

# **Sustainable Development Issues and Decision-Making Techniques**

**E.M. Drake, May 10, 2005**

- **Recap of Sustainability Concerns**
- **Dilemmas of Sustainability**
- **Challenges of Making Decisions**

# Global Population Density Distribution

## World Population

<b>1650</b>	<b>550 million</b>
<b>1750</b>	<b>725 million</b>
<b>1850</b>	<b>1.2 billion</b>
<b>1900</b>	<b>1.6 billion</b>
<b>1950</b>	<b>2.6 billion</b>
<b>1980</b>	<b>4.5 billion</b>
<b>2000</b>	<b>6.1 billion</b>

-----  
**Map shows world  
Population density.  
Range yellow to dark red**

**<1 person/Km<sup>2</sup>**

**1-10**

**10-25**

**25-50**

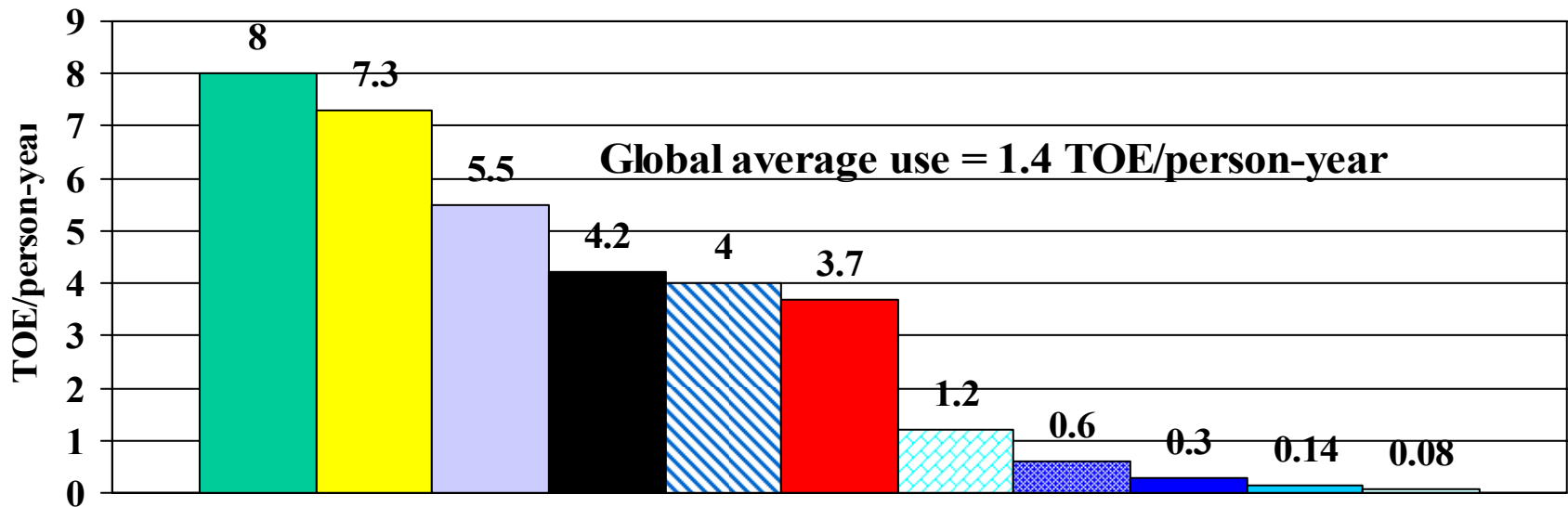
**50-100**      **From Natl. Geographic Atlas of the World, 6<sup>th</sup> Ed., Washington DC, 1990.**

**>100**

Map removed for copyright reasons.

