Modelling the urban FEW-nexus: Approaches, problems and possibilities

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What is urban FEW nexus?

Why model urban FEW nexus?

Social Network Analysis

System Dynamics Modelling

Agent-Based Modelling

Strengths and Limitations

Integration

Conclusion
What is urban FEW nexus?

linear economy

- RAW MATERIALS & RESOURCES
- DESIGN & PRE-Production
- PRODUCTION & PROCESSING
- DISTRIBUTION & SUPPLY
- USE
- WASTE

circular economy

- RAW MATERIALS & RESOURCES
- DESIGN & PRE-Production
- PRODUCTION & PROCESSING
- DISTRIBUTION & SUPPLY
- USE & REUSE
- RECYCLE & RECOVER
- UNAVOIDABLE WASTE & POLLUTION

(Parsa et al., 2021, J. Clean. Prod.)
What is urban FEW nexus?

FEW nexus economy

- Food for biofuels
- Food waste for energy generation
- Fertiliser as a water contaminant
- Effluent for waste water treatment
- Food as virtual water

(Parsa et al., 2021, J. Clean. Prod.)
Why model urban FEW nexus?

How do the urban nexus components interact?
How important are feedback loops in the urban nexus?

What are the bottlenecks in minimizing wastage and pollution in the city?

How will a 20% reduction in household food waste impact the nexus?
What will be the impact of doubling the city’s anaerobic digestion capacity?

How can we achieve a 50% reduction in carbon emissions?
Which approaches are most cost-effective?

Why did the previously implemented change not work as anticipated?

How can we incentivise a reduction in food waste?

How do power relations between actors affect the nexus efficiency?

...
Why model urban FEW nexus?

**Predict**
Costly, cumbersome, impractical, impossible, or unethical to implement and empirically observe.

**Explain**
Hypothetical scenarios, numerical experimentation, control over variables.

**Explore**
Engage stakeholders, communicate, drive discussion and decision-making.
Social Network Analysis

Cape Town

degree = 2.08
density = 0.015

Bristol

degree = 2.30
density = 0.039

(Johnston, 2021, in prep)
System Dynamics Modelling
System Dynamics Modelling

[Diagram of Food Production, Food Waste Composting, Food Waste Anaerobic Digestion]
**System Dynamics Modelling**

- **hh food waste**
  - S1: 0
  - S2: 0%
  - S3: -20%

- **food recovery**
  - S1: 0
  - S2: +14%
  - S3: +5%

- **food consumption**
  - S1: 0
  - S2: 0%
  - S3: +4%

- **carbon emissions**
  - S1: 0
  - S2: -1%
  - S3: -0.3%

- **food import**
  - S1: 0
  - S2: -1%
  - S3: -0.4%

- **energy created**
  - S1: 0
  - S2: +28%
  - S3: +9.7%
System Dynamics Modelling

(Francisco, 2021, WASTE-FEW_ULL presentation)
Agent-Based Modelling

affinity: high
idolization: low

affinity: high
idolization: high

affinity: low
idolization: low

affinity: low
idolization: high
Agent-Based Modelling

nodes = 60
degree = 2.30
density = 0.039

(nodes = 68
degree = 2.32
density = ...)

(Johnston, 2021, in prep)
# Strengths and Limitations

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<thead>
<tr>
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<th>Limitations</th>
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<tr>
<td>Focus on stakeholders Multiple stakeholders Mapping Data light</td>
<td>Static/stationary Boundary Versatility</td>
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<td><strong>SDM</strong></td>
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Integration

- Resource fluxes
- Key metrics
  - waste production
  - carbon emission
  - pollution
  - efficiency
  - profit
  - degree
  - centrality
  - density

- System reconfiguration
- Decisions & actions
- Network reconfiguration
- Key metrics

Integration

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Conclusion

FEW nexus is integral to urban waste minimization.

Models can explore, explain, and predict nexus dynamics.

ABM and SDM are versatile and dynamic approaches, but with limitations.

The main model restrictions can be eliminated by integrating SDM, ABM and SNA.

Two issues remain:
- predictive modelling requires improved data availability;
- system boundaries need careful consideration, and may not align.
Thank you!