ENVE203
Environmental Engineering Ecology
(Sep 24, 2012)

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'Environmental Science and Sustainability: Introduction'

Types of Resources

- *Renewable resources*
- *Nonrenewable resources*

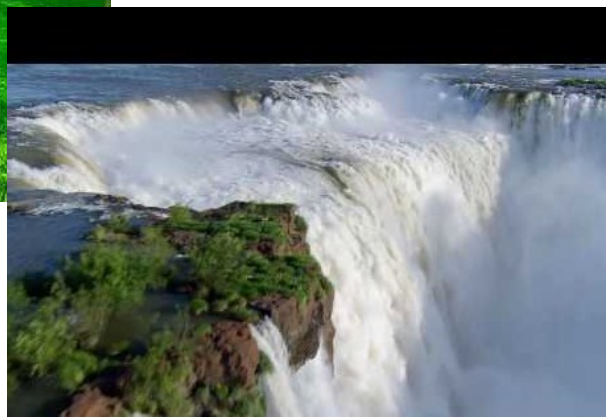
Types of Resources

<u>Two types of natural resources:</u>

Nonrenewable and Renewable resources

- Nonrenewable resources
  - Present in limited supplies
  - Depleted by use
  - Can not be replenished by natural processes within a reasonable period on the human time scale
  - Minerals (e.g. Al, Cu, Ur) and fossil fuels (coal, oil, and natural gas)

Types of Resources



- Renewable resources
  - Can be replaced by nature fairly rapidly (on a scale of days to centuries)
  - Can be used forever as long as they are not overexploited in short term.
  - Trees, fishes, fertile agricultural soil, and fresh water
  - They are only ***potentially*** renewable
  - Must be used in a ***sustainable*** way –in a manner that gives them time to replace or replenish themselves

Natural Resources

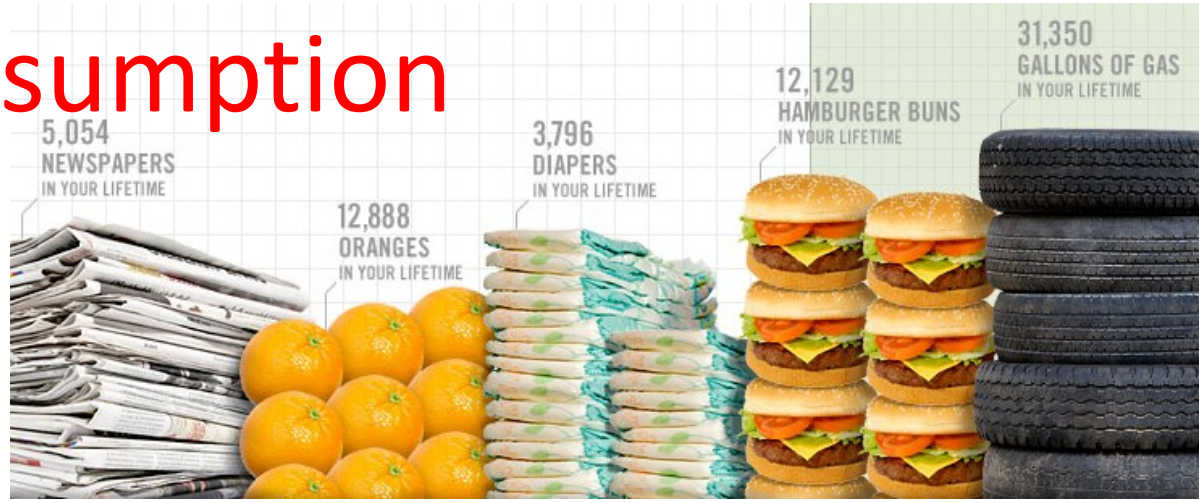
Renewable Natural Resources

- Direct solar energy
- Energy of winds, tides, flowing water
- Fertile soil
- Clean air
- Fresh water
- Biological diversity (forests, food crops, fishes)

Nonrenewable Natural Resources

- Metallic minerals (gold, tin)
- Nonmetallic minerals (salt, phosphates, stone)
- Fossil fuels (coal, oil, natural gas)

Resource Consumption



Consumption ?