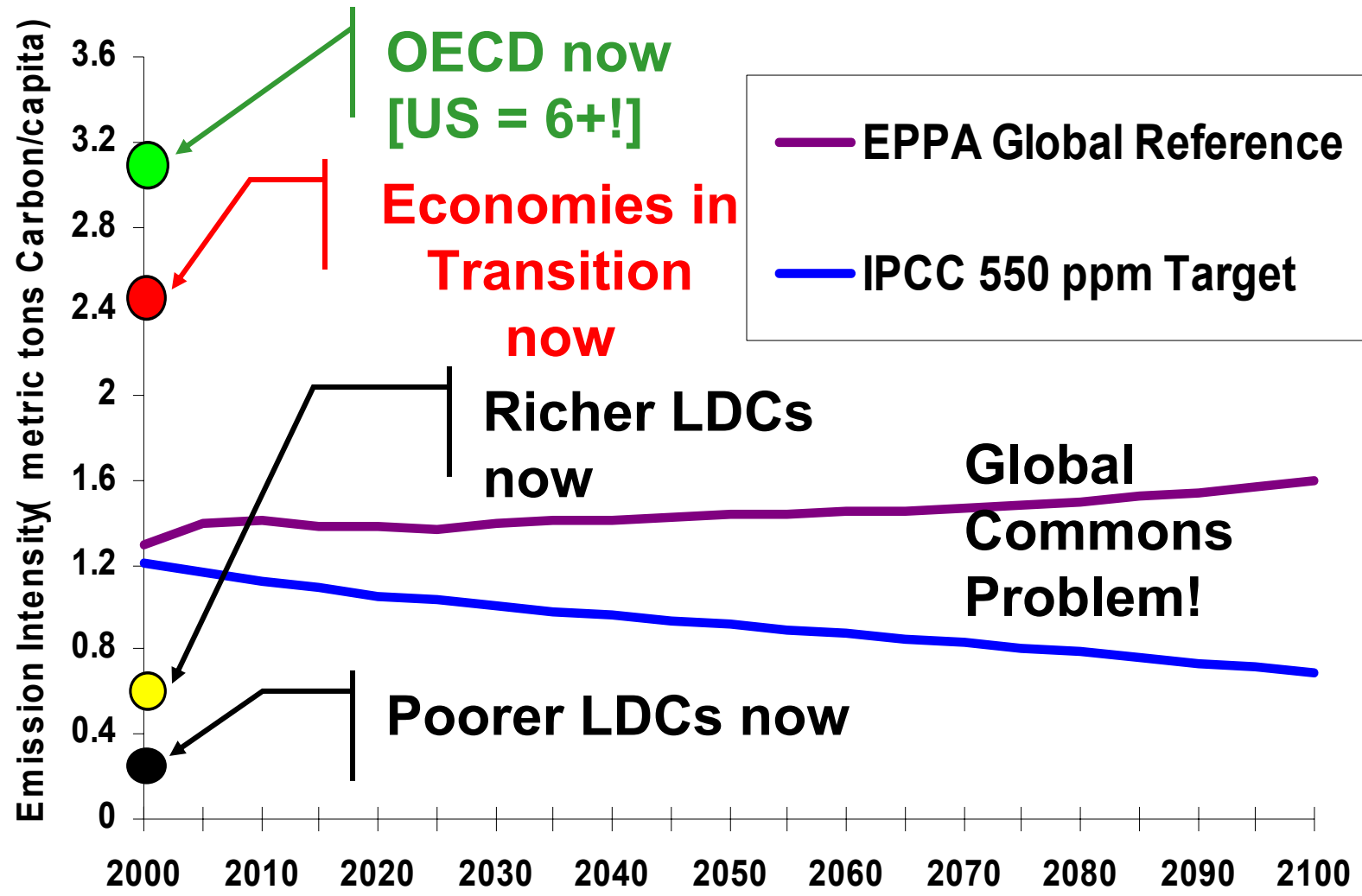
# 1999 Per Capita Average Energy Use for Selected Countries

Tons of Oil Equivalent (TOE) per person per year



Data sources: BP World Energy Statistics 1999 and New York Times World Almanac 2000 (population data).

