

Finnish Nutrient Recycling as a Circular Economy Ecosystem: Actors and Catalysts

Nutrient recycling

Cycling of nutrients, such as phosphorus (P) and nitrogen (N), is one of nature's supporting ecosystem services and essential for all life on Earth. In a societal setting, nutrients are crucial for securing the food system and valuable raw materials for industrial processes. However, global P reserves are diminishing, and fixing N from the atmosphere adds to the already alarming levels of greenhouse gases. In order to operate within the planetary boundaries, recycling nutrients from various side and waste streams and utilizing recycled instead of virgin nutrients has become of great interest. There are diverse barriers and drivers for human and societal action for increased nutrient recycling. In this study, the diverse actors that are able to contribute to nutrient circulation are considered as a circular economy ecosystem for nutrient recycling.

Ecosystem actors and catalysts

The ecosystem of nutrient recycling extends throughout the society and includes multiple actor groups, such as municipal waste and wastewater treatment facilities, biogas producers, farmers, fertilizer manufacturers, food and processing industry actors, media, consumer-citizens, authorities, interest groups, and research organizations.

This poster summarizes the findings of a qualitative case study, which examined nutrient recycling of P and N in a Finnish context, focusing on three societal biomass sources: biowaste, agricultural biomasses, and sewage sludge from municipal wastewater treatment. Diverse actors from the national nutrient recycling ecosystem were interviewed (N = 22), with an aim to shed light on the catalyzing forces that

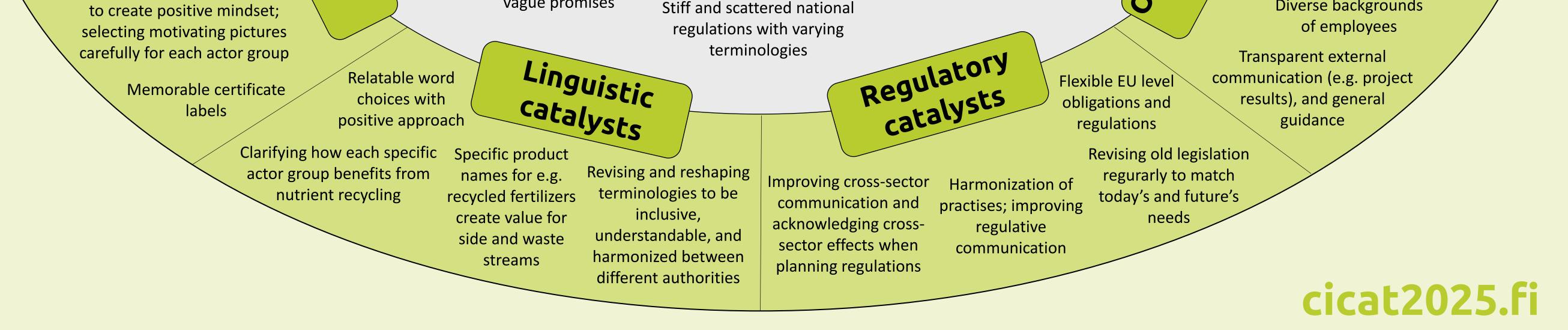
Diverse, multi-disciplinary catalysts and synergies of catalysts are needed for different actor groups to adopt and advocate CE and nutrient recycling. For example, various technological improvements, such as more efficient P and N recovery processes, and better compatibilities of the recycled fertilizers and the fertilizer spreading equipment on farms, are required. However, technical feasibility alone is not enough to guarantee sustainable nutrient recycling, but socio-cultural support and favorable regulatory environment are also necessary. The catalysts for nutrient recycling range from more flexible legislation, ecosystem facilitators, and supportive political agendas to unification of terminology, carefully selected visuals in articles and holistic understanding of nutrient cycles. Combined, these catalysts provide a comprehensive toolbox for understanding the mechanisms that determine the recycling of material streams and shape

advance sustainable recycling of nutrients.

the future of nutrient recycling.

Optimized feed choices for the biogas process Improving soil health e.g. via **Developing fertilizer** (better predictability carbon farming and crop rotation spreading equipment Acknowledging of the outcome) to complement **Optimizing logistics** cultural and recycled fertilizers Good examples and success with digital Anaerobic digestion amended regional differences stories are required to spark technologies Plastic removal with post-processing Empowering people to understand off change technologies for N/P recovery the significance of their everyday waste biomasses Technological technologies Importance of ecosystem's diversity actions (e.g. national campaigns) and strong, cross-sector Psychological catalysts External pressure for companies to Business collaborative network enhance their sustainability Catalysts catalysts Market opportunities from technical Current challenges strategy, and to decrease their innovations; commercialization environmental impacts mindset already from early on Safety concerns (contaminants, Clear market segment for Approaching the topic in a long term effects, etc.) of e.g. recycled nutrients is missing Public support neutral, holistic manner (the role sewage sludge based fertilizers accelerates investments of media) Lack of appreciation, higher Prejudices and preconceptions can prices of recycled fertilizers, slow down CE, and bad examples National and high logistics costs Political agendas with long-term Visualizing nutrient recycling as a and errors from past decades can commitment, and roadmaps diverse, technology-requiring industry, damage the industry's reputation Organizational nutrient Companies have less chances to and showcasing its complexity **Ecosystem facilitators** advance CE compared to e.g. (bringing sectors together, Social media as a tool to The bigger picture of nutrient recycling public actors catalysts Visual Catalusts harmonization of interests) communicate sustainability; cycling is not clear to the influencers of the industry and general public Old habits sit tight Unprejudiced leadership, and the research community ambitious strategic management Risk of using too fancy Encouraging visuals, Risk of differing interpretations with a clear time goal for action terminology, and giving e.g. pictures and art, as a tool of regulations at EU level vague promises

Diverse backgrounds



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