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

photograph by Albachiaraa

Marco Van De Wiel
Ali Parsa
Matt Johnston
(Coventry University, UK)

Erika Francisco
Ester Dal Poz
(University of Campinas, Brazil)

Ian Roderick
(Schumacher Institute, UK)

Coventry University
UNICAMP
SCHUMACHER INSTITUTE for Sustainable Systems
WASTE FEW ULL
Waste: Food – Energy – Water Urban Living Labs

What is urban FEW nexus?

Why model urban FEW nexus?

Social Network Analysis

System Dynamics Modelling

Agent-Based Modelling

Strengths and Limitations

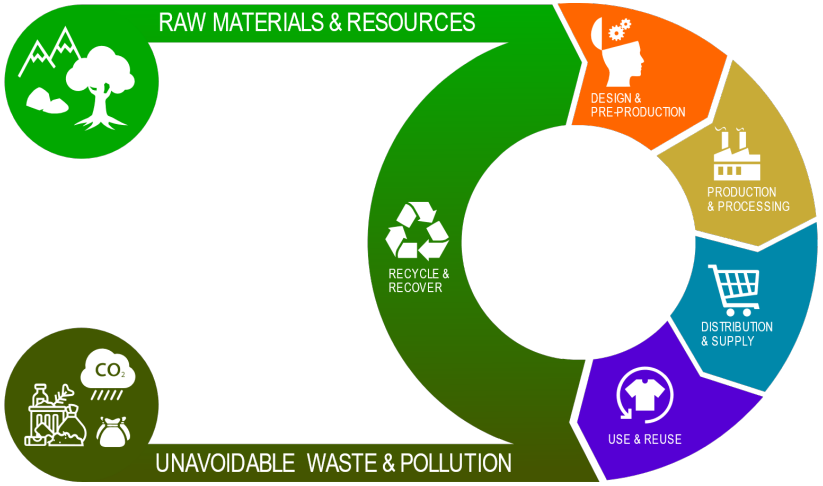
Integration

Conclusion

What is urban FEW nexus?

