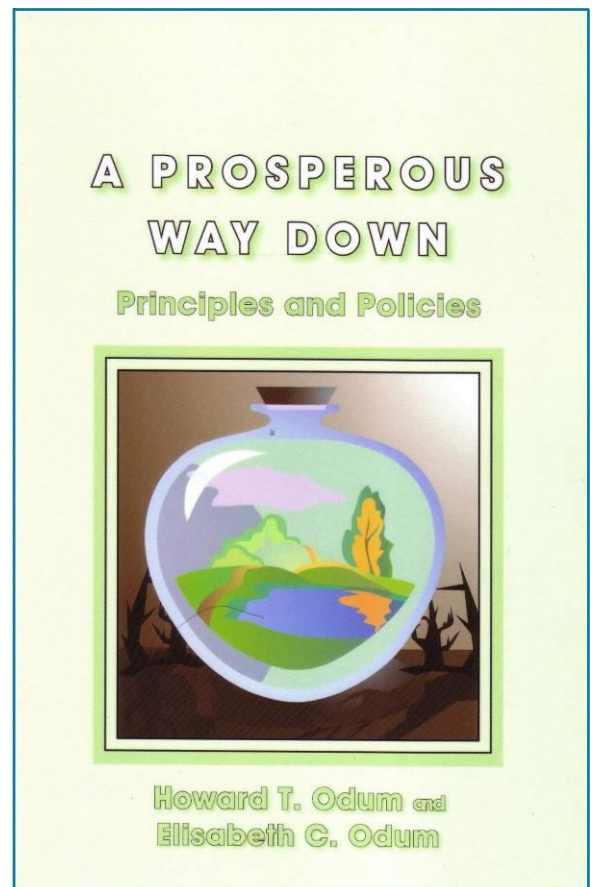


Understanding and Planning A *Prosperous Way Down*

Howard T. Odum and
Elisabeth C. Odum

Produced by Tom Abel



Our Futures

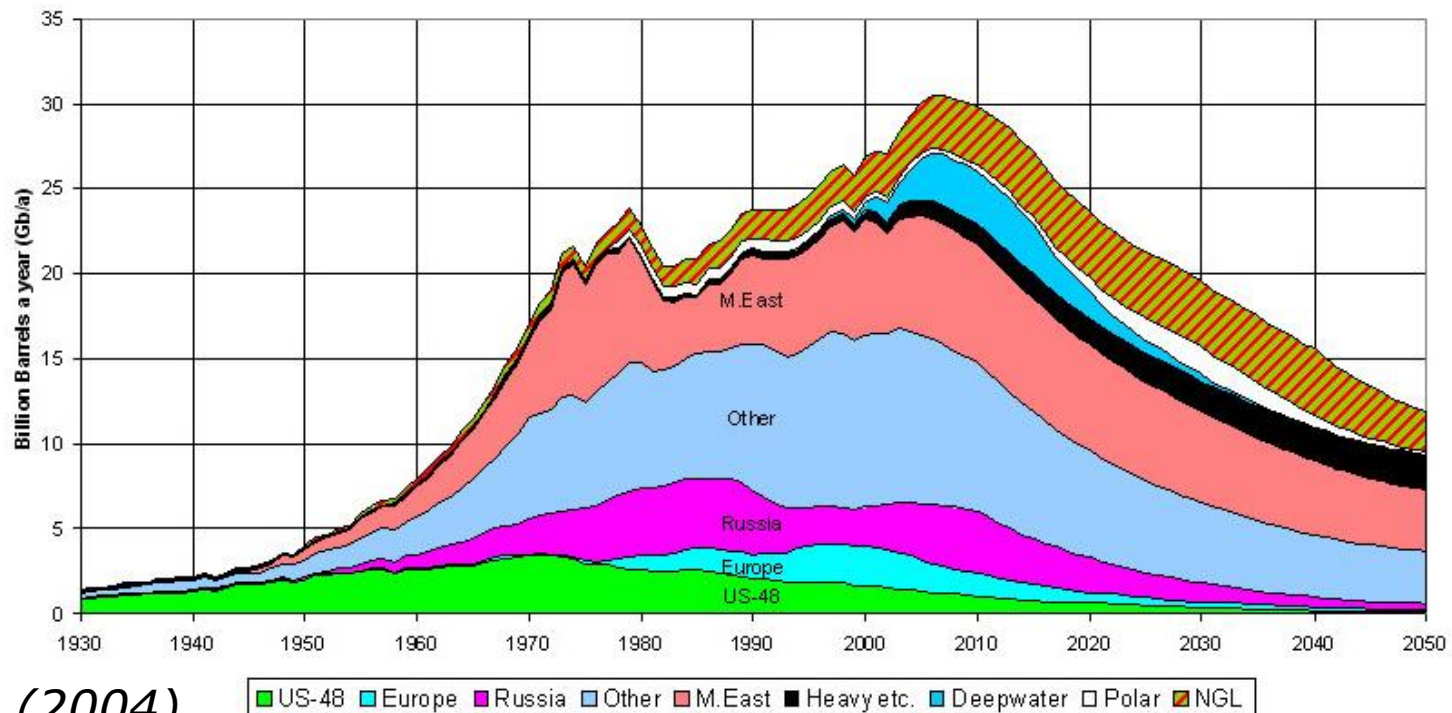
- Now is a time of:
 - Peak Oil
 - Large world populations
 - Stress on many ecosystems
 - Economic problems
 - Growing social inequality



Our Futures

○ Peak oil

OIL AND GAS LIQUIDS 2004 Scenario



Campbell (2004)

Our Futures

- What will our futures look like?



Our Futures

- Grow forever – Techno-optimists
- Imminent collapse – Dystopians



Techno-optimists

← Two extremes →



Dystopia

Our Futures

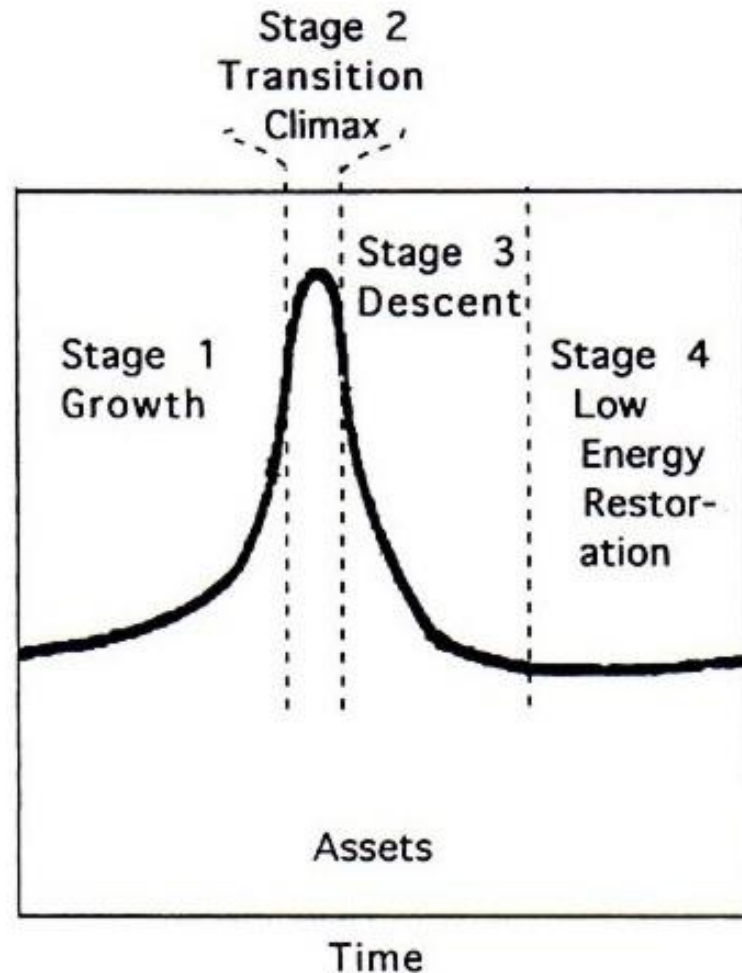
- Value ecosystems
- Recognize limits to resources
- Maintain the essences of life that are meaningful to us...



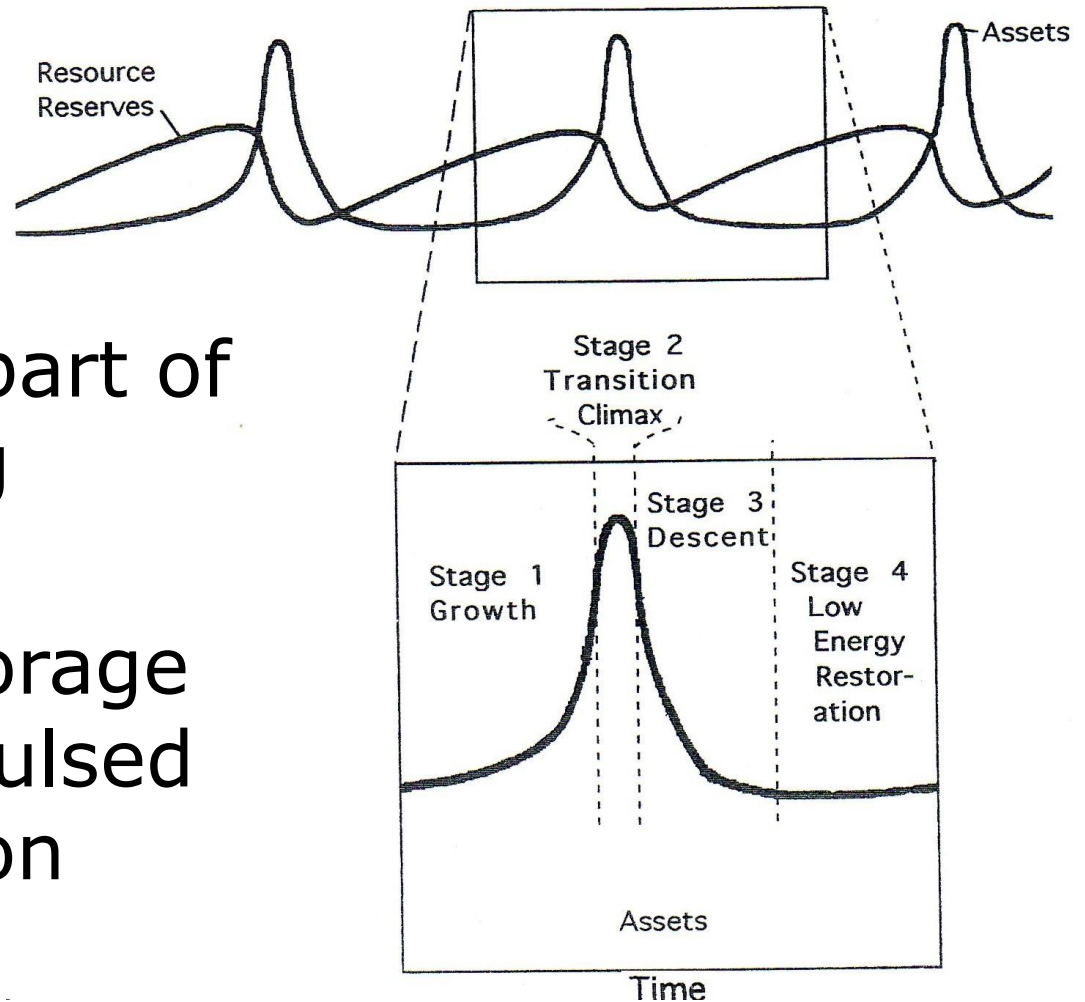
...a prosperous way down

Pulsing

- Pulsing – a general model of growth followed by contraction
 - Growth
 - Transition
 - Descent
 - Low Energy Restoration



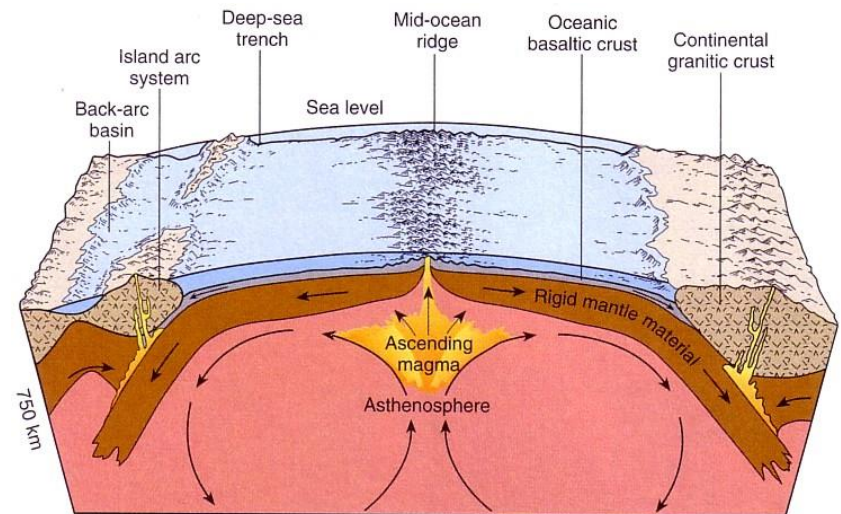
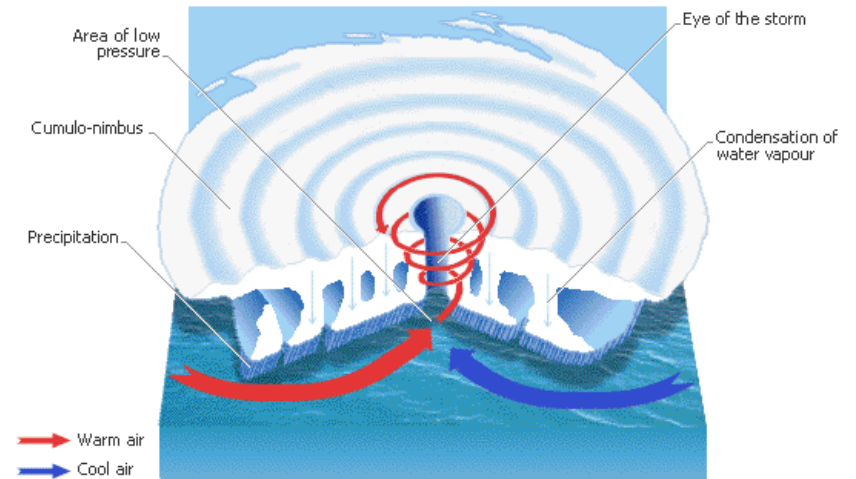
Pulsing



- A pulse is part of a repeating oscillation
- Gradual storage and then pulsed consumption

