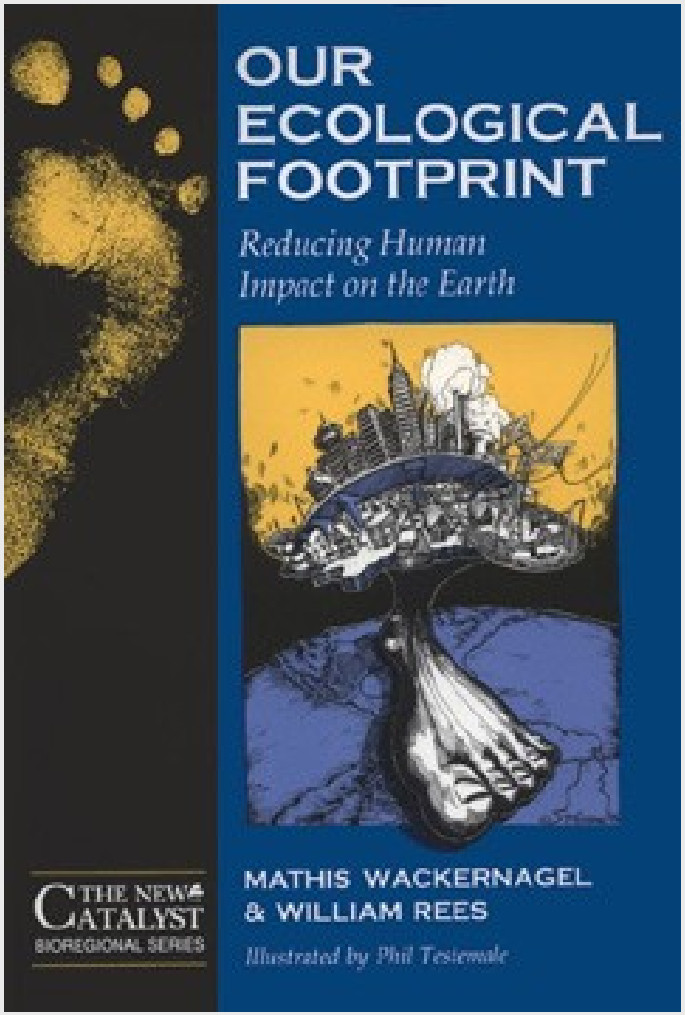
# Ecological Footprints



# We Depend on Nature

- We exchange energy and matter with our environment as we
  - **Eat**
  - **Drink**
  - **Breathe**
- **We use**
  - **Energy for heat and mobility**
  - **Wood for housing and paper**
  - **Food and water for living**

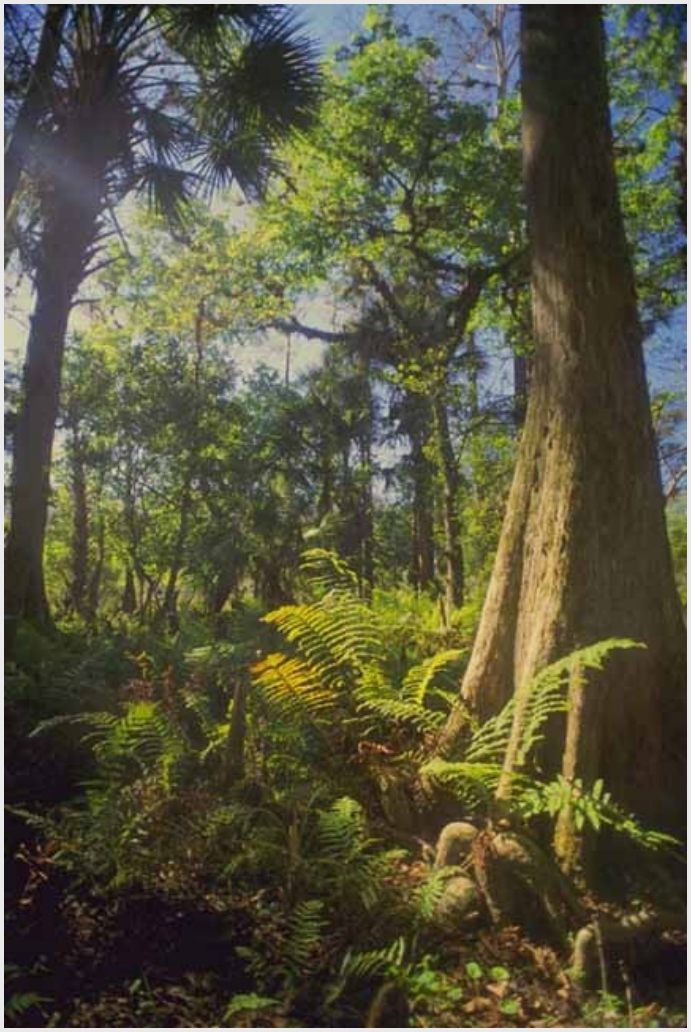
# We Depend on Nature

- **Nature**
  - **Absorbs our wastes**
  - **Provides climate stability**
  - **Protects us from ultraviolet radiation**
- **In cities we tend to think of nature as a collection of commodities we obtain from around the world**
- **But nature is the very source of our lives and well being**