Human use of materials and energy

Many natural resources are used to provide

Automobiles

Air conditioners

Cell phones

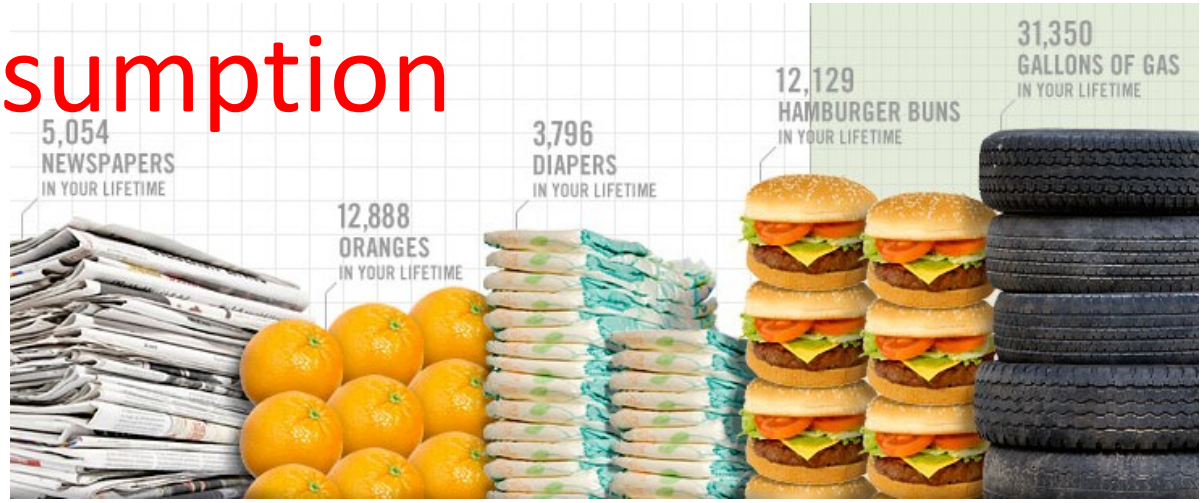
DVD players

Computers

Furniture

and many other 'comforts' of life in highly developed countries

Resource Consumption



Americans collectively consume almost 10 billion tons of materials every year! (*source*: Worldwatch Institute)

Effect on natural resources and environment

Disproportionately large consumption of resources by *HDC*

$\geq$

Population explosion in the developing world

People overpopulation

A situation in which there are more people in a given geographic area than that area can support

- Occurs when the environment is worsening because there are too many people
- Even if those people consume few resources per person
- Current problem in many developing nations

Consumption overpopulation

A situation that occurs when each individual in a population consumes too large a share of resources

- Result of consumption-oriented lifestyles in HDC
- Many HDC suffer from consumption overpopulation

  Highly developed countries represent less than 20% of the world's population, however they consume significantly more than half of its resources

< 20% in population >50% resources consumption

Total resources consumed

Highly developed countries (HDC)...

86% of aluminium used
76% of timber harvested
68% of energy produced
61% of meat eaten
42% of fresh water consumed

75% of the world's pollution and waste

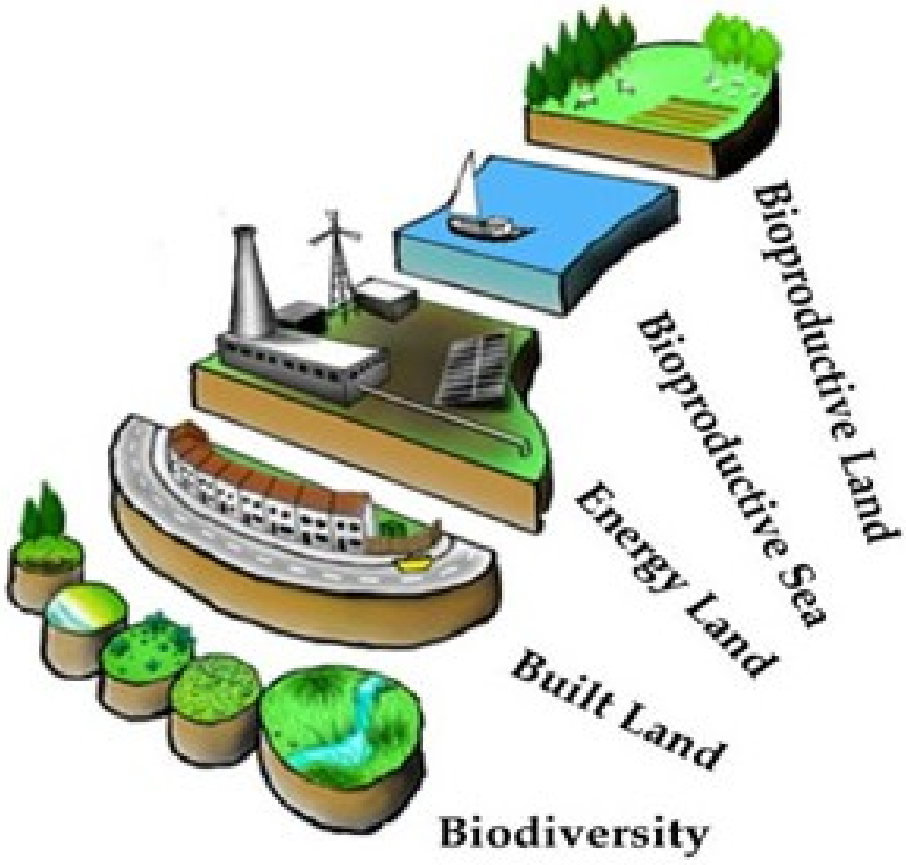
source: Worldwatch Institute

Ecological footprint

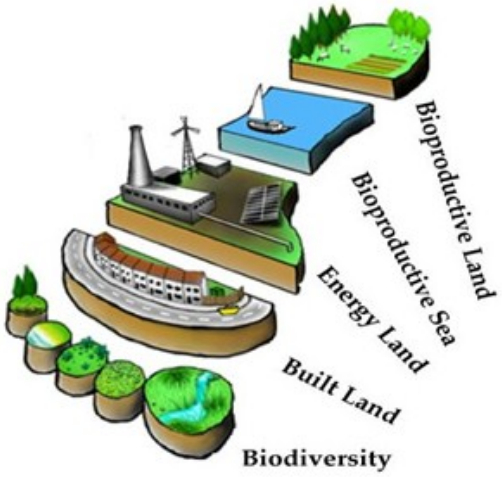
by Mathis Wackernagel and William Rees

A definition to help people visualize what they use from the environment

Each person has an ecological footprint



Ecological footprint



An amount of

- productive land,
- fresh water, and
- ocean

required on a continuous basis to supply that person with

- food,
- wood,
- energy,
- water,
- housing,
- clothing,
- transportation, and
- waste disposal