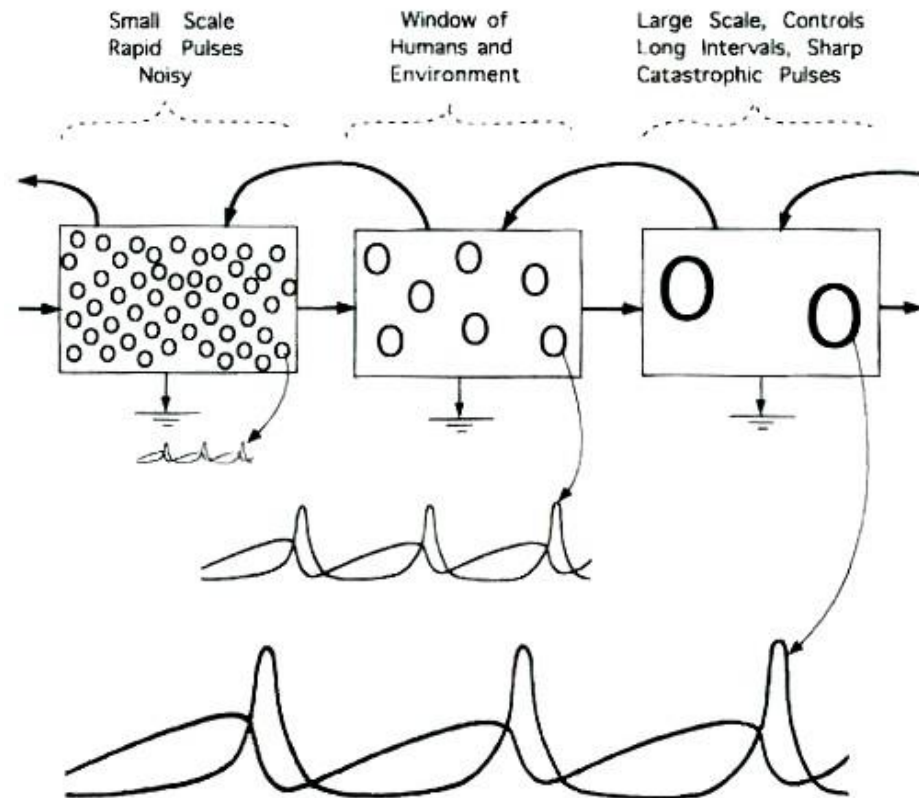
Pulsing

- Self-organized systems pulsing



Pulsing

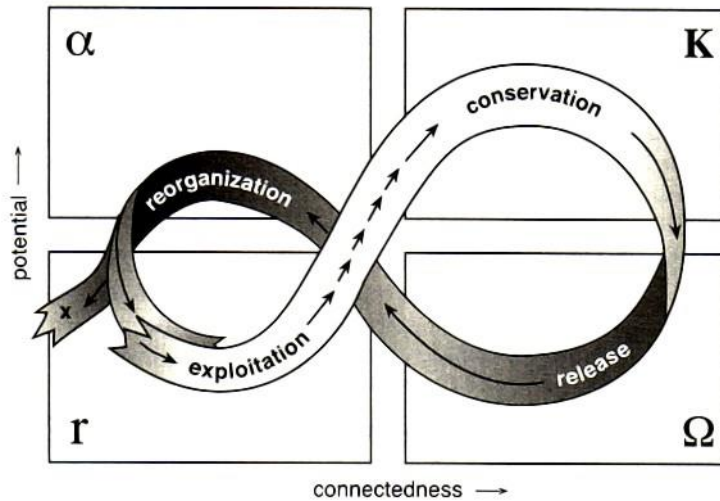
- Pulsing at multiple scales



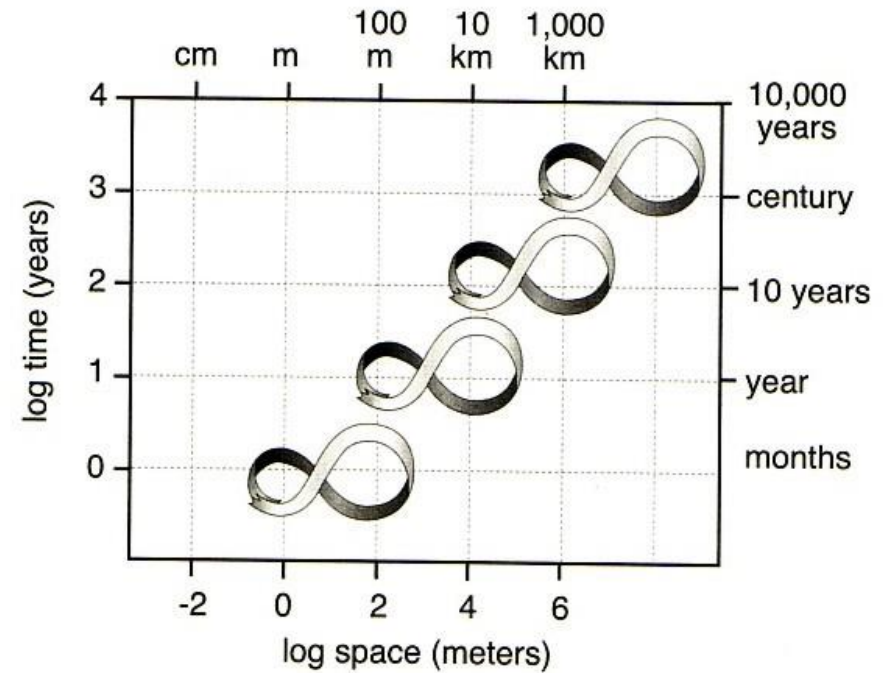
A nested hierarchy of pulsing patterns

Pulsing

- Holling's 'adaptive cycle'

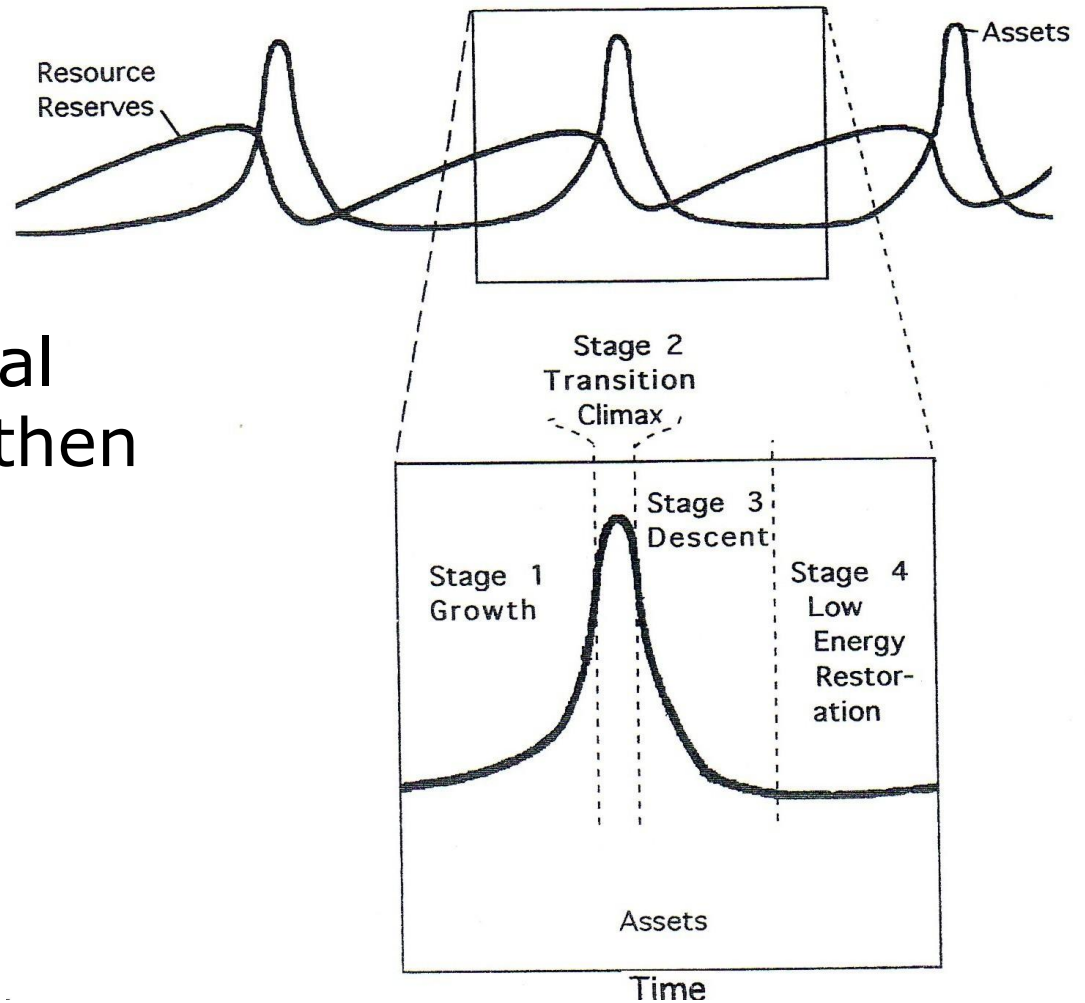


The 'Adaptive Cycle'



Pulsing

- Again, gradual storage and then pulsed consumption



Pulsing

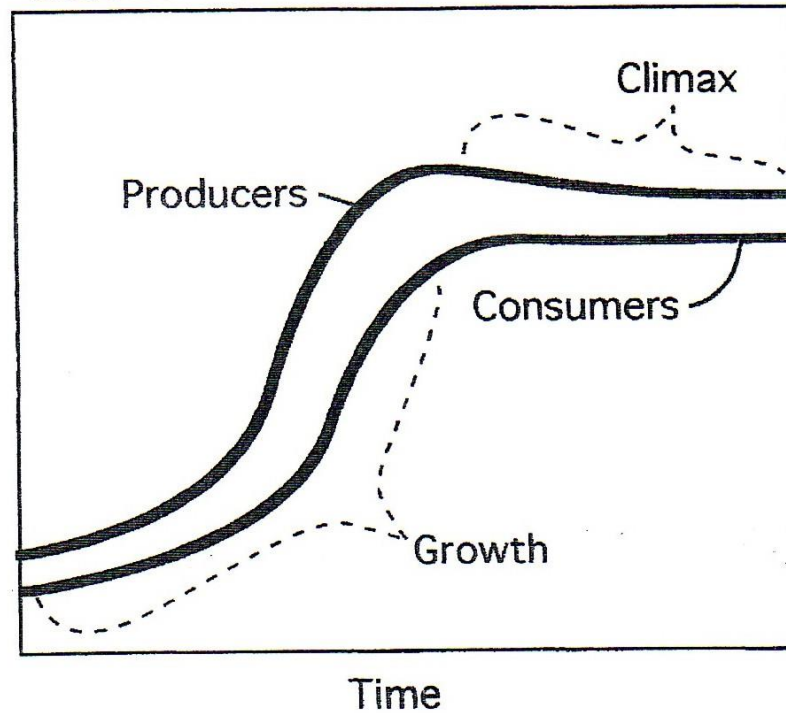
- Think of a shoe factory
- Make *many* pairs
- *Then* ship



Pulsing

- A 'sustainable' steady state?

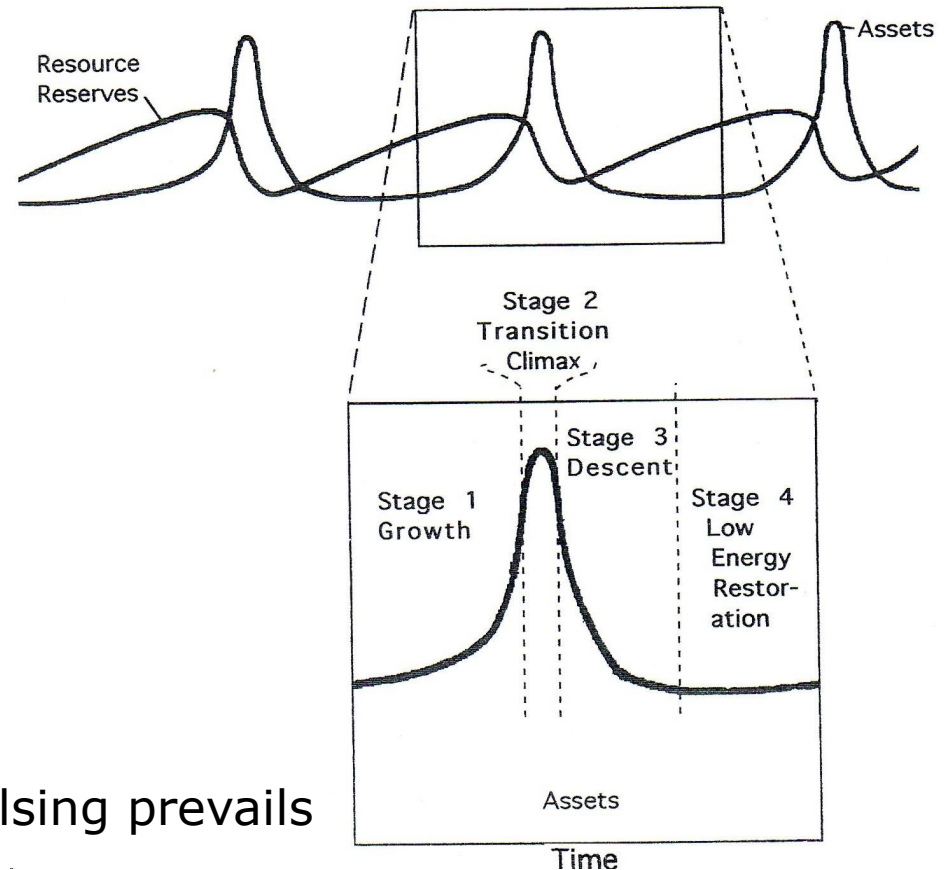
Classical View of Sustainable Succession



“Sustainability”

