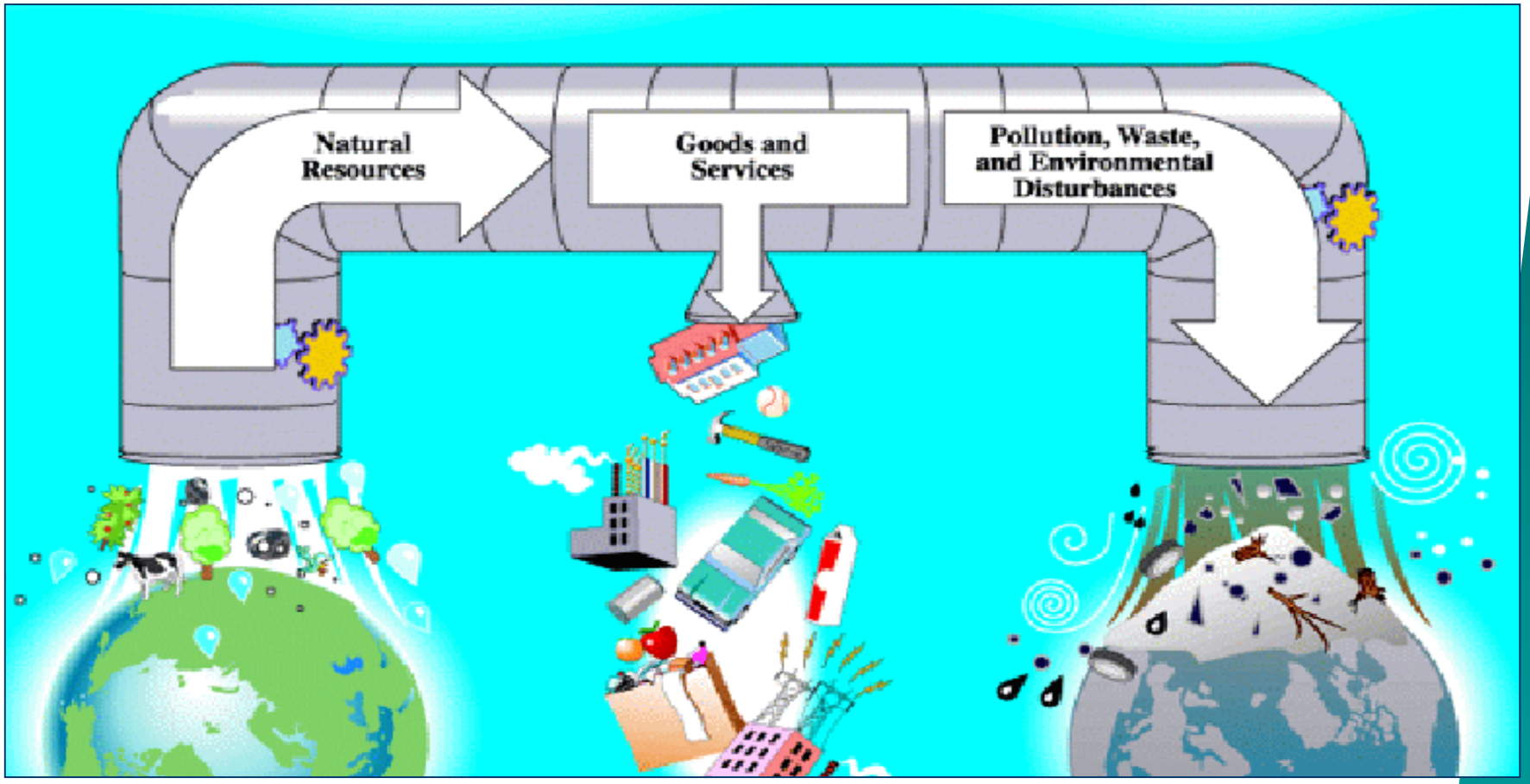
Use energy, **water, ….**

↓

Cause negative environmental Impacts

↓

Produce waste



Only 25% converted to useful products; the rest are waste (we must be to get > 40% useful products) *Driolli 2007*

Human & societal needs

Sustainability of human (society)