# Ecological Footprints

- **The amount of ecologically productive land used by individuals, cities, countries, etc.**
- **Production and use of goods and services involve land use: have ecological footprints**

# Ecological Footprints



- **Energy Land**
  - **Fossil energy consumption requires Co2 sink**

# Ecological Footprints

- **Consumed Land**
  - **Built environment**

# Ecological Footprints

- **Farm Land**
  - **Food production**

# Ecological Footprints


- **Forest Land**
  - **forest products**

# Transportation Footprints

- If one person travels 5 kilometers twice each workday:
  - **Bicycle: 122 sq meters**
  - **Buses : 301 sq meters**
  - **Cars: 1,442 sq meters**

# Agricultural Footprints

- **Open Field production of tomatoes takes up more land than greenhouse production**
- **But Greenhouse production has a much larger ecological footprint (10-20x)**
  - **Energy**
  - **Fertilizer**
  - **Other inputs**

# Urban Footprints

http://antwrp.gsfc.nasa.gov/apod/ap970408.html

- **Imagine New York City covered by a bubble like Biosphere II in Arizona**
- **Most people would die within a few days**
- **Cities depend on much greater amount of land, environment for vitality**

# Urban Footprints

- **Now imagine how big that bubble would have to be for the city to be *self-sustaining***
- **This is the ecological footprint of the city**
- **Actually 347,000 square miles**
  - **to support 20 million in U.S. lifestyle**
  - **size of Texas and Oklahoma combined.**

# National Footprints

- **Holland population  15 million**
- **Density = 4.4 People per Hectare**
- **Consumption is less than in U.S.**
- **Still, Dutch people require 15x more land than is within their country for**
  - **Food**
  - **Forest Products**
  - **Energy Use**
- **Therefore, the ecosystems that support Holland lie far beyond their national borders**

# National Footprints

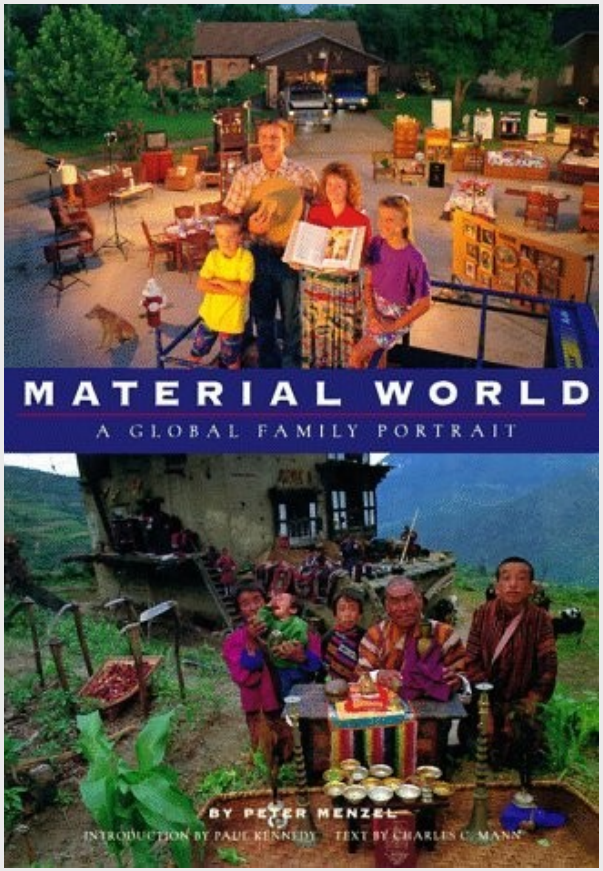
- In U.S. each person uses about 4.5 hectares/person
- Worldwide average = 1.5 hectares/person
- Therefore if everybody were to adopt the U.S. consumptive style, we would need 3 planets



# Iowa Footprint

- **Iowa Population is 2,776,000**
- **U.S. average footprint is 4.5 hectares/person**
- **Iowans need 12.5 million hectares of average land to support themselves**
- **Iowa area is 14.5 million hectares**
- **Therefore we can support at least another 444,000 Americans**

# Inequity




http://www.thesavvytraveller.com/agraphics/insights/geography/1general/photoessays/dalusio_menzel/material_world.jpg