Pulsing

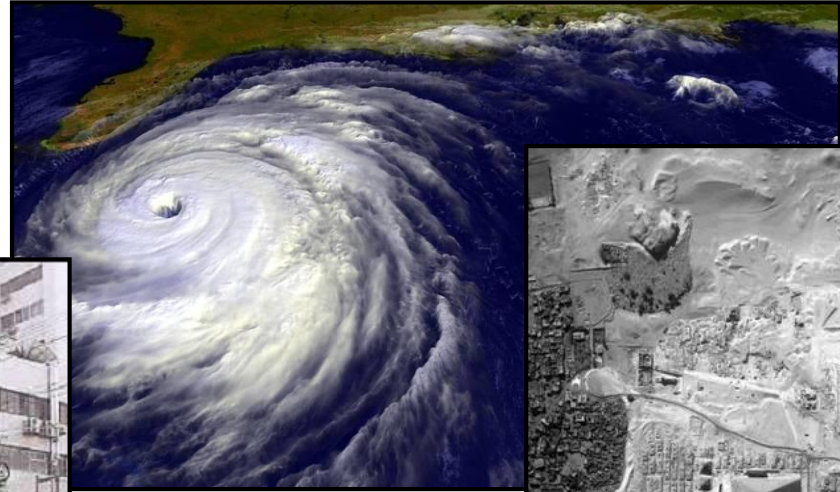
- Pulsing transforms more energy



Pulsing prevails

Pulsing

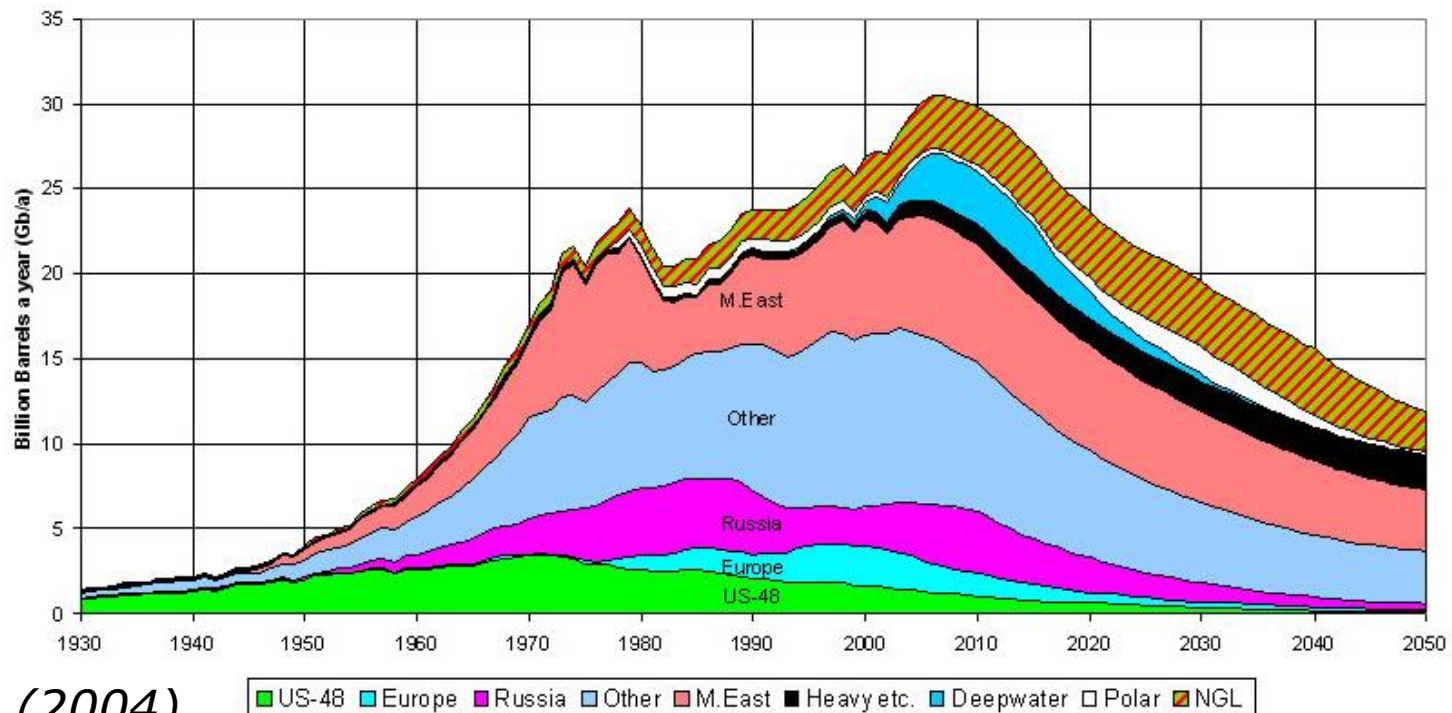
- Optimum frequencies?



Pulsing

○ Peak oil

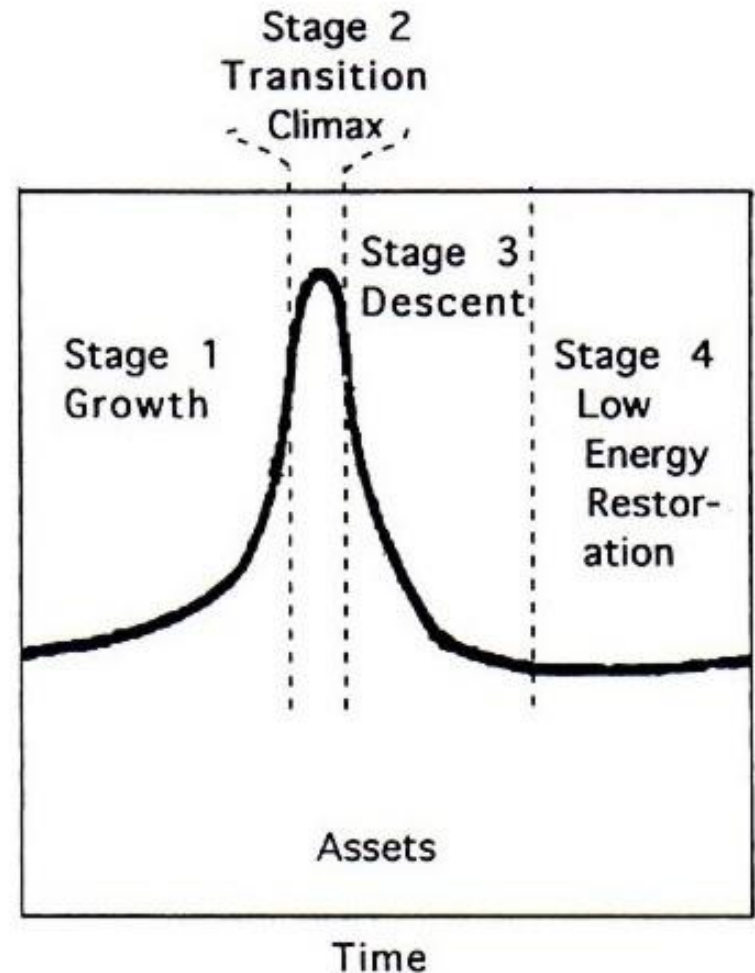
OIL AND GAS LIQUIDS 2004 Scenario



Campbell (2004)

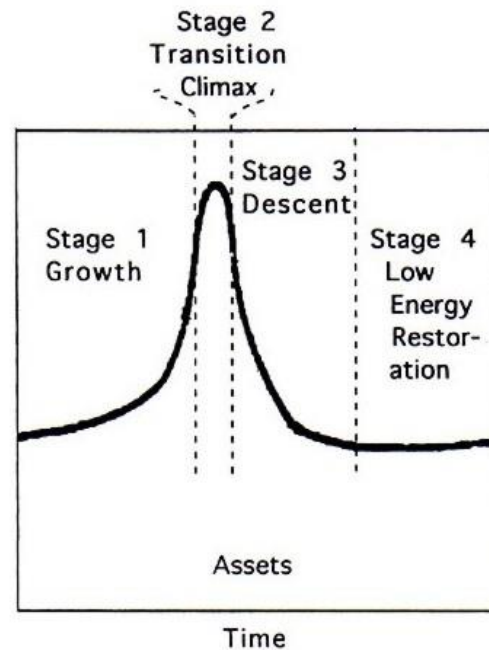
Pulsing

- As oil peaks, are we entering 'transition'?
- Or do we have other energy sources to sustain growth?



The State of the World Today

Growth Becomes Transition



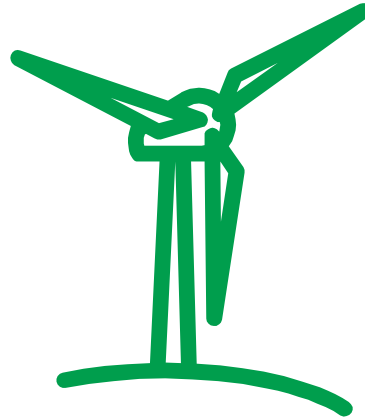
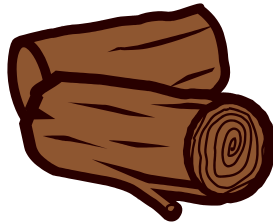
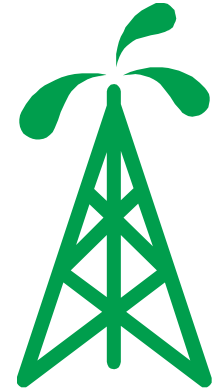
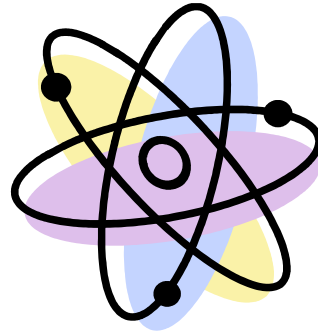


Energy Sources

Chapter 10

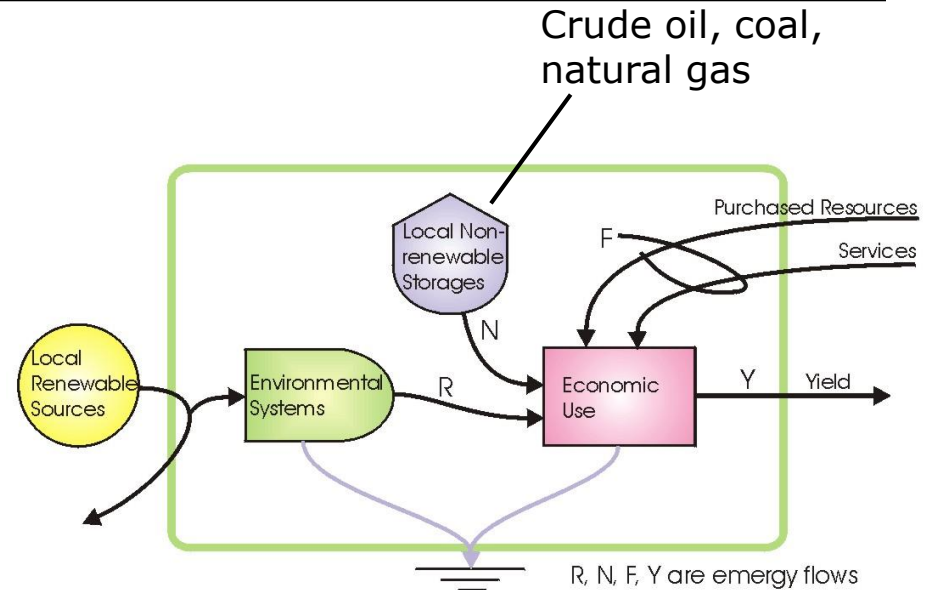
Evaluating Energy Sources

- Is energy a substitutable commodity just like any other?



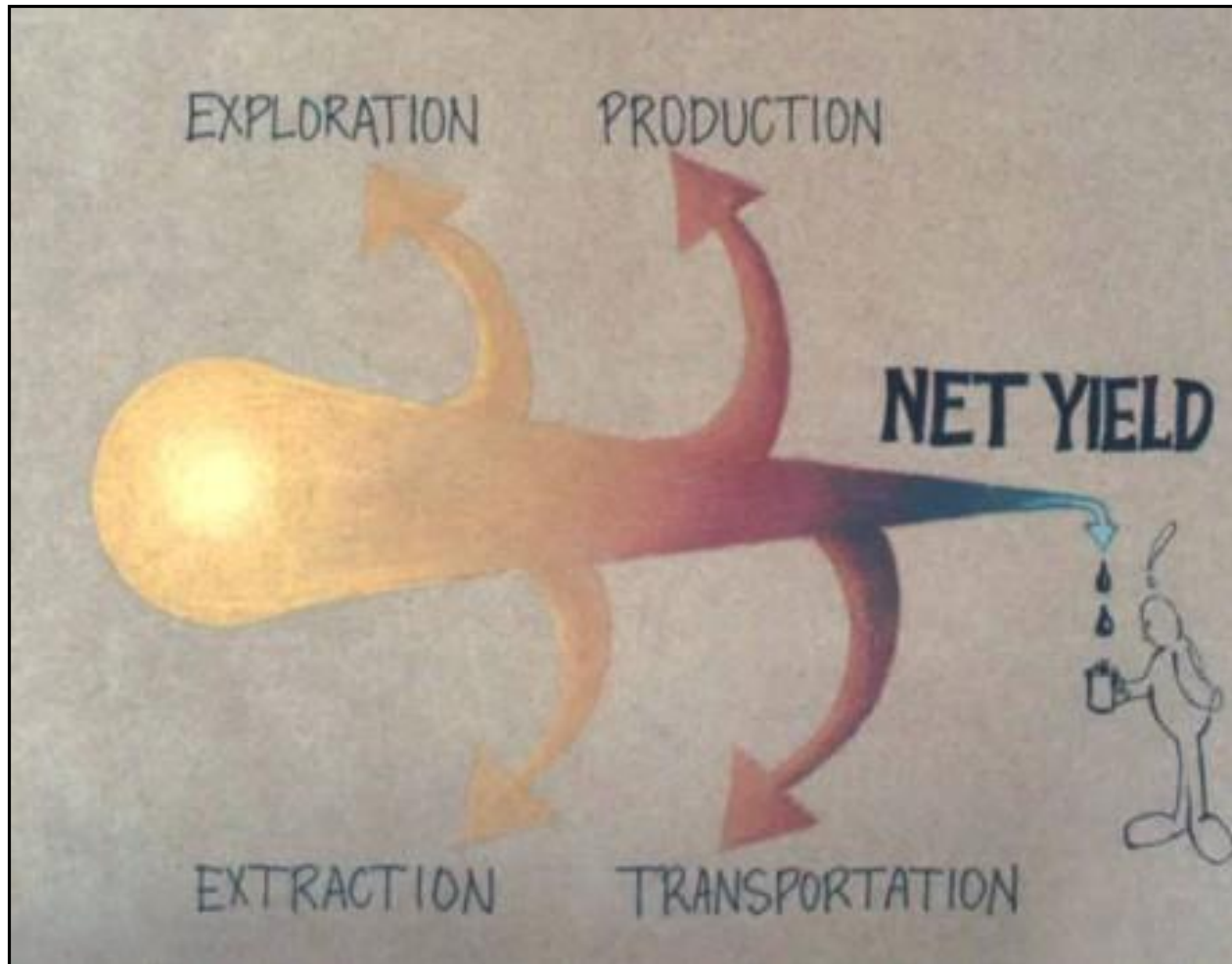
Evaluating Energy Sources

- For energy sources its not yield, but **net** yield
- Net is Y/F



$$\begin{aligned} \text{Yield (Y)} &= R+N+F \\ \% \text{Renew} &= R/(R+N+F) \\ \text{Energy Yield Ratio} &= Y/F \\ \text{Environmental Loading Ratio} &= (F+N)/R \end{aligned}$$

Evaluating Energy Sources



Evaluating Energy Sources

- Energy sources



<i>Item</i>	<i>Emergy Yield Ratio</i>
<i>Dependent Sources, No Net Emergy Yield:</i>	
Farm windmill, 17 mph wind	0.03
Solar water heater	0.18
Solar voltaic cell electricity	0.41
<i>Fuels, Yielding Net Emergy:</i>	
Palm oil	1.06
Energy intensive corn	1.10
Sugarcane alcohol	1.14
Plantation wood	2.1
Lignite at mine	6.8
Natural gas, offshore	6.8
Oil, Mideast purchase	8.4
Natural gas, onshore	10.3
Coal, Wyoming	10.5
Oil, Alaska	11.1
Rainforest wood, 100 years growth	12.0