- Energy

- Food

- Housing

- Health

- Water

- Mobility

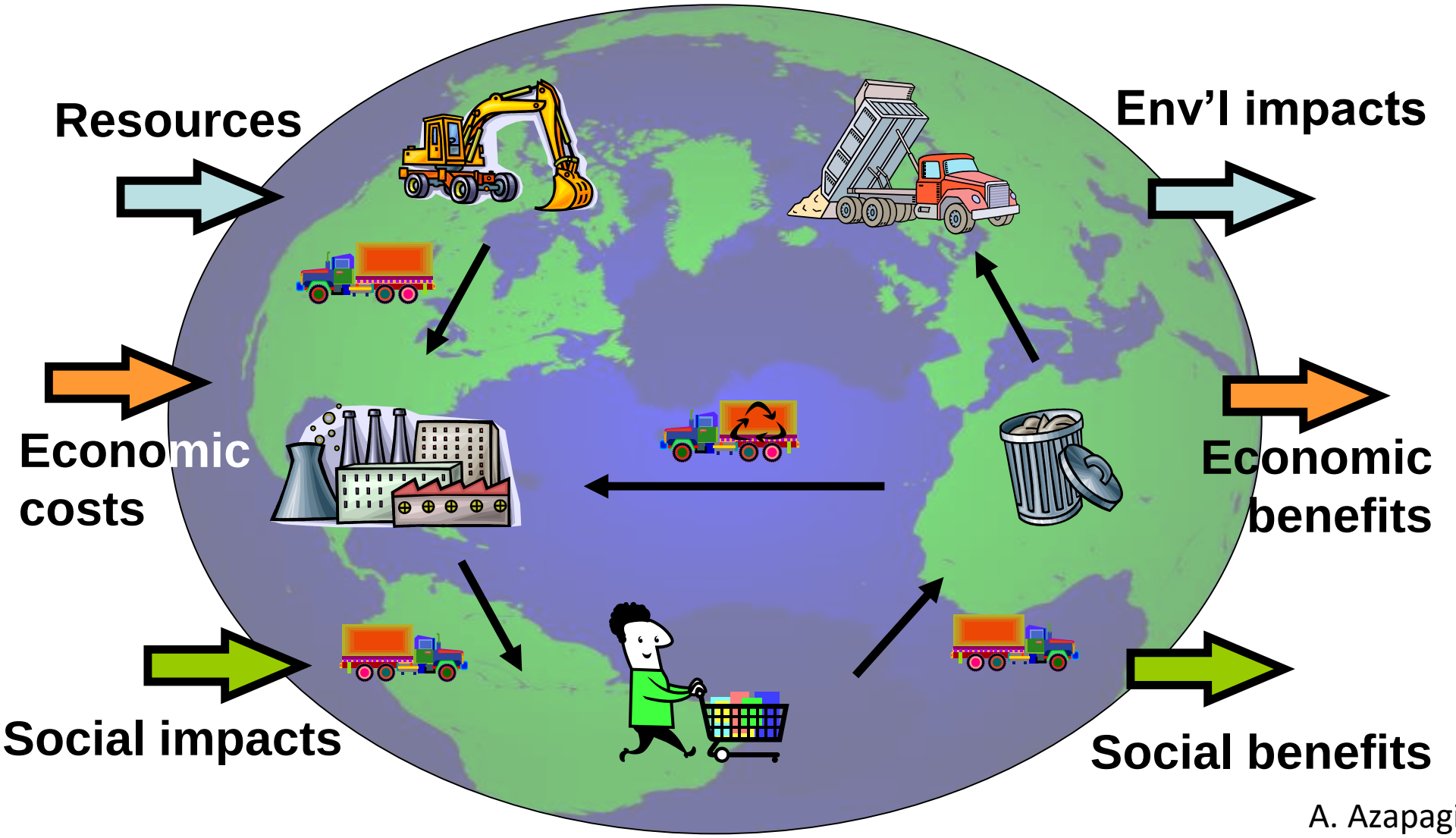
We would like to be sustainable in energy, food, housing, health, water, mobility, ……

System: human or society

Sub-systems: energy, water, food, health, …

A. Azapagic, 2015

Meeting human needs in sustainable ways



A. Azapagic, 2015

In other words, sustainability is how do we go from something like this?

Adopted from Azapagic, 2015

To something like this?

