Uncertainty management

Dealing with inherent uncertainty in complex (socio-enviro-technical) systems

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1. What are Complex Systems?

2. The importance of Framing?

3. A Case Study: Energy-Climate-Economic Nexus

4. Overarching Context

5. Managing Complex Uncertainty?
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Complex Systems; Inherent Uncertainty

Input Factors
Humans/Society
Complex (open) system
Natural world/Environment

Can you think of a Complex system?...

?? Infinite Possible Output(s) from ‘adjacent possible’* ??

System outputs cannot be deterministically predicted, never mind their associated probabilities.

*Stuart Kauffman
What is Complexity?

At a basic physical level, complex systems comprise a large number of nodes or agents (or atoms or cells or units) which exhibit a degree of organisational structure and are linked together via a large number of connections.

Complex neural connections (above) feed into complex social connections (left)
Complex Systems: involve Human or Natural components.

SIMPLE SYSTEMS

HUMAN AGENCY ADDS COMPLEXITY

COMPLICATED SYSTEMS

Bicycle

Pump-Pipeline System

HVAC System

Nuclear Plant
Complex Systems: Operate as Open Dynamic systems

Complex systems operate as open systems which may transfer of material, energy and information across the system boundary.

The system boundary is a function of the observer, who will ‘frame’ the system. Examples include ecosystems (forest, lake, bog, etc.), a manufacturing plant, the earth’s atmosphere, a city, the economy.
Complex Systems: exhibit Emergent behaviour
e.g. art, creativity, aesthetic beauty, culture, transcendence, value, civilisation

*each greater than just the sum of its individual parts*

‘Allegory of Painting (The Painter in His Studio)’ c. 1666 by Johannes Vermeer Kunsthistorisches Museum, Vienna
Complex Systems: exhibit Emergence

Each of the individual **agents** in the system are **unaware** of the emergent behaviour of the system.

- Self-organization @ L’Arc de Triomphe:
  
  https://www.youtube.com/watch?v=LXcFmmBSyNI
Complex Emergence: Cosmic Evolution

Over billions of years, non-equilibrium thermodynamic conditions in the presence of matter allowed the emergence of increasingly complex systems in the form of:

- elements
- galaxies and stars
- heavy elements
- molecules
- life forms
- Agency, values and meaning
- intelligence
- (human) self awareness
- “culture” & technological civilisation

(Chaisson, 2005)
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Viewpoint A

Object

Viewpoint B

Distant background

Viewpoint A

Viewpoint B
Byrne

http://charleseisenstein.net/books/the
more
our
hearts
know
is
possible/truth/
Perceived truth and reality; a function of framing

"Reality is merely an illusion, albeit a very persistent one"

Albert Einstein
Alternative Framings often require.. Independent, Critical, Creative thinking, Dissent from Groupthink..
Contrasting Framings of (un)Sustainability?
Contrasting Framings of (un)Sustainability?

Interlocking Circles Model; Envisages Balance/trade offs/potential ‘win-wins’
Contrasting Framings of (un)Sustainability?

Concentric Circles Model;
No environment => No society!
(=> No economy!)
One Explicit Bottom line.
=> Everlasting Economic & Societal growth is deeply problematic in context of fixed physical planetary Limits
Contrasting Framings of (un)Sustainability?

“Sustainability is the possibility that humans and other life will flourish on Earth forever.”

John Ehrenfeld (2008)

Ehrenfeld (2013): ‘Flourishing’ is nothing more than a state recognized when one says: “All my cares are being satisfied, at least for the moment.”
Contrasting Framings of (un)Sustainability?

Robert Ulanowicz’s model of system sustainability - as contingent balance between agonistic (complimentary, though opposing) tendencies of Order & Control (ascendancy) and Chaos & Flexibility (redundancy, creativity).

Image from: Byrne (2016) Sustainability as contingent balance between opposing though interdependent tendencies, p.47 In: E. Byrne, G. Mullally & C. Sage (Eds.) Transdisciplinary Perspectives on Transitions to Sustainability (Routledge, 2016)
Contrasting Framings of (un)Sustainability?

“Reducing energy demand is compatible with economic growth”

Prof. Ed Rubin
(Carnegie Mellon Univ.)
ISALab, Valencia, 11 June 2018
Contrasting Framings of (un)Sustainability?

“The Impossible Hamster”
New Economic Forum (NEF)
(cited by Dr Dai Morgan, U. Cambridge, ISALab, Valencia, 12 June 2018)
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Energy-Climate-Economic Nexus

Where are we heading?
The facts and data..
The Bigger (and Longer term) Picture?; Global Energy use

US Household Refrigerator Trends:
- Increased efficiency – driven by regulatory standards
- Reduced Cost per unit

**BUT:**
- Increased unit size
  (Rebound effect/’Jevons’ Paradox’)

Source:
American Council for an Energy-Efficient Economy
The Bigger (and Longer term) Picture?; Global Energy use

World energy consumption by energy source (1990-2040) quadrillion British thermal units

- Petroleum and other liquids
- Natural gas
- Coal
- Renewables
- Nuclear

Sources: EIA, BP

Primary energy consumption by fuel

- Renewables*
- Hydro
- Nuclear
- Coal
- Gas
- Oil

*Renewables includes wind, solar, geothermal, biomass, and biofuels.

Sources: EIA, BP
Global Energy Trends, 2018 edition. A step backward for the energy transition?

