Unit 3 Natural Resources

3.1 Global Trends in Consumption

Overview

Extreme Poverty

A person living on less than $1.9 per day.

Fragile Middle Class

A person earn between $2 - $10 per day.

New Global Middle Class

A person earn $10 a day or more.

Ecological footprint

Hypothetical area of land required by a society or an individual to fulfill all resource needs and assimilate all their wastes. (Measured in *global hectares*)

- Tracking the following six things
    - Cropland
    - Grazing land
    - Fishing grounds
    - Built-up land
    - Forest area
    - Carbon

Water, Food and Energy

Embedded Water (Virtual water / Water footprint)

A measure of the amount of water used in the production and transport to market of food and commodities. *May include use of local water resources and in distant places.*

Nutrition Transition

A change in diet from *staple carbohydrates* to *meat and fish proteins* and *dairy products*.

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- Happens when income rise from *Extreme Poverty* to *Fragile Middle Class*.

Energy

Different Energy Sources

- Hydrocarbons
  - Oil and Natural Gas
  - Coal
  - Shale gas 页岩气
- Renewable Energy Sources
  - Wind turbines (Variable: Weather)
  - Solar power (Photovoltaic cells or Heat Conversion; Variable: Weather)
  - Wave and tidal power
  - Hydroelectric power (Dam schemes)
  - Geothermal (Tectonic plate margins)
- Nuclear Power
  - Radioactive fuel and nuclear waste

Solar Power

Light converted into electricity using solar panels. Stored in batteries or national grid.

- Advantages
  - Free
  - Effective for low-power usage
  - Potential in warm and sunny countries
- Disadvantages
  - High initial input
  - Not effective in cloudy countries
  - Not effective in high-latitude countries
  - Less effective for high-output uses

Wind Power

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Using turbines to capture wind energy from the atmosphere.

- Advantages
  - No pollution
  - Little affection to ecosystem.
  - Strong wind in winter provide high supply in Europe
  - Free fuel
  - Source of income for farmers
- Disadvantages
  - High initial input
  - Not effective in low-wind countries
  - Not effective for high demands

Biofuels

Includes any fuel which comes from biomass, (Liquid fuels, biogas and solid biofuels) including fuel wood.

- For Example, *Oil seed rape* in UK is used for biodiesel production.

Bioethanol 生物乙醇

An alcohol made by fermenting the sugar in plants such as maize.

- Added to petrol to increase octane values.
- Improve vehicle emissions.
- Widely used in USA and Brazil.

Biodiesels 生物柴油

Made from vegetable oils and recycled cooking oils from restaurants and kitchens.

- Additive to other fuels.
- Reduce level of air pollution by diesel-powered vehicles.

Biogas 沼气

Methane produced by the breakdown of organic materials by bacteria.

- Produced from waste materials or energy crops

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- By-products can be used as biofuel
- Produced naturally in landfill sites

Advantages:

- More stable than oil prices
- More secure on supplies and reduce reliance on imported fuels
- Fewer pollutants are produced
- Carbon neutral for zero emissions

Disadvantages:

- Land previously used for food changed to produce biofuel crops.
- Increase world food prices, decrease food supply.

Hydrolytic Power 水力发电

Advantages:

- Constant rate of power after dam constructed.
- Respond quickly to changing demand.
- No fuel costs
- Reservoir serve for water sports
- Water stored for irrigation
- No atmospheric pollution

Disadvantages:

- Dams are extremely expensive
- Long profit cycle
- Flooding areas of land, destroying environment, natural habitat and historical features
- Population removal from the domestic area
- Cause geological damage
- Past dams are possible to collapse
- Cross-boarder rivers could lead to disputes between countries
- Sediments are deposited in the dam instead of downstream

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Nuclear Power 核能

Advantages:

- Small amount of uranium are needed
- Will not run out in foreseeable future
- Environmentally clean
- Safety record has improved and regulated industry
- Nuclear reduces dependency on foreign oil.

Disadvantages:

- Serious incidents could happen at nuclear sites.
- Nuclear power stations near earthquake zones
- Radioactive waste is a kind of health hazard
- Produce material that are raw material for nuclear weapons.
- Capital cost are high.

Geothermal Power 地热能

Hot areas near *plate margins* has great prospects for geothermal energy.