linear economy

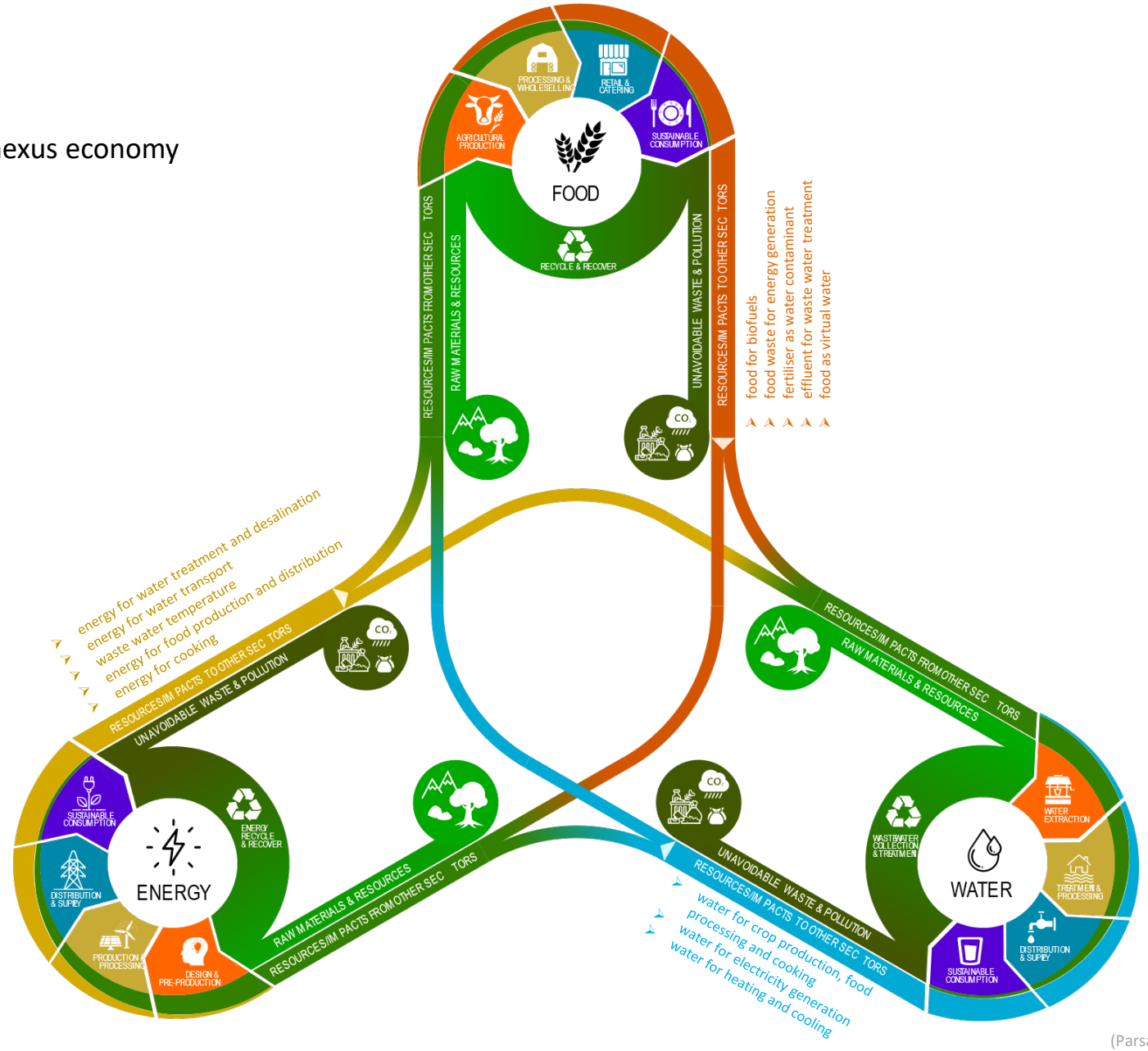
circular economy



(Parsa et al., 2021, J. Clean. Prod.)

What is urban FEW nexus?

FEW nexus economy



(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 **Explain** **Explore**

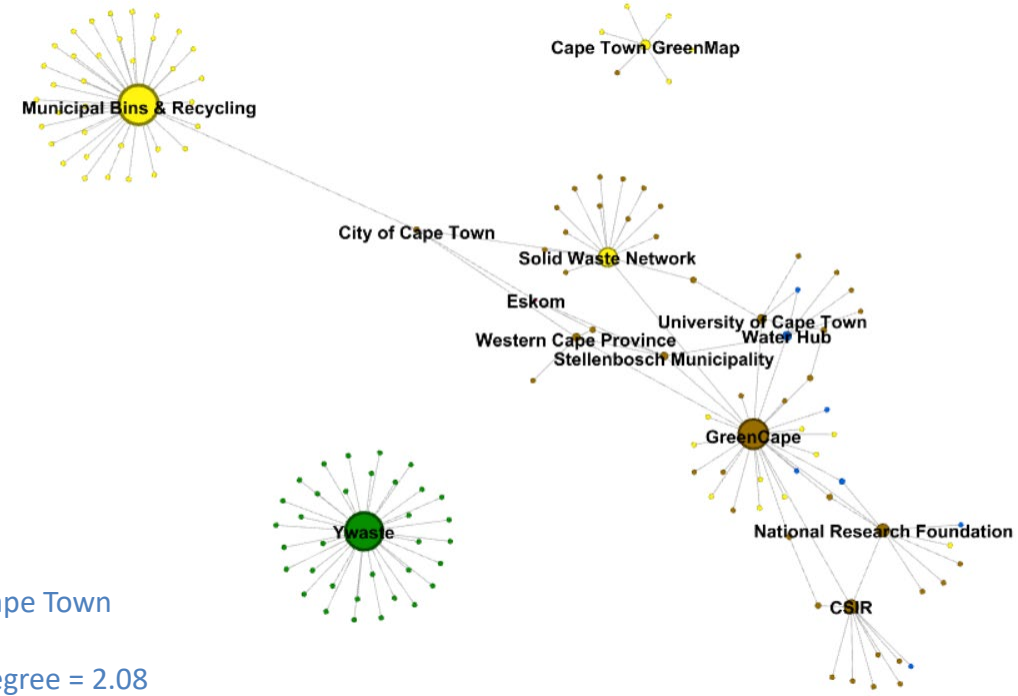
(Desjardins et al., 2020 – Earth-Sci Rev.)

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

Hypothetical scenarios, numerical experimentation, control over variables.

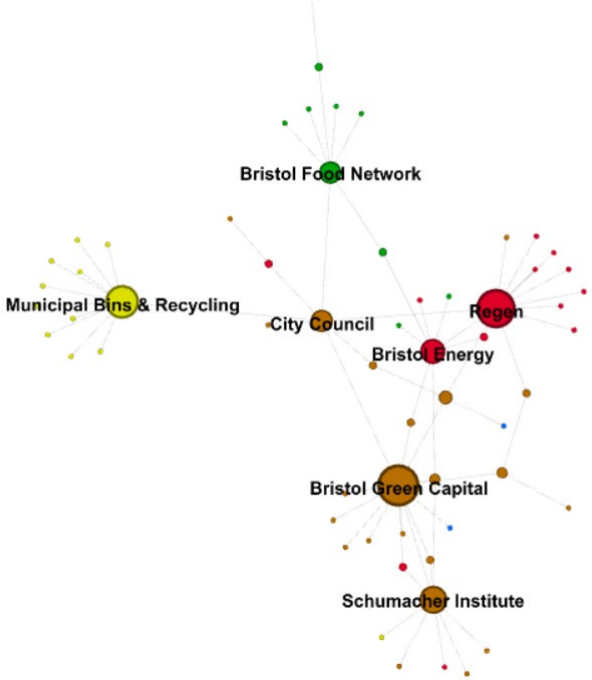
Engage stakeholders, communicate, drive discussion and decision-making.

