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# Lessons from History of Collapse

## Sustainable Cities Sustainable Transport Forum, Melbourne

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# Messages

- There are success stories of avoiding collapse, but very few within isolated systems
- There is a very common recourse to using technology, rather than changing behaviour
- It appears that we (modern society) have progressed SLOWLY along the road map (stages) toward addressing our global problems
- But we now appear to be potentially in the last stage:
  - solution unlikely

# Outline

- **Historical reflections**
  - The Roman Empire – a common case study
  - LeBlanc
    - competition for resources
  - Tainter
    - diminishing returns from complexity and technology
  - Diamond
    - choices along the road to failure or survival
  - Homer-Dixon
    - gap between increase of challenges and ingenuity
- **Lessons from history applied to contemporary times**
  - Successes?
  - Contemporary issues
  - Prognosis

# Selection of comprehensive historical analysis

- Steven LeBlanc

- *Constant Battles: why we fight*  
St Martin's Griffin, 2004

- Joseph Tainter

- *The Collapse of Complex Societies*  
Cambridge University Press, 1988

- Jared Diamond

- *Collapse: how societies choose to fail or survive*  
Penguin, 2005

- Thomas Homer-Dixon

- *The Ingenuity Gap: can we solve the problems of the future*  
Random House, 2001
- *The Upside of Down: catastrophe, creativity, and the renewal of civilisation*  
Island Press, 2006

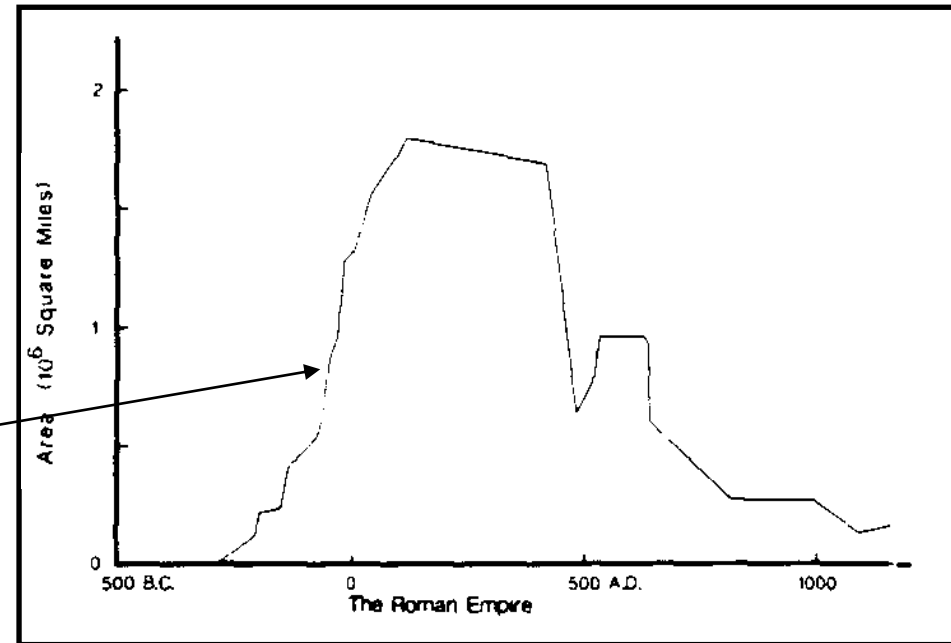
# The Roman Empire – a common case study

- Pressures:

- Wars
- Barbarian raids
- Lack of popular support
- Agricultural constraints
- Plagues

- Solving problems involved:

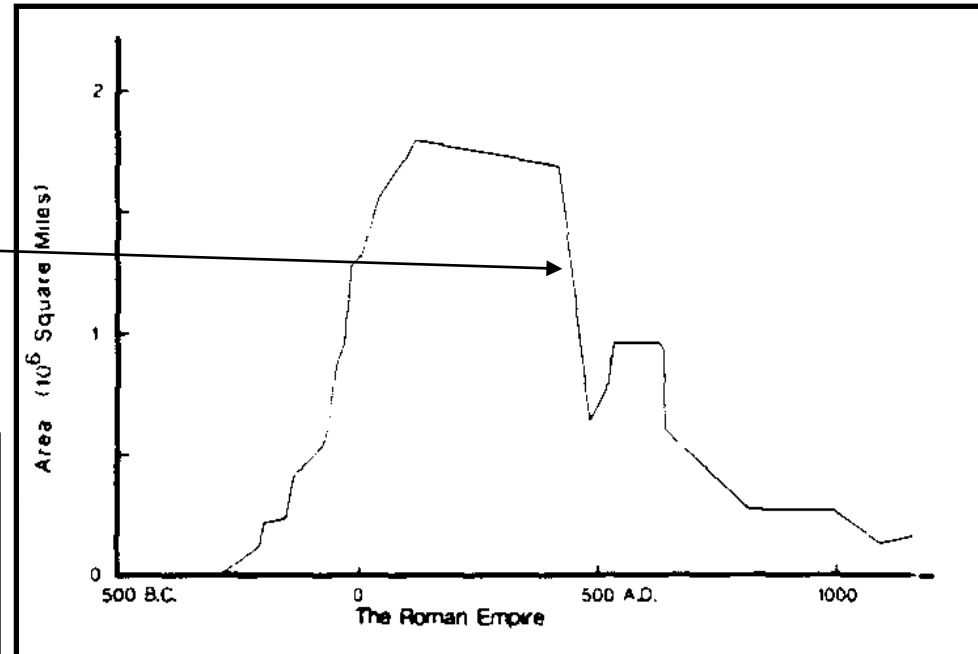
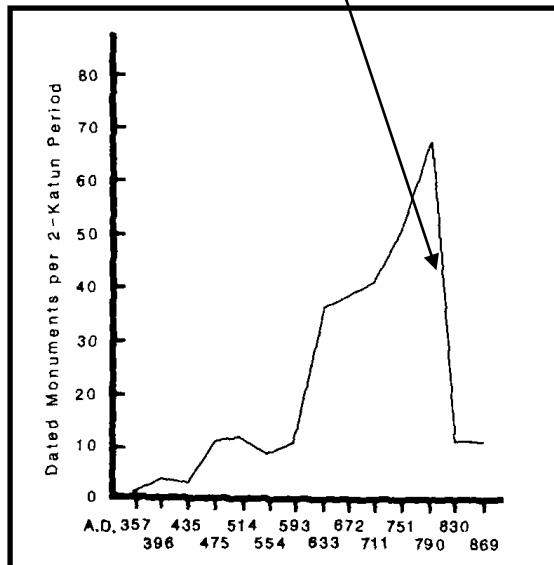
- Technology
- Expansion
- Bureaucracy
- Taxation
- Currency debased (print more money)



# The Roman Empire – a common case study

- What does collapse mean?

- loss of society hierarchy
- loss of living standard
- loss of life
- usually rapid



