Contraction and Convergence
Policy Recommendations for
Global Sustainable Supply of
Strategic Natural Resources

Kristín Vala Ragnarsdóttir¹ and Harald U. Sverdrup²
¹University of Iceland, ²University of Lund

STHESCA, Krakow, Poland, July 5-7, 2011
Contraction and convergence

• North – contract their resource consumption

• South – increase their resource consumption

• Meet at the same equitable consumption rate...

• CONVERGEproject – FP7
Planetary boundaries

We have surpassed 3 of 9

Rockström et al. 2009

Acidification of oceans
Ozone in stratosphere
Cycling of nitrogen
Cycling of phosphorous

Climate change

Chemical pollution
Atmospheric aerosol loading
Biodiversity loss
Land use change
Freshwater use

Rockström et al. 2009
Resource depletion

• Man is a geologic force!!!
  – We move annually 10x more than nature
  – We now are in a biological extinction phase
    • 25% of mammals endangered
      – Thousands of species become extinct every year
      – Ecosystems on land and in oceans endangered
  – In 30 years
    • We have used up 1/3 of the Earth’s resources!
      – Destroyed 30% of forests, lost 25% of soil, 50% of oil, 50% of P...
      – Metals and other commodities are becoming scarce

= Because of consumption
Exponential growth
1750-2000
Exponential growth forever?
“The greatest imperfection of mankind is that it does not understand the consequence of exponential growth”

Albert Allen Bartlett

“Anyone who believes that exponential growth can go on for ever in a finite world is either a madman or an economist”

Kenneth Boulding
Seven steps toward sustainability

- Think long term
- Understand systems
- Know limits
- Protect nature
- Change commerce
- Show equity
- Support entrepreneurship

(AtKisson 2008)
Sustainability Compass:

• **N = Nature**
  Environment, resources, ecosystems, climate, resource use, land-use

• **E = Economy**
  Production, consumption, employment, investment, infrastructure, labor, risk

• **S = Society**
  Government, culture, institutions, collective concerns, education system

• **W = Wellbeing**
  Individual health, families, education, quality of life, personal development, relationships
3 different methods used

• Burn-off rates

• Hubbert curve estimate

• Dynamic simulation models solving differential equations for metal stocks, use rates, market-price-mechanisms, mining rates
Phosphorus burn-off rates

- Australia: 27
- Brasil: 35
- Canada: 22
- China: 81
- Egypt: 26
- Israel: 38
- Jordan: 66
- Morocco and West Sahara: 85
- Russia: 14
- Senegal: 24
- South Africa: 126
- Syria: 21
- Togo: 19
- Tunisia: 9
- United States: 28
- Other: 64
Phosphorus

Oil

Rock phosphate production Nauru Island

World rock phosphate production

OIL AND GAS LIQUIDS
2004 Scenario

Hydrocarbon production

Production
Predicted
Hubbert’s curve
Mass flows
Business as usual, population trajectory, but with phosphorus limitation
Mining and supply

- Mined high grade
- Mined low grade
- Mined ultralow grade
- Mining Total
- Weathering

Million tons of phosphate rock per year

1800 2100 2400 2700 3000 3300 3600
Recycling versus global population

Million people

2000 4000 6000 8000 10000 12000 14000

1: 10%
2: 26%
3: 42%
4: 58%
5: 74%
6: 90%
The magic hand of the market is stupid
The recycling amplification effect
The race on resources is on. This applies to many more strategic materials, phosphorus is only one of them.

Procrastination and denial is futile against mass balance and only lead to humiliation.

Exponential growth forever is a thermodynamic impossibility.

Adaptation of society is required.
Policy Recommendations

• Strict enforcement of all activities within sustainability boundaries.
• Define critical extraction rates. Enforce them.
• Make recycling of all natural resources compulsory – aim for over 90% within 5 years
Policy recommendations

• Place a large and substantial payable deposit on every ton of resource removed from the ground, returning the deposit to the entity carrying out the recycling.

• Arrange for production quotas from a long term basis for fossil materials that already are scarce. Stop in time when EROI goes negative.
Policy recommendation

• Vision a “happy” sustainable future.
• Promote the values of equity and ethical behaviour.
• Promote the culture of “enough.”
For a Sustainability Revolution

• In addition to
  - population reduction, more efficient use of resources, pollution control, technological advancement etc…

• We need
  - visioning, networking, truth telling, learning … and loving

Meadows et al. (2004)
Thank you!

Thanks to coworker
Harald Sverdrup
University of Lund, Sweden