Ecological footprint

In 2008: 'Living Planet Report'

Earth has ~ 11.4 billion hectares of productive land & water

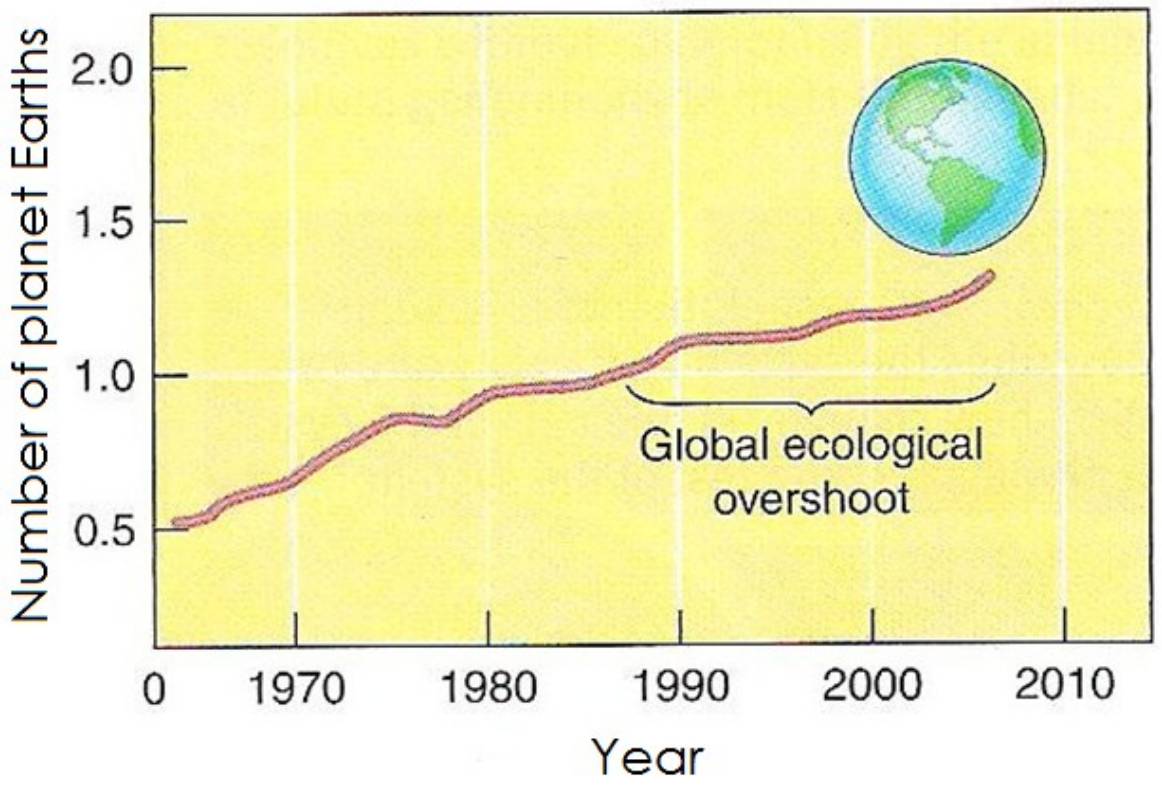
$$\frac{11.4\ billion\ hectares}{human\ population} = Each\ person\ has\ alloted \sim 1.8\ ha$$

However...

The average global ecological footprint is currently about 2.7 hectares per person!

'We humans have depleted our ecological footprint'

Ecological footprint

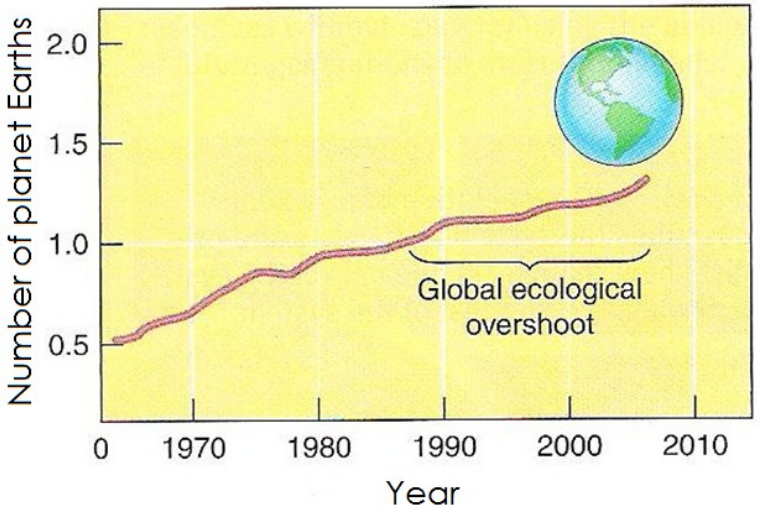


Earth's ecological footprint has been increasing over time.