Adopted from Azapagic, 2015

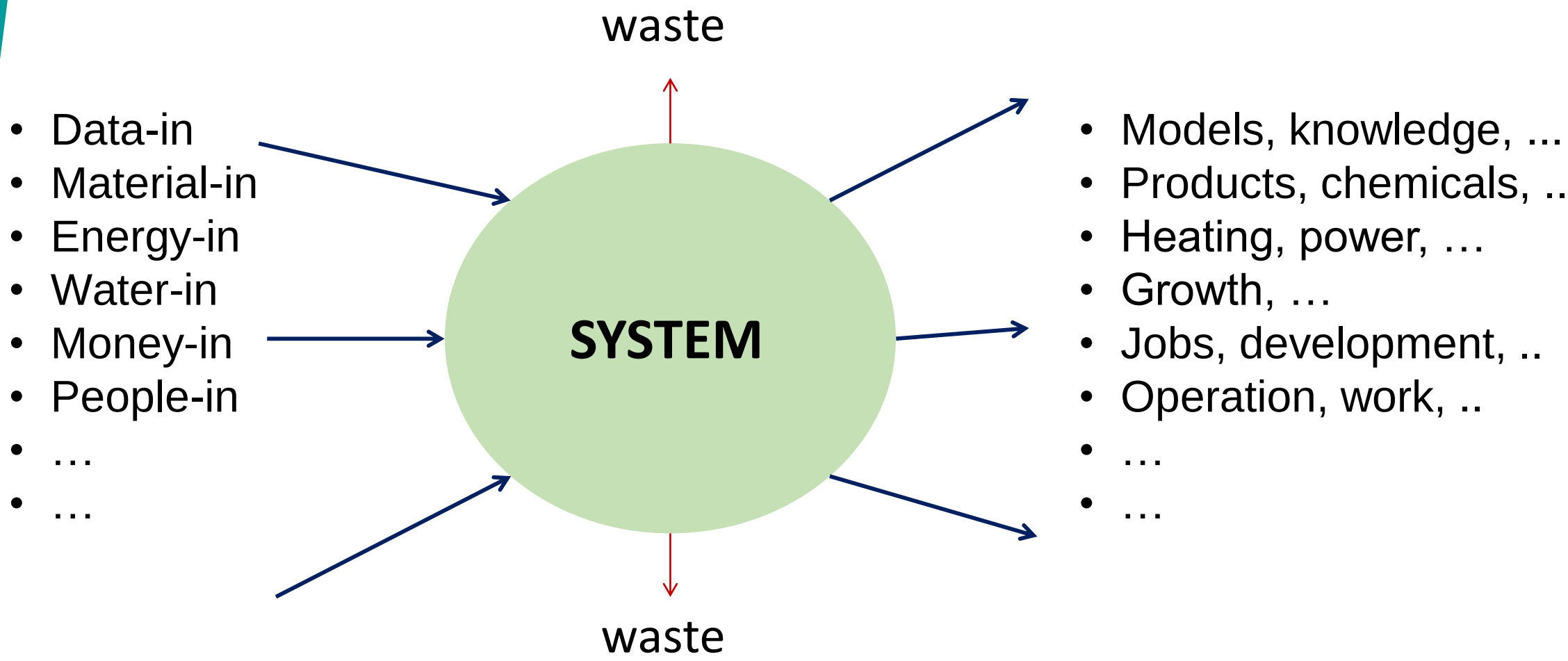
Goals, measures and computation of sustainability

Sustainability goals (partial list)

- End hunger, achieve food security and improved nutrition, and promote sustainable agriculture
- Ensure healthy lives and promote well-being for all at all ages
- Ensure inclusive and equitable quality education and promote life-long learning opportunities for all
- Ensure sustainable consumption and production patterns
- Ensure availability and sustainable management of water and sanitation for all
- Ensure access to affordable, reliable, sustainable, and modern energy for all
- Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
- Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
- Take urgent action to combat climate change and its impacts
- Conserve and sustainably use the oceans, seas and marine resources for sustainable development
- ……

Dahl, Industrial Environmental Forum, 2014

Model for measure of sustainability: Metrics S_j



$$S_j = Input_j - output_j \; OR = output_j / input_j$$

Measures of sustainability

Lower than 1 is good

Material
Land
Energy
Water

Atmospheric impact
Impact to land
Aquatic impact

+ve good, -ve bad

Environmental

METRICS

Health & safety
Society*
Employments*
Workplace

Social

*Higher than 1 is good**

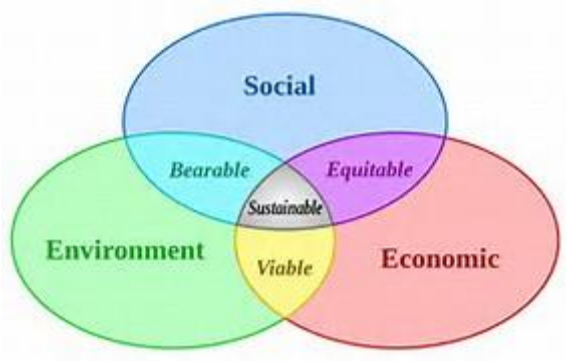
Value*
Investment*
Profit*
Tax

Economic

Factors affecting achievement of sustainability

Challenge: Technological solutions must be provided within an industrial, social, regulatory and ethical framework

The Ecological Footprint Explained.mp4 (video not included)



