Ecological Network Analysis of Urban Agriculture

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1. Abstract

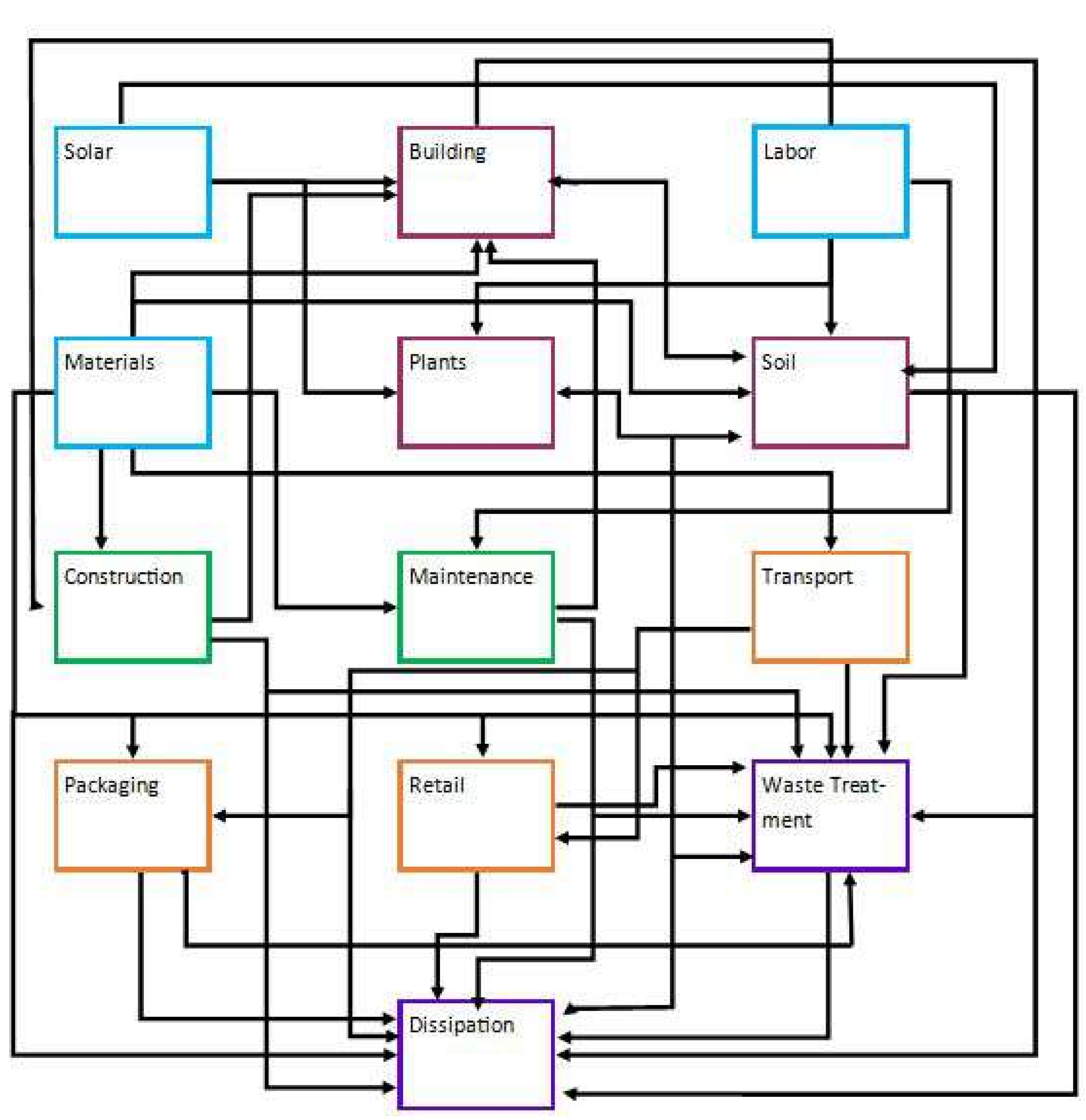
Conventional agriculture is a major consumer of energy, and other materials that have environmental implications. A possible solution to this problem is found in urban agriculture. In considering the feasibility of urban agriculture and planning for the future of food production and energy, it is important to understand the relationships between energy flows throughout an agriculture system, and identify downfalls and possibly make suggestions. The goal of this study is to analyze the energy flows in a rooftop garden system to better understand the energy consumption of food production in the city. An ecological network analysis (ENA) will be performed on the system with a supplementary resiliency analysis. The direct and indirect flows between compartments will be analyzed, the energy exchange between sectors of urban agriculture will be identified, and the control and dependence of each sector on each other will be uncovered. Additionally, resilience of an urban agriculture system will be determined by investigating system efficiency and redundancy. The information from these analyses will be collected to identify problems and successes in the system, and suggestions can be made to improve the relationships between energy flows in urban agriculture.