By 2005, humans were using the equivalent of 1.3 Earths, a situation that is not sustainable

'Ecological overshoot'

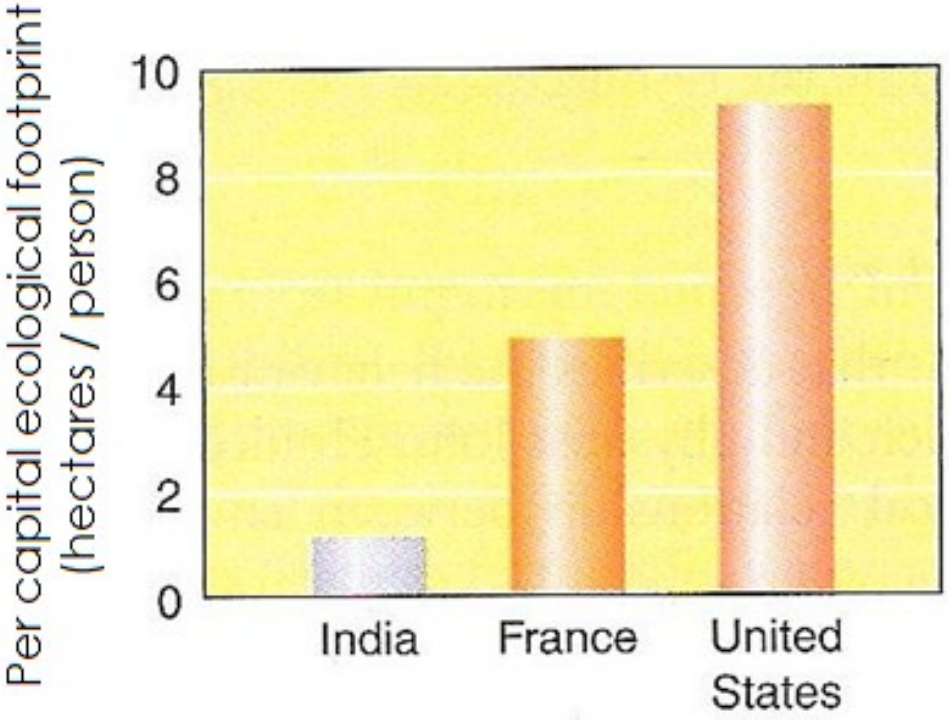
Ecological overshoot



- Short-term results
  - *Forest destruction*
  - *Degredation of croplands*
  - *Loss of biological diversity*
  - *Declining fisheries*
  - *Local water shortages, and*
  - *Increasing pollution*

- Long-term result is potentially disastrous

(if we do not seriously address our consumption of natural resources)



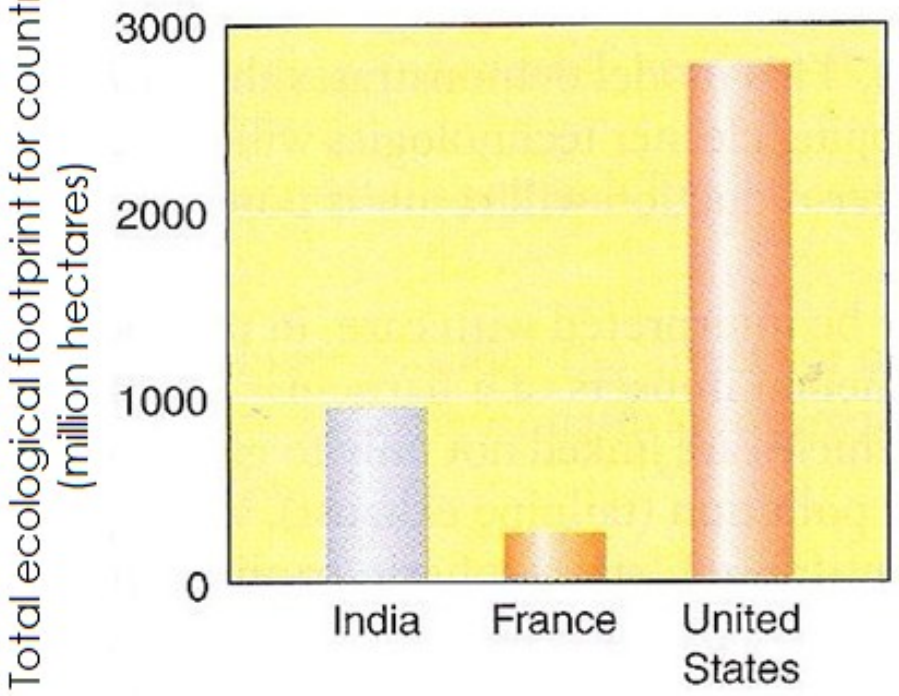
Average ecological footprint of a person

'Each Indian requires 0.9 ha of productive land and ocean to meet his/her resource requirements'

Total ecological footprint

If everyone in the world had the same level of consuption as the average American, it would take the resources and area of 5 Earths!