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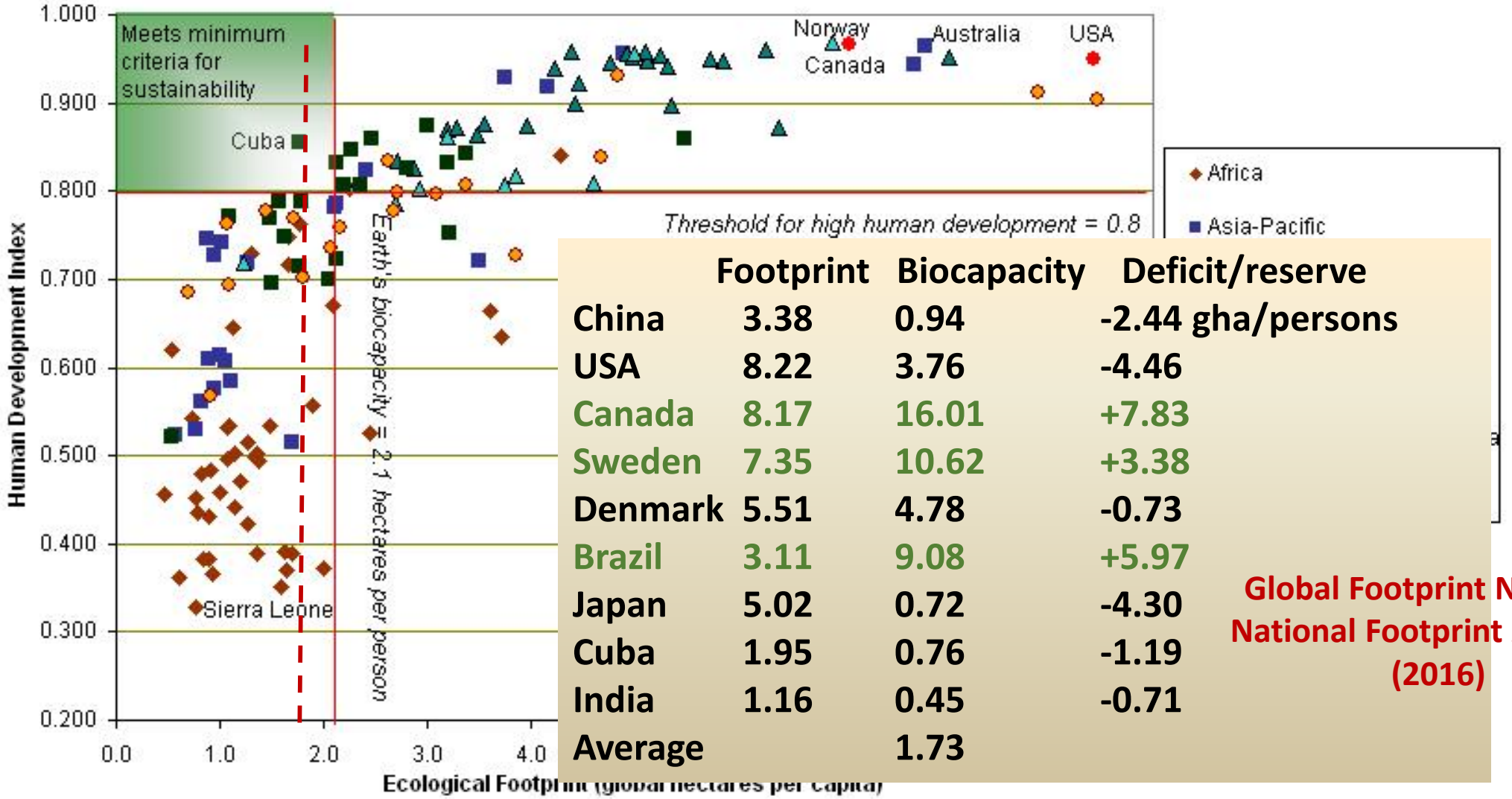