Advantages:

- Cheap and reduces dependence on fossil fuels.
- No greenhouse gases produced
- Water is pumped back to be reused
- Can operate at any time of the year.

Disadvantages:

- Restricted area with suitable geology
- Areas with suitable geology are highly possible to be affected by earthquakes and volcanoes.
- Each well can only be used for 25 years.
- Groundwater is often saline and poisonous.

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3.2 Impacts of Changing Trends in Resource Consumption

Water, Food and Energy Security

Water Security

All people, at all times, have sustainable access to *adequate quantities* of *acceptable-quality* water for sustaining livelihoods, wellbeing and development.

Food Security

All people, at all times, have physical, social and economic access to *sufficient*, *safe* and *nutritious* food that meets dietary needs and food preferences for and active and healthy life.

Energy Security

When all people, at all times, enjoy the *uninterrupted availability* of the energy they required to meet their needs at an *affordable price*.

Drought and Aridity

Semi-arid areas

Having rainfall of less than *500mm* annually.

Arid areas

Having rainfall of less than *250mm* annually.

Extremely Arid Areas

Having rainfall of less than *125mm* annually.

Water Scarcity

Physical water scarcity

Water resource development is approaching or has exceeded unsustainable levels.

- Relates water availability to water demand
- Implies arid areas are not necessarily water scarce

Economic water scarcity

A country physically has sufficient water to meet its needs, but requires *additional storage and transport facilities*.

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Access to water

Physical Factors

- Temperatures and the amount of evaporation
- Importance of agriculture
- Amount of precipitation
- Proximity to rivers
- Level of economic development
- Presence of water-bearing rocks
- Population

Desalination 海水淡化

Uses a lot of energy and cost a lot.

Access to safe water

Purification

Removal of impurities from water, which include chemicals, suspended solids, biological contaminations and gases.

Water Insecurity resulting from Food and Energy Production

- Water resource is at risk of *depletion* and *pollution* from agriculture
- *Meat and Diary diets* cause even more water consumption
- *Hydropower* infrastructure expense *downstream water* users

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Case Study: Overdrawing surface water for food production
- Aral Sea
- Ogallala Aquifer
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Food Insecurity

Water Scarcity

Based on population density, some of the world's key agricultural centers are threatened by water scarcity.

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Marine pollution from oil spills

Harm fish stock resulting in food insecurity.

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Case Study: Marine Pollution from Oil Spills
- Exxon Valdez Oil Spill in 1989
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Production of Biofuel

- Land turned over to biofuels in the USA could have been used to produce grain for 250 billion people.
- In Indonesia, huge areas of land have been taken over for *Palm Oil* to produce ethanol.

Increased use of Biofuel

Land previously used for food production was changed to produce crops for biofuel production instead.

Increases in world food prices and decreases in the food supply.

Energy Insecurity

Food production and Supply chain

Energy is required to produce, transport and distribute food as well as to extract, pump, lift, collect, transport and treat water.

Oil Transit Chokepoints include:

- Panama Canal
- Suez Canal
- Danish Traits
- Turkish Straits
- Bab el-Mandeb Straits
- Strait of Hormuz
- Strait of Malacca

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Impact of Climate change for the Water-Food-Energy Nexus

How Impact Water Security

- Saltwater Intrusion
- Intensive Drought
- Seasonal distribution of discharge

How Impact Energy Security

- Shrinking ice stores and changing river regions may threaten hydroelectric power supplies.
- Changes in wind patterns, cloud cover and rainfall may impact on renewable energy production using wind or solar power.

Municipal Solid Waste 城市固体废弃物

Materials discarded from homes, small businesses, and institutions such as hospitals and universities.

Pyramid of MSW Disposal

Remove / Reduce / Re-source / Reuse / Recycle / Recover / Return

Recycle Process

Divert waste material from landfills and incinerators, allowing it to be remanufactured into other items.

- Reduces demand for resources
- Saves energy

Two Types of Recycling

- Closed-loop recycling: Material in a product is reused to produce a similar product.
- Open-loop recycling: Material is recycled into a different product that may or may not be discarded after it is used.

Factors affecting the feasibility of recycling

- Markets for recycled material
- Cost of waste disposal

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- Public awareness

Composting 堆肥

Decomposition of biodegradable material. Recycles organic household waste into a humus-like soil, or compost, which returns valuable nutrients to soil.