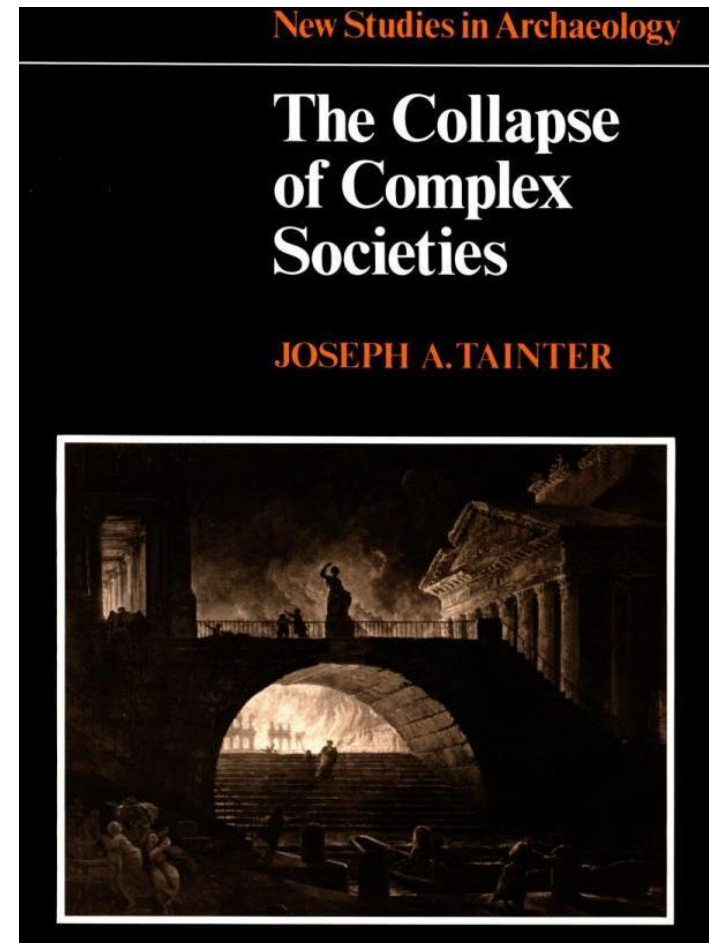
# Constant fighting

- **LeBlanc**
  - we have always fought
    - including pre-humans, hunter-gatherer, tribal farmers, complex societies
  - wars over resource competition
    - typically food supply
  - there are individual cases of peaceful co-existence
    - involve periods when population is below carrying capacity
      - sometimes as a result of earlier conflict!
  - modern period is relatively peaceful
- **but doesn't necessarily imply collapse**
  - though there is clearly great pain and death

# Diminishing returns

- Tainter

- Complex societies that collapsed
  - Western Chou Empire
  - Harappan Civilization
  - Mesopotamia
  - Egyptian Old Kingdom
  - Hittite Empire
  - Minoan Civilization
  - Mycenaean Civilization
  - Western Roman Empire
  - Olmec
  - Lowland Classic Maya
  - Mesoamerican Highlands
  - Casas Grande
  - Chacoans
  - Hohokam
  - Eastern Woodlands
  - Huari and Tiahuanaco Empires
  - Kachin
  - Ik





# Diminishing returns

- Tainter

- Possible causes of collapse
  - resource depletion
  - catastrophes
  - insufficient response
  - intruders
  - conflict
  - mismanagement
  - social dysfunction
  - mystical factors
  - chance set of events
  - economic factors
- Complex societies survived earlier pressures and shocks
- So why did they eventually collapse?

# Diminishing returns

- Tainter

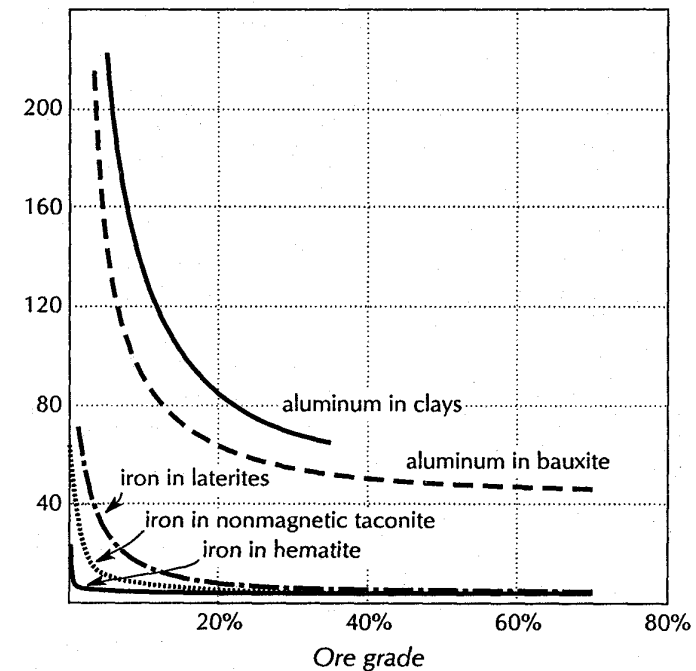
- diminishing returns

- i.e., marginal returns from increasing complexity (including technology) become increasingly smaller over time
      - i.e., pick the low hanging fruit first
      - marginal returns may even become negative?

- consequently the “buffer” to cope with additional pressures and shocks is smaller

- society is overwhelmed by subsequent shock

**Figure 4-6** ENERGY REQUIRED TO PRODUCE PURE METAL FROM ORE  
*Thousand kilowatt-hours per ton of metal*



# Choosing to fail or survive - failures

- **Diamond**
  - societies that have failed
    - Easter Island
      - who cut down the last tree?
        - no-one – a tipping point was reached
    - Pitcairn & Henderson Islands
    - Anasazi
    - Maya
    - Norse Greenland

# Choosing to fail or survive - success

- **Diamond**
  - societies that have survived
    - Tikopia
      - bottom-up solution
      - small island (1.8 square km) in SW Pacific Ocean
      - 1,200 people: high density
      - individual farmers all aware of problems
      - combined decision to impose self-constraint
    - Tokugawa Japan
      - top-down solution
      - 1600's semi-feudal society
      - overuse of forest resource, faster than growth
      - shoguns invoke Confucian principles
        - limit consumption
        - impose quota system
        - (any substitution from beyond Japan?)