2. Objectives

The goal of this study is to model the energy flows of urban agriculture and reveal the interactions between sectors, and the implications that result from these relationships. Suggestions will be made to improve environmental performance of agriculture systems. This study will also bridge the literature gap between ENA and agriculture.

3.2 Methods: Case Study of Urban Agriculture

An ENA will be applied to study the rooftop garden that was built on the Institute of Environmental Science and Technology (ICTA) building at the Universitat Autònoma de Barcelona (UAB). A lifecycle assessment has already been done on the rooftop garden (RTG) by Sanyé-Mengual, E., et al. (2015). The preliminary energy flows are shown below. The colors indicate hypothesized trophic energy levels, described in the key to the right.

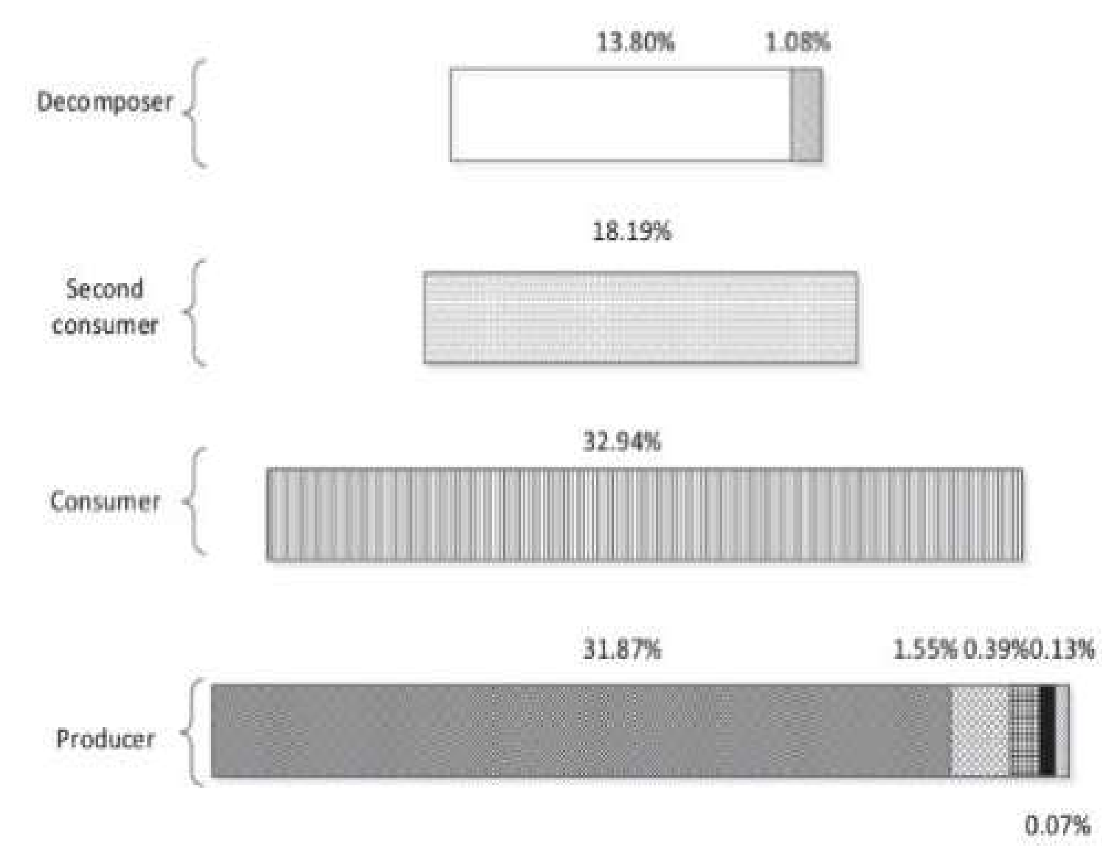


Producers
Primary Consumers
Secondary Consumers
Tertiary Consumers
Decomposers

3.1 Methods: General Framework of ENA

Ecological Network Analysis

Plans for ENA to be applied to urban agriculture network; steps 1- 3 to be adapted from Fang, D and B. Chen (2015) with step 4 robustness analysis adapted from Yang, J and B. Chen (2016)