Social Network Analysis



Cape Town

degree = 2.08
density = 0.015

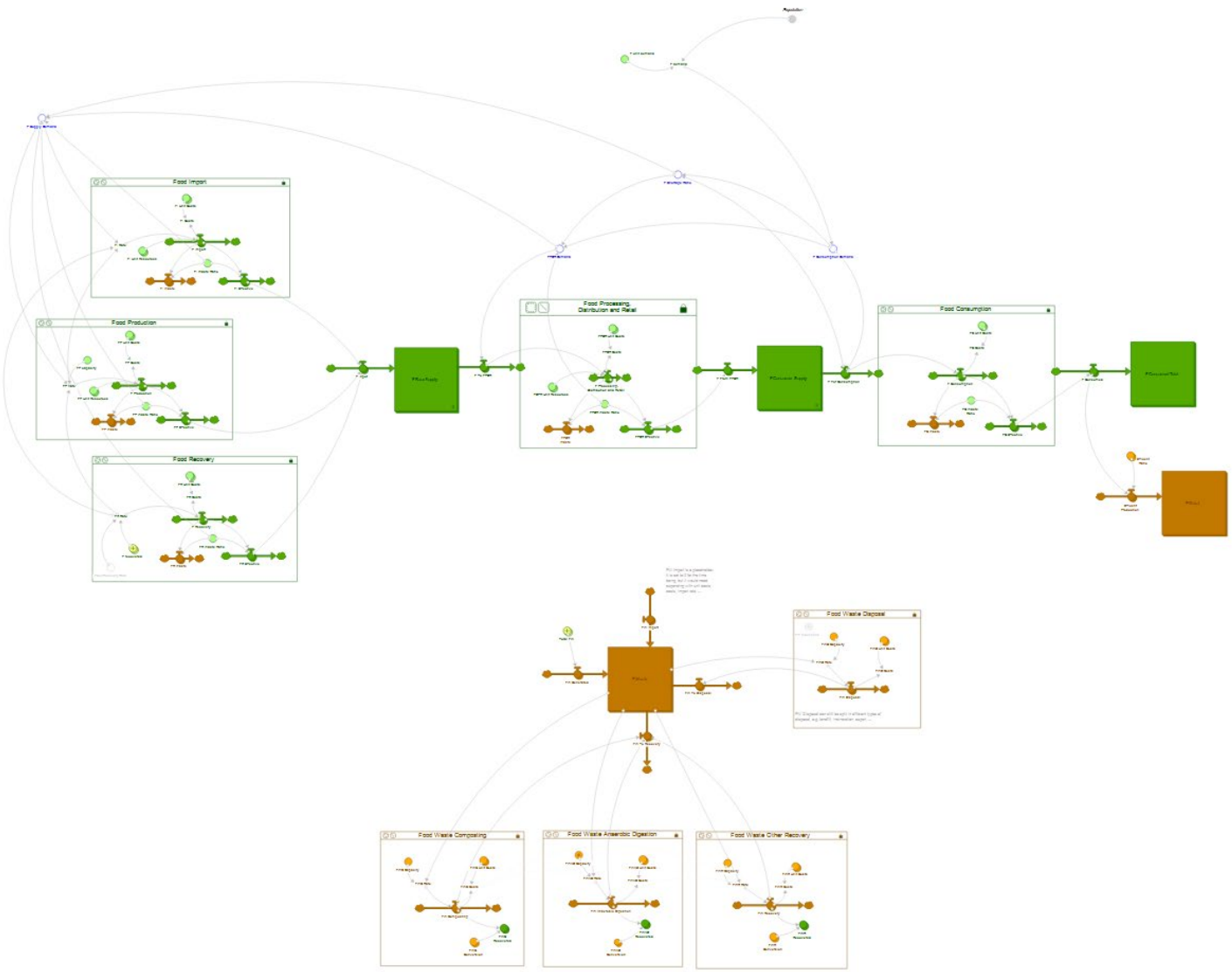


Bristol

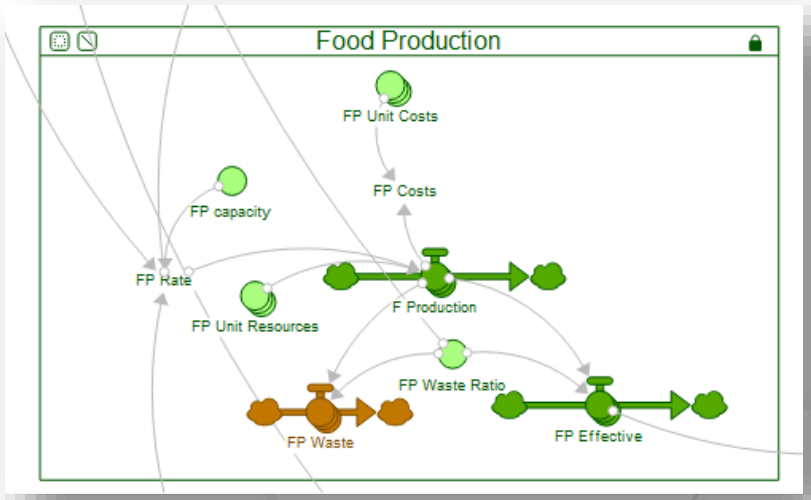
degree = 2.30
density = 0.039

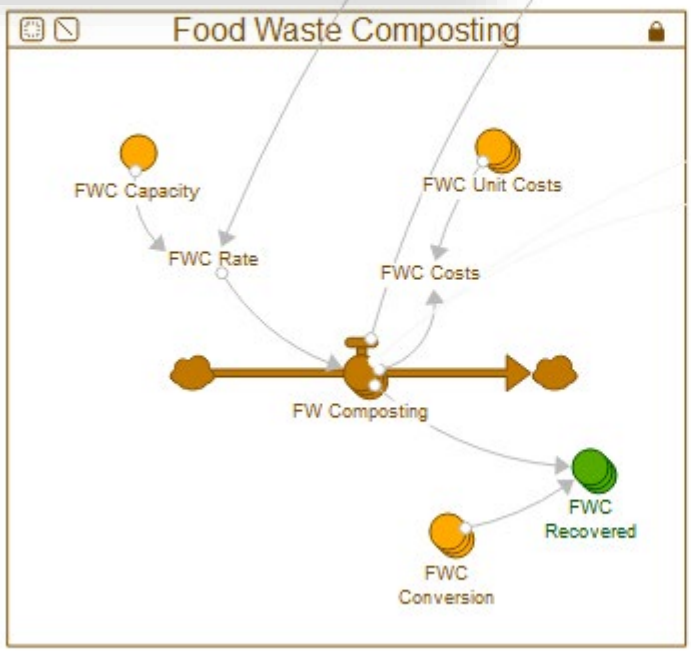
(Johnston, 2021, in prep)

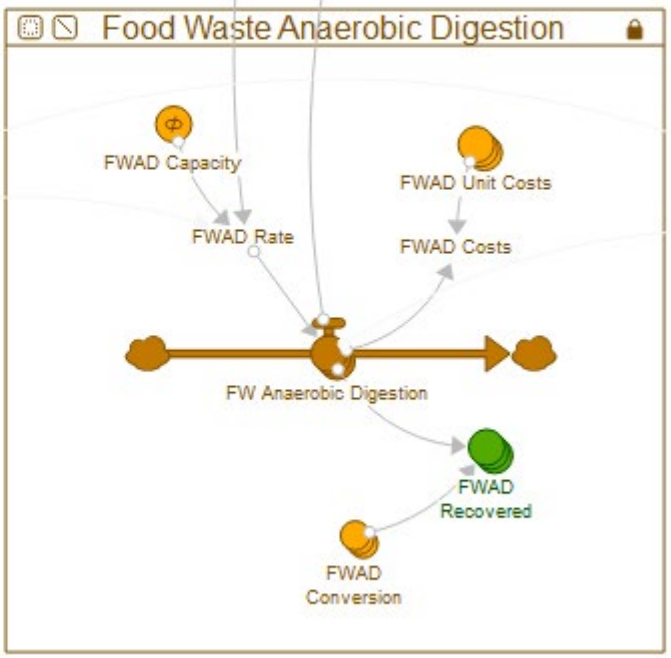
System Dynamics Modelling