Energy Sources

Evaluating Energy Sources

- Electricity production

<i>Item</i>	<i>Emergy Yield Ratio</i>
<i>Sources of Electric Power, Yielding Net Emergy:</i>	
Ocean-thermal power plant	1.5
Wind electro-power, strong steady wind regime	2-?
Coal-fired power plant	2.5
Rainforest wood power plant	3.6
Nuclear electricity	4.5
Hydroelectricity, mountain watershed	10.0
Geothermal electric plant, volcanic area	13.0
Tidal electric, 25 ft tidal range	15.0

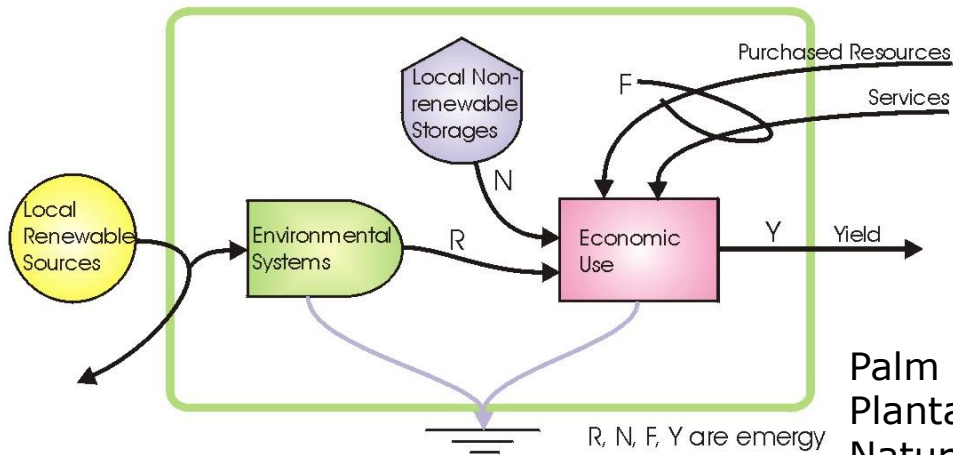
Electricity Production



Coal-fired
Power
Plant

Evaluating Energy Sources

○ Burning Fuel for Heat (many uses)



$Yield (Y) = R + N + F$
 $\%Renew = R / (R + N + F)$
 $Energy\ Yield\ Ratio = Y / F$
 $Environmental\ Loading\ Ratio = (F + N) / R$

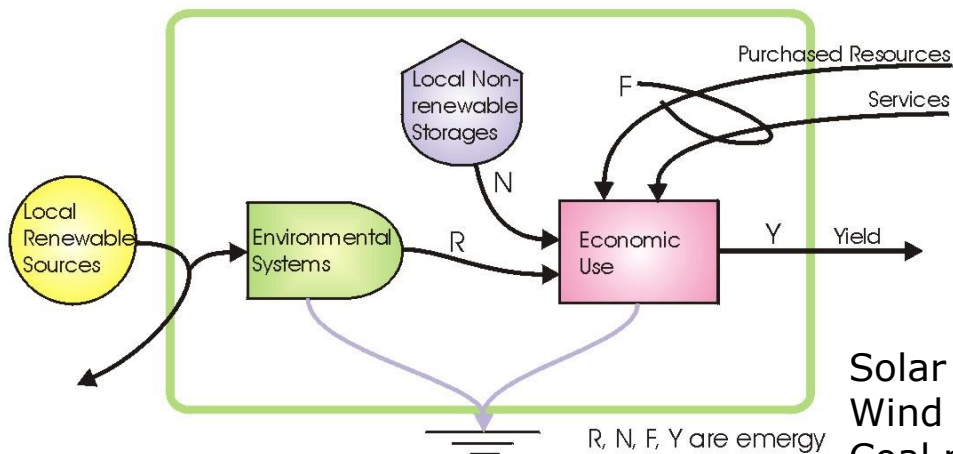


Energy Yield Ratio

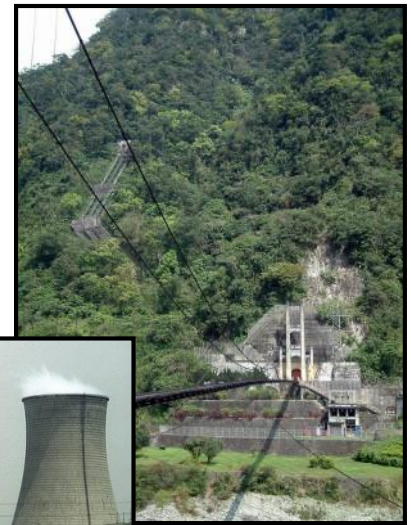
Palm Oil	1.06
Plantation Wood	2.1
Natural gas, offshore	6.8
Oil, Mideast	8.4
Coal, Wyoming	10.5
Oil, Alaska	11.1

Evaluating Energy Sources

o Making Electricity



$Yield (Y) = R + N + F$
 $\%Renew = R / (R + N + F)$
 $Energy\ Yield\ Ratio = Y / F$
 $Environmental\ Loading\ Ratio = (F + N) / R$



Energy Yield Ratio

Solar cell	0.41
Wind power	2-?
Coal power plant	2.5
Nuclear power	4.5
Hydroelectricity	10
Geothermal	13

Evaluating Energy Sources



Sunlight is a *dilute* source, its net energy yield is 0.41

Evaluating Energy Sources

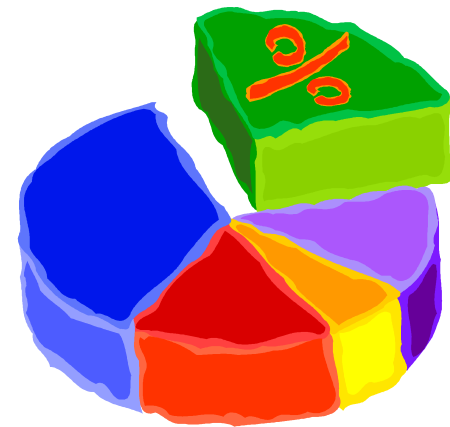
- Proven fuel reserves are not increasing



Liquid Natural Gas

Evaluating Energy Sources

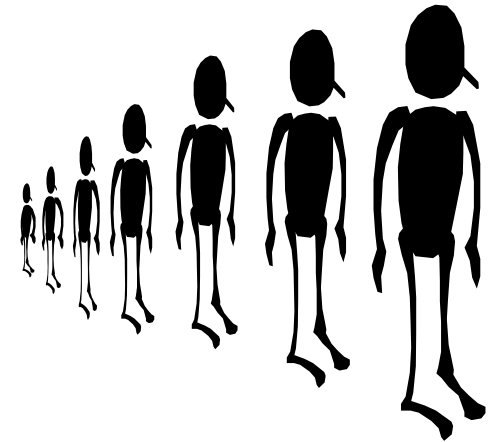
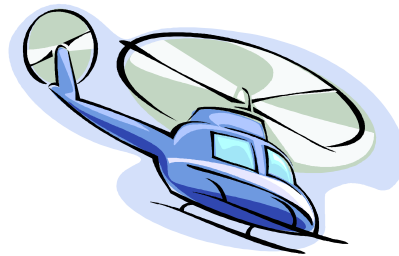
- 71% of the whole Earth's power comes from fossil fuels
- As these reduce, all scales of society will reduce



Eventually we must live on one-third the energy

Evaluating Energy Sources

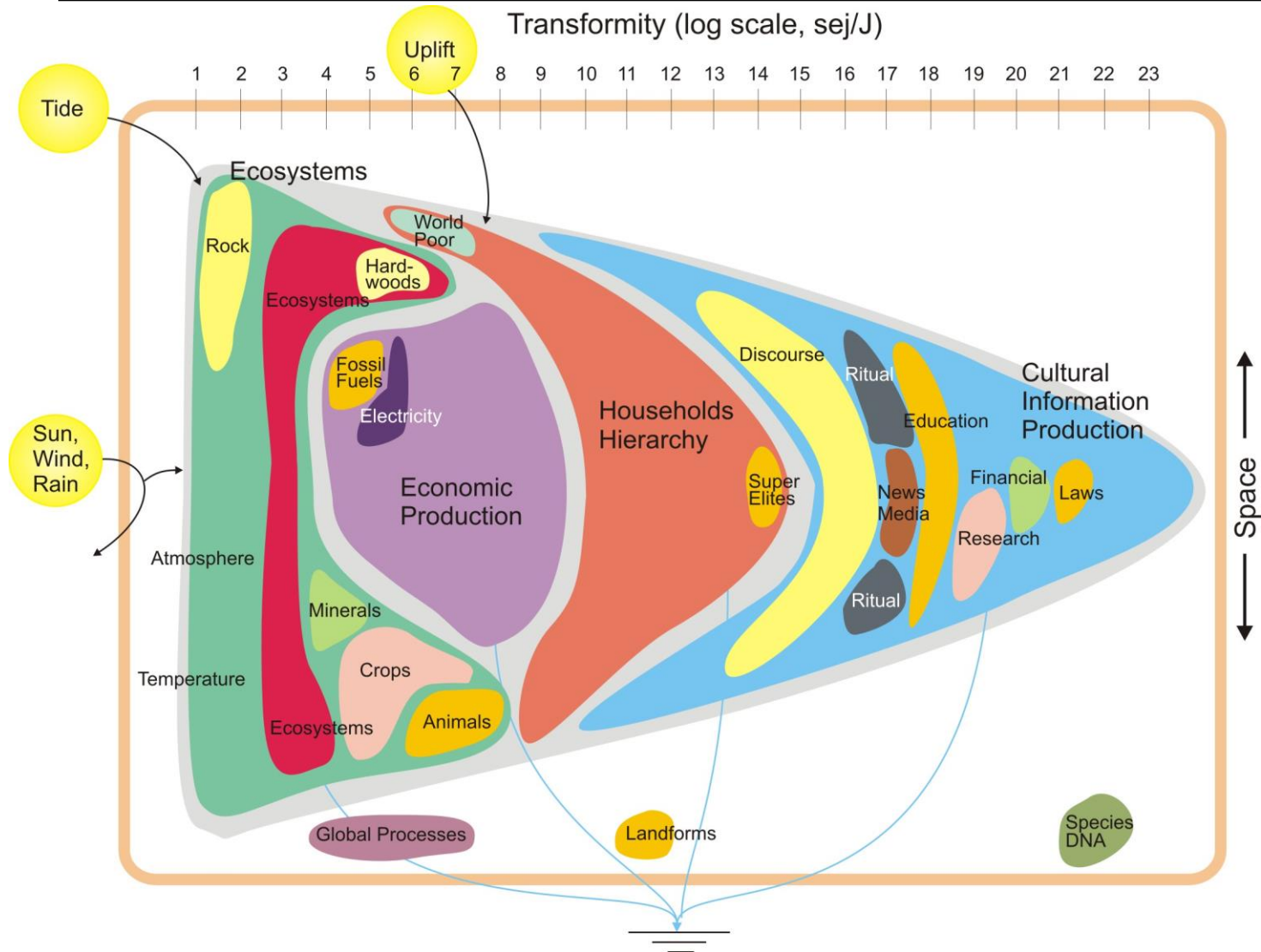
- The percentage for developed nations is even higher



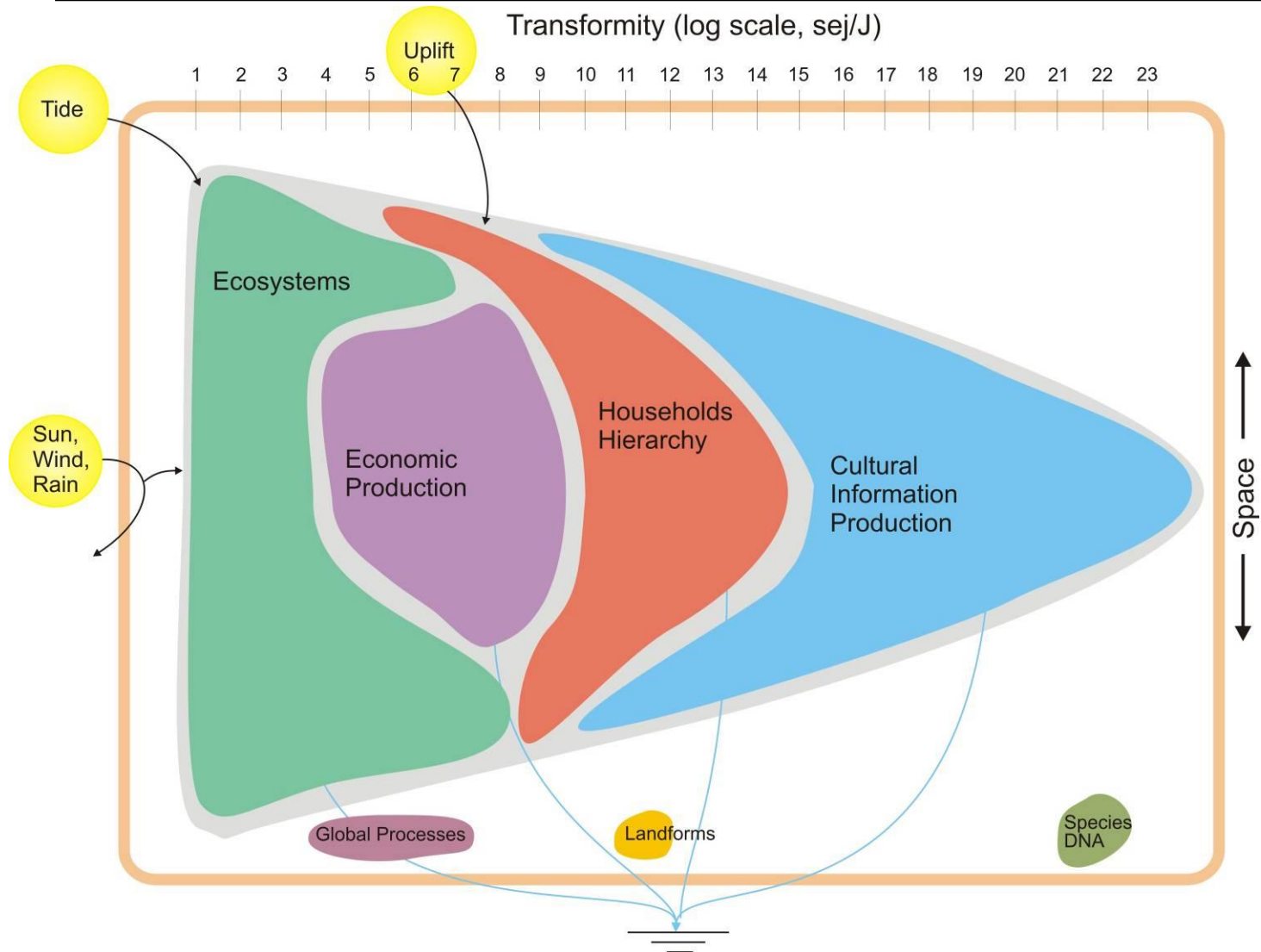
- Must reduce populations or living standards by 80-90%