- We all compete for ecologically overloaded world
- Excess consumption by affluent countries takes up ecological footprint that would be used by poorer nations

# Resource Distribution

- **Wealthiest 25% of the world uses 75% of the world's resources**
- **If four people landed on an island, could divide the land up into 4 equal sections, trade goods.**
- **Is it fair if one of those people claims ¾ of the land, forcing the other 3 to live off of ¼ of the land?**

# Can everyone live like we do?

- **No. There is not enough earth to support it**
- **Thus all poor countries cannot follow the miracle of developed countries**
- **Someone must bear the ecological burden of consumption by the affluent**
- **Our continued over-consumption hits the poor hardest**

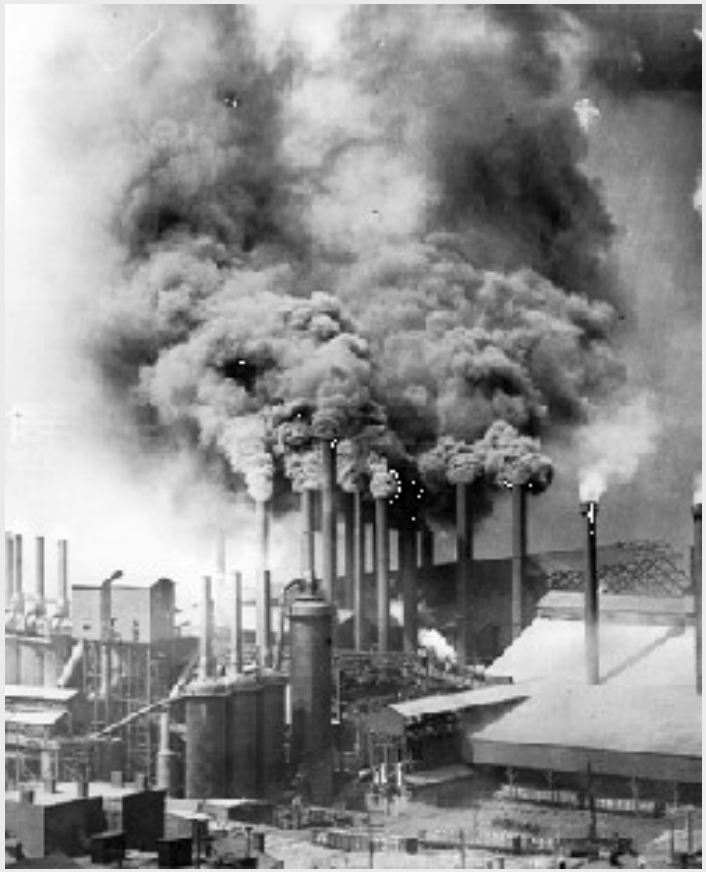
# Science Objection

- Footprint Analysis is a crude simplification
- Interactions with nature are complex
- Can’t reduce such complexity to a mater of hectares

# Answer to Science

- **Footprint analysis may not tell whole story**
- **Is good enough to show us what must be done**
- **Newtonian physics good enough to get us to moon**
- **Avoid paralysis by analysis**
- **Footprints may actually underestimate impact of humans on environment**

# Marketplace Objection



- Global income is rising faster than human population
- Agricultural production is responding to growing demand
- **Environmental problems are due to poorly defined property rights or prices**
- If prices right, market will solve problems