System Dynamics Modelling

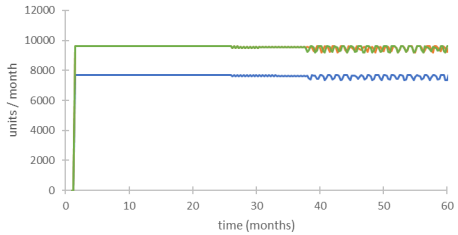


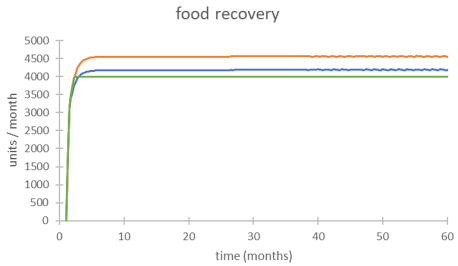


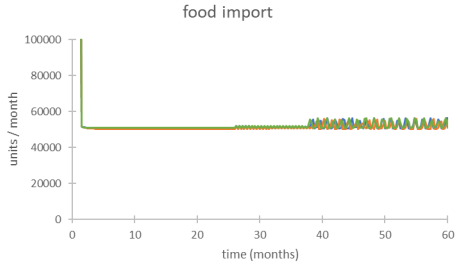


System Dynamics Modelling

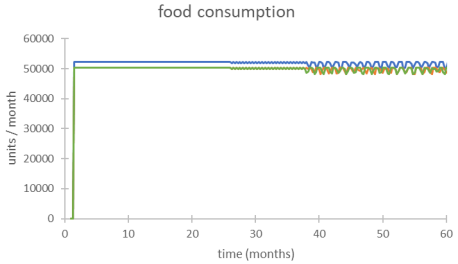
	S1	S2	S3
hh food waste	0	0%	-20%
food recovery	0	+14%	+5%
food import	0	-1%	-0.4%

