Aquaponics and Sustainability

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Resource depletion

• Man is a geologic force!!!
  – We move annually 10x more than nature
  – Now have biological extinction period
    • 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 Earth’s resources!
      – Destroyed 30% of forests, lost 25% of soil, 50% of oil, 50% of phosphorous...
      – Metals are becoming scarce

= Because of consumption
The Earth is **shrinking**

**YEAR**

**Hectares of surface per person**

1900: 7.91
1950: 5.15
1987: 2.60
2005: 2.02
2030: 1.69
2050: 1.44

Ecological footprint = the land we need to provide daily needs and take up the waste. Now we are using 1.5 Earths per year.
Ecological footprint
American way of life – 5 planets!

EU and Norway 3 planets!

Iceland 10 Earths or 7!!
Planetary boundaries

We have surpassed 3 f 9

Rockström et al. 2009
Exponential growth forever?

Sverdrup and Ragnarsdottir, unpublished

![Graph showing annual global production of various minerals and resources over time.](image)
Exponential growth 1750-2000

- Population
- GDP
- Dams on rivers
- Water use
- Urban population
- Paper consumption
- Number of telephones
- McDonalds
- Tourism
- Car transport

HÁSKÓLI ÍSLANDS
“Anyone who believes that unlimited growth is possible in a limited world is either a madman or an economist”

Kenneth Boulding  
Economist

“The greatest imperfection of mankind is that it does not understand the consequences of exponential growth”

Albert Allen Bartlett  
Mathematician

Both at University of Colorado, Boulder
Peak fish, soil, phosphorus, oil

Global fish catch

Fossil fuels

Soil

Phosphorous

2000

Oil 2006
Gas 2015
Coal 2015
Hubberts "peak" curves for 12 key metals and materials

Figure 8. Hubbert-curve fittings for gold (a) silver (b), copper (c), zinc (d) lead (e), indium (f), iron (g), molybdenum (h), chromium (i), nickel (j), platinum group metals (40% Pt, 43% Pd, 5% Rh, 5% Ru, 5% Ir, 2% Os) (k) and (l) that shows a one-curve phosphorus plot. We can see that the data suggest gold already passed the production peak. The scale on the Y-axis is production in ton per year, the x-axis is the year. Data: http://minerals.usgs.gov/ds/2005/140/

Sverdrup Ragnarsdottir Koca 2013
From cradle to grave to cradle to cradle

Biomimicry – Cradle to cradle

- Fossil Phosphorus, Nitrogen from air (high energy demand)
- Fertilizer factory
- Food
- Solid waste, excess sludge
- Inclination, landfill
- Accumulation of Phosphorus and Nitrogen in surface and groundwater
- High water demand
- Health risk

* Biological metabolisms return all ingredients to the soil safely, like in nature: Waste equals food.
* Technological metabolisms use materials that can be disassembled and reused indefinitely – and never head for the landfill.
Sustainability

Sustainability is..

A set of conditions and trends in a given system that can continue indefinitely

Sustainable development is..

A directed process of continuous innovation and systemic change in the direction of sustainability

Atkisson 2008
Systems and sustainability

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

System thinker
- Looks for the big picture
- Looks for cycles, causes and effects
- Sees how things within the system change with time
- Looks for new angles
- Investigates causes of short-term and long-term actions
- Finds unexpected connections

(AtKisson 2008)
Aquaponics

• Many available scales
  – Hobby at home in the garage
  – In schools
  – Community engagement
  – Mini production for local restaurants
  – Mega production for commercial purposes
Research/training needed for Aquaponics

- Urban agriculture, Sustainable cities
- Permaculture
- Operational
  - Feed for fish, flies, larvae, algae...
  - Closing nutrient cycles, modelling
  - Organic certification
- Economic
  - Feasibility
  - Green economy
- Environmental
  - Impact Assessment
  - Footprint – water, CO₂, energy..
- Sustainability Indicators
- System dynamic modelling
- Education
  - Open source
  - Community involvement
  - Vocational training
Conclusions

• Natural resources are being overused
• Learning from nature is a key to the future
• Aquaponics is one step in the right direction
• Good luck with all your efforts!

Thank you for listening!