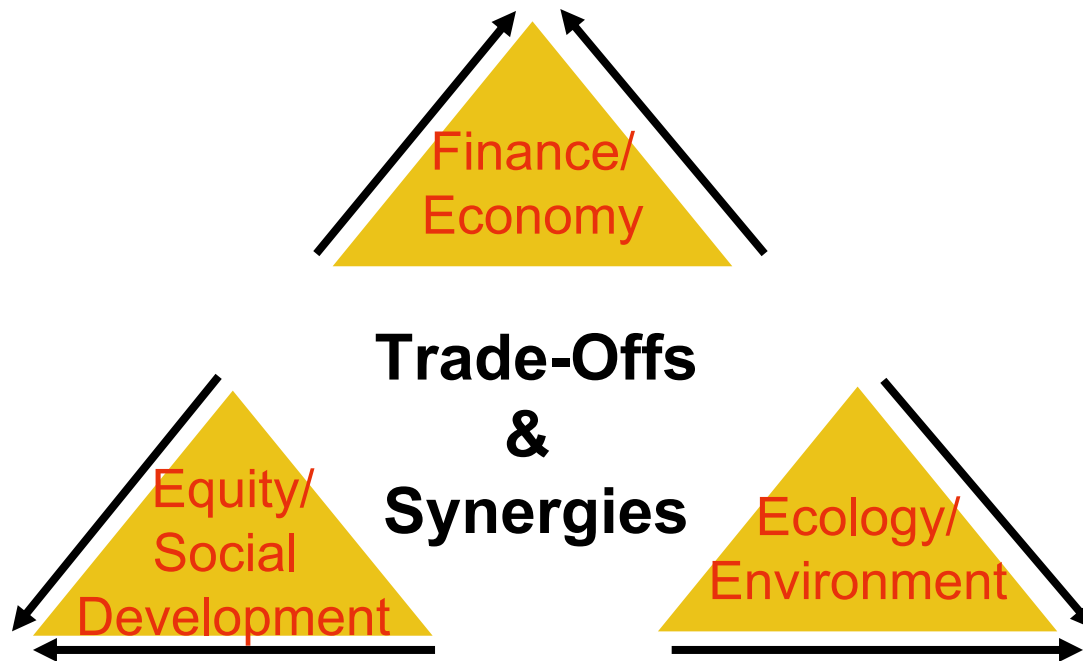
# Global Per-Capita Carbon Emissions Needed to Meet a 550 ppmv Concentration Target



**Dilemmas of Sustainability:**

**Trade-offs and Balances**

# The Three Dimensions of Sustainability



Derived from World Bank (1996)

# **Social “Sustainability”**

- **Production is key “lubricant” to development and to support of basic social systems**
  - Products, income, services, communications, mobility, etc.
- **Standard of living influences community values, options, and choices**
- **Inequity and intolerance damage social systems**
- **Production and its infrastructures produce disparate benefits and negative impacts across different groups**
  - Accidents, health problems, congestion, noise, ecosystem disruption, pollution, wars, addiction, crime, etc.

# **Economic/Financial Sustainability**

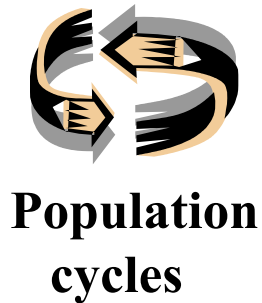
- **Industrialization and public/private infrastructure investment is essential to industrial development and general economic well-being**
- **Taxation and charges of various types are used (or mis-used) to finance governments and common needs**
- **Financing for infrastructure and necessary institutions competes with other public needs**
- **Mobility has facilitated globalization and increased international trade of goods and services**
- **Economic growth is tied to impacts of energy growth**
- **Globalization and communication have impelled poorer countries to seek rapid industrialization**
- **Do all humans have a right to basic services? Who pays?**



# **Environmental/Ecological Sustainability**

- **Rapid population growth, urbanization, and industrialization require resources and land**
- **When population density is high, the environment may be seriously impaired due to:**
  - **Air/water/land pollution**
  - **Greenhouse Gas emissions and climate changes**
  - **Disruption and damage in urban/suburban areas and rural & “wild” settings**
  - **Loss of biodiversity**
  - **Depletion of natural resources and ecosystem changes**
  - **Loss of wetlands, infrastructure-induced land use changes, partition of habitats, etc.**
- **Present use of environmental and mineral resources may limit quality of life for some others now or for future generations**