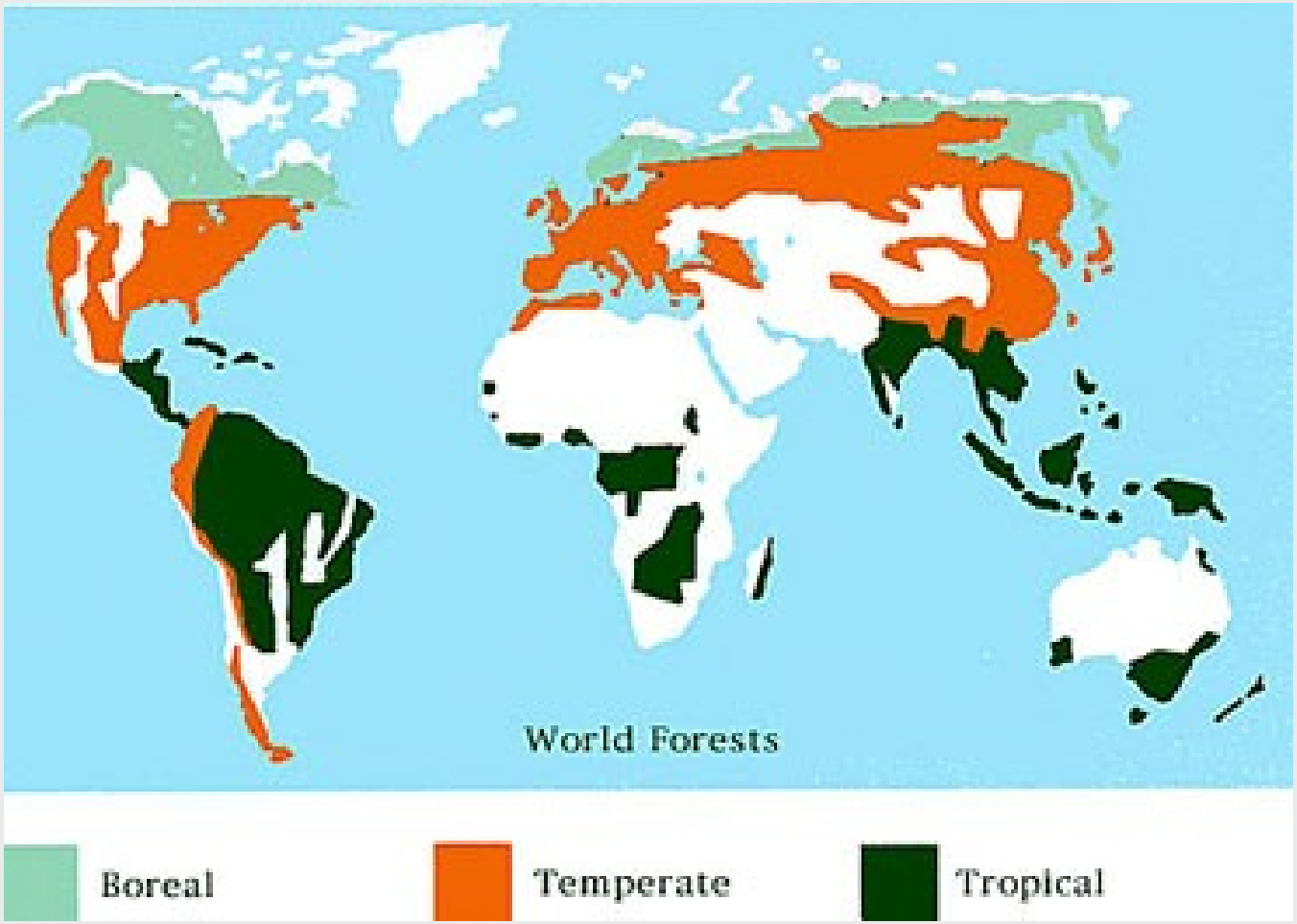
# Answer to Marketplace

- Yes, when nature is undervalued, it gets used and abused
- Pollution charges and depletion charges can be useful to reduce environmental damage
  - **Require Government Intervention**
- Footprint analysis may help determine true costs