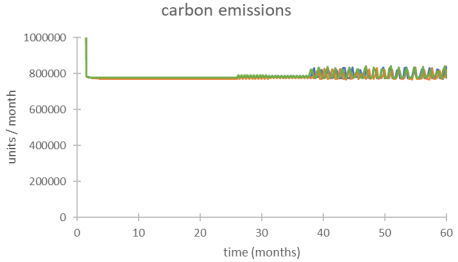


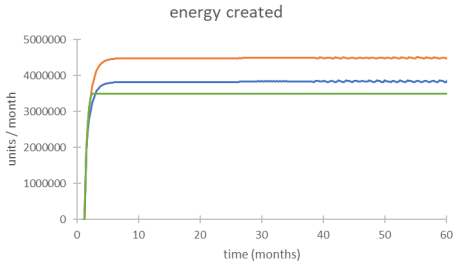




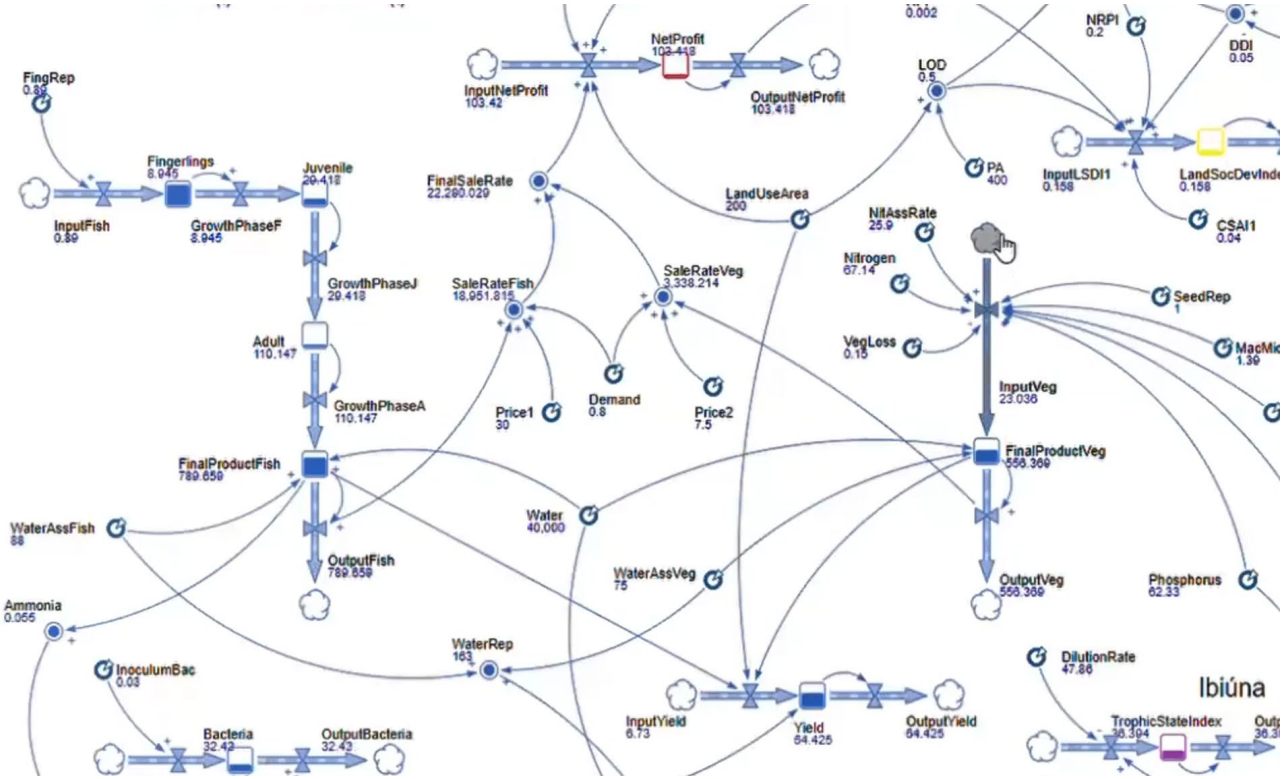
	S1	S2	S3
food consumption	0	0%	+4%
carbon emissions	0	-1%	-0.3%
energy created	0	+28%	+9.7%