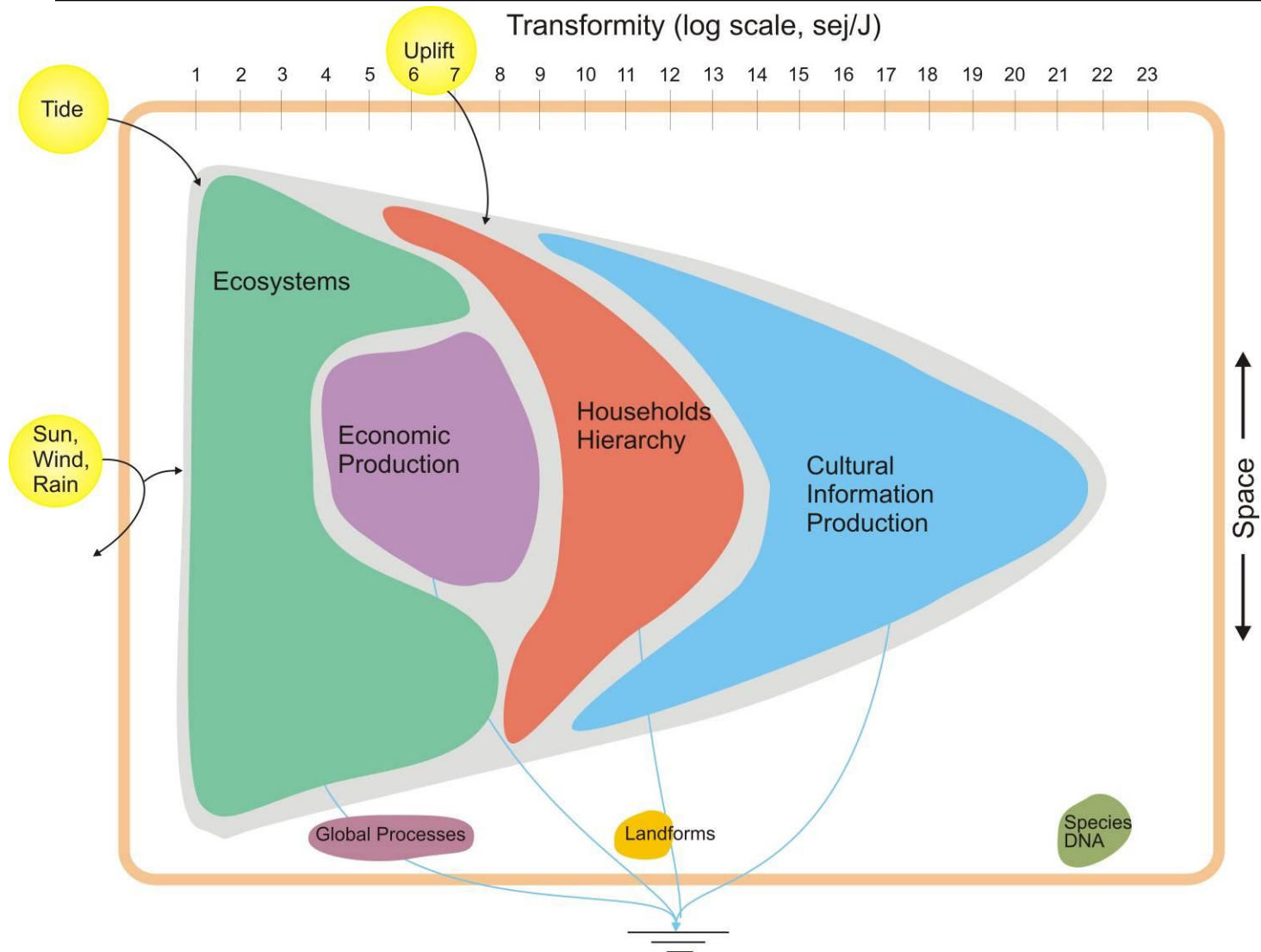
Contracting Energy Supply



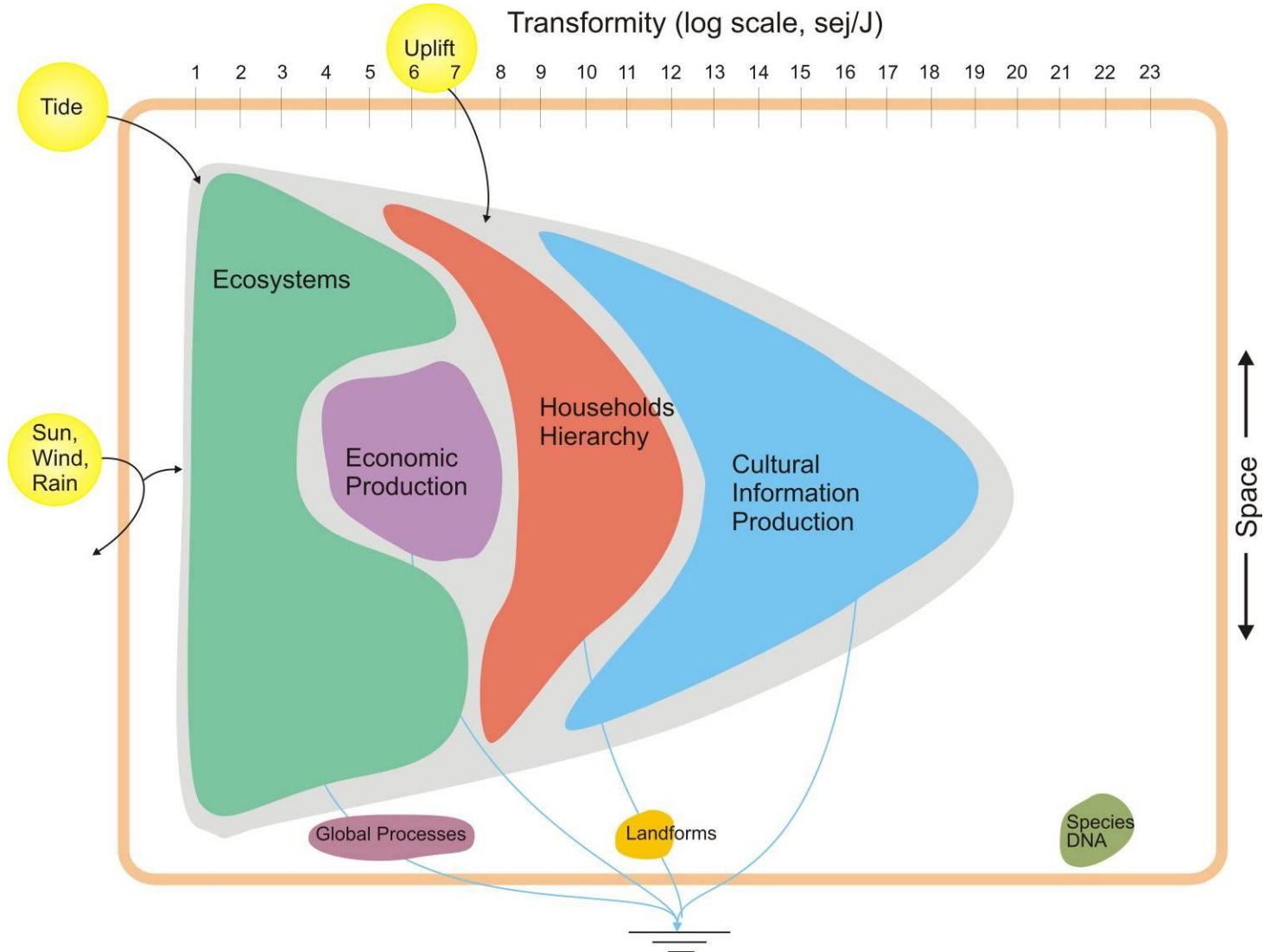
Contracting Energy Supply



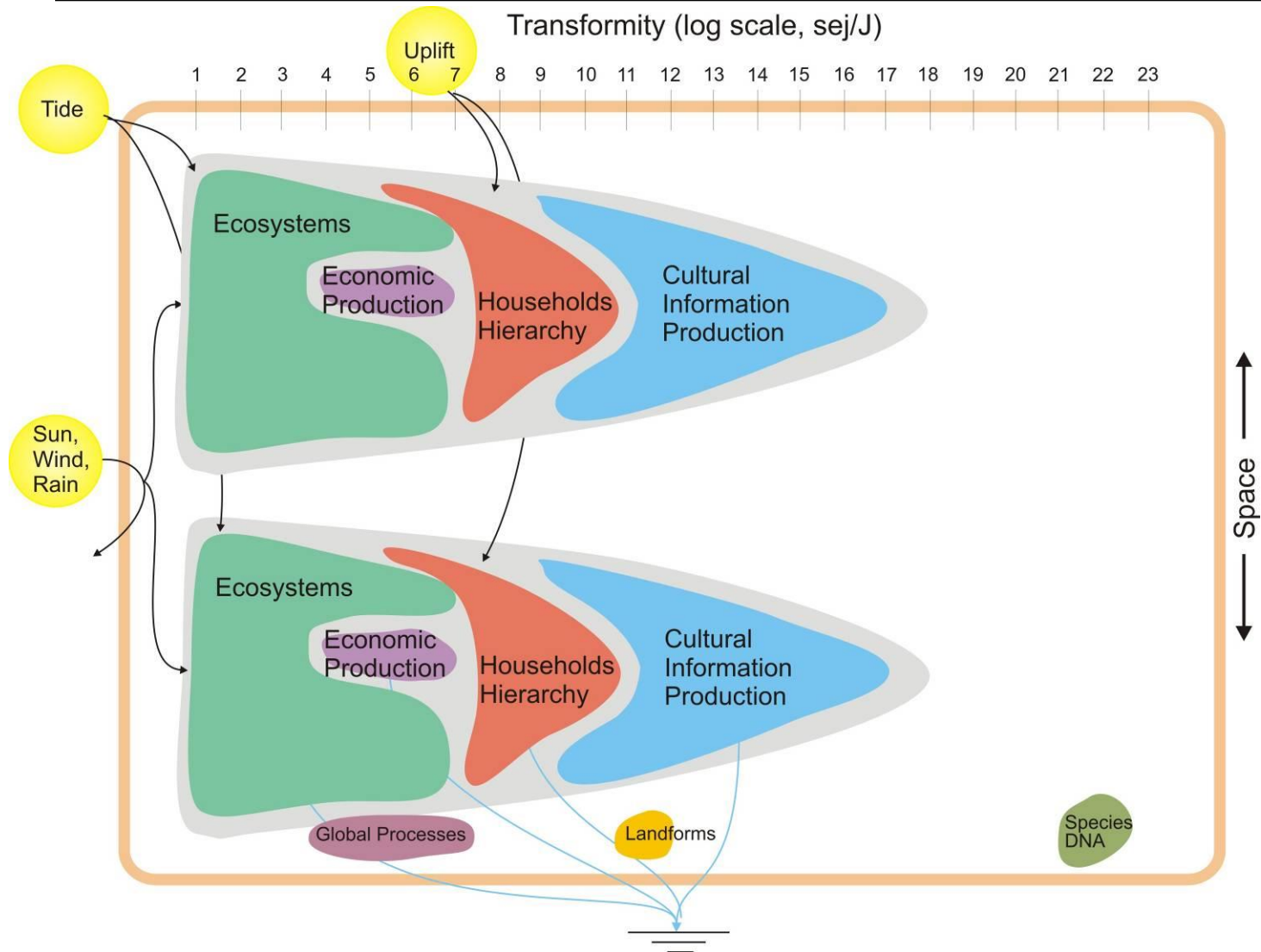
Contracting Energy Supply



Contracting Energy Supply



Contracting Energy Supply

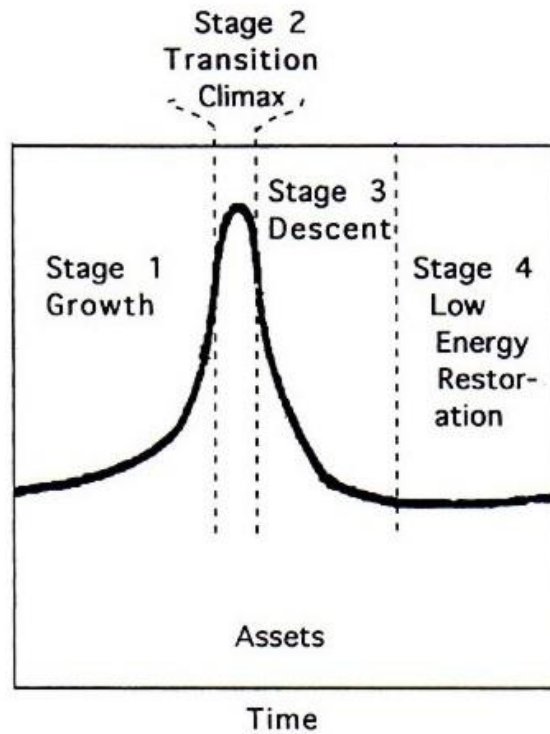


Contracting Energy Supply

- With reduced populations we can look forward to a new but smaller agrarian economy, green again, enriched with knowledge developed in the fuel-rich century of complexity



Transition



Transition

- As we pass through 'transition', how do we...
 - Sustain nations?
 - Sustain people?

- These are two questions with different answers



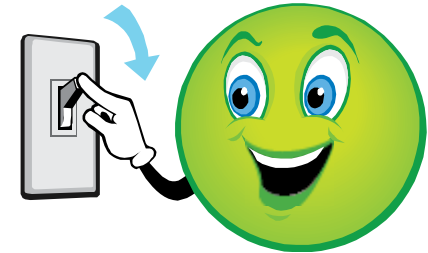


Sustaining a Nation

Chapter 11

Sustaining a Nation during Transition

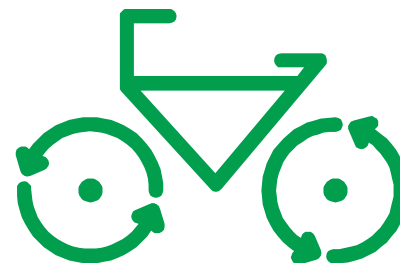
- To *extend* the summit we must...