# Answer to Marketplace

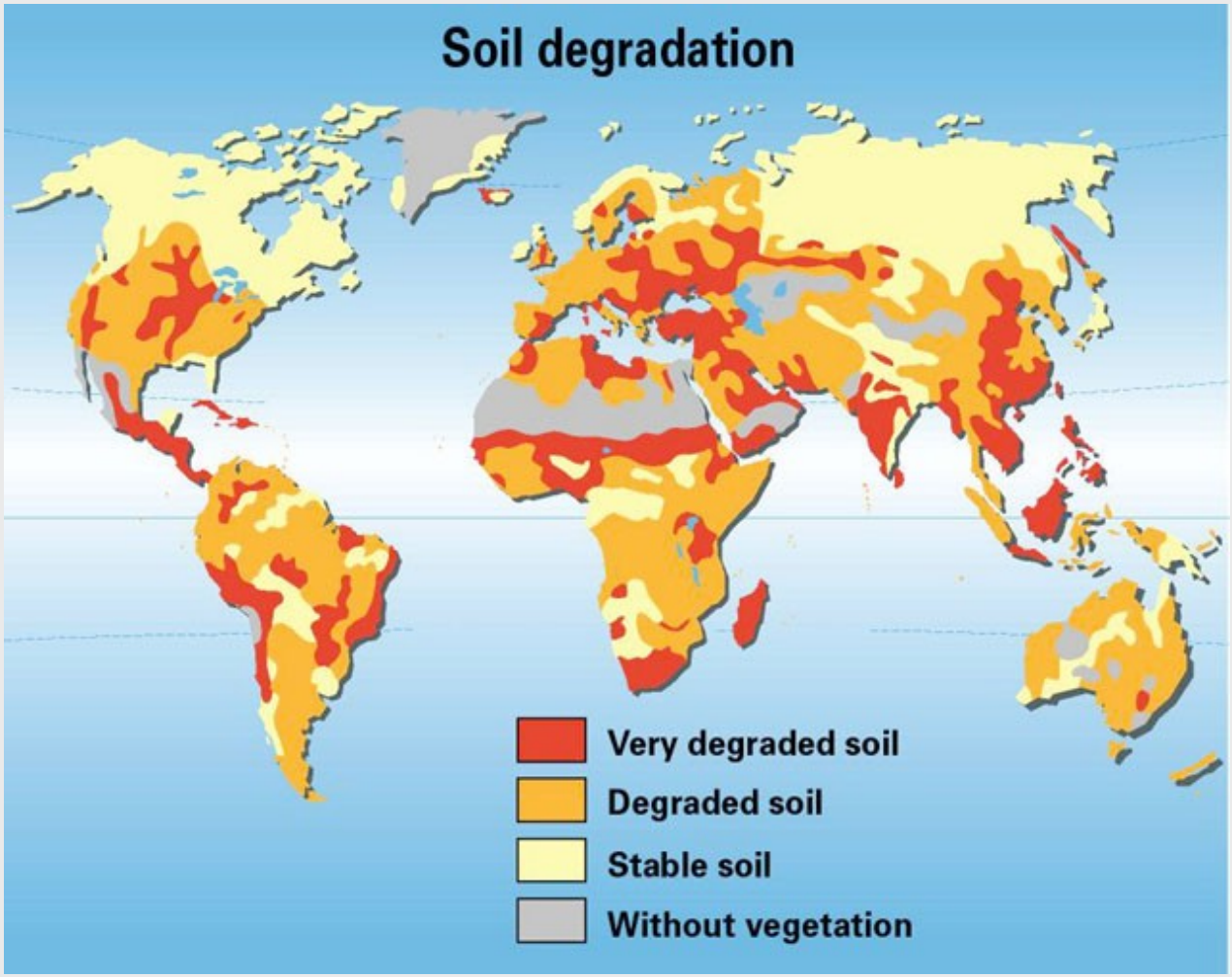
- Not everything in nature should be privatized or priced
  - **Stable Climate?**
  - **Safe Ozone Level?**
- Much of our income today derived from liquidation of our natural “capital”

# Natural Capital: Forests




http://www.iisd.org/wcfsd/worldmap.jpg

# Natural Capital: Soils




http://www.povertymap.net/mapsgraphics/index.cfm?data_id=23360&theme=

# Free Trade Objection

- **Trade is beneficial, has improved standard of living**
- **Let people in different parts of the world do what they do best: Comparative Advantage**
  - **Coffee and Bananas from Developing Countries**
  - **Computers from Developed Countries**
- **Is also more economically efficient to do what is more ecologically efficient**
  - **Makes sense for tomatoes to be grown in Mexico rather than in greenhouses in Canada**

# Answer to Free Trade

- **Economics looks at money flow**
- **Footprint analysis looks at Ecological flow**
- **Hong Kong, Switzerland, Japan provide little ecological productivity to the world, draw a lot.**
- **Not everybody can be a net importer**

# Answer to Free Trade

- Expanding economy stimulates depletion of planet's natural resources
- People who are using Footprint resources far from home have no incentive to conserve them

# Answer to Free Trade

- **Intensive production methods accelerate depletion and pollution**
- **Economic benefits of intensive production are not equitably distributed**
- **Those who need income displaced from land**
- **Profits from intensive Ag go to those already well off.**