# Choosing to fail or survive

- **Diamond**
  - five key choices
    1. failure to **anticipate** a problem
      - no previous experience, no science
    2. failure to **perceive** a problem in progress
      - no measurements, too complex to observe
    3. failure to attempt a solution (rational, **bad behaviour**)
      - rational for vested interests to maintain their dominance
    4. failure to change **bad values**
      - irrational behaviour, societal values entrenched
    5. failure to change **other irrational behaviour**
      - psychological denial
  - and a sixth cause
    6. failure of solution
      - technically not possible

# Too smart by half

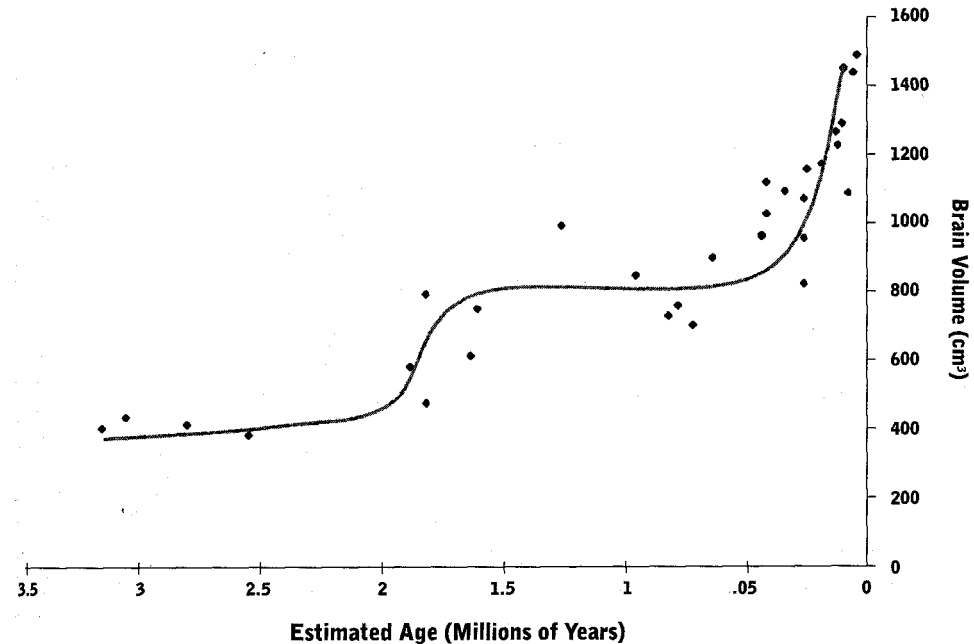
- Homer-Dixon
  - Ingenuity Gap
    - Biosphere

Biosphere 2 Taught Us a Lesson about Managing Complex Ecosystems



- Upside of Down
  - energy profits ratios decreasing
  - barrels of oil out for one barrel in: 20 (1970's) → <10

Hominid Brain Volume Has Expanded in Two Bursts



# Consolidating the lessons

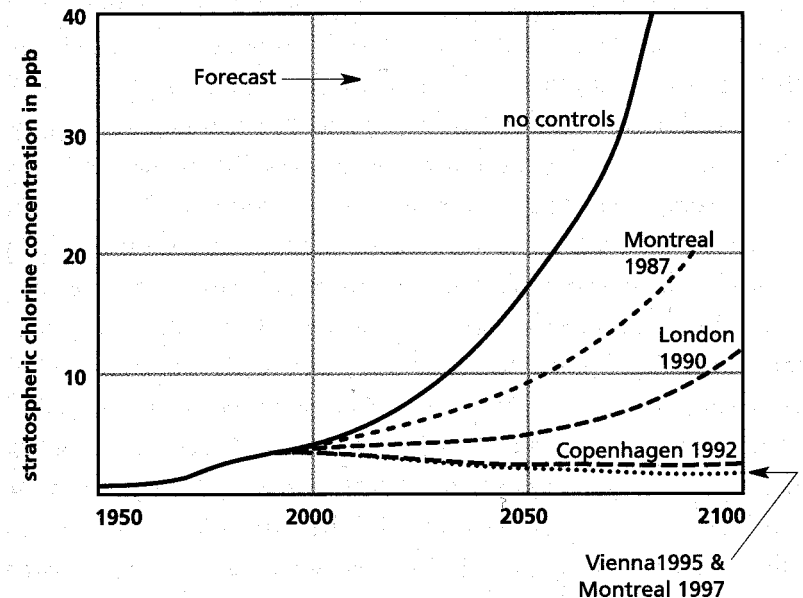
- Diamond provides a comprehensive structure
- Do other views correspond with Diamond's structure?