- ...sustain inputs and waste it less



- ...create favorable balances of international exchange



Sustaining a Nation during Transition

- Ecosystem analogies



- Positive interactions

Ecosystem Engineers

Sustaining a Nation during Transition

- Cooperation in climax ecosystems
- Make trading partners prosperous
- Share military expenditures



Mutualism

Sustaining a Nation during Transition

- National energy policy
- Maintain access to fuel sources



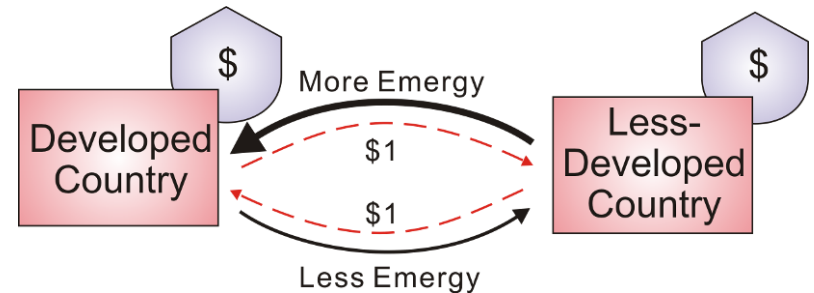
Sustaining a Nation during Transition

- Positive energy trade balance from:
- Energy conservation
- Trade treaties
- Shared military costs



Sustaining a Nation during Transition

- Equitable Trade
- All exchanges should be balanced (except fuel imports)
- Use treaties



Sustaining a Nation during Transition

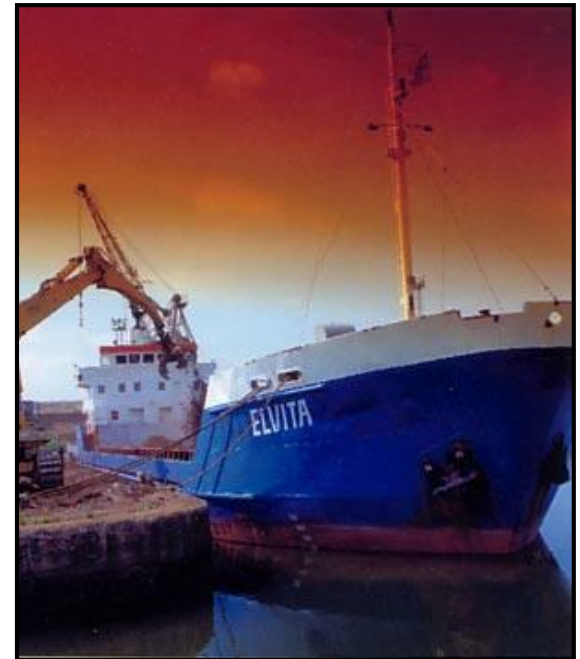
- Trade policy
- Only fuel exporters get a negative energy exchange
- They will still live well!



Dubai

Sustaining a Nation during Transition

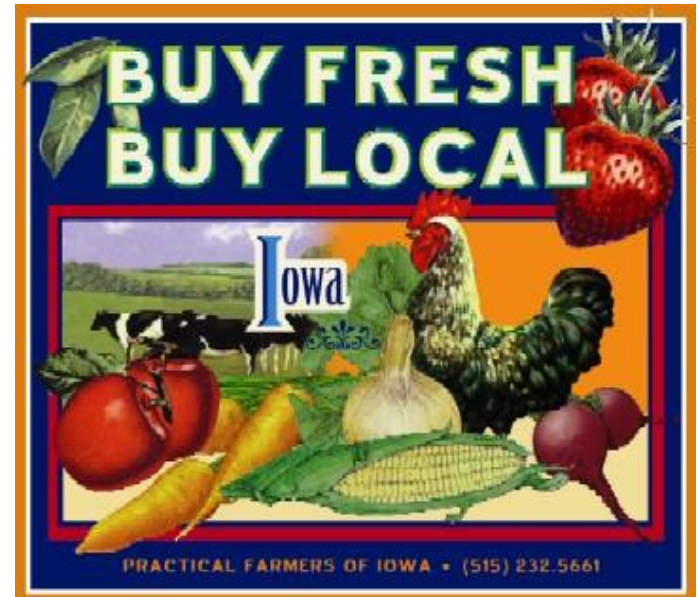
- Trade policy
- Do not export raw products
- Use them at home



Exports of real wealth

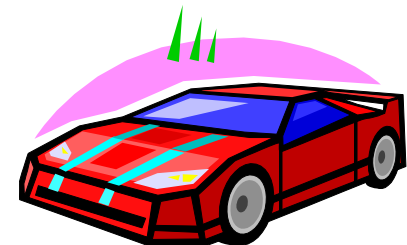
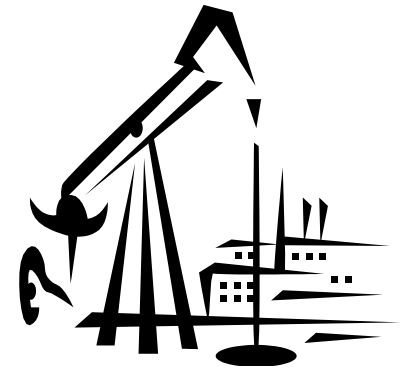
Sustaining a Nation during Transition

- Resource use at home lowers prices of food, housing, paper, and fuel
- Less energy goes for transportation



Sustaining a Nation during Transition

- Keep fuels globally available in markets
- Importing fuels is good...do not discourage
- Do not tax *productive* use of fuels
- Do not waste fuel



Sustaining a Nation during Transition

- New policies should emphasize:
- Information innovation
- Efficiency rather than speed
- Cooperation rather than competition
- Diversity rather than conformity
- Good maintenance rather than growth
- Suppression of borrowing



Sustaining a Nation during Transition

- Eliminate luxury and waste





Sustaining People

Chapter 12

Sustaining People during Transition

- To sustain people need:
- A limit on personal income (a *maximum* wage)
- Public works programs
- A living minimum wage



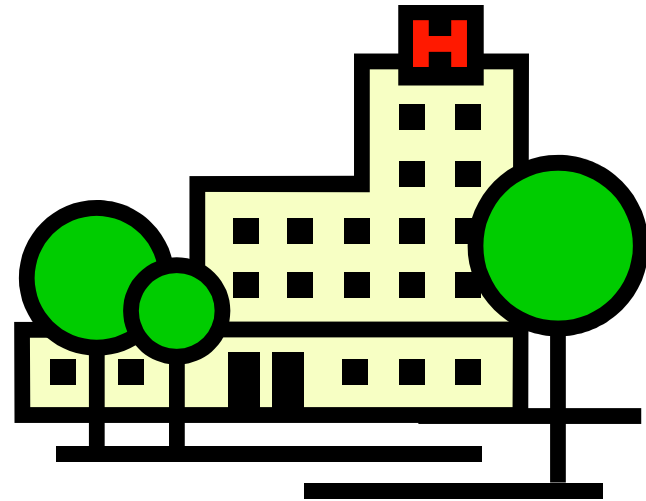
Sustaining People during Transition

- Ensure full employment
- Part-time work for elders
- Eliminate early retirement
- Protect social security



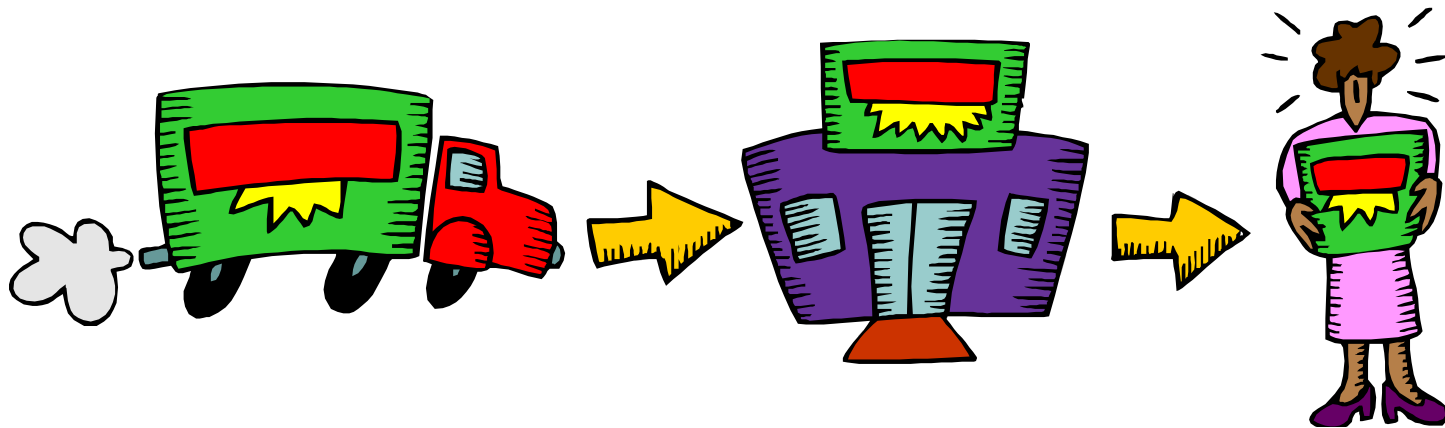
Sustaining People during Transition

- Need universal public health care system
- Private insurance for expensive medicines



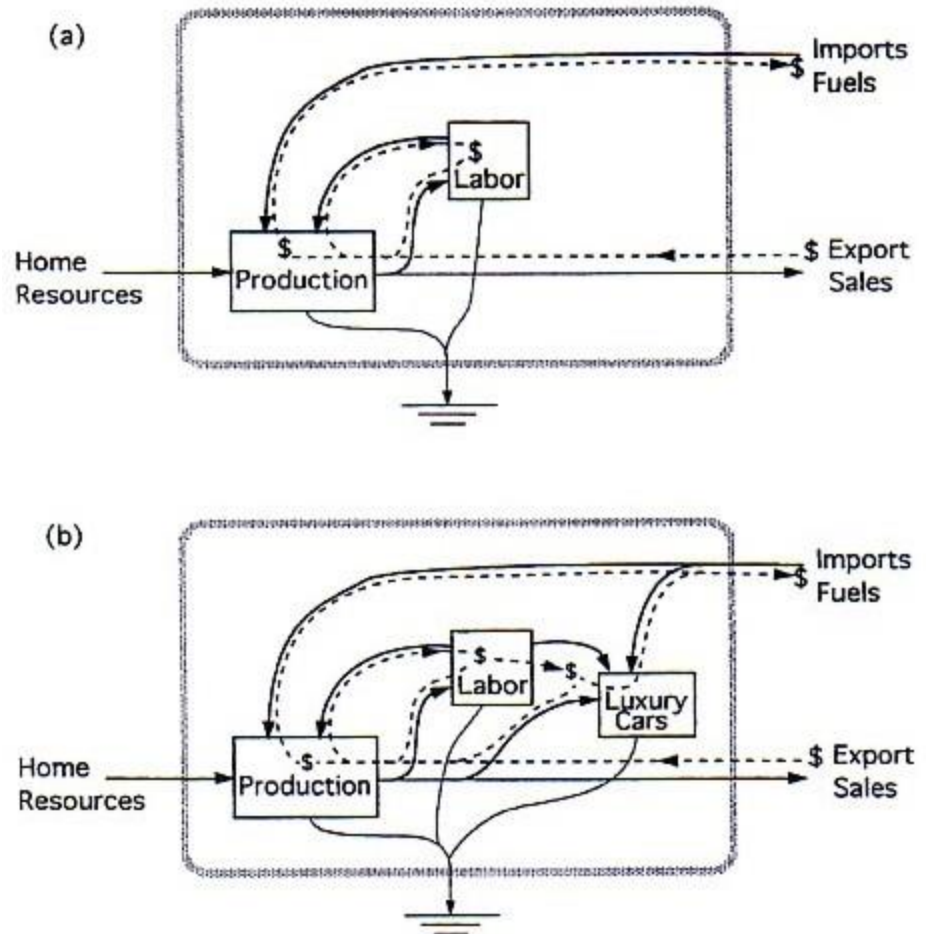
Sustaining People during Transition

- Free consumption hurts the economy by wasting energy

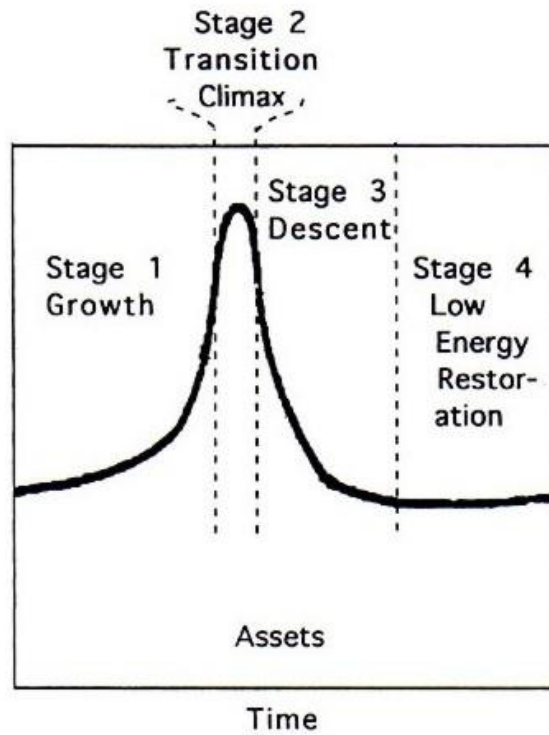


Sustaining People during Transition

- Luxury reduces exports



Descent



Descent

- As we move into 'descent', what should we expect, and how do we react?
 - Starting Down
 - Reorganizing Cities
 - Restoring Waters
 - Refreshing the Landscape
 - Transmitting Knowledge



Starting Down

Chapter 13

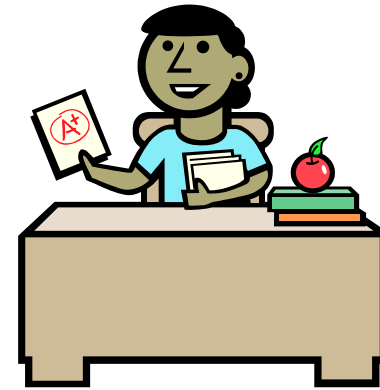
Starting Down – Beginning Descent

- Need task forces throughout society working on descent
- Reverse attitudes:
 - 20th Century growth is bad
 - Descent is good



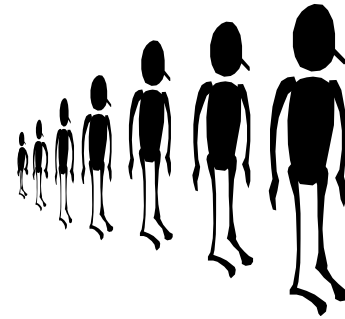
Starting Down – Beginning Descent

- Education now avoids the inefficiency of trial and error



Starting Down – Beginning Descent

- To maintain the standard of living:
- Decrease the population
- Reduce the money supply



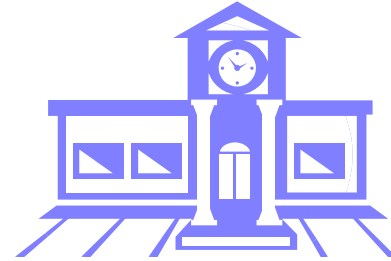
Starting Down – Beginning Descent

- Stop commodity exports
- Except necessary to buy fuels and information



Starting Down – Beginning Descent

- During descent the real wealth system can hold its monetary value better than bank savings