# Engines of “More”



## ULTIMATE RISKS

**GROSS INEQUITY:**  
Poverty, Wars, Mass  
migration

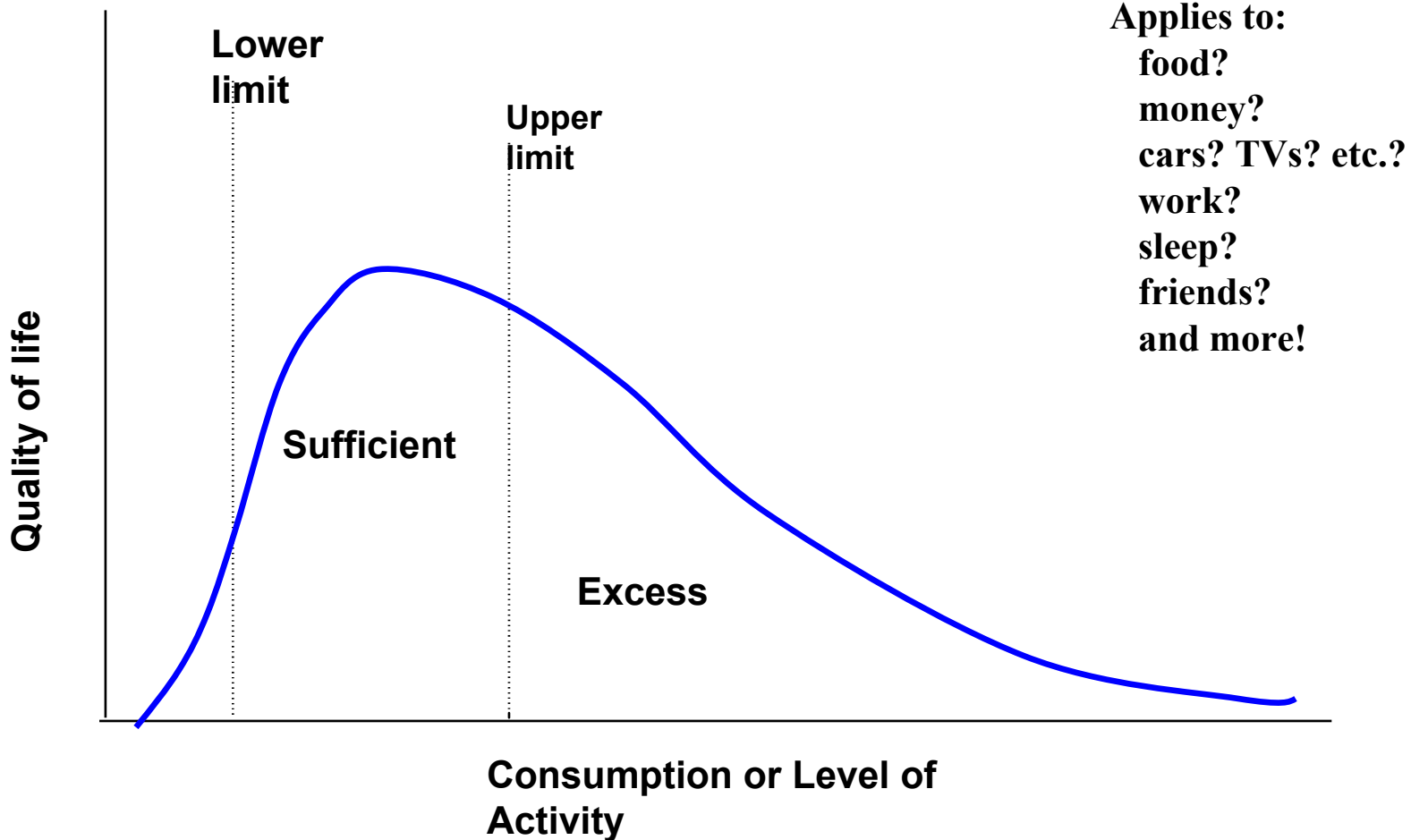
**ENVIRONMENTAL  
DAMAGE:** Climate  
Change, Pollution,  
Habitat/Species loss,  
Ecosystem disruption

