Applying System Analysis and System Dynamics in Complex Research Projects - the Case of VALUMICS

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Introduction

Contemporary food supply chains tend to be complex, include many stakeholders, stretch across countries and even continents. In addition to stakeholders involved in the physical processes from producers to final consumers, other stakeholders such as governments, monitoring and control organizations, insurance companies, financial institutes, and various service providers, are involved. Furthermore, throughout the supply chain, value is generated by many of these stakeholders and in an incorporated supply chain, value chain can be identified and defined (FAO, 2014).

Objective

The aim of the VALUMICS project is to analyze the dynamics of food supply systems using a structural analysis including system analysis and reconstruction using system dynamics.

Methods

Dynamic systems analysis is applied to capture within the food systems under study both value chain complexities and the supply chain system and decision structures to progress from the current state of art. The approach is designed to obtain an understanding of the complex connections and interactions of the distinct parts of a system, recognize patterns and thus identify causes and effects of complex relations within the system. This understanding of the functioning of the system can in turn then be used to identify policy interventions.

System analysis involves identifying the components of a system, building a mental model of how they relate to one another and presenting it as a causal loop diagram (CLD). Once a mental model has been constructed, the dynamics of the system can be recreated using mathematical simulation models. Such models can then be used to explain past behavior of the system and predict and influence future outcomes.

In the VALUMICS project the inherent learning mechanism of the CLD building process is applied, which is described as the learning loop (see Figure 1). Building a CLD involves identifying, sorting and drawing the relevant variables into a CLD. The CLD is the foundation on which a mathematical simulation model is built. The model is tested using actual historical data and conclusions made based on the current knowledge and understanding. New insights can then be developed based on these conclusions which calls for a redefinition of the problem and the question starting a new iteration of the learning loop.

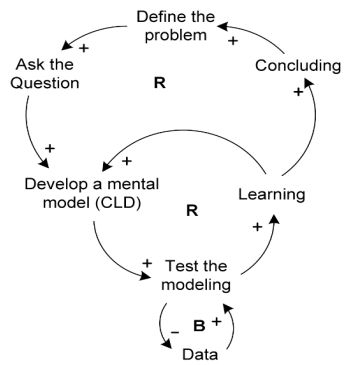

Figure 1: The learning loop (B=balancing loop; R=reinforcing loop)

Research approah

In VALUMICS the system analysis is carried out through iterations of learning loops, as the key driver of the project. The initial mapping of food systems is driven by a combination of internal and external stakeholder workshops, four in total, where the transdisciplinary expertise of the various participants is used to analyze the system in terms of its causal relationships and feedback structure. All of the consortium members will initially attend the workshops to provide expert input. Furthermore, external stakeholders will be involved in the workshops to provide specific inputs to ensure the relevance of the approaches and provide complementary expertise and background information linked to case studies. After each workshop, new insights and questions are formed and addressed which adds to the overall understanding. Figure 2 demonstrates the dynamics and iterative nature of the project approach reflecting the learning loop process.

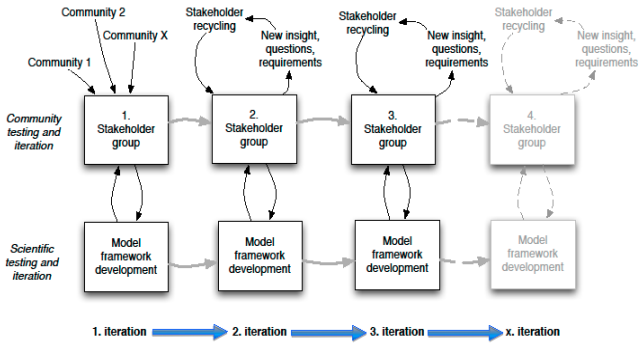

Figure 2 Workshop format

Discussion

The understanding of the functioning of the food supply chain networks will give insights to explore model assessments through policy development of the physical, social and economic domains. Policy is developed in a recursive manner, where a policy proposal is always followed by an assessment of the outcome from that policy with respect to the goal, as well as being investigated for side effects and goal conflicts. The process will incorporate the conflicts, political contexts, and the power relationships and asymmetries, to provide optimal potential policy and governance recommendations based on real life value chain working.

Furthermore, the mapping of advanced market mechanisms and causalities will provide an aggregated first draft of causality link diagram to grasp those issues. Price transfer in a value- and supply chain implies coupling such models along the chains and studying price transfer dynamics. The transfer of a price signal along a chain depends on transaction speeds, signal delays, supply chain delays, degree of transparency, extraction of costs and rents, and a number of other factors that needs to be explored and studied.

References

FAO (2014). Developing sustainable food value chains – Guiding principles. Rome;

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VALUMICS
Food Systems Dynamics