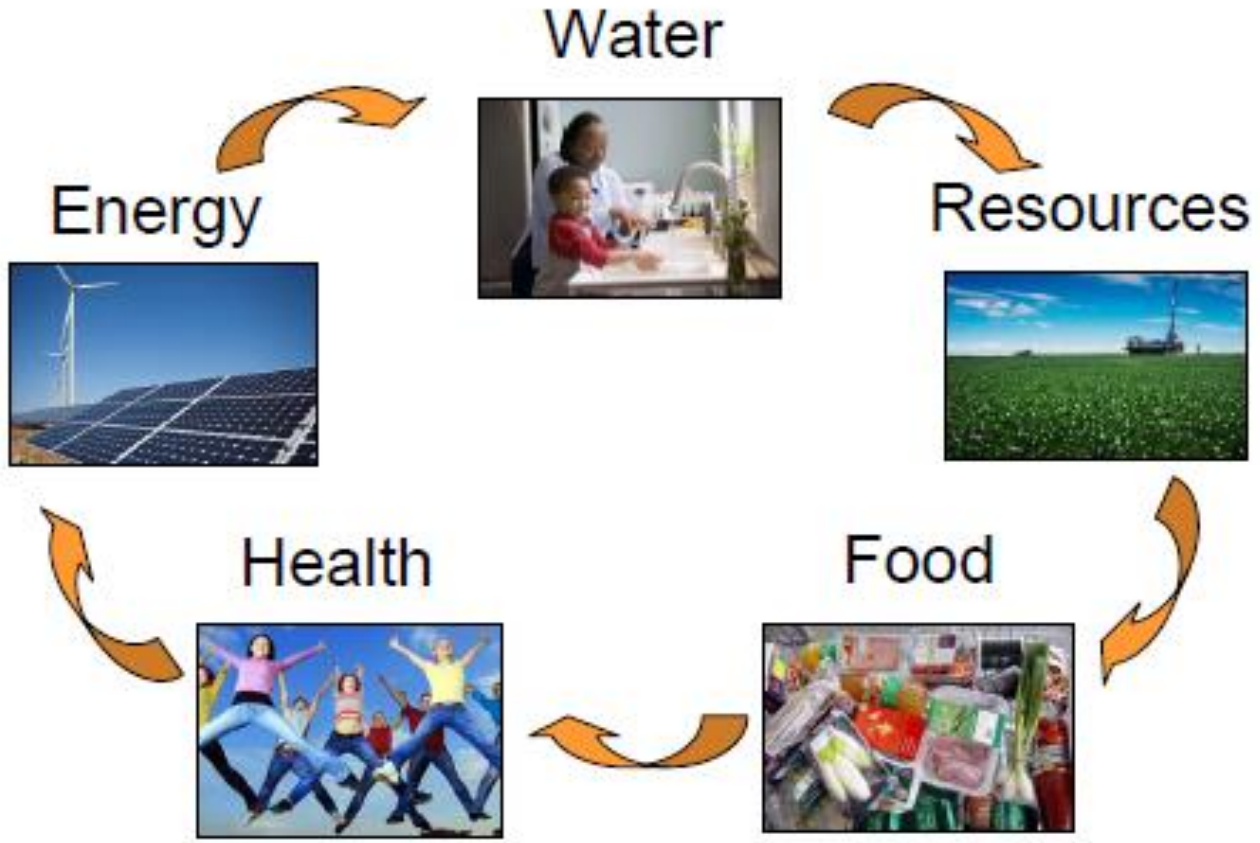
Human Welfare and Ecological Footprints compared