**INSTITUTIONAL  
COLLAPSE:** Govts.  
and Businesses

**RESOURCE  
DEPLETION:** Water,  
Materials. and Non-  
renewable Energy

**HUMAN HEALTH  
IMPAIRMENT**

# Thring's Sufficiency Concept (slightly modified)



# Forecasting the future

- **Joint Program Model** – shows that it is difficult to reduce carbon emissions while trying to allow LDC growth
- **Hammond (1998): Which World?**
  - **Market World?** Grow wealth to afford to solve any environmental impacts – high technology! Hope or Pipe Dream?
  - **Fortress World?** Enclaves of wealth and prosperity coexist (well-defended) in a larger world of poverty and desperation (the dark side of Market World?)
  - **Transformed World?** Fundamental social and political change, helped by technology and behavioral change, create a sustainable society

## **Forecasting the future, cont'd.**

- **Meadows (1992): Beyond the Limits**
  - **A systems dynamics model that extends the earlier work by Forrester and Meadows (1972)**
- **Uses “World3” model which simulates aggregated stocks, sources, and sinks and the feedback interactions among them**
- **Performs a scenario analysis, with Scenario 1 being a world that continues present policies as long as possible**

# **Some World3 Characteristics**

- **Treats major stocks including population, cultivated land, industrial capital, pollution, etc. - boxes**
- **Nodes in model represent attributes impacting stocks; arrows show causal relationships between nodes**
- **Each arrow quantifies the sign and behavior of the causal relationship (negative loops lead to depletion, positive to accumulation, an underlying equation or matrix describes the relationship in terms of timing and magnitude of change)**

