



Graphs theory applied to agroforestry system design

H. Transitioning to a Viable Development

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* Laëtitia Lemière, INRAE, France

Marc Jaeger, CIRAD, France

Gérard Subsol, LIRMM, France

Marie Gosme, INRAE, France

Designing agroforestry systems is a complex task due to the numerous elements and their multiple interactions. Co-design workshops are useful to overcome these difficulties by gathering people from different disciplines. But these workshops use tools that do not provide a standardised representation of agroforestry systems nor the provision of ecosystem services. Our objective is thus to develop a conceptual information framework based on graphs that allows modeling the agroforestry system and its ecosystem functions. In the first step, we infer a topological graph from the position of the physical objects representing system components: trees, crops, tree lines, and their spatial relationships (e.g. adjacency, inclusion...). We represent then the relationship between ecosystem structure and functioning as a graph. Applying graph technics such as subgraph research, we can estimate whether a specific system (graph) can support a specific ecosystem function (subgraph). This results in a new graph-based model to describe both the spatial and functional relationships between elements of agroforestry systems. Figure 1 illustrates the different steps to apply this model to a simple agroforestry system: 1. Create a system mock-up with physical objects 2. Acquire the scene by a camera and identify physical objects 3. Automatically extract the topological graph 4. Perform subgraphs research to identify functions 5. Visualize the scene with both realistic trees and schematic representations of ecosystem functions In the future, this work will be combined with augmented reality to visualize the agroforestry system and the production of ecosystem services directly on the physical mock-up. Thus, our work will improve the efficiency of co-design workshop by (i) formalizing the knowledge on the relationship between structure and function in agroforestry systems and, by (ii) sharing this information with non-specialists in a visual way, while allowing intuitive interaction through the physical mock-up. Thus, the designed system answers farmer's needs better.