1. Throughflow Analysis

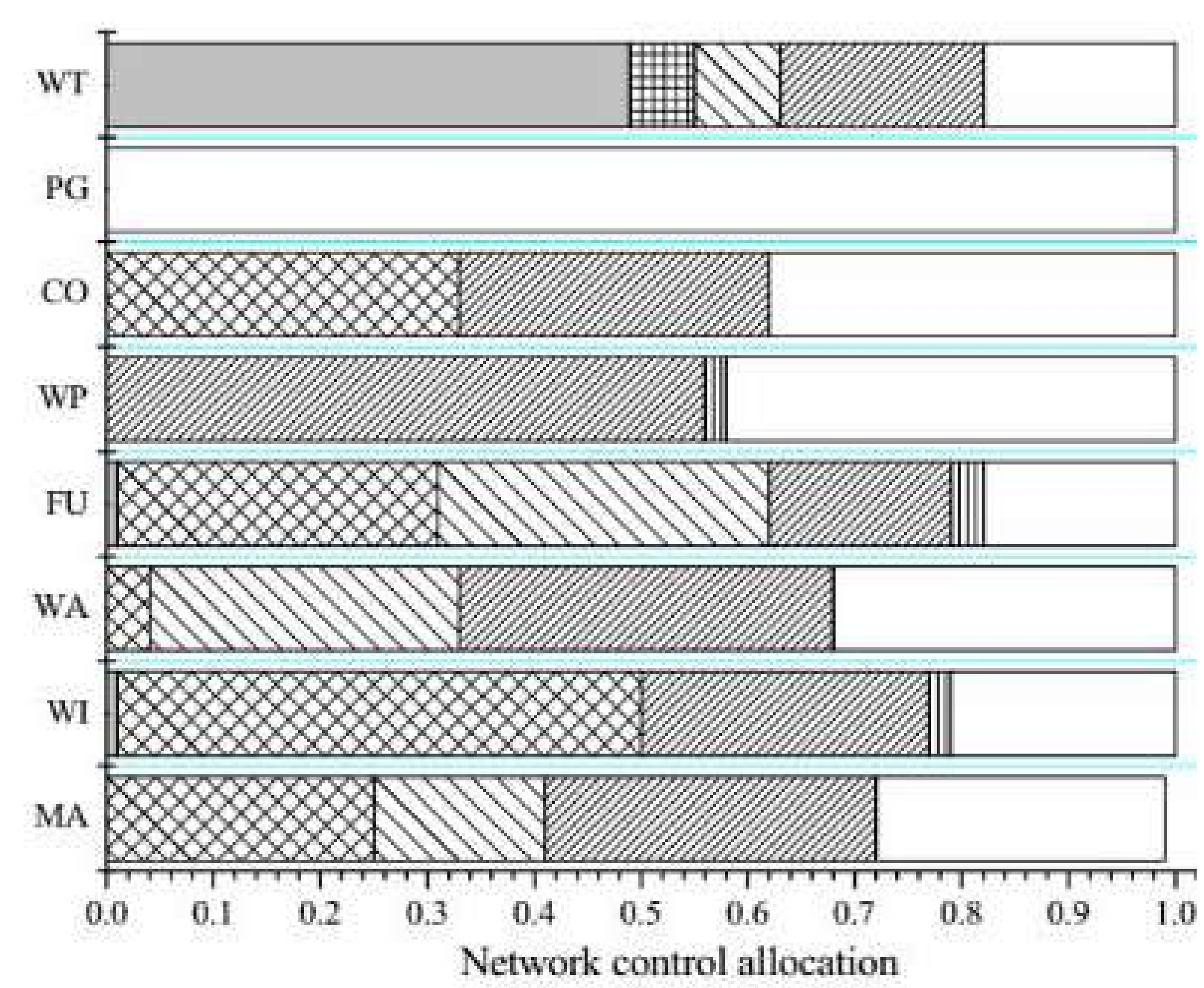
Direct and Indirect energy flows and paths

Possible binary relations between compartments.

