Lessons from History of Collapse
Sustainable Cities Sustainable Transport Forum, Melbourne

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26 March 2009
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

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

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

<table>
<thead>
<tr>
<th></th>
<th>LeBlanc</th>
<th>Tainter</th>
<th>Homer-Dixon</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diamond</strong></td>
<td>Resource wars</td>
<td>Diminishing returns</td>
<td>Ingenuity gap</td>
</tr>
<tr>
<td>No anticipation</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>No perception</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Bad behaviour</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bad values</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Other irrational</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Solution unlikely</td>
<td></td>
<td></td>
<td>✓</td>
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</tbody>
</table>
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?

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

- 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?

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

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Evident in the LtG?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource wars</td>
<td>Not included</td>
</tr>
<tr>
<td>No anticipation</td>
<td>The purpose of the modelling</td>
</tr>
<tr>
<td>No perception</td>
<td>Overshoot &amp; collapse – it is possible to temporarily exceed the carrying capacity due to time lags in the impacts</td>
</tr>
<tr>
<td>Bad behaviour</td>
<td></td>
</tr>
<tr>
<td>Bad values</td>
<td>Incorporated in behavioural response functions; but alternative behaviours explored</td>
</tr>
<tr>
<td>Other irrational</td>
<td></td>
</tr>
<tr>
<td>Diminishing returns</td>
<td>More capital and inputs required for lower grade resources</td>
</tr>
<tr>
<td>Ingenuity gap</td>
<td>Adaptive technology did not work unless it was instantly available (no delay of decades) and rate of improvements where faster than economic growth</td>
</tr>
</tbody>
</table>
| Solution unlikely     | Collapse is likely unless:  
  a. there is less consumption (combined with technology);  
  b. technological progress is ‘infinitely accessible’ |
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

• 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 toward addressing our global problems

• But we now appear to be potentially in the last stage:
  • solution unlikely
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