- Benefits
    - Decayed organic matter that can be used to improve the fertility and water-holding capacity of soil, thereby improving plant growth.
    - Small-scale or household composting can significantly reduce the volume of yard waste and food scraps entering the waste stream.
    - Large-scale composting diverts foul-smelling and methane-producing organic matter.
    - Sold in agricultural production for additional revenue,
- Costs
    - Leachates contaminate surface water and groundwater
    - Facilities need to minimize odors and pests
    - Cost of transporting
    - Divert inorganic material from waste

Dumping 垃圾填埋

- Problems
    - Accumulation of methane
    - Contaminate ground water
    - Odor
- Costs
    - Liners may fail and leachate may leak to contaminate groundwater
    - Methane leaking may enhance greenhouse effect.
    - Public opposition for construction
    - Loss of useful materials.

Waste-to-Energy facilities

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Reduce waste volume and produce energy. Designed with filtration process to reduce emissions of aerosols and pollutants.

International Waste Flow

Mainly from HICs to LICs/MICs

- Restriction on waste burial of environmental problems and public opposition.
- LICs receive raw materials and reusable parts
- HICs save CO_2 emissions and better environment.

Issues caused by waste flow:

- Harmful toxic waste. (Example in *Ivory Coast*)

3.3 Resource Stewardship

Malthusian View 马尔萨斯主义

While food supply could only increase by a constant amount in *Arithmetic Rate*, the human population tends to increase in *Geometrical Rate*. In time population would outstrip food supply.

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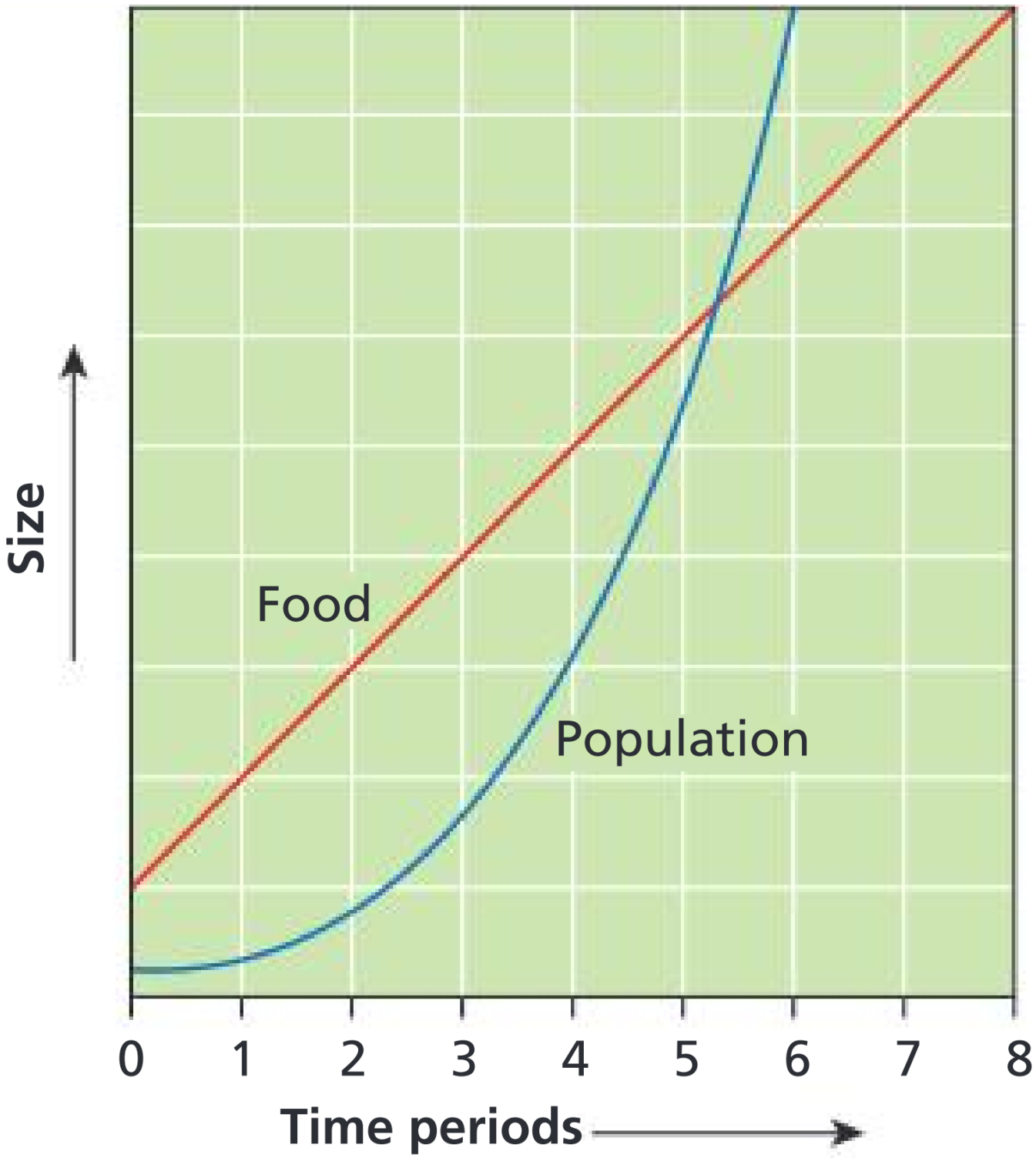