	LeBlanc	Tainter	Homer-Dixon
Diamond	Resource wars	Diminishing returns	Ingenuity gap
No anticipation	✓	✓	
No perception			
Bad behaviour	✓		
Bad values	✓	✓	✓
Other irrational			
Solution unlikely		✓	✓

# Have we learnt anything?

## Success stories

- Consider “modern” beginning with the Industrial Revolution
- Ozone depletion from chemicals in refrigerants, etc.
  - global causation
  - regional direct effects
  - global indirect effects
- Disease eradication
  - not a crippling problem
- City smog
  - local issue, not global
- Cuba (oil crises of 1980-90's)
  - supply of imported oil suddenly withdrawn
  - difficult transition, including revival of local food production
  - local issue





# Have we learnt anything?

## Success stories

- But do they provide indications of choosing to solve the problem?

	Ozone depletion	City smog	Cuba oil
<b>Anticipated</b>	✗ chemicals in use before reactions known	✗ no previous experience	?
<b>Perceived</b>	✓ measurements were available, but not accepted until unequivocal	✓ illness and death obvious	✓ very obvious
<b>Good behaviour</b>	✗ initial resistance to change	?	✓ change lifestyle
<b>Good values</b>	✗ no change in values	✗ no change in values	?
<b>No other irrational</b>	?	?	?
<b>Solution possible</b>	✓ chemical substitute; positive signs of improvement, but not certain	✓ improved technology	-

- Poor record of response?
- Technology was used to avoid other changes, or
- Drastic lifestyle change imposed

# Have we learnt anything?

## Contemporary issues

- **climate change**
  - growing awareness now of acceleration of emissions and impacts
  - potential for catastrophic events
- **ozone depletion**
  - under control?
- **water availability**
  - extraction approaching fresh water resource
  - climate change impacts
- **peak oil**
  - extraction rate unable to support growth in demand
  - transport systems dependent on oil
- **aging populations**
  - insufficient labour force
- **food production**
  - fisheries peaked
  - dependence on mono-cultures
  - uncertainty about genetically modified foods

# Have we learnt anything? Where on the road map?

Lesson	Is it demonstrated? Yes	No	Time
Not anticipated	Climate models; Limits to Growth, etc.	Arrhenius	1900 1960-
Not perceived	Globalisation hides distant problems; Signal-to-noise issue (e.g., climate variability masks the slower changes)?	Atmospheric measurements; inc'g impacts	1800- 1980-
Bad behaviour	Vested interests influence decisions; free-markets, financial speculation (GFC)		ditto
Bad values	Consumption		ditto
Other irrational	Weary of warnings	Public discontent	1970-
Diminishing returns	Large efficiencies gains have already been used		1800-
Ingenuity gap	Energy profit ratio decreasing		1900-
Solution unlikely	Massive change required; technology alone increases the problem		2010- ?
Resource wars	Iraq, African states, etc.		1800-

# Links with the Limits to Growth

Lesson	Evident in the LtG?
Resource wars	Not included
No anticipation	The purpose of the modelling
No perception	Overshoot & collapse – it is possible to temporarily exceed the carrying capacity due to time lags in the impacts
Bad behaviour	Incorporated in behavioural response functions; but alternative behaviours explored
Bad values	
Other irrational	
Diminishing returns	More capital and inputs required for lower grade resources
Ingenuity gap	Adaptive technology did not work unless it was instantly available (no delay of decades) and rate of improvements where faster than economic growth
Solution unlikely	Collapse is likely unless: <ul style="list-style-type: none"> <li>a. there is less consumption (combined with technology);</li> <li>b. technological progress is 'infinitely accessible'</li> </ul>

# Have we learnt anything?

- Consider “modern” as the Industrial Revolution
- LeBlanc
  - resource wars – Iraq, others (Afghanistan – pipelines; Middle East – water)?
- Diamond
  - largely unaware of global issues (climate, oil) until last half century
  - denial of climate change; peak oil
  - wrong responses – market forces (no foresight, just reactive); technology (efficiency contributes to growth)
  - truly massive changes are required – may be technically impossible (too late); unless demand (consumption) is reduced absolutely, and work less
- Tainter and Homer-Dixon
  - energy efficiencies (and growth), EIOR decreasing;
  - geo-engineering proposals (massive, unknown side effects)

# Messages

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- But we now appear to be potentially in the last stage:
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# Thank you

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