'Note the change in India's footprint' Why?



The *IPAT* Model

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

- Human impacts on the environment are difficult to assess
- Proposed by Paul Ehrlich and physicist John Holdren (1970)

- Mathematical relationship between environmental impacts and the forces driving them

How changes in one part of the system will affect the rest of the system

The *IPAT* Model

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

- Estimation using the three factors most important in determining environmental impact (***I***) is possible:
  - The number of people (***P***)
  - Affluence, which is a measure of the consumption or amount of resources used per person (***A***)
  - The environmental effects of the technologies used to obtain and consume the resources (***T***)

The *IPAT* Model

$I = P \times A \times T$

Example

Determine the environmental impact of emissons of the greenhouse gas CO_2 from motor vehicles

Multiply

- The pollution
- The number of cars per person (affluence/consumption per person)
- The average car's annual CO_2 emmisions per year (technological impact)

The *IPAT* Model

I = P x A x T

To reduce pollution and environmental degradation...

- Developing cleaner technologies of motor vehicles
- Population control
- Per capita consuption control

- The number of people (***P***)
- Affluence, which is a measure of the consumption or amount of resources used per person (***A***)
- The environmental effects of the technologies used to obtain and consume the resources (***T***)

The *IPAT* Model

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

- Limited usefulness for long-term predictions?

Environmental Sustainability

- Sustainability

Humans can manage natural resources indefinetely without the environment going into a decline from the stresses imposed by human society on the natural systems that maintain life.

Natural systems: fertile soil, water, and air.

Environmental Sustainability

Humanity's present needs are met without endangering the welfare of future generations

environment is used sustainably

Environmental sustainability applies at many levels:

- Individual
- Community
- Regional
- National, and
- Global levels

Environmental Sustainability

Stabilize human population	Prevent pollution where possible	Restore degraded environments
Protect natural ecosystems	Focus on Sustainability	Use resources efficiently
Educate all boys and girls	Prevent and reduce waste	Eradicate hunger and poverty

Ideas of which the Environmental Sustainability is based on

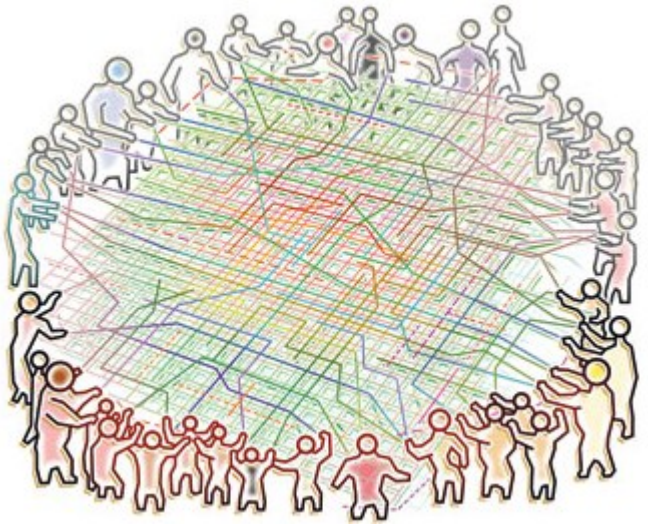
- Consider the effects of actions on natural ecosystems
- Live within ecological limits that let renewable resources regenerate for future needs (*Earth's resources not in infinite supply*)
- Understand all the costs to the environment/and society of the products consumed
- Share the responsibility for environmental sustainability

Why human society is not operating sustainably?

- Use of nonrenewable resources as if they are present in unlimited supplies
- Use of renewable resources faster than natural systems can replenish them
- Polluting the environment with toxins as if the capacity of the environment to absorb them is limitless
- Numbers of population continue to grow despite Earth's finite ability to feed us, sustain us, and absorb our wastes

‘The Tragedy of Commons’
Article by G. Hardin (*Science*, 1968)

Our inability to solve many environmental problems is the result of the struggle between short-term individual welfare and long-term environmental sustainability and social welfare



‘The Tragedy of Commons’
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Common-pool resources:

Those part of environment available to everyone but for which no single individual has responsibility

