

Statistics and Environmental Resources

Projects for Collaboration

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Background

- B.A. and PhD in Physics
 - Computational Modeling of the Brain
- Teaching
 - Physics
 - Meteorology
 - Neuroscience
 - Artificial Intelligence and Robotics
- Past/Current Research
 - Computational Modeling of the Brain
 - Computer interfacing
 - Bayesian Statistics

Research Interests

- Computational Modeling of the Brain
- Applications of Bayesian Statistics
- Modeling Environmental and Climatic Systems
- Economics of Resource Issues

Environmental Resources

Two Schools of Thought

Malthusian

The combination of exponential growth and limited resources is a deadly combination: we will, as a result of population growth, run out of every possible resource.

Cornucopian

The economic perspective that all resources are effectively infinite, given intellectual capacity for technological development: we *create* resources.

Who is right?

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Introducing Toy Models

A Physicists Approach

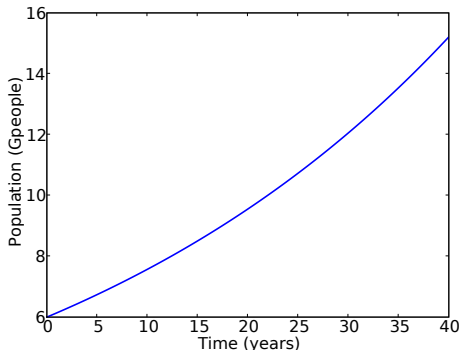
- A toy model is a model stripped down to the barest of elements, ignoring almost all details
- Start with a toy model, add complications incrementally

Model of Resource Depletion

- r : amount of a resource
- v : rate of resource use per person
- p : number of people

The basic equation is then

$$\frac{dr}{dt} = -v \cdot p$$



Model of Resource Depletion

Malthusian Perspective

Assumptions

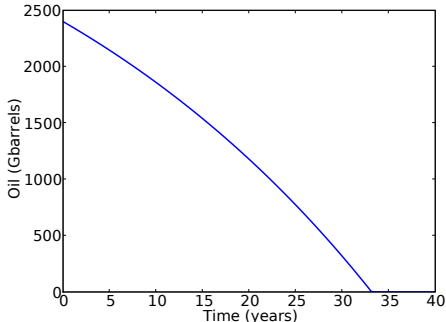
- Constant Usage Rate, $v = v_o$, and no Renewal of Resource
- Exponential Population Growth: $p = p_o e^{t/\tau}$

$$\frac{dr}{dt} = -v \cdot p$$

$$= -v_o \cdot p_o e^{t/\tau}$$

$$r(t) = A - v_o \tau \cdot p_o e^{t/\tau}$$

(A sets the initial value)



Model of Resource Depletion

Cornucopian Perspective

There are several ways of extending the life of a resource:

- 1 increasing the efficiency of the use of the resource: $v \downarrow$
- 2 finding an alternate resource, so you don't have to use the first resource as heavily: $v \downarrow$
- 3 increasing the amount of the resource (discovering new sources): $r_o \rightarrow r_o + r'(t)$

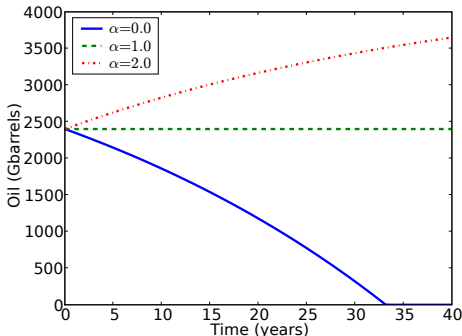
Model of Resource Depletion

Cornucopian Perspective

One Possible Set of Assumptions

- Rate of Use Dependent on Population: $v = v_o \left(\frac{p_o}{p} \right)^\alpha$

$$\begin{aligned} \frac{dr}{dt} &= -v \cdot p \\ &= -\frac{v_o p_o^\alpha}{p_o^\alpha e^{\alpha t/\tau}} p_o e^{t/\tau} \\ r(t) &= A - \frac{v_o p_o \tau e^{t(1-\alpha)/\tau}}{(1-\alpha)} \end{aligned}$$



Conclusions

Introduce toy models, with increasing degree of complexity

- What are the necessary conditions for stability?
- Are the variables measurable?
- What other variables are important?
- Resource differences? e.g. oil versus copper
- Dynamics?

Thank you!

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