Evidences

- Limits to agricultural productivity gains in early 1800s.
- Informed in part by the economically and politically unstable times he lived with.

Further View

- Population would outstrip food supply until a catastrophe occurred in the form of *famine, disease or war*.

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- This is called a **Positive Check**
- It can bring population numbers back to sustainable levels

Negative Check

- Might be introduced before the ceiling to growth is reached.
- Positive checks can be avoided by:
    - Later age of marriage
    - Abstinence

Limits to Growth

- Growth in human population is accompanied by decline in amount of food.
- Declining resources will result in a decline in industrial input.
- Human population began to decrease as a result of starvation.

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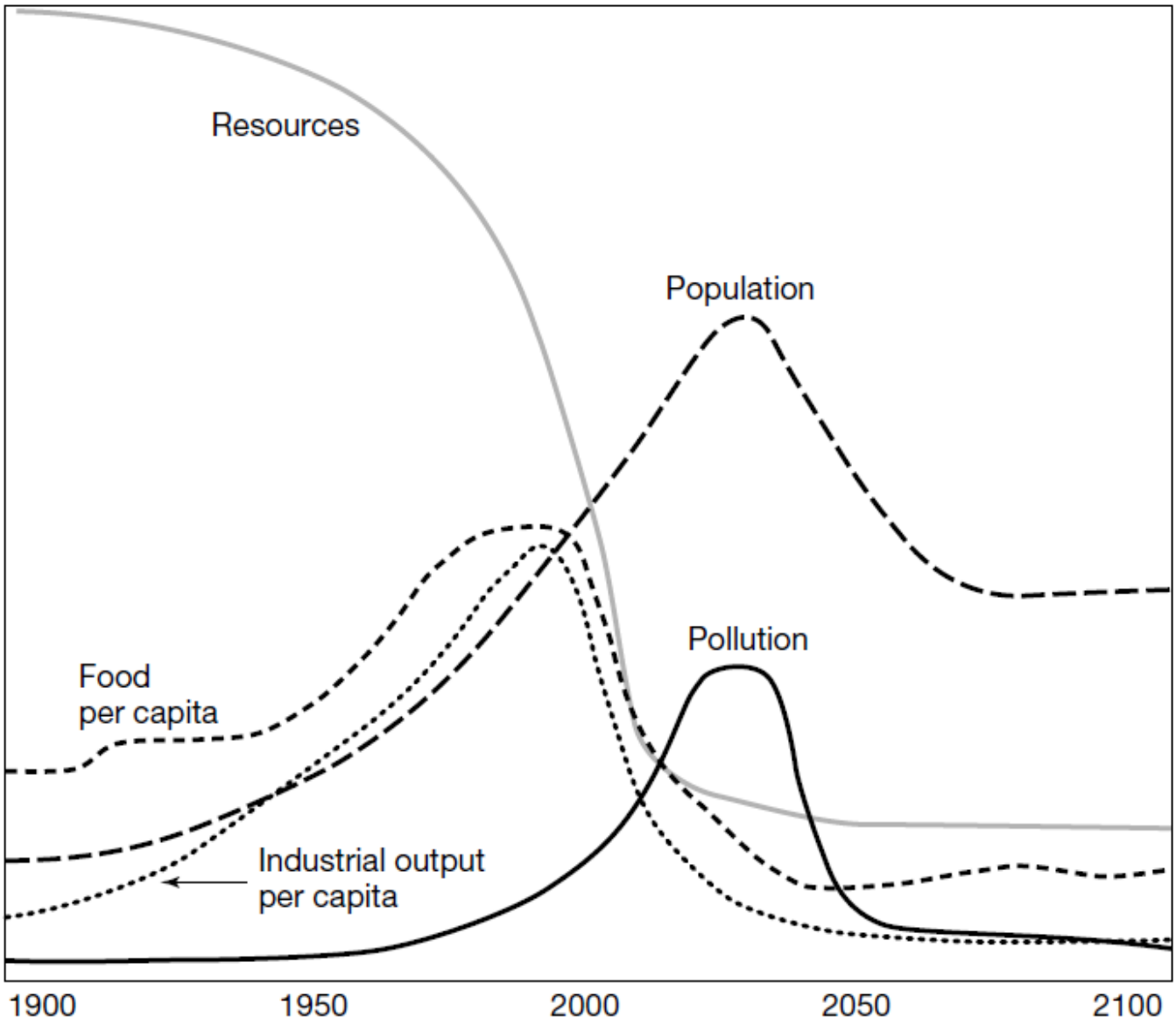