- Atmosphere and climate
- Fresh water
- Forests
- Wildlife
- Ocean fisheries

Global Plans for Sustainable Development

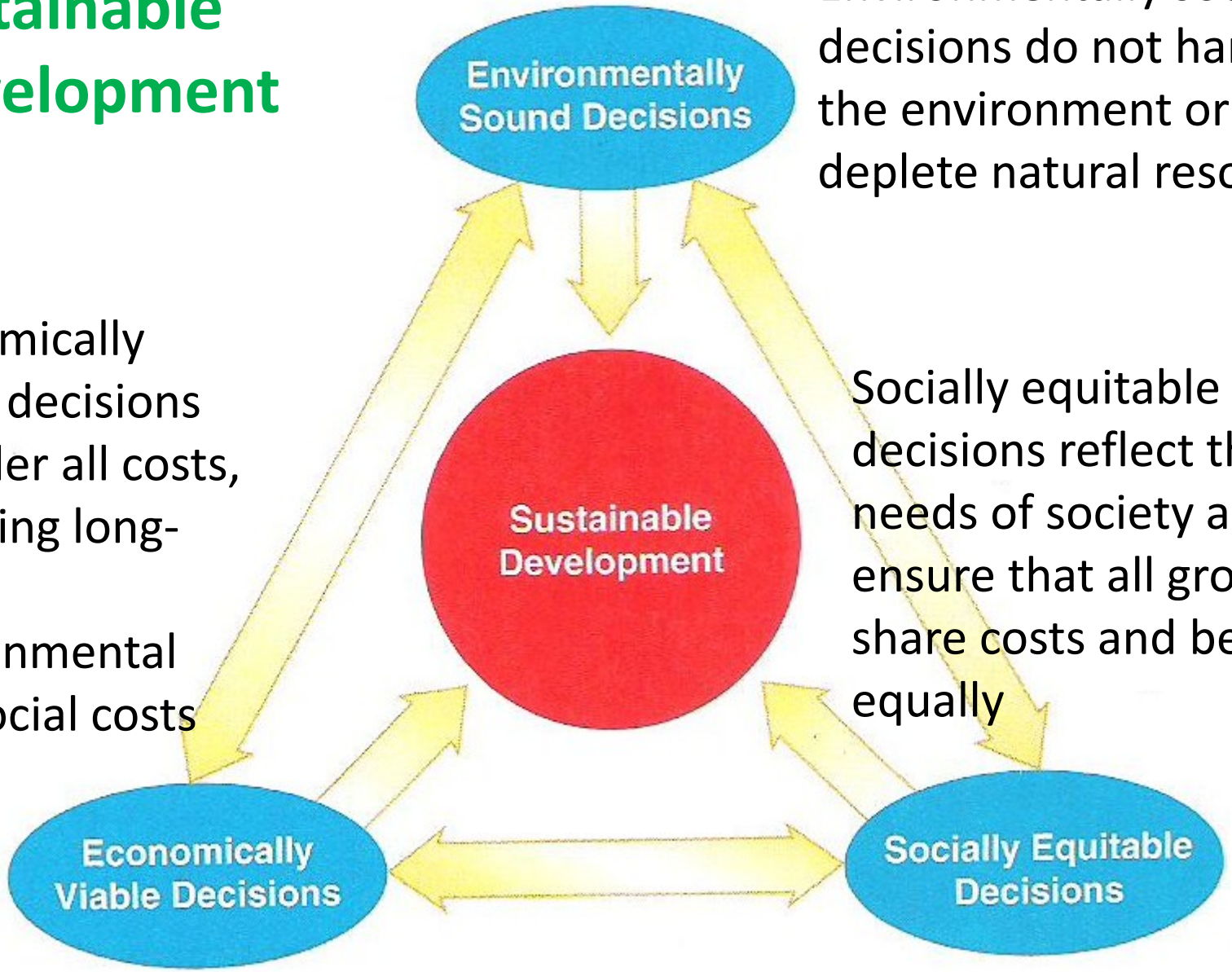
- In 1987: ‘Our Common Future’ World Commission on Environment and Development Report
- In 1992: U.N. Conference on Environment and Development – most of the world’s countries met in Rio de Janerio, Brazil
  - Environmental problems of international scope
    - Pollution and deterioration of the planet’s atmosphere and ocean
    - Decline in the number and kinds of organisms
    - Destruction of forests

Sustainable Development

Environmentally sound decisions do not harm the environment or deplete natural resources

Economically viable decisions consider all costs, including long-term environmental and social costs

Socially equitable decisions reflect the needs of society and ensure that all groups share costs and benefits equally



Environmental Science

Encompasses many interconnected issues

- Human population
- Earth's natural resources
- Environmental pollution

Ecology

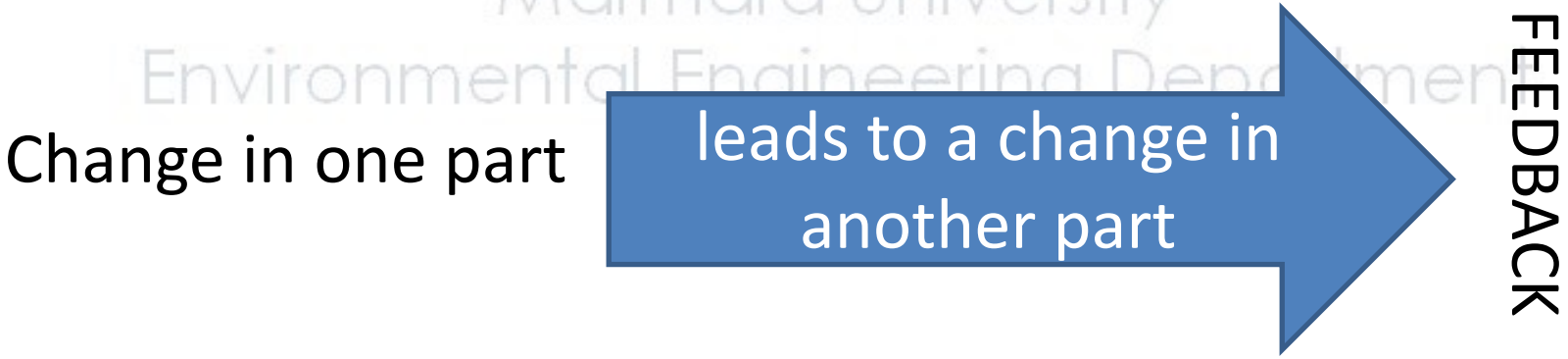
- The branch of biology that studies the interrelationships between organisms and their environment
- A basic tool of environmental science