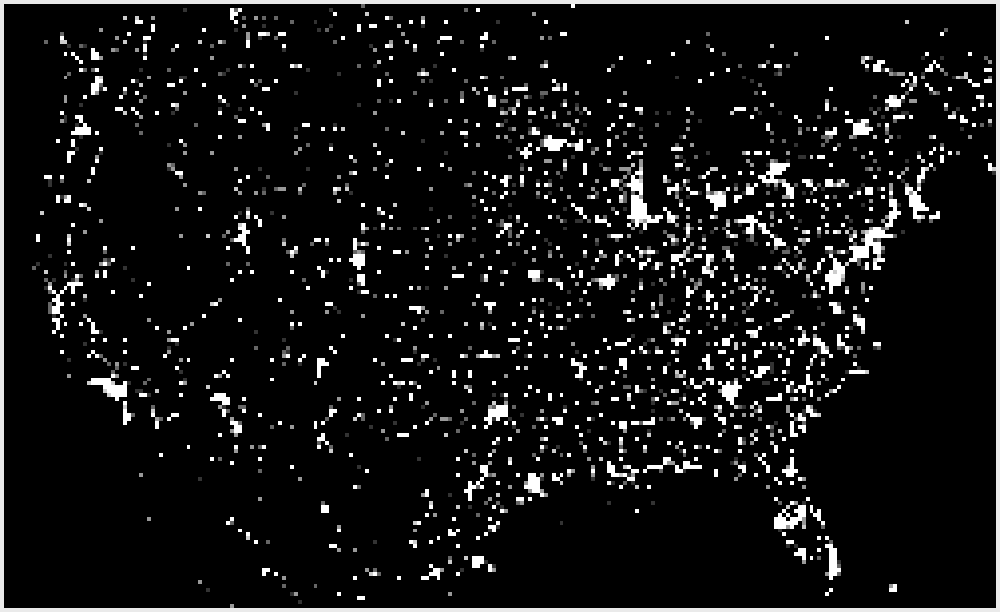
# Answer to Free Trade

- **Global economy is pressing ecological limits**
- **Poverty still affects 1 billion people**
- **We don't need "Free Trade"**
- **Need terms of trade that**
  - **Encourage rehabilitation of natural capital**
  - **Direct benefits of export activities to those who need them**

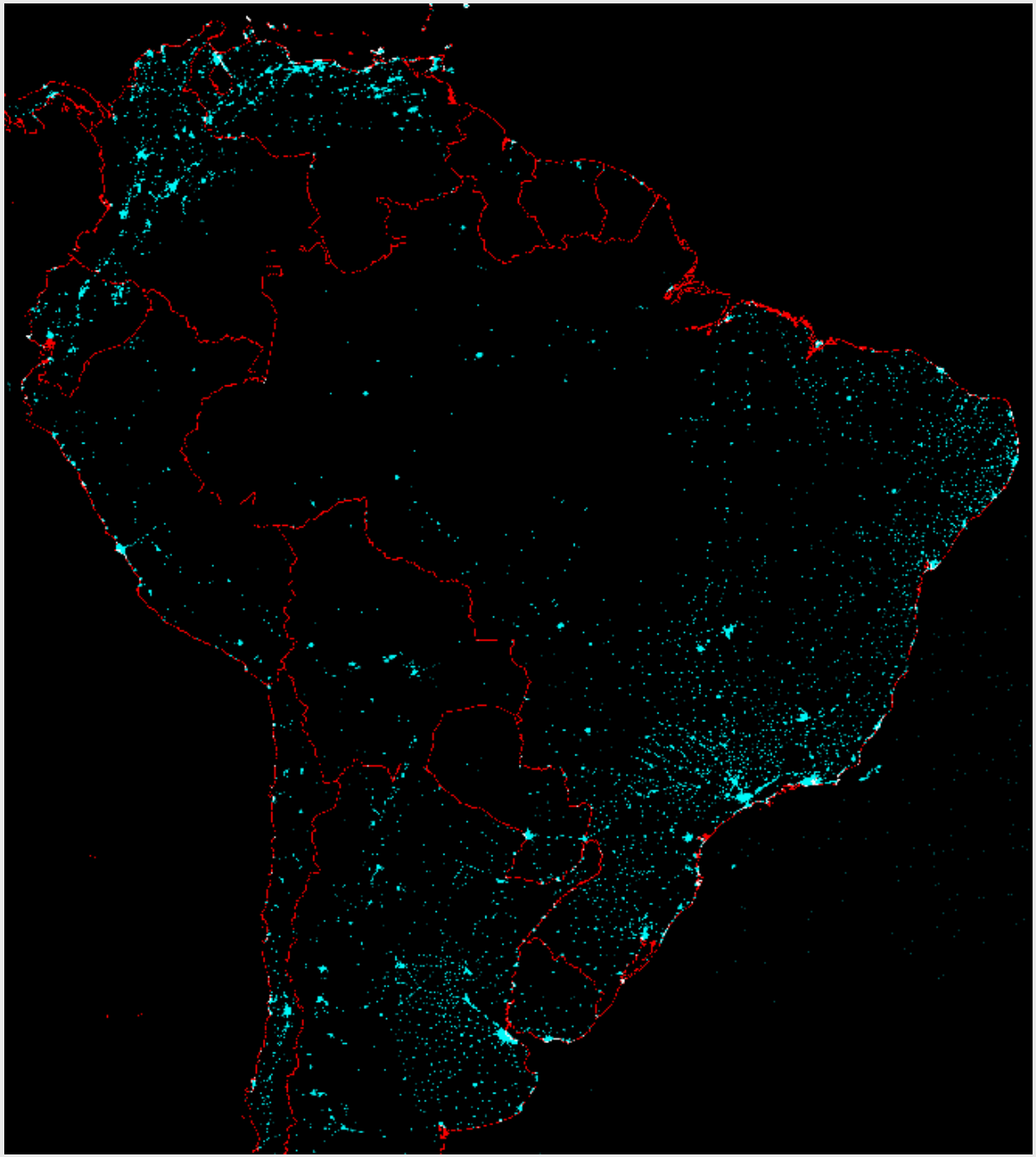
# Uncertain Future Objection


- Prediction about the future are always way off
- Can be sure the future will be different from what we expect