# World3 example

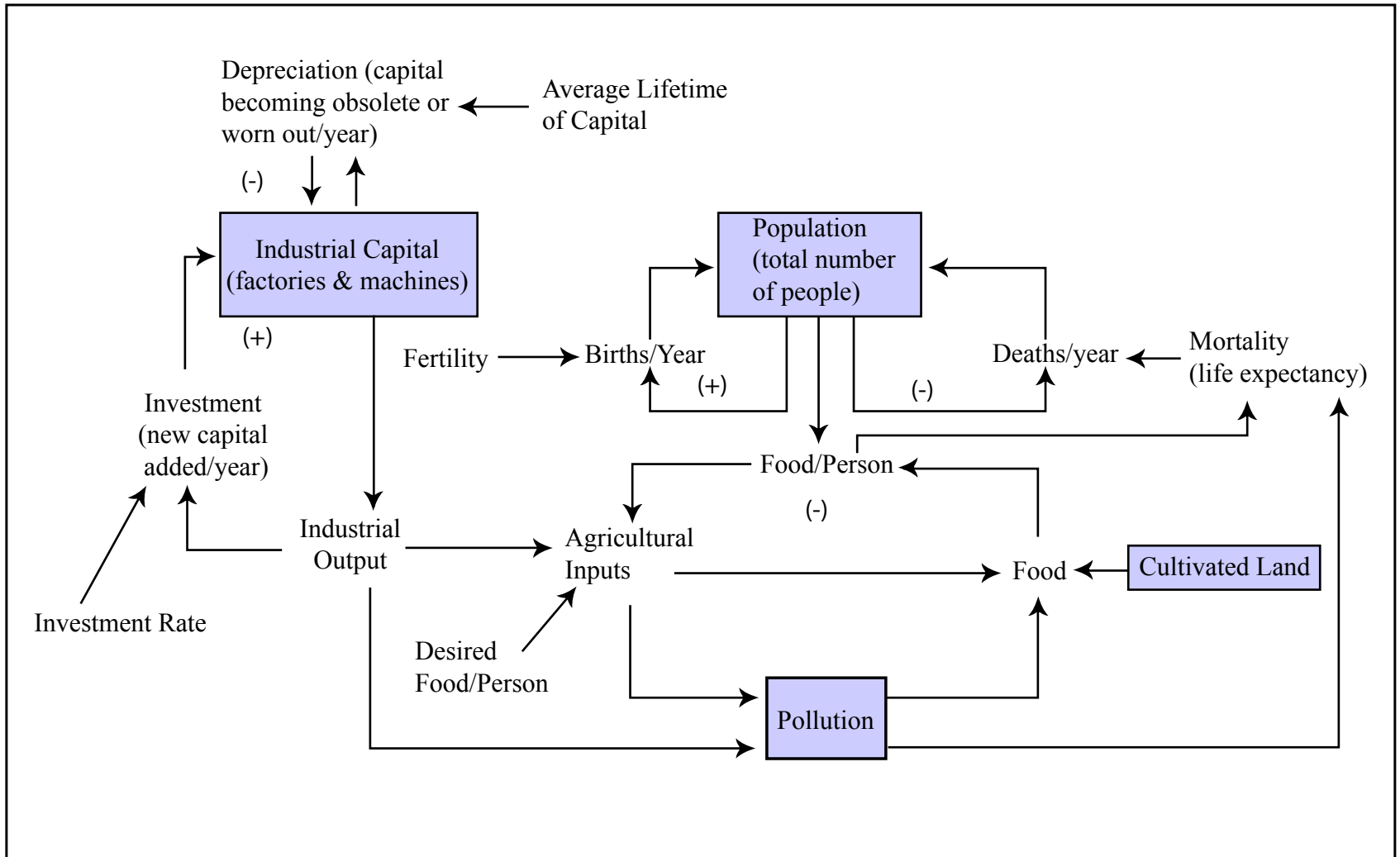


Figure by MIT OCW. After Meadows, D. H., D. L. Meadows, and J. Randers. *Beyond the Limits: Confronting Global Collapse, Envisioning A Sustainable Future*. Post Mills VT: Chelsea Green, 1992.

# Scenario Analysis

- **Scenario 1 – business as usual – until resources are seriously depleted and pollution rises. Food and industrial output decline rapidly – by 2100 industrial activity is a few per cent of its peak level, population is lower, and most resources are depleted**
- **Other scenarios examine various other types of changes and timing of changes**
- **Scenario 12 – world population stabilizes and policies change to downsize industrial output starting in 2015. By 2100, end state is better than for scenario 1, but still well below present levels**

