Coevolution of Social and Ecological Systems
an Analytical Economics approach

Peruvian campesinos protesting against Conga Gold Mine 2011
http://www.economist.com/node/21541420 [Reuters]

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WINS Inception Workshop,
Humboldt-Universität zu Berlin,
15. July, 2014

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Overview – 4 Questions

• Georgescu-Roegen’s Analytical Economics - a General Theory for Institutional Economics

• Scientific Communities using Georgescu-Roegen

• Some Ideas as to how these Communities might enrich and benefit from working with/in WINS

• A few Recommendations regarding future Design and Development of WINS
Economic Process & Analytics of Change

Economics is about qualitative biological change


Wicksteed's production function \[ P = f (a,b,c,\ldots) \] “an acme of imprecision”


following on from his work at Harvard, in the 30s, on Consumption Theory and Activity Analysis, reflecting on his time back in Romania during WWII …

(1) “Romania’s institutions were not adapted to the Walrasian principle of profit maximisation”


(2) “One certainly would not expect a society that cannot live according to the Walrasian distribution theory to commit suicide rather than adopt another system”

“...an arithmomorphic model has no value unless there is a dialectical reasoning to be tested”

- GR, 1971:341 emphasis original

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
<th>Description</th>
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</table>
| 1894 | Wicksteed | production function $P = f(a,b,c,...)$
        |        | mischievous math | *role of time not specified* |
| 1950s | Boulding | proposes the recipe as a metaphor
            |        | list of ingredients | *role of time not specified* |
| 1960s | Georgescu-Roegen | finds some value in Boulding's metaphor
            |        | *explicitly* adds mixing instructions | *timing is everything* |
| 1970s | Georgescu-Roegen | *implicitly* contextualises the metaphor
            |        | adding the economic *Anschauung* of a society (cuisine) | *the final cause fixes the time-frame* |

Georgescu-Roegen‘s flow fund model
a brief introduction to the concepts

a constructive critique of Walras / Wicksteed / Leontief; of reliance on a
fixed algebraic distinction between stocks and flows

process-specific flow/fund replaces freeze-frame stock/flow distinction

a biological theory of value / energy doing usefull work
- usefulness depends upon purpose; no purpose, no useful
- purpose determines what is the point of focus
- focus, combined with capacity for scope, determines the temporal
  and spatial boundaries of process
- the temporal and spatial boundaries of the specified process
determine the flow/fund status of the elements of production

GR, 1971
Brennan, T. 1997. Economy for the Earth:
Farrell, K.N. and K Mayumi. 2009. Time horizons and electricity futures:
Flows and Funds

“Flows are elements that enter but do not leave the process or, conversely, elements that exit without having entered the process. Funds ([typically] capital, people and Ricardian land\(^2\)) are elements that enter and exit the process unchanged, transforming input into output flows” (Mayumi, 1999:191).


\(^2\) Mayumi includes here, the following note:

“in this representation, outflows of any kind are represented by positive coordinates, inflows by negative coordinates”
Grannies Cookies / Georgescu-Roegen’s General Theory
cuisine specifies the space/time structure of the process

list of ingredients | timing not specified
3 eggs
2 cups flour (fine)
3/4 cups cane sugar
3/4 cups brown sugar
1/2 lb butter (room temperature)
2 tsp vanilla extract
1 tsp baking soda
1 tsp salt
1 lb chocolate

mixing instructions | timing is everything
pre-heat oven to 325F
set the butter out to warm if you have not done so already
    (do not cook or microwave the butter! - if you forgot, chop the chocolate and wait)
chop chocolate into pieces smaller than a hazelnut but bigger than a pea
    put the chocolate somewhere cool, for use later in the recipe
sift flour, baking soda and salt together
    put the flour mixture somewhere dry, for use later in the recipe
mash the butter in a large bowl until it is smooth
add the cane and brown sugar to the butter and mix until smooth
add the eggs to the butter and sugar mixture and mix until smooth
add the vanilla to the butter, sugar and egg mixture and blend
    in small stages add the flour mixture to the batter in the big bowl
    (make sure to incorporate each round of flour before adding more)
in small stages add the chocolate chunks to the batter/flour mixture in the big bowl
using two table spoons, place golf ball sized dollops of batter on to an ungreased cookie sheet
    (make sure to leave at least 2 inches ‘growing room’ between dollops)
bake at 325F for 8-12 minutes (but check them sooner) until golden brown and firm to the touch

Purpose, Production and Apple Trees

Produced or Producing?  
Product or Capital?  
Flow or Fund?

to the farmer – the tree is a producer of fruit (fund)

to the carpenter – it’s a supply of wood (flow)

to the bee – a producer of nectar (fund)

to the termite – a direct source of food (flow)

Institutions and Social-Ecological Co-evolution in Georgescu-Roegen’s Analytical Economics (Chapter 10 GR, 1971)

referring to Lotka’s term **exosomatic evolution**:

“[i]n place of slow adaptation of anatomical structure and physiological function in successive generations by selective survival,

... increased adaptation [in the human species] has been achieved by the incomparably more rapid development of

... ‘artificial’ aids to our native receptor-effector apparatus, in a process that might be termed **exosomatic** [outside the body] evolution”


- acquired knowledge, become tacit knowledge – institutionalised
- phenotype become genotype – population level manifestation
- niche construction embeds habituated patterns – co-evolution
- human biology & human evolution are institutionally attenuated

Humans use technologies, including institutions such as hammers, money, markets, laws, courts, customs, habits, taboo, ritual, etc., to sort matter into low entropy. Choices about the purpose of economic activity set the parameters of economic processes—Cadillacs or crops?