# Answer to Uncertain Future



- Footprint Analysis is not a predictive tool
- Is an “ecological camera” that takes a snapshot of our current demands on nature
- Extrapolation into future really measures sustainability gap”



# South America

# Europe

# East Asia

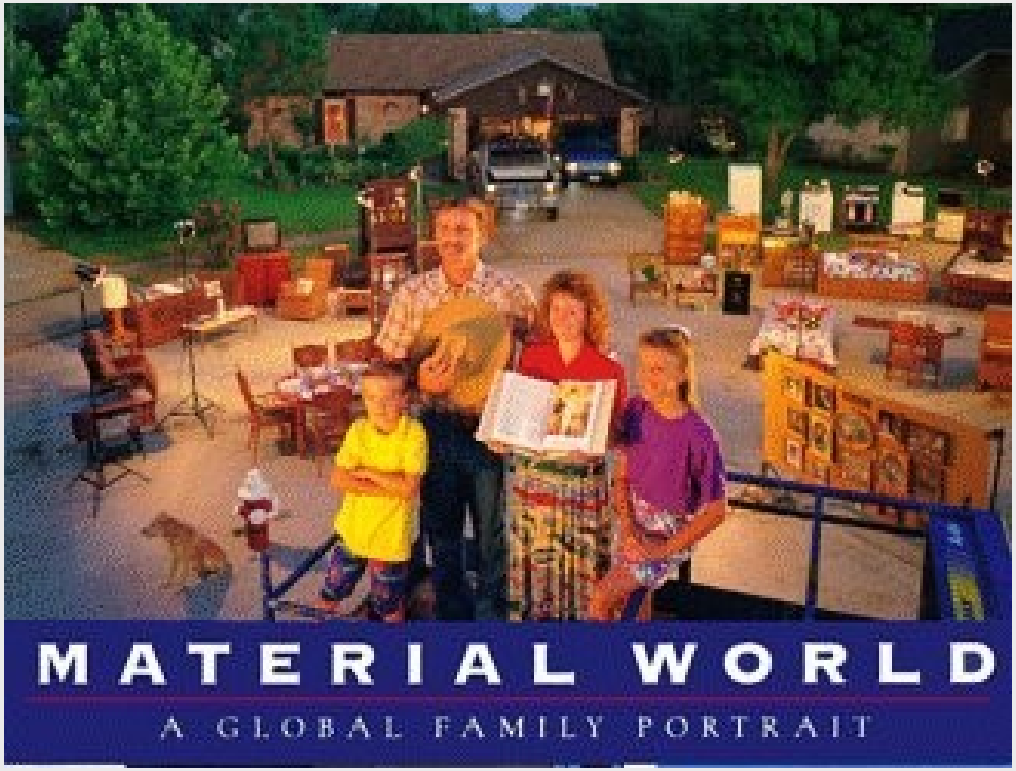
# Answer to Uncertain Future

- Footprints also show material inequity
- Footprints show us how much we must
  - **reduce our consumption**
  - **improve technology**
  - **change behavior to be sustainable**

# Technology Fix Objection

- **For hundreds of years people have worried that we would run out of resources**
- **Technological revolution has increased abundance and lowered prices of goods and services**
- **Thus one farmer produces more than 200 farmers did 200 years ago**