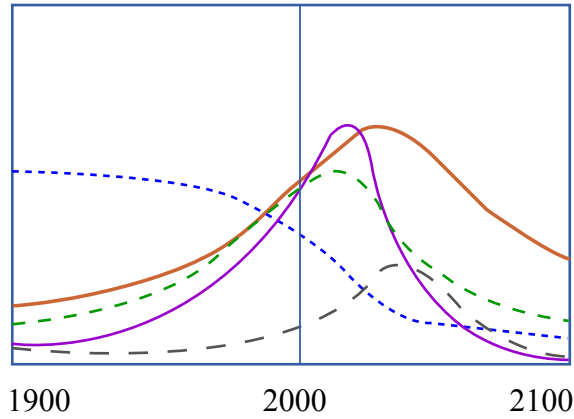


# Population stable and Transition to sustainable behavior in 2015

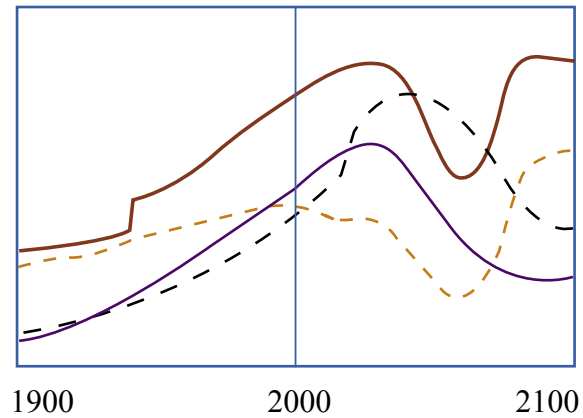
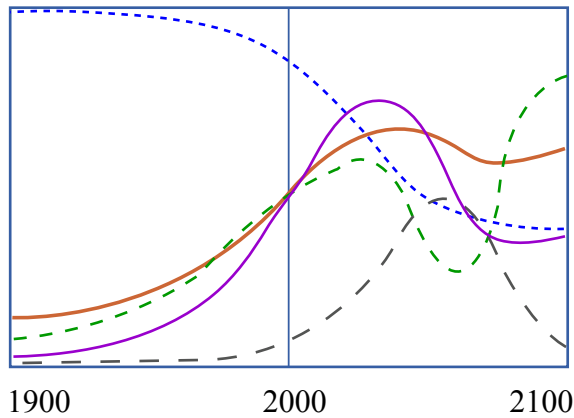
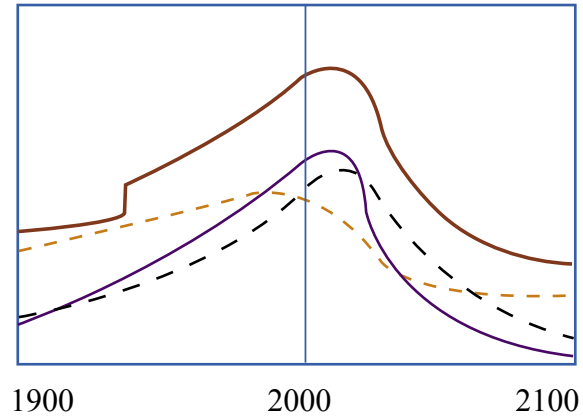
## Business as Usual

## Note resource scale expansion x 2!

State of the world



Material standard of living



## Is this World3 Model Real?

- Includes many assumptions
- May not include all important factors
- Cannot be considered an accurate forecaster, BUT it
- Captures major factors
- Gives some insights on future possibilities that seem to fit our general knowledge

# **Value of Models and Scenario Analysis**

- **Demonstrate some of the dilemmas of sustainability**
- **Give a framework for examining the effects of various potential strategies for change**
- **Show the great inertia in the global system that makes some types of change difficult**
- **Provide some understanding of the time frames for global system changes and impacts**

# **How much can technology do?**

- **Technology impacts have amounted to 1-2% efficiency improvement per year – a mix of innovations and improvements**
- **Communications, IT, and mobility overlap in ability to connect people**
- **Technology alone will not offset the high rates of growth expected in China nor the growing consumption in the US**

# **Challenges of Making Decisions**

- **Multiple layers of decision making – individual to global**
- **Multiple goals that often conflict and require compromise**
- **Trade-offs required – both in time and space**
- **Different value systems and cultures**
- **Difficulty of allocating resources and care to the commons**

# How might decisions be made?

- **Decision support tools**
  - **Simulation models - optimization**
  - **Decision models – utility assessment, MAUA**
  - **System dynamics models**
  - **Game Theory**
  - **Risk Assessment**
  - **Consultants, Advisory Panels, Scenario Analysis**
  - **Negotiation**
  - **Mediation**
  - **Non-violent communication techniques....**

# **What are the barriers?**

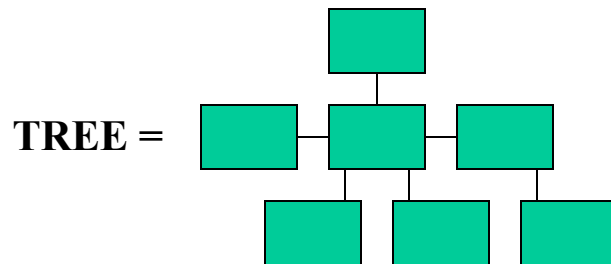
- **Government and Institutional structures traditionally have managed with subdivided (compartmentalized) spheres of authority**
  - **Difficult to manage broader priorities that cross competing interest groups**
  - **Difficult to value “externalities”**
  - **Difficult to deal with uncertainties**
  - **Difficult to restrain human behavior that tends to value short term gains more than long term stewardship**

# Solving and Learning Modes

- **Solving**

- Mechanistic, rule-based
- Specialist, self-focus
- Deterministic, Linear
- Cause-Effect, root cause
- Error avoiding
- Decompositional
- Technological
- Right-wrong, win/lose

Examples: Litigation, wars



- **Learning**

- Knowledge-based
- Generalist, goal focus
- Divergent, Intuitive
- Non-linear, dynamic
- Error expected
- Integrative
- Collaborative
- Consensus

