

# Ecological concepts applied to industrial ecology

Dr. Audrey Mayer

University of Tampere


School of Economics and Business Administration

Research Centre Synergos

[audrey.mayer@uta.fi](mailto:audrey.mayer@uta.fi)



# Hot Topics in Ecology

- Diversity / Productivity / Stability (Resilience) relationships
  - Niche construction
  - Self-organization
  - Dynamic regimes, catastrophes (as related to stability/resilience)
- 

# Diversity, Productivity, Stability

- Three-way relationship is generally positive
  - Diversity → more species, more specialized species
  - Specialization allows for limited resources to be used more efficiently
  - Redundancy allows for greater stability
- However, there are exceptions and limitations
  - Fertilizer can increase productivity at the expense of diversity and stability
  - Low-diversity ecosystems can naturally be very stable and productive

# ... as applied to industries

## ➤ Diversity: analogous agents

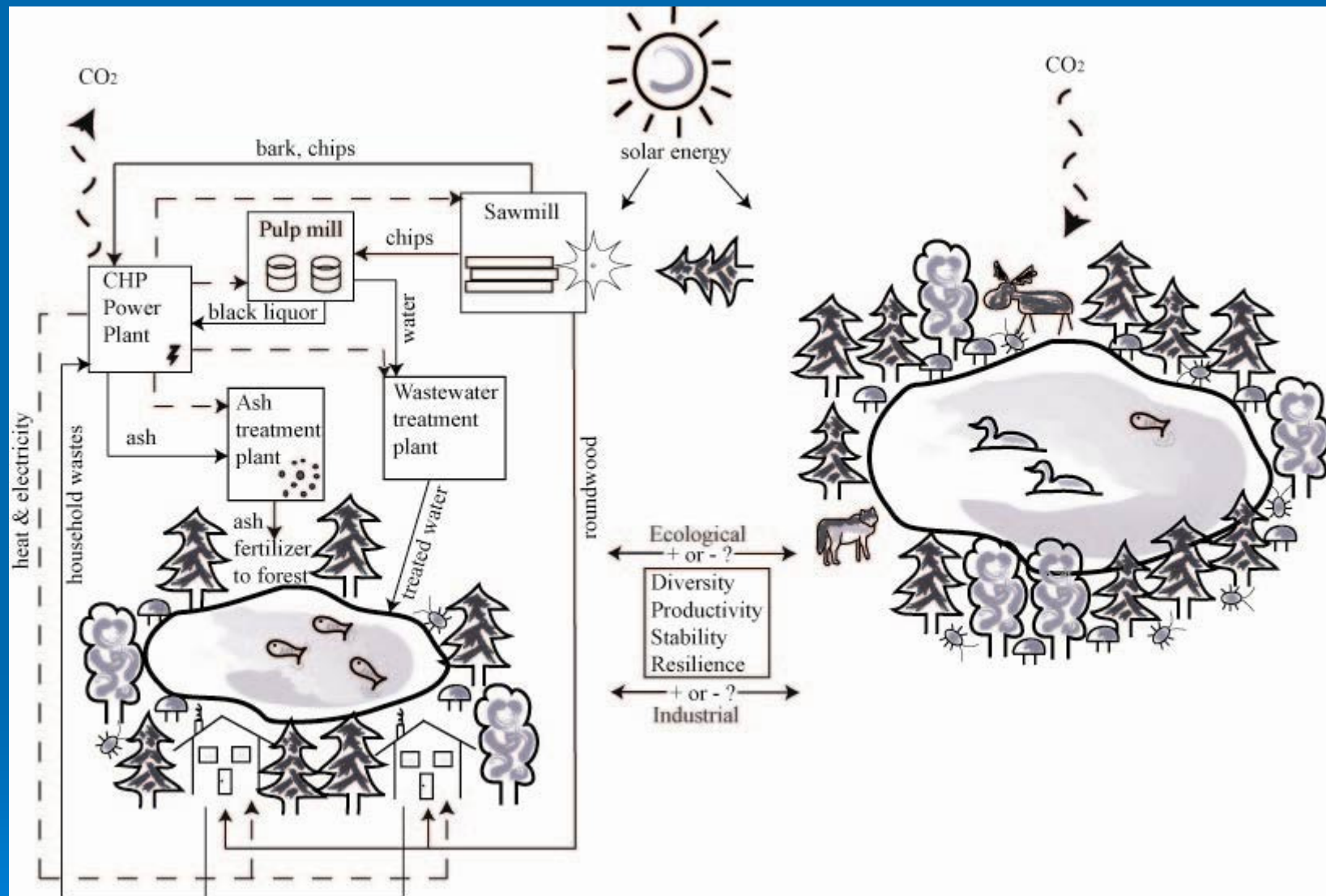
- Firm = species
- Industry = guild
- System of industries = community

## ➤ Productivity

- Ecological → energy and nutrients converted to biomass
- Industrial → several potential measures

## ➤ Stability

- Ability to withstand internal and external disturbances
- Ecological → fires, floods, pest outbreaks (external); species extinction, population dynamics (internal)
- Industrial → recessions, resource/input shortage (external); labor strike (internal)



