1. Existing agriculture paradigm ≠ Resiliency

- Thermodynamically imbalanced
  - 10:1 caloric food-input ratio

- Reliant on depleting resources
  - Soil bank
  - Water supply
  - Fossil fuels
  - Mined nutrients (e.g., phosphorus)

- Ecologically degrading
Resilient Food Regions

- **Urban Agriculture**
  - Local Inputs
  - Models: intensive vegetables, vertical farming, fungiculture, aquaculture

- **Rural Restoration**
  - Perennial-based farming systems
    - Agroforestry + Keyline Design + Managed Intensive Grazing

- **Urban/rural Interface**
  - Waste-to-resource exchanges (e.g., phosphorus, organics)
  - Value-chain connections = profitable farms = resource protection

The Tao of Stormwater

2. Watershed goals require broad, stakeholder engagement.
   - Socio-economic strategies
   - Multifunctional Infrastructure + Integrated Planning

*The Tao of Stormwater*

Urban Agriculture = Green Infrastructure
Why Invest in Urban Ag?
Socio-Economics

- Community Revitalization
  - Fresh food access
  - Public health improvement
  - Crime reduction
  - Vocational training
  - Beautification and greening
  - Social connection

- Marketability
  - Increased property values
  - Micro-enterprises

Evidence of Biophilia
Spartanburg, SC
Environmental Benefits

- Soil Building:
  - Organic matter
    - Water storage
  - Microbiology

- Hydrologic: retention + infiltration + ET

- Urban biodiversity
  - Habitat + beneficial/supporting plant species

- Heat island and air quality

- Reduced carbon/water footprints

Problem to Solution:
RAINWATER

- Most limiting factor in plant growth
- Oxygenated
- Atmospheric deposition = free fertilizer
  - 70-90% of TN in urban runoff (Wu et al., 1998)
  - 15-30% of TP (Bannerman et al., 1993)
  - Minerals and microorganisms
  - Sulfur (essential to amino acid formation)

- Desirable pH
- Cost effective
Problem to Solution

- Match quality of runoff with intended end use

<table>
<thead>
<tr>
<th>Source</th>
<th>Storage or Treatment</th>
<th>Use</th>
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<tr>
<td>Rooftops</td>
<td>Cisterns (intensive) Green Roofs</td>
<td>Active Irrigation</td>
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<td>Managed Pervious</td>
<td>LID Features</td>
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<tr>
<td>Roadways Parking Lots</td>
<td>Engineered BMPs</td>
<td></td>
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</tbody>
</table>

- An Emerging Land Use

- Residential Lots

- Institutions
  - K-12
  - College farms

- Public Parks
  - Food forests

- Commercial Rooftops

- Suburban
  - Ag-supported development
County-level: Cuba

- Country-wide urban farming movement
- Supplies 90% of Havana’s vegetable consumption

Ultra urban: NYC Rooftop Farms

- Brooklyn Navy Yard
- Chicago Botanical Garden
- Eagle St. Rooftop Farm
Rust Belt Cities

- Vacant lot conversions
- Ex. Detroit – 15 acres of idle land in food production

Source: The Anthropik Network

Ag-Supported Developments

- Village Homes (225-home, 70-acre subdivision, Davis, CA)
  - Early LID pioneer (started in 1975)
  - Edible landscaping
    - 23 acres in food production
    - Incorporated into stormwater management systems
**Urban Stormwater Farm**

M.B. Liebman et al. (Melbourne AU)

- **Goals:**
  - Model: large-scale stormwater treatment and reuse for agriculture
  - Quantify: hydrologic, energy, and economic benefits

- **Methods:**
  - Runoff source: 740 acre area (40% impervious)
  - Runoff sink: 128 acre residential development (38% “farmed”)
  - 41-year water balance simulation

- **Results:**
  - 81% of farm irrigation offset
  - 14 year payback period
    - Excluded revenue from 560 tons/yr produce

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**Barriers to Broader Use**

- **Land access** (cost, zoning, competition)
- **Water access**
- **Legal/regulatory issues**
  - Permitting
  - Land use and ordinances
- **Safety and compliance**
  - Soil contamination (e.g., Brownfields)
  - Food safety
- **Gaps in education, experience, and business training**
  - “Status-quo” within local governments and public utilities
  - Start-up and operating costs
**R & D Needs/Opportunities**

- **TBL Metrics for Improved Decision Making**
  - Environmental: water/sediment/nutrient balance, urban soil contaminants, etc.

- **Urban Agriculture Planning & Implementation Toolbox**
  - Codes & ordinances
  - Economic models and business training
  - Design standards and guidance
  - Site planning tools (e.g., for prioritizing sites)
  - Public education and outreach

- **Pilot Projects**
  - To generate data and build local capacity

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**Comprehensive Support**

- **Diversified Stakeholder Committee**
  - “De-silo” urban agriculture
  - Barriers analysis
  - Policy and implementation planning

- **Technical service provider (3rd party)**

  Ohio City Farm – Cleveland (Resilience.org)