Examples: Treaties, town meetings





# **Some Key Issues for the US**

- **Present international policies seem to move in the direction of “fortress world”**
- **Climate change concerns are being addressed in a manner that will make minor changes with modest or no impact on the economy**
- **US companies are moving production to cheaper labor and materials locations in other countries – US industry becoming more dependent on outside resources**
- **US policy on renewable energy and conservation will only yield small changes at present levels – we are still dedicated to our right to have access to cheap energy (favoring fossil fuels)**

# LDCs? How is China Doing?

- **Progress**

- **Elimination of abject poverty**
- **Population control**
- **Rapid growth in GDP**
- **Cautious removal of trade barriers**
- **Gradual government restructuring**
- **Cautious transition from managed to market economy**

- **Challenges**

- **New institutions with limited capital struggle to meet growing demands**
- **Corruption and lack of strong legal system**
- **Urban congestion and pollution**
- **Huge, diverse country**
- **Balancing the past and the future; the foreign and domestic; the present and future**

# **Lessons from the OECD**

- **Land use and economic planning are important**
- **Business economics are focused on the short-term; long-term public interests will not be preserved unless some public provision is made through regulation or economic policies**
- **Vested self interests can destroy the Commons**
  - [Corporate, National, Personal]
- **There is no easy answer; complex issues**
- **Great benefits from doing the work!**

# **A Transition Toward Sustainability?**

- **Use of indicators to measure progress in areas of social and environmental as well as economic concern (poverty, inequity, local and global pollution, resource depletion, health, political instability.....)**
- **Integration of sustainability goals so that tradeoffs can be made in time and space depending on local circumstances**

# Rio Principles

- **Fundamental human rights met**
- **Common concerns protected (e.g., local/global env.)**
- **Common but differentiated responsibilities**
- **Duty not to cause environmental harm**
- **Integration of environmental and social factors**
- **Polluter pays**
- **Precautionary principle**
- **Public participation**
- **Right to development**

# Speth's\* 8 Transitional Pathways

1. **A stable or smaller world population**
2. **Free of mass poverty**
3. **Environmentally benign technologies**
4. **Environmentally honest prices**
5. **Sustainable consumption**
6. **Knowledge and learning**
7. **Taking “good governance” seriously**
8. **Transition in culture and consciousness**

**\*Speth, J.G., “Red Sky at Morning,” Yale Univ. Press 2004**

# So, how are decisions *really* made?

- **Consumers: cost, value, features, availability**
- **Investors: ROI and windfalls**
- **Regulators: set minimum standards of acceptability; protect from litigation and error**
- **Congress: election impacts, some deals and swaps**
- **Industry: short term profits; shareholder value**
- **NGOs: litigation, PR, shareholder initiatives**
- **Nations: security, growth, economic health**
- **UN: negotiations reflecting self interests while working on global issues**

# Rewards of Action

- **Perhaps a better quality of life with enough to meet our needs – not our wants!**
- **A different business paradigm – not mass production, but life cycle service production with regard to externalities**
- **Greatly reduced social inequity and improved societal stability**
- **Appreciation and care for diversity, both human and environmental**



# So, who can lead us to the future?

- **Government leaders? (How much success will Tony Blair have)**
- **Business Leaders? (Could a group of multi-national CEOs decide to commit to a set of sustainability transitional principles?)**
- **Educators/Media? (usually more responsive to wants of public and potential students)**
- **Committed individuals? (voting choices, buying choices, lifestyle choices... need critical mass)**
- **All of us in our own ways?**

# What can we each do?

- In choosing careers?
- In our professional lives?
- As private citizens?
- As national citizens?
- As global citizens?

*How much are we willing to do?*

## Some web sites of interest

- <http://web.mit.edu/globalchange/www/>
- <http://www.ipcc.ch/>
- <http://www.nationalacademies.org/publications/>
- <http://www.sustainableliving.org/>
- <http://unfccc.int/>
- <http://www.un.org/millennium/summit.htm>
- <http://www.un.org/esa/sustdev/index.html>
- <http://www.cnvc.org>
- <http://publications.worldbank.org/WDI/>