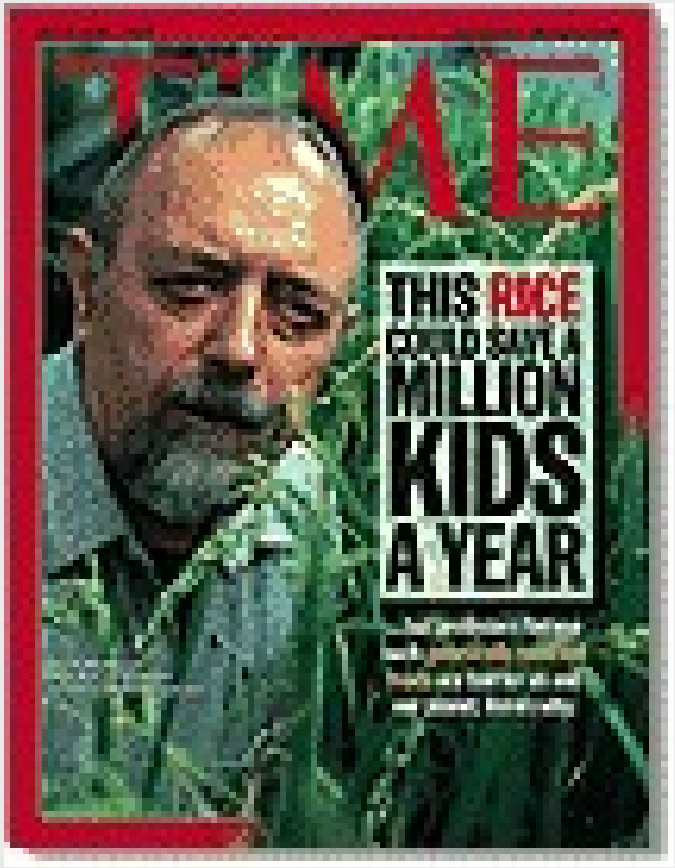
# Technology Fix Objection




http://www.thesavvytraveller.com/agraphics/insights/geography/1general/photoessays/dalusio_menzel/material_world.jpg

- Millions in N. America better off than kings and queens in past due to technology:
  - **Live more comfortably**
  - **Are healthier**
  - **Feel more secure**
  - **Eat better**

# Technology Fix Objection




- **Computer revolution could not be predicted**
- **We can't anticipate future benefits of genetic engineering**
- **When people faced with a problem they come up with a solution**
  - **Medicine**
  - **Transportation**
  - **Communication**
- **We can fix any problem in the future**

# Answer to Technology Fix

- Technology will play a role in making society more sustainable
- If global economy to be 10x the size of today, we need technology that makes us 10x more resource efficient
- Solar water heaters, insulation reduce our footprints and maintain standard of living

# Answer to Technology Fix

- Some technologies substitute natural capital for labor:
  - **Intensive Agriculture**
- Gains in technology can encourage consumption
  - **Efficient cars just used more frequently!**
  - **Despite efficiency gains, energy consumption has increased**

# Optimism Objection

- Footprints are depressing
- Apocalyptic visions never come true
- Look on the bright side!

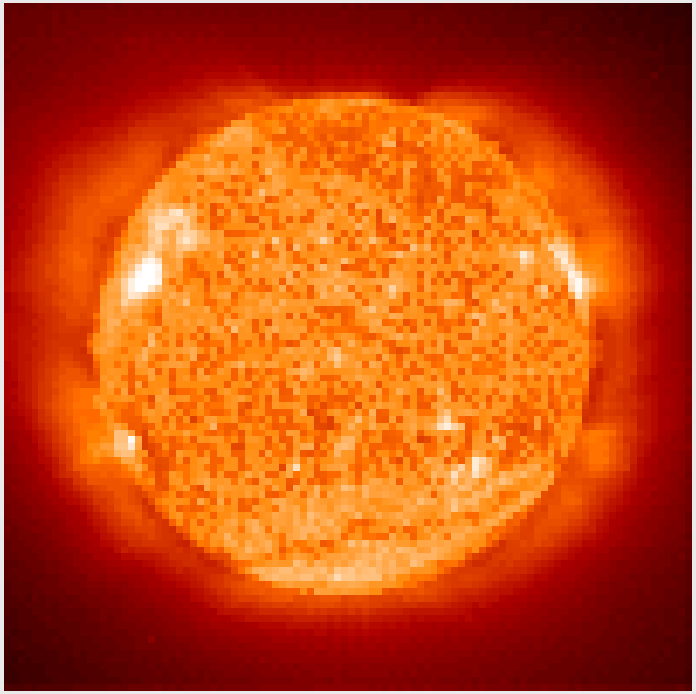
# Answer to Optimism

- Acknowledging finite capacity of Nature is not pessimistic: is realistic
- It allows wise decisions
- Footprint assumption: we must live with global carrying capacity
  - Number of people the earth can sustain
- If we choose wisely, may increase quality of life
- Concerned that our life now is destructive
- Sooner we start moving toward sustainability, easier it will be for humanity

# Energy Production Objection

- **Energy is driving force of human enterprise**
- **With enough energy we can do anything**
  - **Clean up environment**
  - **Irrigate Deserts**
  - **Build fast transportation networks**
  - **Power highly productive greenhouses**
- **Soon we will have unlimited energy sources**
  - **Fusion, Fission**
  - **Tidal, Solar**

# Answer to Energy Production



- Sun = 175,000 terawatts shine on earth
- Fossil fuels use =10 terawatts
- Imagine impact of unlimited energy supply
- We've run down planet with just 10 terawatts
- extended human activities may produce new limiting factor: Waste Assimilation
- Still, moving toward solar energy would be good, would reduce our footprint

# What Should We Do?

- **I asked the author of this book what kind of technology research he thought the universities should be doing**
- **Answer: Research to help us reduce our ecological footprint without reducing our standard of living:**
  - **sustainability**