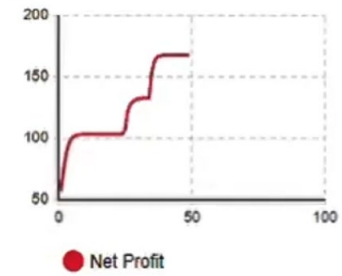


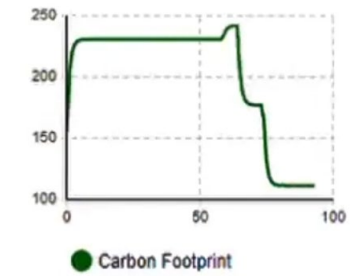


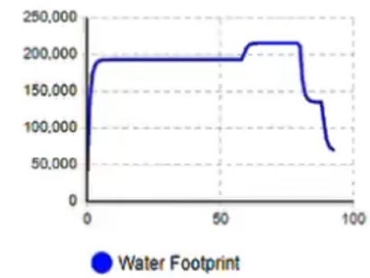


System Dynamics Modelling



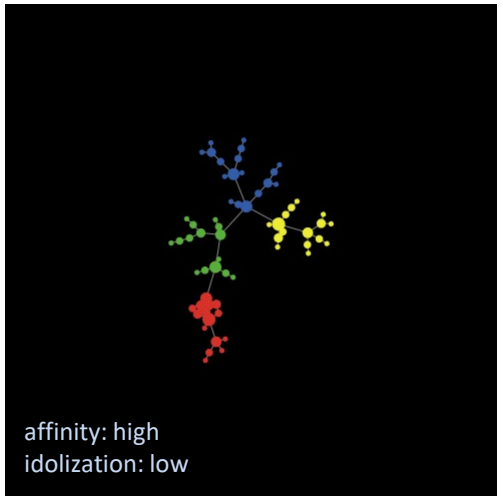


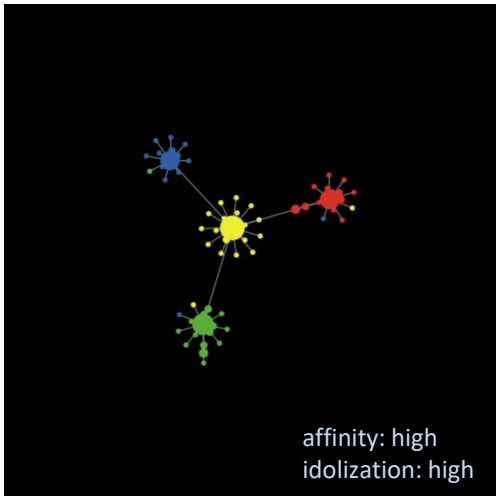


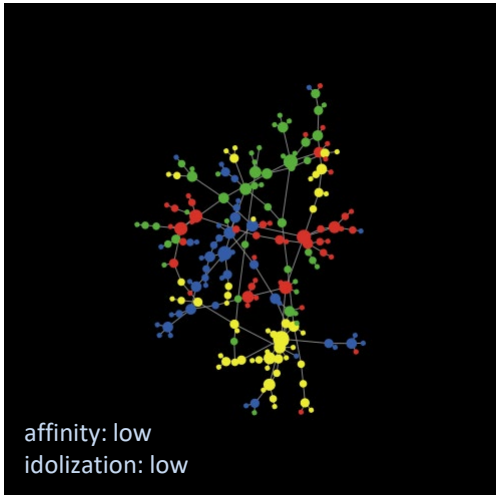


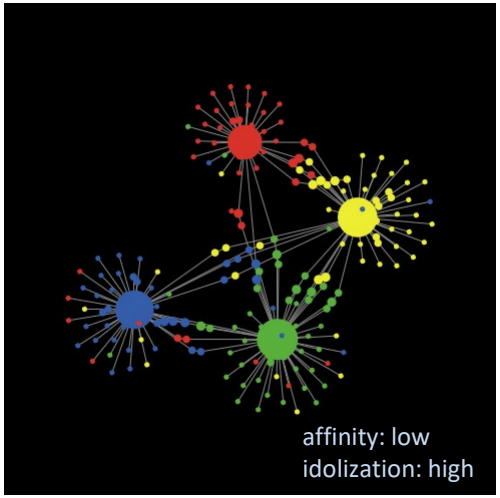
(Francisco, 2021, WASTE-FEW_ULL presentation)