	Footprint	Biocapacity	Deficit/reserve
China	3.38	0.94	-2.44 gha/persons
USA	8.22	3.76	-4.46
Canada	8.17	16.01	+7.83
Sweden	7.35	10.62	+3.38
Denmark	5.51	4.78	-0.73
Brazil	3.11	9.08	+5.97
Japan	5.02	0.72	-4.30
Cuba	1.95	0.76	-1.19
India	1.16	0.45	-0.71
Average		1.73	

Global Footprint Network
National Footprint Accounts
(2016)

Turning challenges into opportunities: some key areas (human needs)

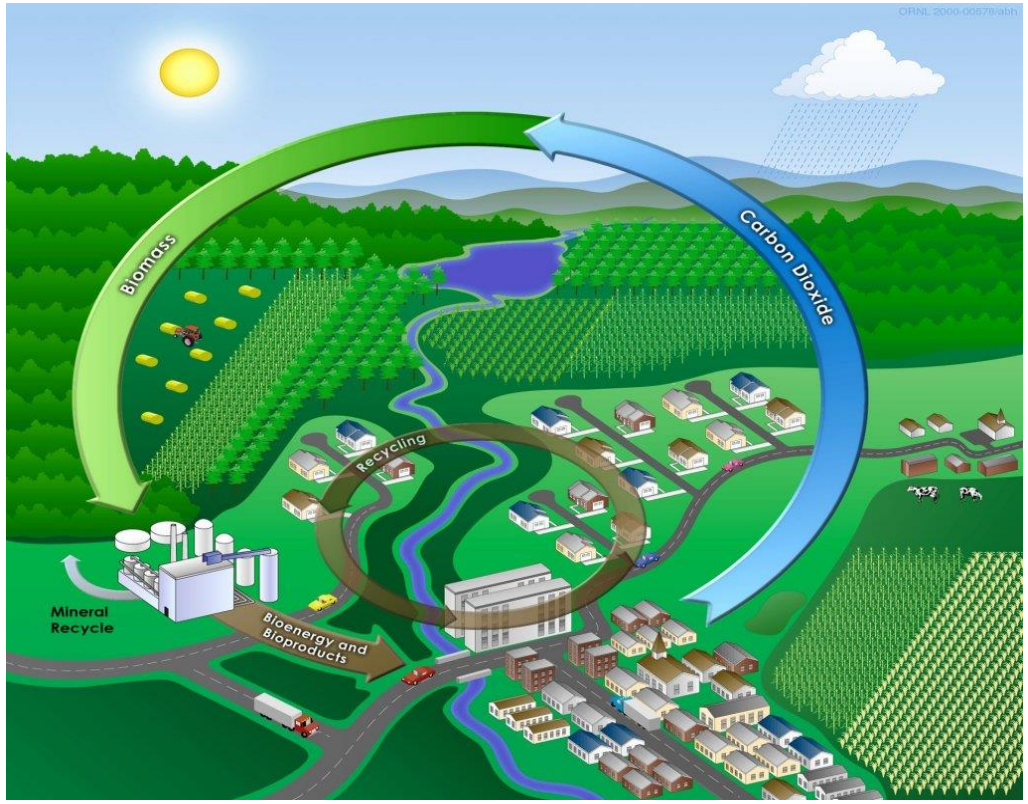


Question: Can we survive if any of these issues become unsustainable? What should we do?

A Azapagic, WCCE 2013, Seoul, Korea

The need for cleaner and renewable technologies*

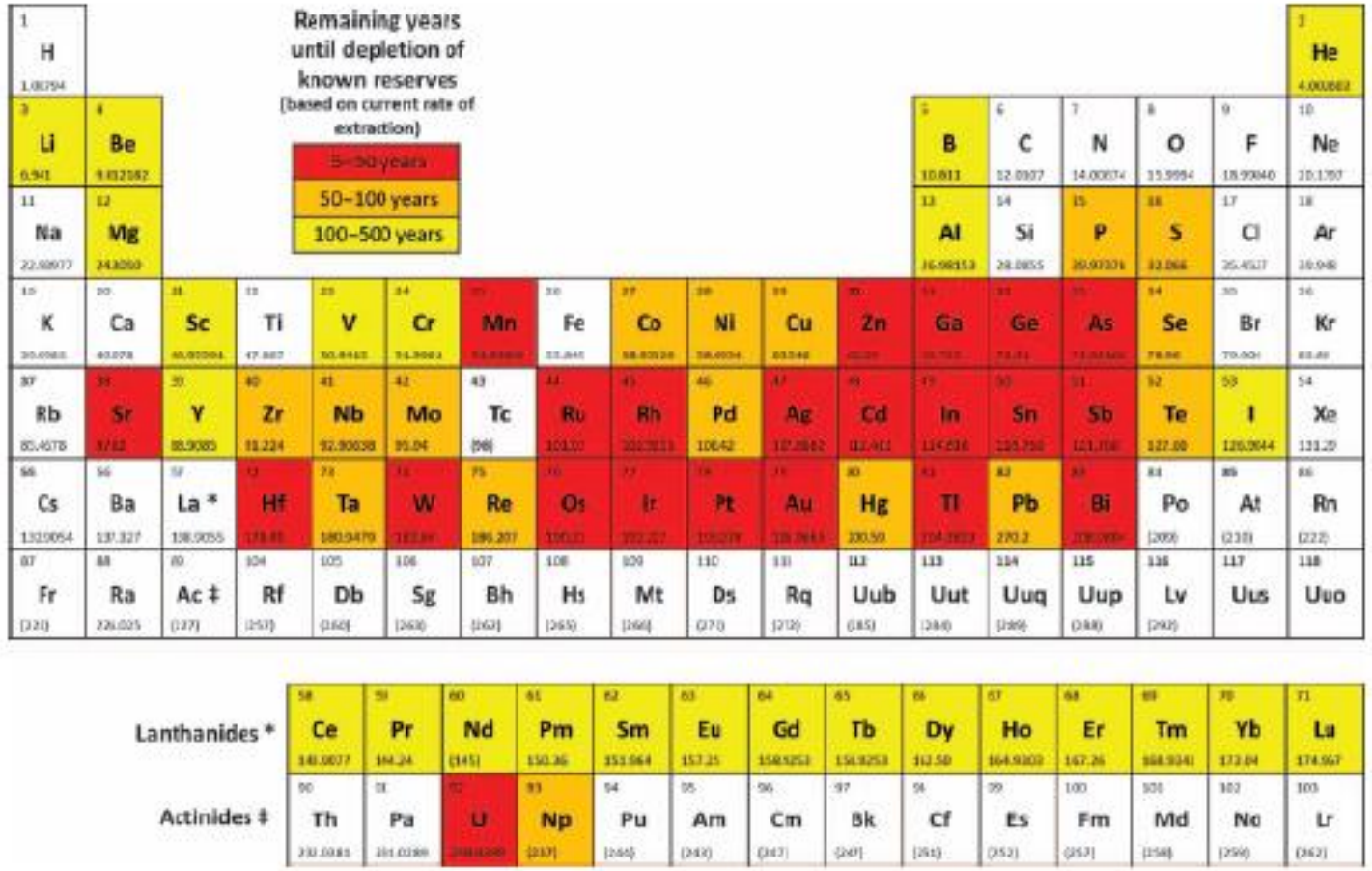
Uncontrolled manufacturing negatively impacting the atmosphere negatively & causing great harm!