30 May 2018

Press Release

After a 3-year stagnation, CO₂ emissions are on the rise again
Energy mix decarbonization and energy efficiency improvements remain insufficient

Paris (France) – May 30, 2018
<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic growth</td>
<td>+3.7%</td>
<td>At purchasing power parity</td>
</tr>
<tr>
<td>Rising energy consumption</td>
<td>+2.1%</td>
<td>11.1 Gtoe</td>
</tr>
<tr>
<td>Rebound in CO₂</td>
<td>+2%</td>
<td>27 GtCO₂</td>
</tr>
</tbody>
</table>

* CO₂-energy emissions from energy combustion (>80% of CO₂ emissions)

“Reducing energy demand is compatible with economic growth”? A Contested Perspective; little empirical historical evidence base.

Source: Enerdata (2018)
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Overarching Context:

Why, in light of all we know, do we find it so difficult to make any Progress?

or

What are the Structural Barriers to achieving Sustainability?
Overarching Context:
Why, in light of all we know, do we find it so difficult to make any Progress?

What are the Structural Barriers to achieving Sustainability?

The Dominant Global Paradigm of CONSUMPTIVE GROWTH

ISA Lab Workshop, UPV, 14th June 2018

E.P. Byrne
Paradigm of **GROWTH**

Herman Daly (2009):

“When we “grow up” the first thing to do is to **stop further growth**, to become a **mature steady state** in physical dimensions, and then concentrate on **qualitative development** and maintenance: knowledge, wisdom, justice, ..etc.”
Paradigm of **GROWTH**

Growth for the sake of growth is the ideology of the cancer cell.

(Edward Abbey)
Paradigm of GROWTH

Tim Jackson (2009) argues in ‘Prosperity without Growth’ that we cannot find ‘prosperity’ in GDP growth:

“An economy predicated on the perpetual expansion of debt-driven materialistic consumption is unsustainable ecologically, problematic socially and unstable economically”
Paradigm of **CONSUMPTIVE GROWTH**

John Ehrenfeld (2008):

Promoting *increased consumption* as a means of stimulating *growth* produces neither *prosperity* nor *flourishing* but rather *inauthenticity* leaving ‘a hole, something *unsatisfied* even if the task seems to have been successfully executed’, resulting in an *addictive* craving for more.
Alternative framings to the dominant paradigm:

The Metaphoric power of ART as a critique of Consumerism
IPAD  
THEFORE IAM  
The iPad is the only show in town at the moment when it comes...
$pend a life behind bars.
THE JOY OF NOT BEING SOLD ANYTHING
Jesus Christ with Shopping Bags
(Banksy, 2005)
TheBuyerarchy of Needs
(with apologies to Maslow)
DON’T BUY THIS JACKET

COMMON THREADS INITIATIVE

REDUCE
WE make useful gear that lasts a long time
YOU don’t buy what you don’t need

REPAIR
WE help you repair your Patagonia gear
YOU pledge to fix what’s broken

REUSE
WE help find a home for Patagonia gear
you no longer need
YOU sell or pass it on

RECYCLE
WE will take back your Patagonia gear
that is worn out
YOU pledge to keep your stuff out of
the landfill and incinerator

REIMAGINE
TOGETHER we reimagine a world where we take
only what nature can replace

How many brands can run an ad like this?
Visit a Repair Café
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Managing Uncertainty in Complex Systems?

John Ehrenfeld suggests that Adaptive Governance, which would seek to maintain some emergent system property such as resilience, is more appropriate than traditional Systems Management, where the focus tends to be on some quantitative outcomes such as sustainable yield.
Managing Uncertainty in Complex Systems?

“If a single feature of adaptive governance stands out, it is the criticality of building understanding about the system. In practice this generally means a constant search for and recognition of areas of uncertainty and ignorance, coupled to planned intervention designed to produce learning as well as keep the system functioning and healthy.”

John Ehrenfeld (Sustainability by Design, p. 183)
How can we best;

• identify suitable possible interventions
• to achieve experiential system learning and healthy (sustainable) functioning
• of complex socio-enviro-technical systems with inherent uncertainty? (e.g. your project, water in Cape Town, South Africa)
There are no whole truths; all truths are half-truths. It is trying to treat them as whole truths that plays the devil.'

Alfred North Whitehead (1954)

..how humans relate to world around them through stories, myths, (meta-)narratives; ultimately an issue of ethics

..developing/applying a global legal framework

..incorporating economic externalities

..developing/applying appropriate technologies

The climate-water-energy-food nexus

Water

Water for energy (Cooling, hydro, extraction, etc.)
Energy for water (Extraction, transport, treatment)

Water for food/feed/fibre
Impact of land use practices on water resources

Energy for food/feed/fibre
Fibre for energy production
Crops for energy v food
Transdisciplinarity; seeking emergent knowledge built on strong disciplinary pillars, while transcending them

‘Unitas multiplex’ (Morin, 2008)

‘Unity amidst diversity and diversity through the unity’ (Klein, 2004)
Key take away points:

1. Socio-Enviro-Technical Systems are Complex, and are characterised by inherent Uncertainty.

2. Such systems cannot be uniquely and ‘objectively’ described but are open to framing.

3. ‘Managing’ such uncertainty is best achieved through Adaptive Governance; understanding the system and proposing potentially useful interventions, which can best be done via Transdisciplinary approaches.