# Niche Construction

- Organisms modify their environment to increase their own success, often at the expense of competitors
  - water/hydrology
  - nutrients
  - self-produced toxins ("allelopathic")
- "ecosystem engineers" – those species which modify their environment at a scale much larger and longer than similar species (e.g., beaver vs. badger)
  - other species are often adapted to these modified conditions

# ... as applied to industries

- Modifying local environment to improve success
  - at the expense of competitors
- "Industrial system engineer"
  - firms which modify environment (ecological, socio-economic) at fairly large scales
  - and the firms specialized to co-locate with them

# Self-organization

- Pattern at the global level emerges solely from numerous interactions among the lower-level components
- **Local** rules and information govern interactions among the components are executed using only local information
  - No rules or information about pattern at global scale

# Flocking behavior

- Three (local) rules:
- Separation - avoid crowding neighbors
- Cohesion – avoid getting too far away from neighbors
- Alignment - move towards average heading of neighbors



# ... as applied to industries

- Local drivers, global patterns
  - Local regulations, tax rate, socioeconomic characteristics
  - Minimum distance between competing firms, industries; patterns at larger scales?
- Self-organized eco-industrial parks
  - Top-down planning for parks less effective than expected

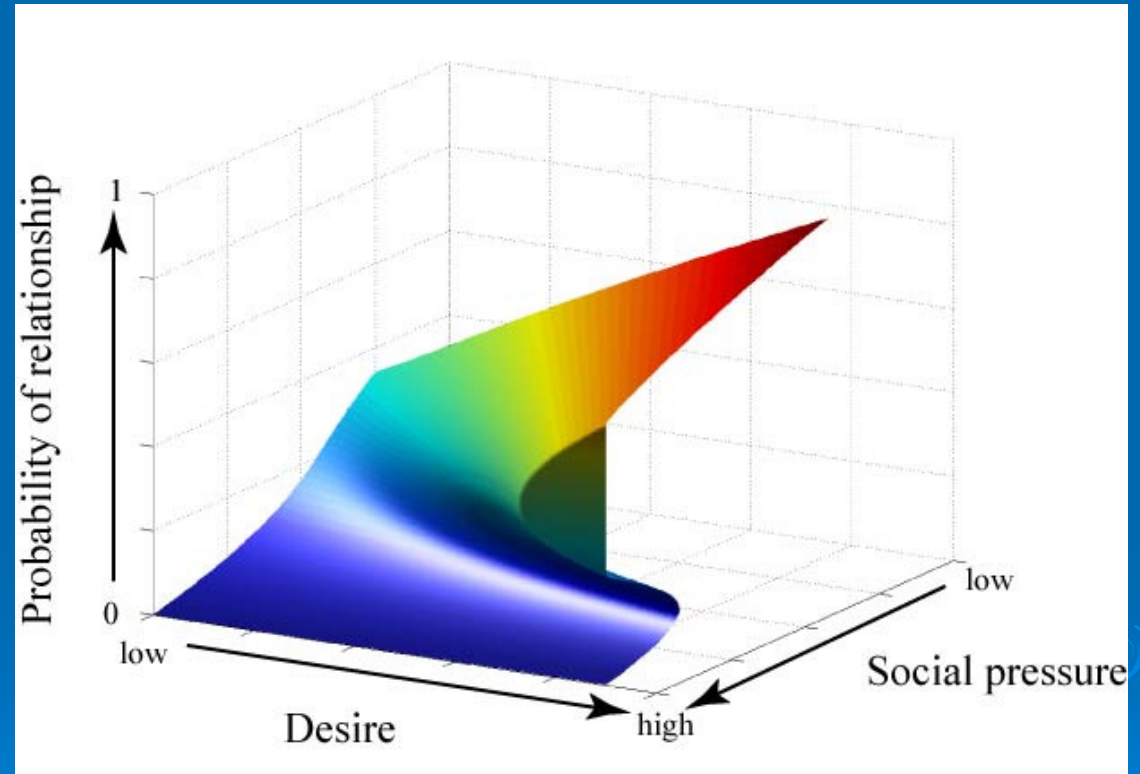
# Dynamic Regimes

- Based on René Thom's mathematical work in "Catastrophe Theory"
- His work was initially criticized, but he did have his supporters
- Dynamic regimes = multiple attractors = alternative stable states = multiple equilibria



# Regimes and “catastrophic” shifts between them

- Feedback loops which maintain regimes
- Disturbances
- Catastrophes
- Hysteresis



# ... as applied to industries

- Resilient regimes: practices which can produce the same level and quality of output/product despite disturbances
  - Which negative feedbacks lead to firm or industry resilience?
  - Which positive feedbacks lead to collapse?
- Catastrophic shifts: do firms & industries slowly decline, or sudden collapses common?

# Case Studies

- Firms, industries, industrial parks which have displayed some of these patterns or behaviors
- First: conceptual foundation
- Second: gather case studies and data