Totally integrated system with recycle of resources leading to a circular economy – green engineering!

We have a responsibility to control our emissions and reduce our waste

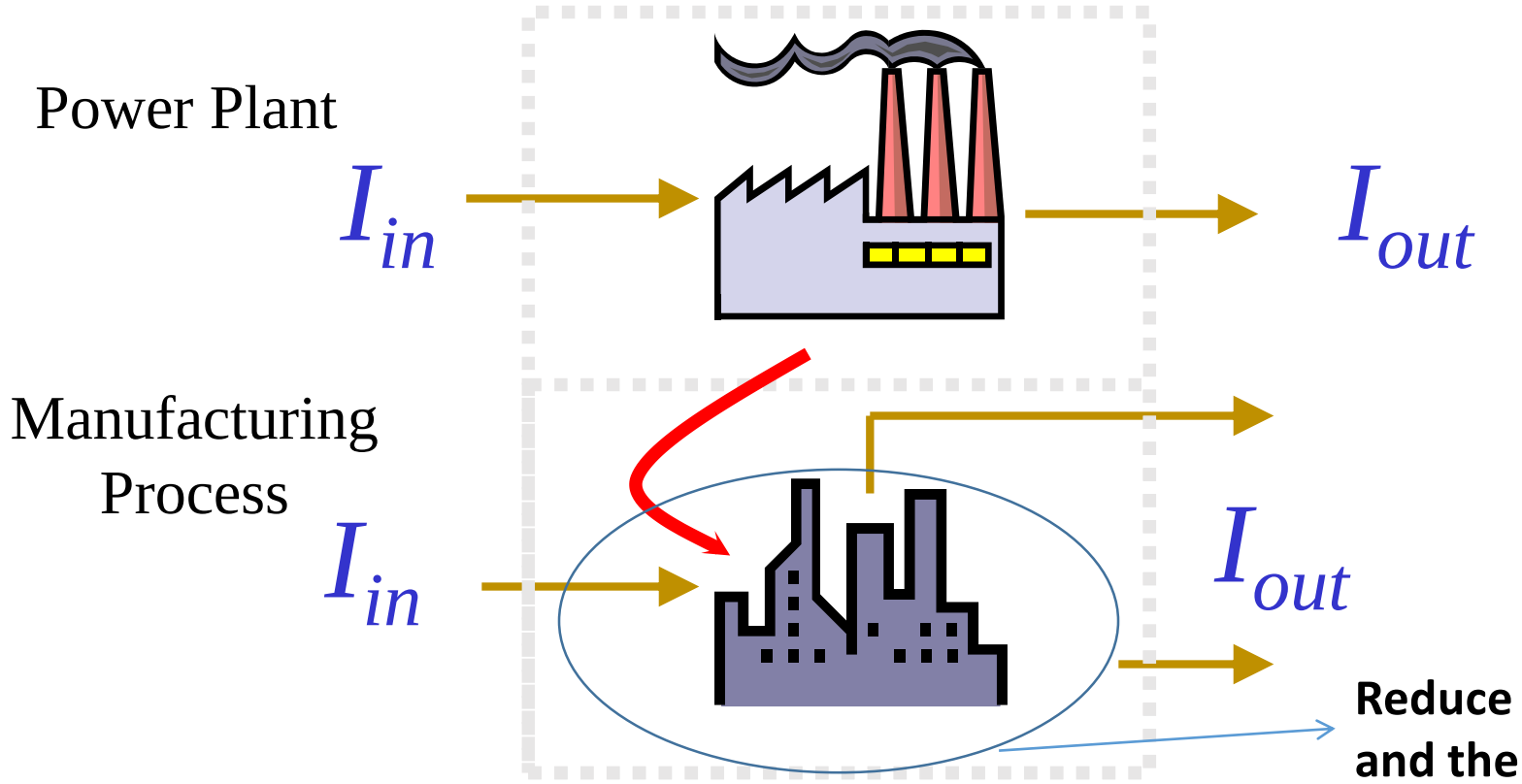
Resources scarcity: how to reuse the metal



Question: What will happen if a large percentage of the population in China decide to have a car?