“Choices regarding what constitutes social-ecologically appropriate human behavior and how this should be regulated are the raw materials with which fit institutions may be brought into being.”

Applications of Analytical Economics


• materials from both Chapters 9 and 10 of that text are used widely in evolutionary and ecological economics
  
  – C.9 is mathematics: used in bioeconomics and energetics studies and in agro- and industrial economic modelling
  
  – C.10 is social theory: used in political ecology
  
  – the two are rarely used together, in spite of that having been, it would seem, his intention …
Decommissioned Yanacocha Mine
Representing Purposive Complexity as Parameters for Process Elements


0,250 tons / USD : material moved / capital equipment
6,2 tons / USD : waste generated / waste infrastructure

Fig. 6 Mine infrastructure versus land materials (as flows). Source own elaboration inspired in Giampietro.


Tibetan Pastoralism
A Social Ecological System

Photo Credit: Jampel DellAngelo

Khandro Tsering Chödrön
Tibetan Lama (1929-2011)
Source: chronicleproject.com/stories_295.html

a Purposive Sorter at the heart of a complex, evolving Social-Ecological System
Khandro Tsering Chödrön in Exile
Tibetan Lama (1929-2011)
source: http://www.rigpawiki.org

Main rivers in China - high resolution map

http://www.china-food-security.org/data/maps/rivers/riv1_h.htm

Source:
IIASA LUC Project
Digital Map of the World
Main rivers in China - high resolution map
http://www.china-food-security.org/data/maps/rivers/riv1_h.htm

Source:
Tibetan Pastoralists have been obliged to settle in changed sorters - changed system.
the Great Ruaha River, her Usangu Plains

and her people(s)

maps accessed online via the CIA Factbook
Ihefu – Usanagu Weltlands, Mbarali, Tanzania
Photo: Adam Mwarabu

Mbarali Evictions, 2006-2008
Photo: Adam Mwarabu

The I’I Parakuiyo wymyn forced to resettle after the Mbarali evictions
Photo: Adam Mwarabu

Western and Eastern Usanagu Weltlands, Mbarali, Tanzania (source: Google Earth 2008)

Kilosa Evictions, 2009
Photo: Adam Mwarabu

Western and Eastern Usanagu Wetlands, Mbarali, Tanzania (source: Google Earth 2014)

Local Photos all Taken by Evelyn Kaney, 2013

Some Ideas on how the communities using Georgescu-Roegen might enrich and benefit from working with/in WINS

Georgescu-Roegen’s Analytical Economics provides a basis for constructing process-specific functional math equations, suitable for modelling dynamic relationships between physical and social systems


perhaps combining MuSIASEM with the IoS


a recommendation accommodate modelling modularity

Embrace:
– the impossibility of an ultimate ‘meta-model’ as the only reasonable ultimate ‘meta-model’

Conduct:
– purposive analysis of purposive processes

Think:
– outside the box before you set about unpacking it
a working ontology of the typical SES research project

1. complexity & 6. team research

2. ontological diversity

3. methodological diversity

4. dominance and gate keeper disciplines

5. a dual role for social science

Mapping the Complexity of Interdisciplinary Team Level Discourses

<table>
<thead>
<tr>
<th>Methodological Compatibility</th>
<th>Ontological Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent</td>
<td>Political</td>
</tr>
<tr>
<td>Weak</td>
<td>political / ontological</td>
</tr>
<tr>
<td>Strong</td>
<td>Confusion &amp; Creativity</td>
</tr>
<tr>
<td>Strong</td>
<td>ontological / technical</td>
</tr>
<tr>
<td>Strong</td>
<td>Technical</td>
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</tbody>
</table>

and as with any journey of adventure…
keep things in perspective

Take the salmon as the point of focus, for example…
the young salmon swim off to the sea,
with a preordained purpose – stay alive
the mature salmon returns to the same river,
with a preordained but entirely different purpose – to reproduce

Take the forest as the focus and we can see the two purposes converge,
the young salmon swimming off to the sea have the purposes to collect low entropy and get safely back to their home river, bringing nutrients with them…
mature salmon, returning, have the purpose to give these nutrients to the forest, and to produce new young salmon that repeat the cycle of creative destruction…
thank you for your attention!

a jaguar at rest in the Amazon
Photo taken by Robert Williams
given to me by Jose Carlos Silva Macher: for inspiration

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Katharine Farrell and Adam Mwarabu
Photo Taken by Richard Norgaard,
Nairobi, 2008