Anti-Malthusian Views 反马尔萨斯主义

Population stimulates the scientific community into working to raise the carrying capacity of their environment.

Evidence

- Green Revolution
  - Draining marshlands
  - Reclaiming land from the sea
  - Cross-breeding of cattle
  - Growing high-yielding crop varieties
  - Terracing steep slopes

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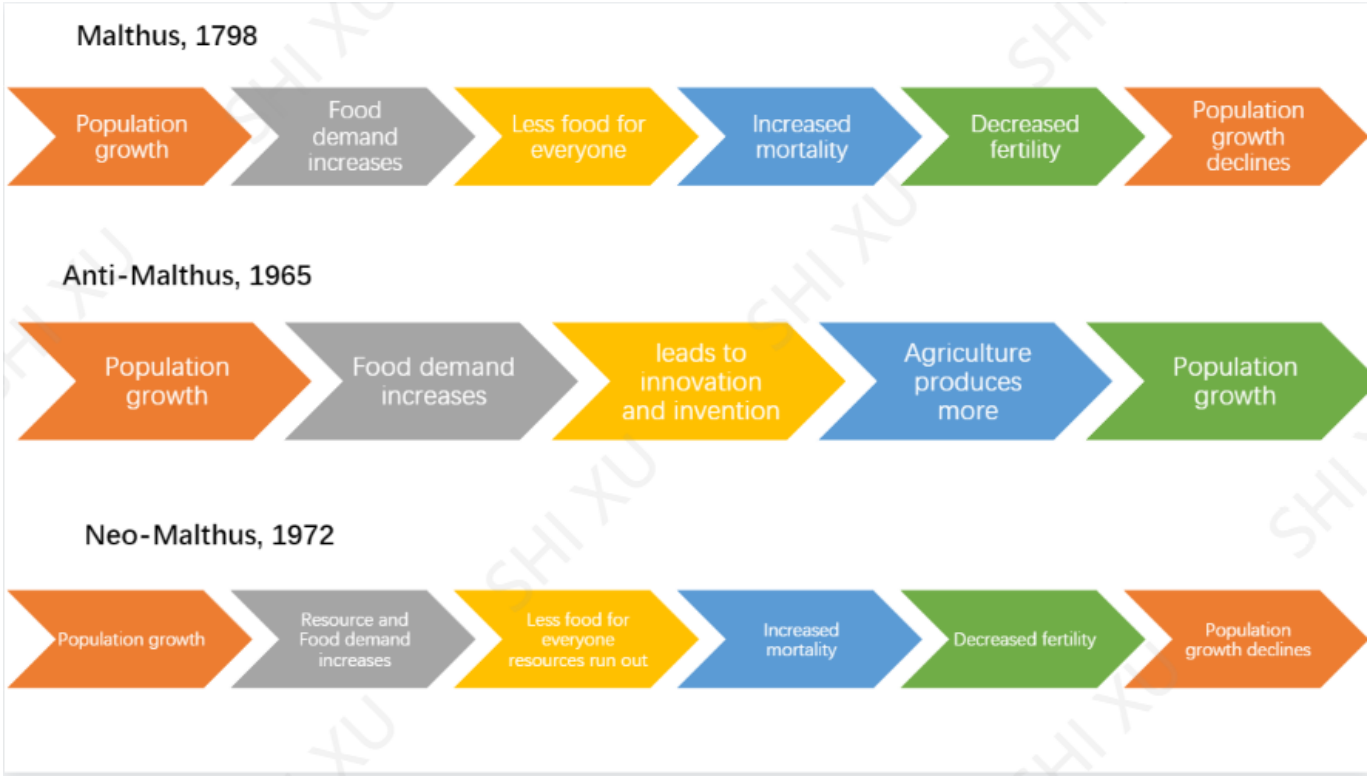
- Growing crops in greenhouses
- Use irrigation techniques (hydroponics)
- Artificial fertilizers
- Fish farming