A Azapagic, WCCE 2013, Seoul, Korea

Sustainable development & impact on global warming?



Question:
Where is the real boundary of our system?

More efficient energy demanding technologies combined with more efficient energy producing technologies: Manufacturing processes (example)

Sustainable development & innovation

Question: Why should we encourage him to research & innovate?

If I change one molecule of this useless & polluting product, we can make an excellent & sustainable hair-spray!

Sustainable development &making right decisions

Question: Which option is more sustainable: drinking from the water-hose, or, watering the plant?

Managing enormous amounts of data, information & knowledge – better models needed to make decisions!

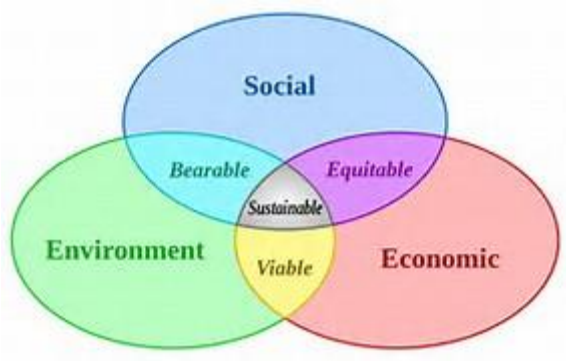
Conclusions

- We face unprecedented challenges and problems some of which have been caused by our mistakes in the past
- We should see this as an opportunity to not make the same mistakes of the past
- We should make the future the cause of our present actions
- We should design and operate our production systems that are environmentally benign, economically viable & socially beneficial
- We should engage the public and educate the next generation of all classes of people with sustainability in mind

Concluding Remarks

What have we learned about sustainability and sustainable development?

The sustainability challenge explained (through animation).mp4 video not included



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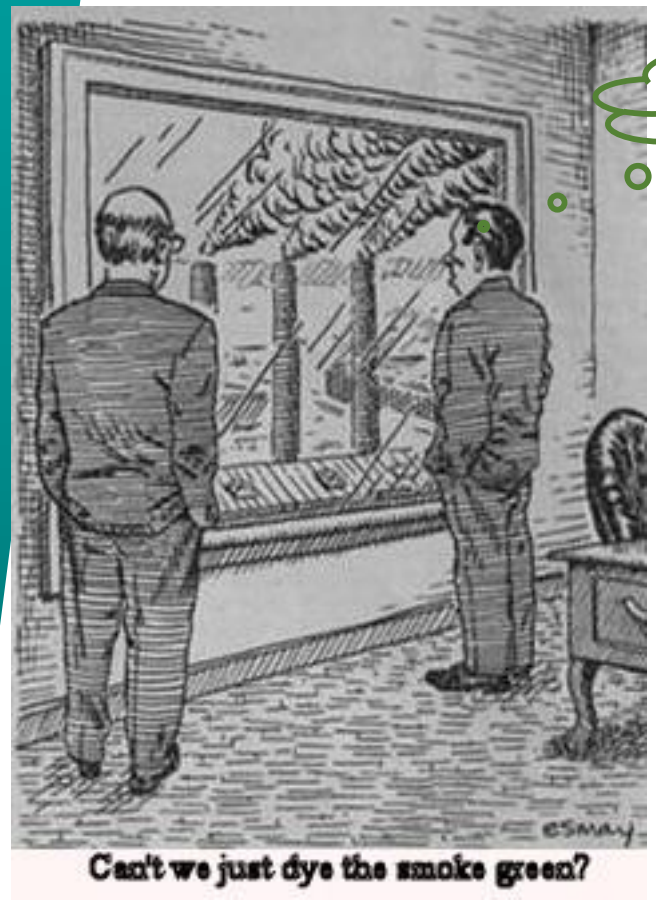
Something to think about!



New definition of green engineering

Nuclear, oil, coal are OK but the wind-mill with zero CO2 emission - not in my backyard

The goal is to make everybody rich!

Conclusions & future directions

Barcelona Declaration, 2017 (World Congress of Chemical Engineering)

We (chemical & biochemical engineers) should agree to:

- Promote research and development as a fundamental pillar and encourage technology development to achieve a planet able to sustain a growing population, while improving quality of life.
- Facilitate global dissemination of chemical and biochemical engineering technical knowledge and industrial best practices, striving to bring together academia and industry worldwide.
- Promote conservation and care of global resources, health, safety, and the environment.
- Promote the highest standards of professional ethics and conduct for chemical engineers worldwide, to safeguard the public.