Starting Down – Beginning Descent

- Need a gradual, noncatastrophic deflation of excess money in stocks and bonds



Starting Down – Beginning Descent

- Cut salaries *uniformly*
- Create an international *minimum living wage*



**LIVING WAGE
PAID HERE!**



www.justeconomicswnc.org

Starting Down – Beginning Descent

- Sustain global shared information

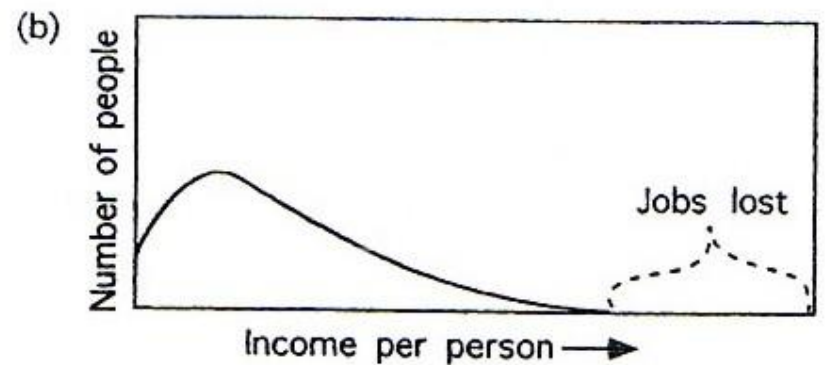
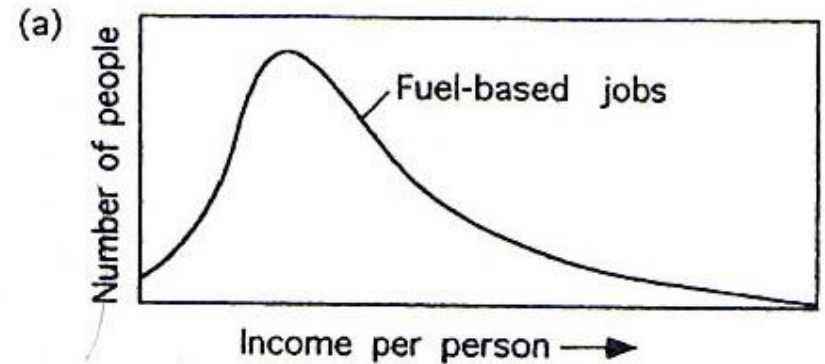


- Information centers near mountains



Starting Down – Beginning Descent

- Shrink population and salaries



Starting Down – Beginning Descent

- Finance downsizing and redevelopment



- Fewer stocks and bonds, borrow less



Starting Down – Beginning Descent

- International minimum wage
- Some achievements of the climax civilization must become dormant



Ancient
library of
Alexandria

Starting Down – Beginning Descent

- Landscapes can reorganize with fewer cars



Starting Down – Beginning Descent

- Plan, to avoid collapse
- Share a vision of a less-intensive but better world



Maya

Guidelines for Orderly Descent

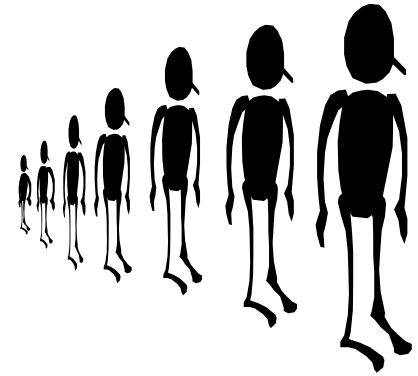
- Dedicate TV drama, literature, and art to adventures about descent



Teach descent

Guidelines for Orderly Descent

- Reduce populations
in a humanitarian
way

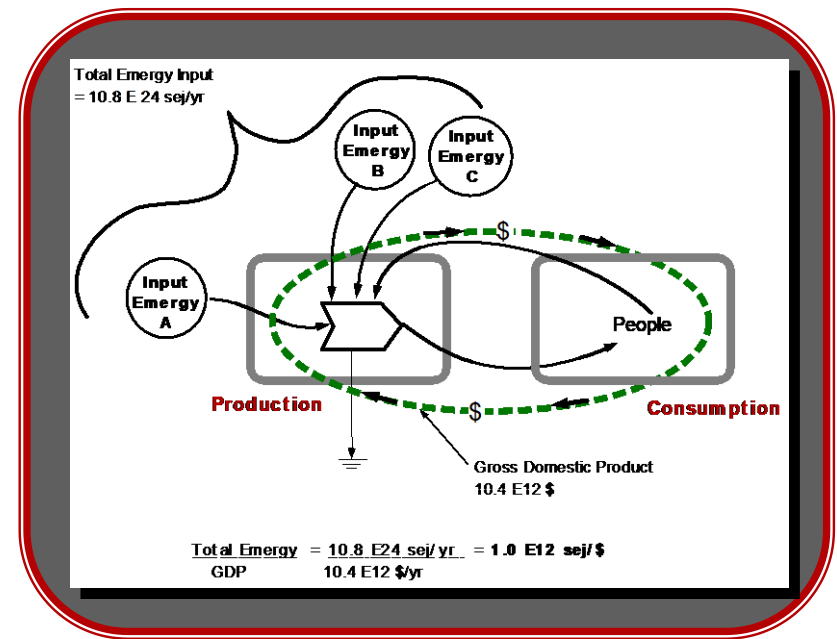


- Reduce salaries and
wages as necessary
to maintain full
employment



Guidelines for Orderly Descent

- Keep the energy-money ratio stable by adjusting the money in circulation



Energy/Money Ratio

Guidelines for Orderly Descent

- Reduce
consumption
- Laws and taxes to discourage unproductive resource use



Guidelines for Orderly Descent

- Sustain the production of the environment



Guidelines for Orderly Descent

- International respect and cooperation for global sharing



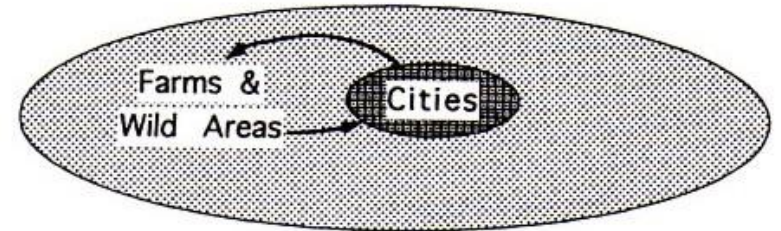


Reorganizing Cities

Chapter 14

Reorganizing Cities during Descent

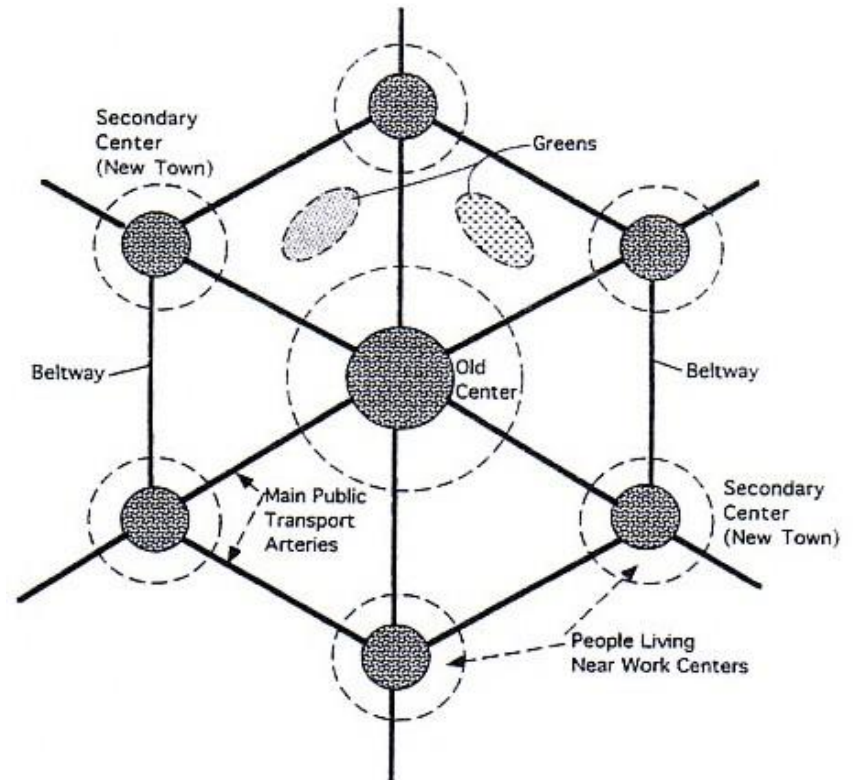
- Reintegrating cities with their region of support



- Reorganize to use less fuels

Reorganizing Cities during Descent

- Cluster around smaller more dispersed centers



Reorganizing Cities during Descent

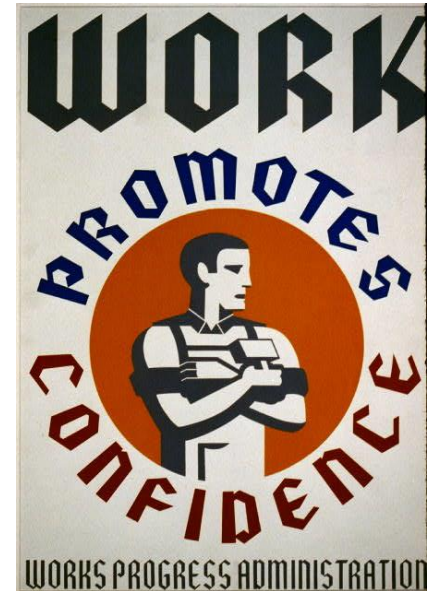
- Live near work
- Use bikes



Bike Commuter

Reorganizing Cities during Descent

- Public works projects to reorganize cities
- Keeps the poor and unemployed in the economy



Reorganizing Cities during Descent

- Decentralized cities have:
- Less-intense fuel consumption
- Less transportation
- Better cycles of materials between cities and environment



Reorganizing Cities during Descent

- Add green areas:
- Wetlands
- Ponds
- Parks
- Retention basins



City wetlands

Reorganizing Cities during Descent

- The inner city remains the information center



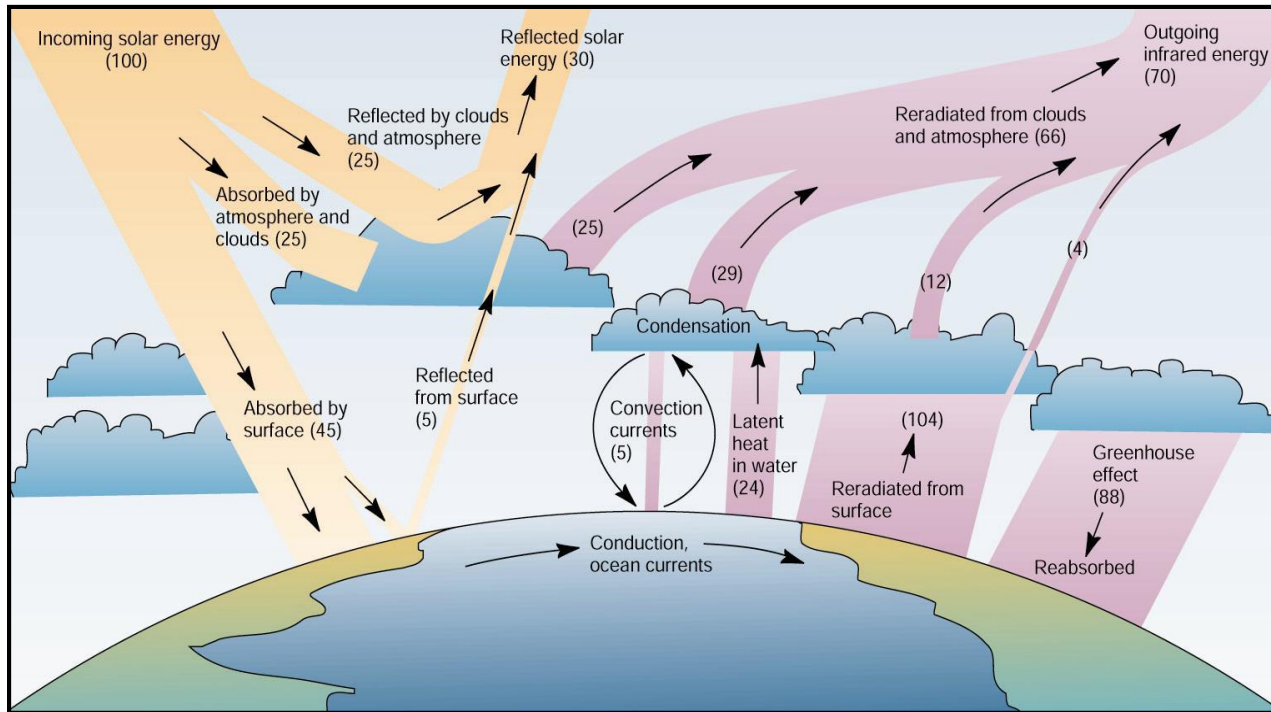


Restoring Waters

Chapter 15

Restoring Waters during Descent

- Fit into the global hydrologic cycle



Hydrological cycle

Restoring Waters during Descent

- Use multiple values of rivers, estuaries, and beaches



Restoring Waters during Descent

- Nature's treatments:
 - Use floodplains to maintain water quality
 - Restore estuarine circulation
 - Remove jetties
 - Stop pumping coastal groundwaters
 - Operate lower-intensity aquaculture ponds
 - Restore reefs
 - Set levees back from the shore



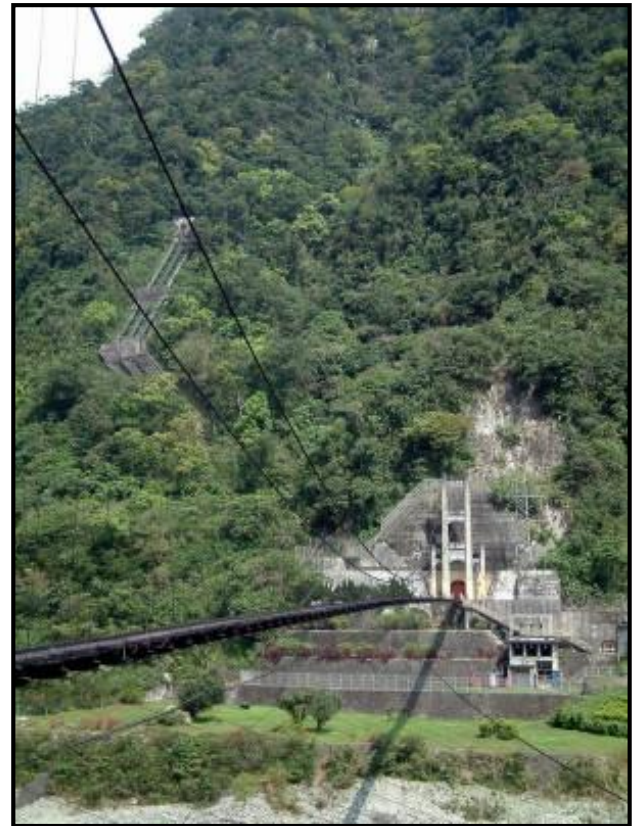
Restoring Waters during Descent

- Coastal fisheries will recover with less pressure and nutrient discharge



Restoring Waters during Descent

- Mountain waters still used for hydroelectric power for information



Hualien Hydroelectric Power

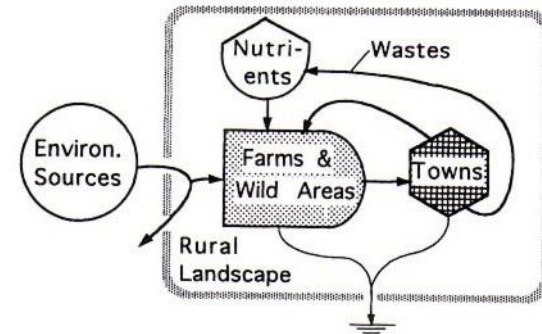
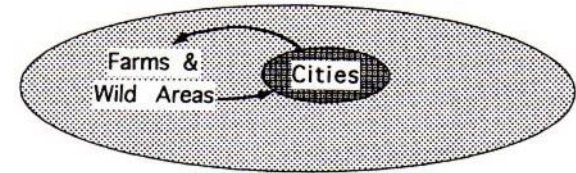