Agent-Based Modelling

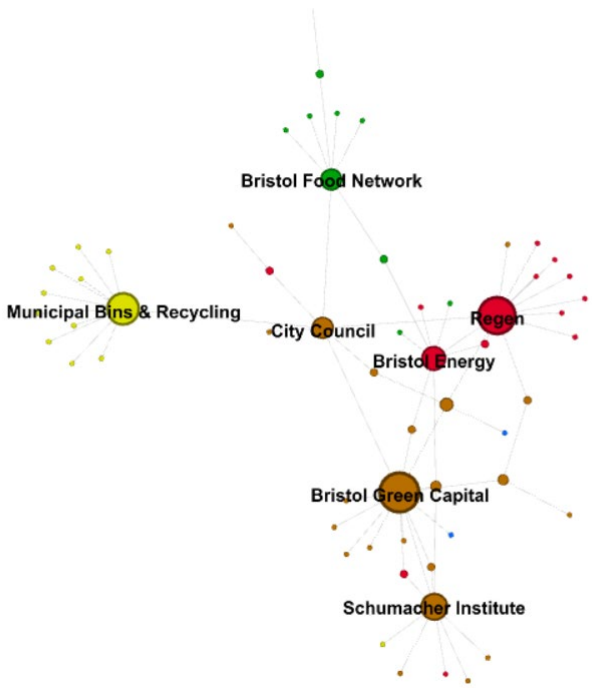




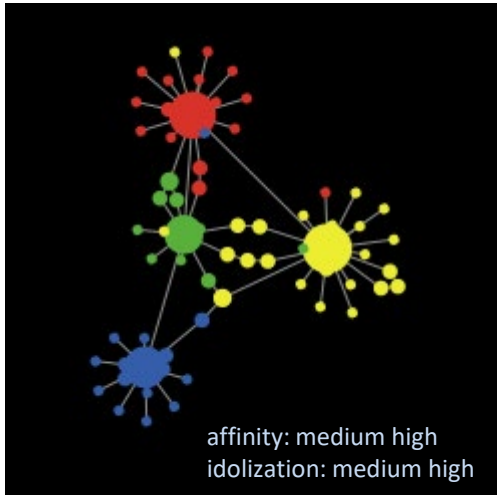




Agent-Based Modelling



nodes = 60
degree = 2.30
density = 0.039



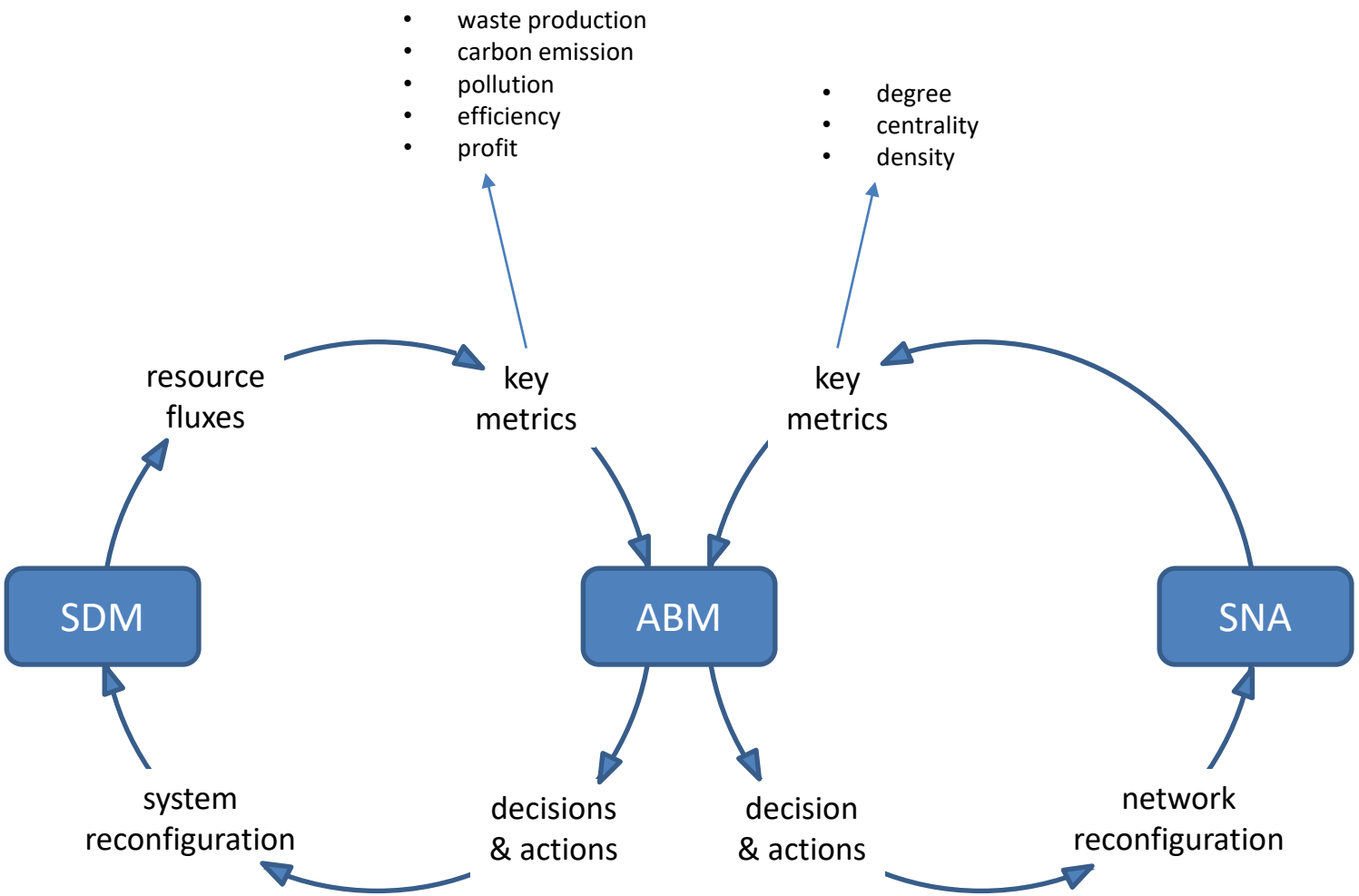
nodes = 68
degree = 2.32
density = …

(Johnston, 2021, in prep)

Strengths and Limitations

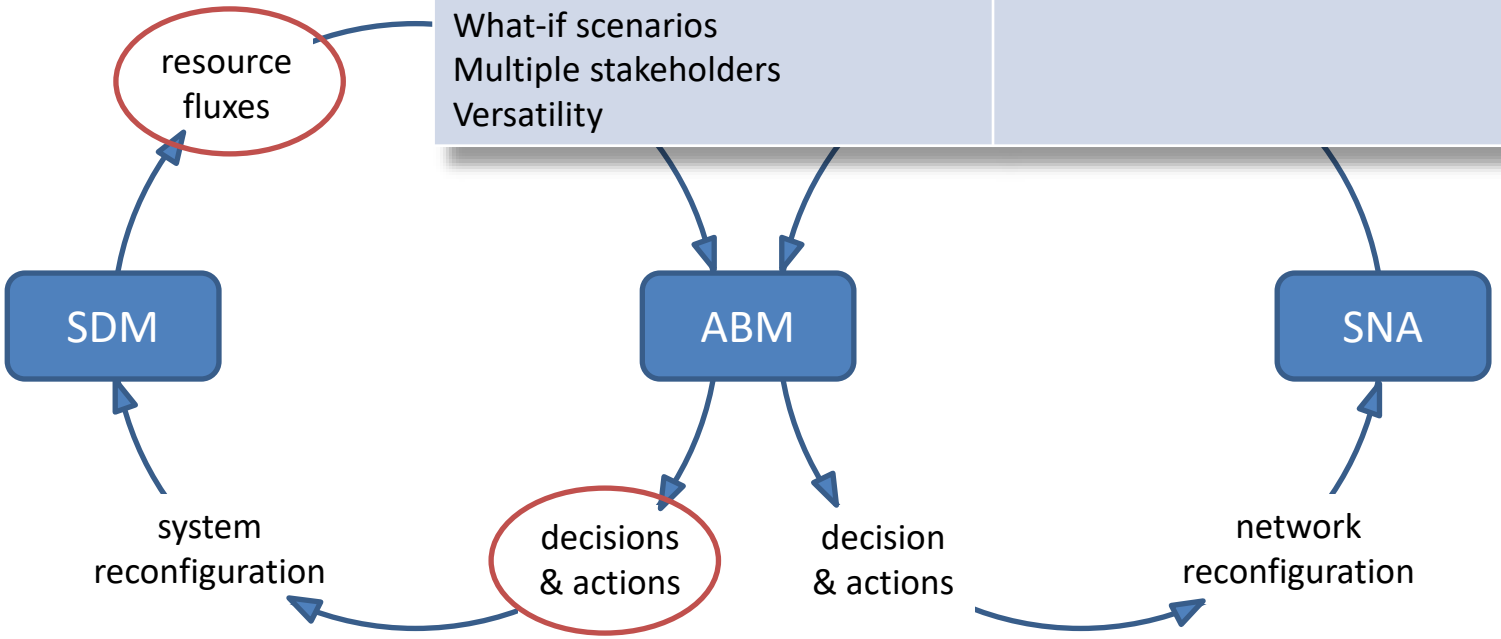
	Strengths	Limitations
SNA	Focus on stakeholders Multiple stakeholders Mapping Data light	Static/stationary Boundary Versatility
SDM	Focus on resources Dynamic Interactive Exploratory Multiple scales What-if scenarios	Many parameters Data availability (predictive) Uncertainties Boundary Stakeholder decisions
ABM	Focus on stakeholder decisions Dynamic Interactive Exploratory Multiple scales What-if scenarios Multiple stakeholders Versatility	Many parameters Data availability (predictive) Uncertainties Boundary Resource dynamics

Integration



Integration

Strengths	Limitations
Focus on stakeholder decisions Focus on resources Dynamic Interactive Exploratory Multiple scales What-if scenarios Multiple stakeholders Versatility	Many parameters Data availability (predictive) Uncertainties Boundary



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 !

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Waste: Food – Energy – Water **Urban Living Labs**