Ecosystem

- A natural system consisting of a community of organisms and its physical environment
- Biological processes (e.g. photosynthesis) interact with physical and chemical processes to
  - Modify the composition of gases in the atmosphere
  - Transfer energy from the sun to living organisms
  - Recycle waste products
  - Respond to environmental changes

Dynamic Equilibrium

Rate of change in one direction is the same as the rate of change in the opposite direction



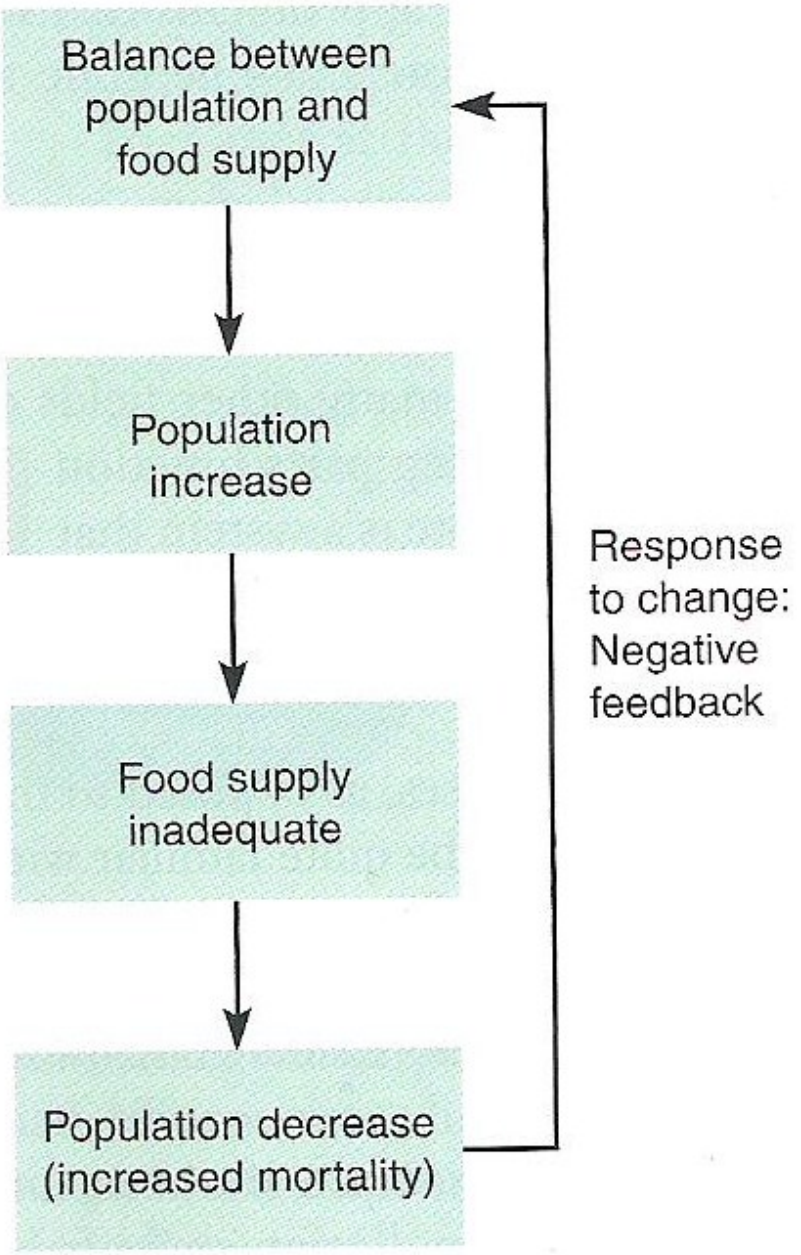
- Negative feedback
- Positive feedback

Negative Feedback

Fish in a pond

Number of fish increases

Available food decreases
Fewer fish survive
Fish Population Declines

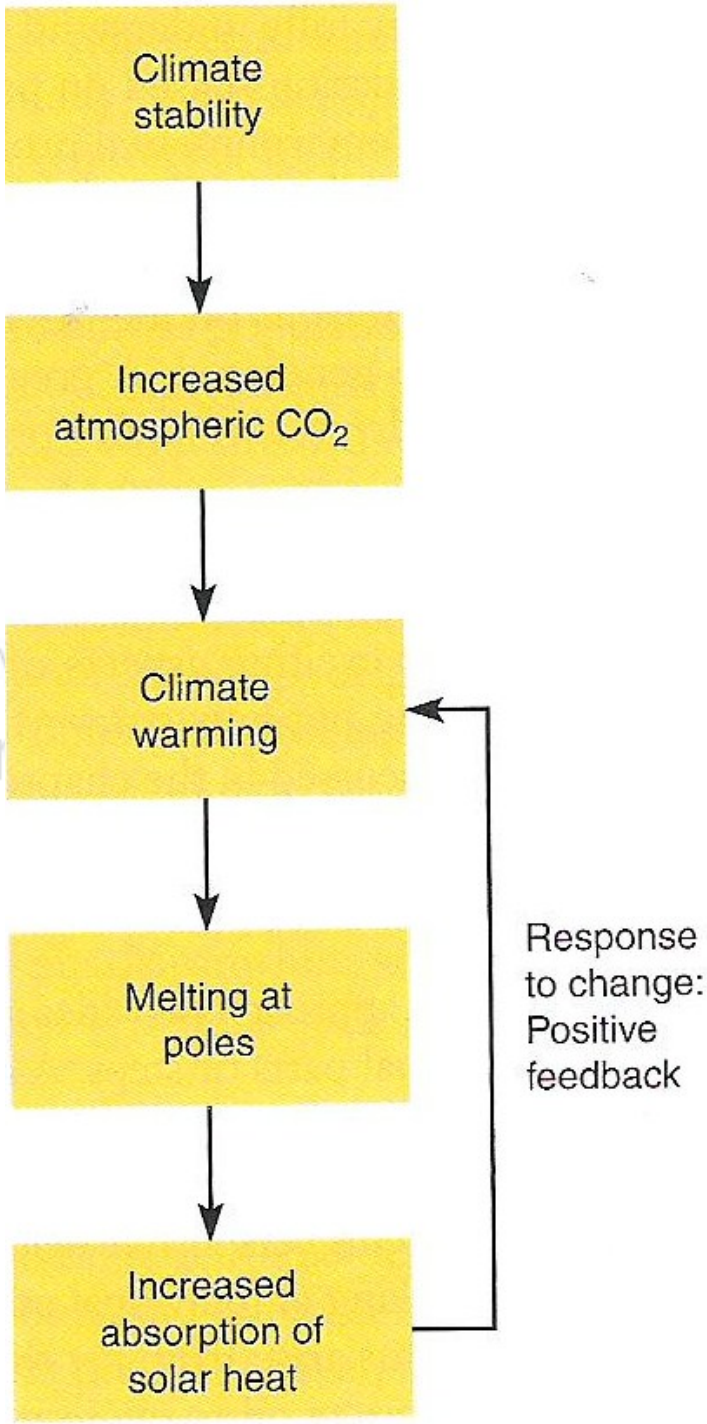


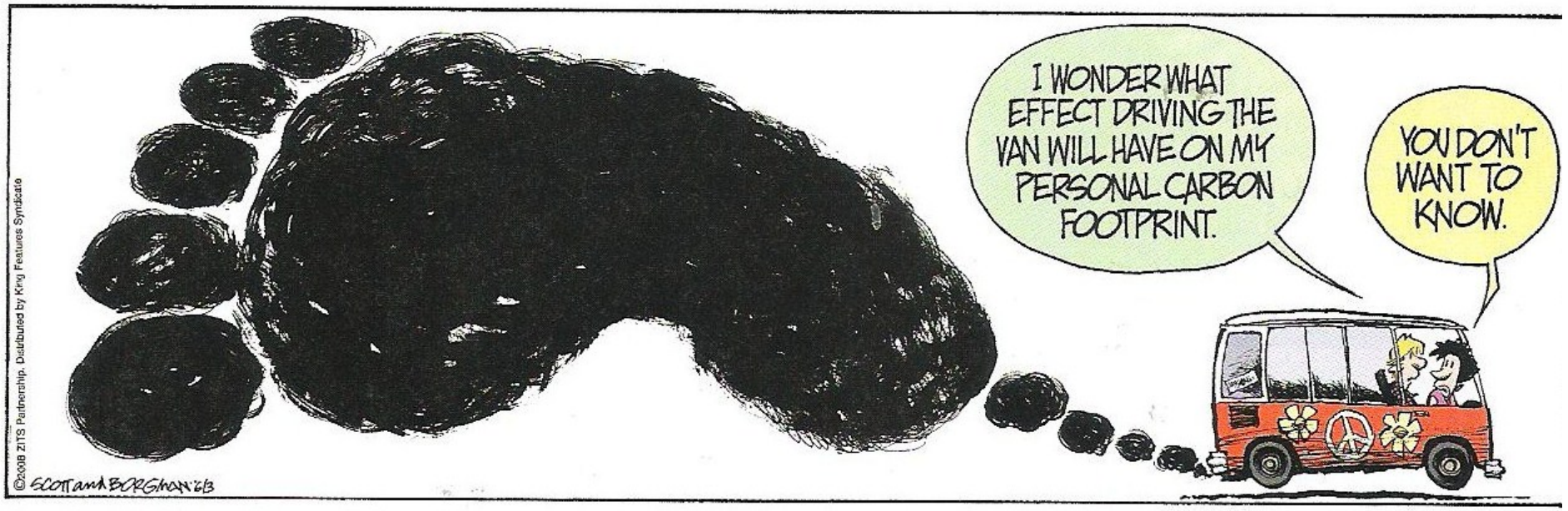
Positive Feedback

Melting of polar / glacial ice

Greater absorption of solar heat by the exposed land area

More rapid melting





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