Refreshing the Landscape

Chapter 16

Refreshing the Landscape during Descent

- Rural landscapes symbiotic with decentralized cities



Symbiotic reorganization of cities with rural landscapes

Refreshing the Landscape during Descent

- Rotate lands
- Reforest
- Sustain forest biodiversity



Complex forest



Rotating and fallowing fields

Refreshing the Landscape during Descent

- Labor-intensive rural farming



Labor-intensive rural farming

- Recycling can replace most mining



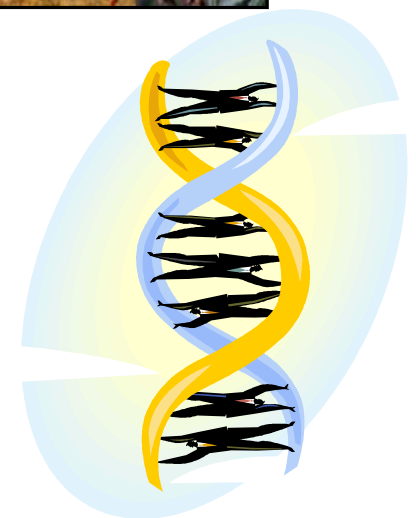


Transmitting Knowledge

Chapter 17

Transmitting Knowledge through Descent

- Information is genetic and cultural



Transmitting Knowledge through Descent

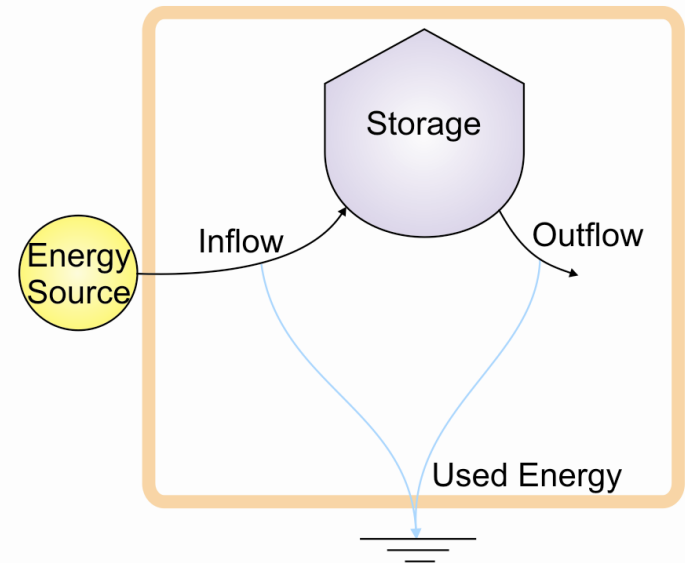
- Maintain large areas of diverse ecosystems



Maintain vast areas of forest

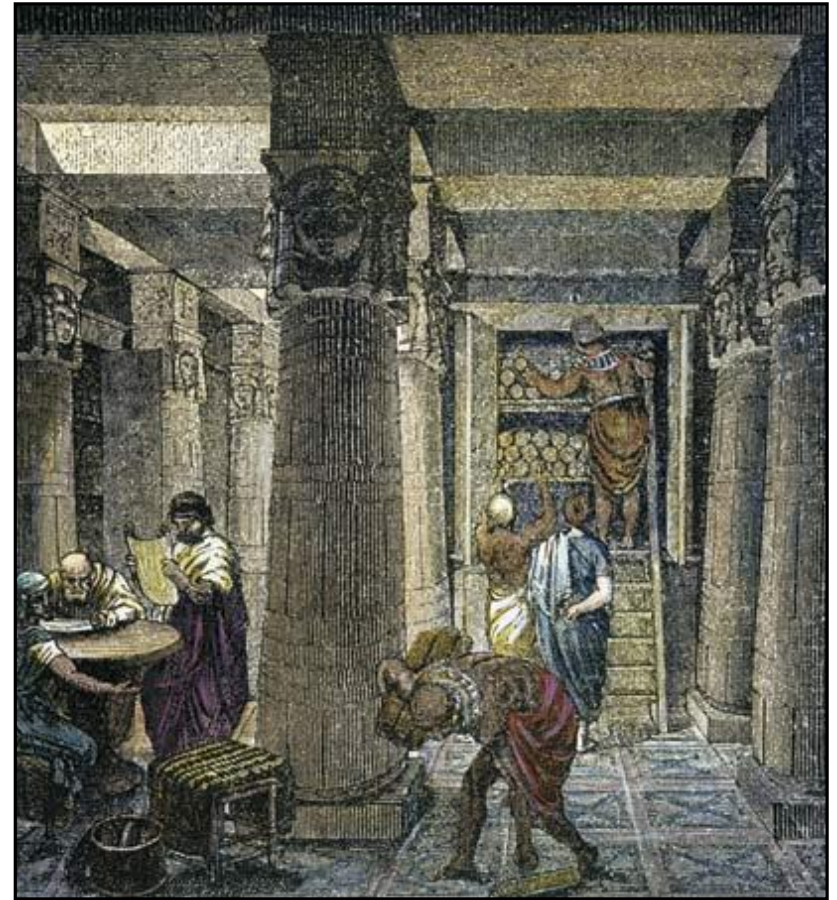
Transmitting Knowledge through Descent

- Information requires energy to be maintained



Transmitting Knowledge through Descent

- Descent requires only some information
- Preserve unused knowledge



Alexandria library preserved unused knowledge from antiquity

Transmitting Knowledge through Descent

- Sustaining and sharing knowledge will require electrical power



Hydropower for electricity

Transmitting Knowledge through Descent

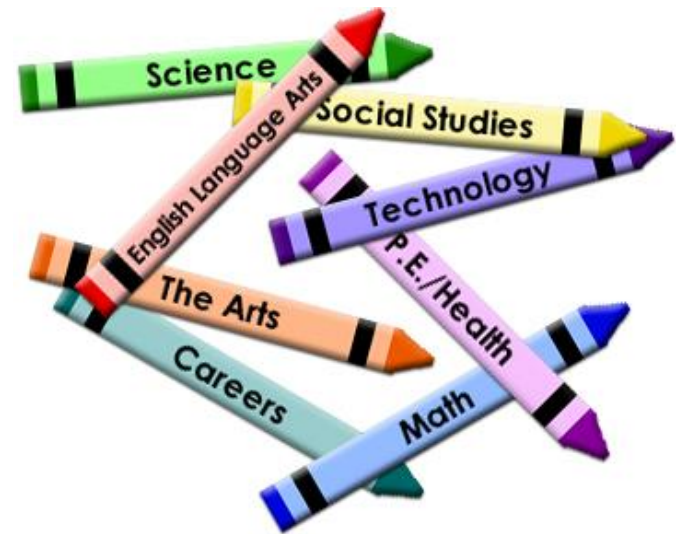
- Society to set television priorities

Set TV Priorities

1. Serious purpose
2. ..
3. ..
4. ..
5. ..
6. ..
7. ..
8. Entertainment
9. Advertisement

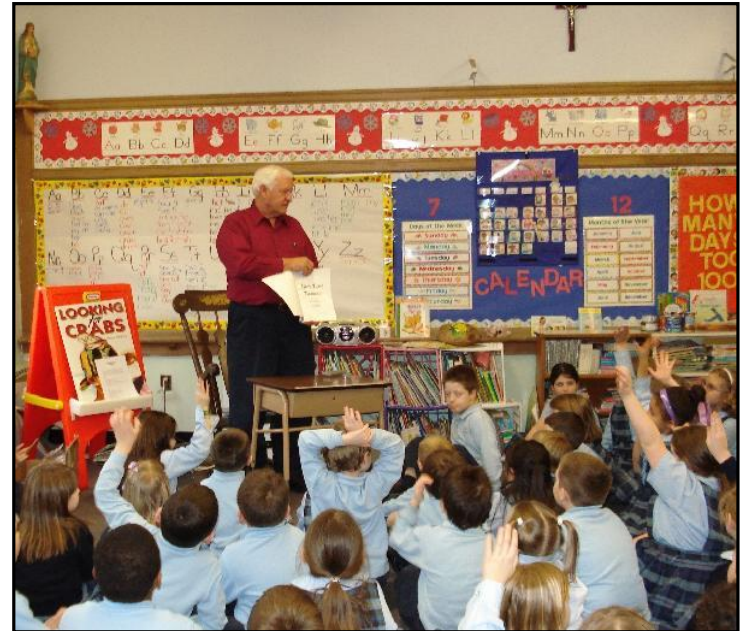
Transmitting Knowledge through Descent

- State-approved standard education for all children



Transmitting Knowledge through Descent

- Provide full-day daycare for small children
- Prepare children to be taught in the nations' primary language



School extending through working hours of parents

Transmitting Knowledge through Descent

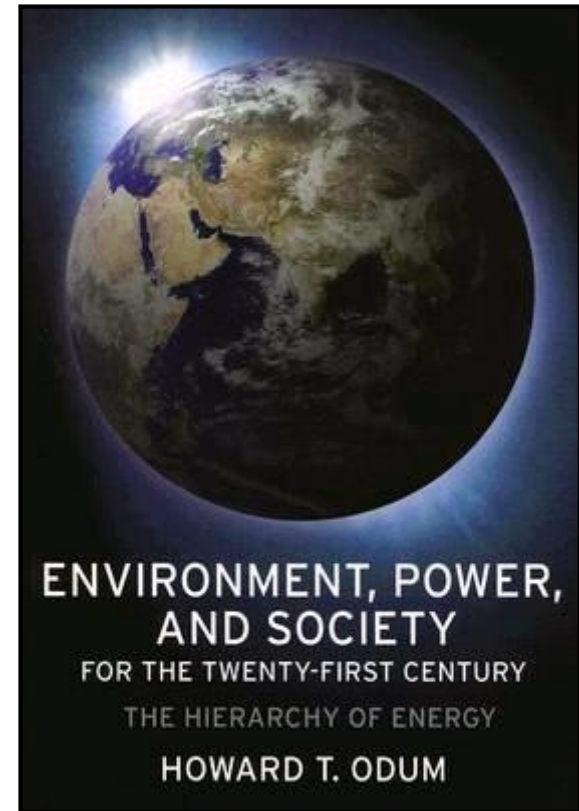
- Provide after-school activities for all ages
- Sports that include all students



Sports for *all* students

Transmitting Knowledge through Descent

- Provide a unified 'systems' course in energy, economics, and environment



A 'systems' textbook

Transmitting Knowledge through Descent

- Education to share common knowledge and achieve basic skills
- Leave room for innovative teaching



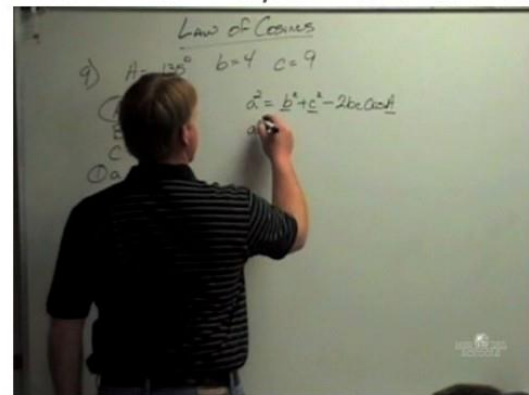
Creative learning activities

Transmitting Knowledge through Descent

- Experiment with internet teaching



Pre-AP Math Analysis – Law of Cosines



Mid-Del Public Schools teacher Colin White, teaching via video podcast on the Law of Cosines

<http://podcast2.mid-del.net/groups/colinw/>

Transmitting Knowledge through Descent

- Learning through the whole day and year-round
- Include internships and vocational experiences



the year 'round school



never stop learning



Transmitting Knowledge through Descent

- Community support for all the children



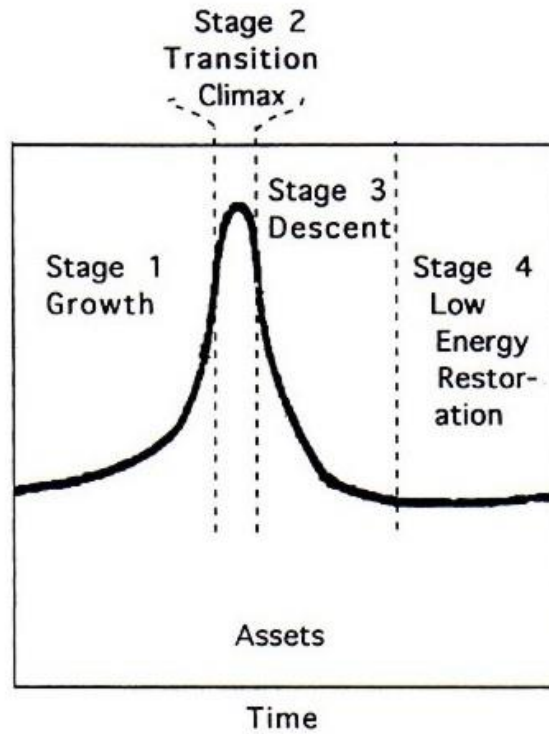
Transmitting Knowledge through Descent

- Eliminate nonacademic waste
- The smaller university leading descent and preserving knowledge from the Era of Growth



The 'great university' is small in size, but focused solely on academic functions

Restoration



Stewardship for the Period of Restoration

- A human culture will be needed that assists environmental restoration



Stewardship for the Period of Restoration

- We may expect new ethics to develop to restore:
- Resource reserves
- Soils
- Forests
- Peat deposits
- Mineral deposits



Stewardship for the Period of Restoration

- As in the past, people may find glory in being an agent of the Earth



Stewardship for the Period of Restoration

- It remains to be seen whether the social mechanisms will be conscious, logical, emotional, ritualistic, regimented, or by some means that we cannot yet imagine

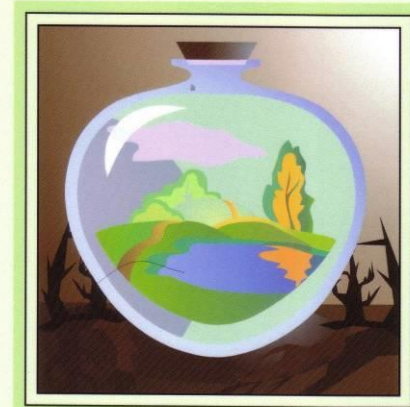


Stewardship for the Period of Restoration

- *All members of society must preserve knowledge, sustain progress, and serve the Earth in ways appropriate to the stage of its cycle*

A PROSPEROUS WAY DOWN

Principles and Policies



Howard T. Odum and
Elisabeth C. Odum