Resource Stewardship 资源统筹协调

Humans can use resources in such a way that they will be available to future generations.

- Not only *Environmental Sustainability* but also *social equity* over access to resources.
- Powerful governments, organizations and businesses will act as stewards.
  - Adopting conservation and preservation.
  - Safeguard natural resources for the future.

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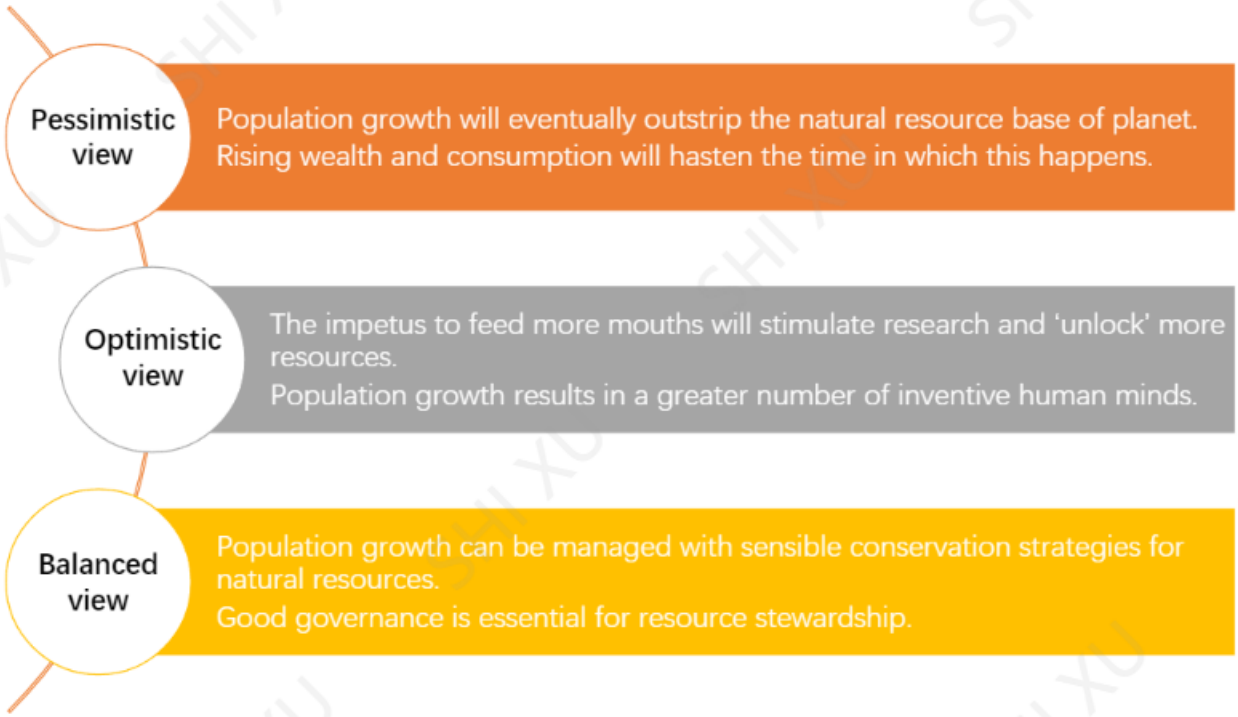

Circular Economy

- ALL outputs are *reprocessed* and all waste is viewed as a resource.
- All waste is *composted*.
- People *rent or share goods* instead of buying them.

UN Sustainable Development Goals

THE 17 GOALS | Sustainable Development

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