	+	0	–
+	(+,+)mutualism	(+,0)commensalism	(+,–)exploitation
0	(0,+)commensal host	(0,0)neutralism	(0,–)amensalism
–	(–,+)exploited	(–,0)amensal host	(–,–)competition

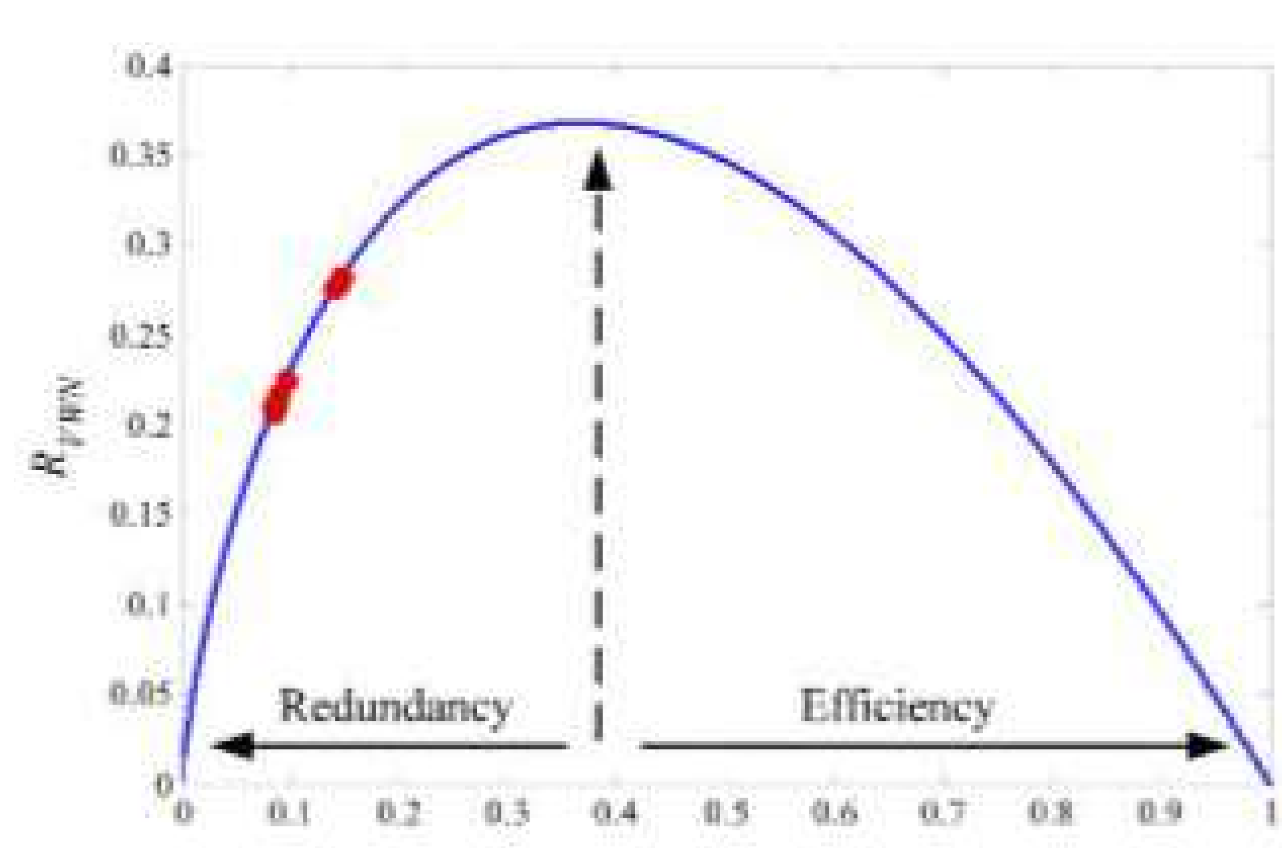
2. Network Utility Analysis

Symbiotic relationships in system



3. Network Control Analysis

Control and dependence between compartments



4. Network Robustness

System efficiency, redundancy, and robustness

4. Further Study

The next steps in this work are to create and quantify a network of energy flows for the RTG in UAB using the available LCA data. Then, the ENA can be performed and results from each step will be found. An identical analysis can be done for conventional agriculture and the results can be compared. These results can be combined to help pinpoint the downfalls in a system and make suggestions on agricultural systems to increase environmental performance by making better use of its energy consumption. Additionally, other material flows and natural resources can be analyzed using the same methods to draw conclusions about overall environmental performance

5. References

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Sanyé-Mengual, E., et al. (2015). "An environmental and economic life cycle assessment of rooftop greenhouse (RTG) implementation in Barcelona, Spain. Assessing new forms of urban agriculture from the greenhouse structure to the final product level." The International Journal of Life Cycle Assessment **20**(3): 350-366.

6. Acknowledgements

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