40 years after Limits to Growth
The World3 system dynamics model and it’s impacts

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Sustainability became a theme

• Carrying capacity as a concept first arose in Netherlands in the 1670’s. It was concerned with food, land, agricultural production and growing population

• Industrialization involved a huge increase in physical capacity of human society and a rapid growth of populations
Global sustainable population estimate

- Low estimate
- High Estimate
- Recorded and UN predicted global population under present paradigm
  - According to WORLD3
  - According to FoF-model
The Ehrlich equation

\[ I = P \times A \times (1-R) \times (1-E) \]

- Impact
- Population, the number of consumers in the system
- Affluence (GDP, Standard of living)
- Recycling, degree of circularity
- Resource efficiency
Limits to growth team at MIT
The World3 model

- A system dynamics model
- Based on a thorough systems analysis, using causal loop mapping of the global system.
- The World3 model was simplified to be executable on the available MIT mainframe computers available. It took weeks to run...
- All natural resources were lumped into one R
Figure 1-3 Causal-loop diagram of several important feedback loops in World3
World3

Population module
- Population dynamics and demography
  - Fertility control
  - Mortality control

Resource module
- Resource conservation technologies
  - Non-renewable resource

Economy module
- Labour utilization fraction
- Industrial capital
- Service capital
- Consumption controls

Ecology module
- Pollution mitigation technologies
  - Pollution

Food and land module
- Agricultural inputs
  - Food
- Land fertility
- Land yield technologies
- Urban land
- Arable land
- Potentially arable land
- Soil erosion
tions. We will examine several alternatives, each dependent on a different set of assumptions about how human society will respond to problems arising from the various limits to growth. Let us begin by assuming that there will be in the future no great changes in human values nor in the functioning of the global population-capital system as it has operated for the last one hundred years. The results of this assumption are shown in
Assume we had much more of everything
Limits to growth results

• The world would run low on resources and they would become expensive
• We run out of money before we run out of resources physically
• Exponential growth of population, allow consumption to overpower all counteractions like improved efficiencies and circularity
• The time-frame was peak being reached 2020-2030
Things started to happen

• The energy crisis happened 1973
• The proponents of economic growth felt threatened
• Growth was kept up with debt and quantitative easing since 1976 in the US and many other nations
• Neo-liberal philosophies took over, Ronald Reagan and Margaret Thatcher took power.
• Denial started...
Criticism of the World3 model and the concept of limits to growth

• The resources were oversimplified, no distinction was made between materials, metals, phosphorus or fossil fuels
• The resources available were an under-estimate.
• The model was criticized for being too
  – Simple
  – Complex
• The authors were politically attacked and publicly ridicouled
Did it work when we check?
Conclusions

• The World3 model was simplified to be executable on the available MIT mainframe computers available.

• All resources were lumped into one R. That created a credibility problem and a pedagogical problem of interpretation.

• The World3 model runs are valid, and approximately correct when compared to observations 1972-2015.
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