Territorial indicators of circularity and ecosystem carrying capacity for redefining livestock's role in the food system

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Livestock systems play an essential role in the food system but also face growing scrutiny regarding their environmental footprint. Traditional environmental impact assessments emphasize eco-efficiency—minimizing resource use and emissions per unit of animal-sourced food. This approach overlooks the systemic role of livestock in the food system, including their contributions to nutrient cycling, soil fertility, and the upcycling of biomass inedible to humans. To ensure livestock production operates within planetary boundaries, it is essential to shift from a narrow focus on efficiency to a broader perspective that integrates spatial circularity and ecosystem carrying capacity. Geo-SOL, a territorial mass-flow food system model is presented. It integrates detailed, context-specific livestock husbandry systems modelling and uses a spatially explicit module to derive novel indicators of spatial circularity and ecosystem carrying capacity. By modelling livestock's impact spatially, Geo-SOL links livestock production to ecological processes that define local carrying capacities and ecosystem services. This approach allows for a more comprehensive assessment of how livestock interacts with regional resource availability, nutrient flows, and land use constraints. Preliminary results from modelling of selected storylines of the EU-funded project PATHWAYS will be presented. They explore how different adjustments in animal husbandry systems, aligned with different PATHWAYS livestock sustainability narratives, impact these territorial indicators. The analysis will focus on the implications of these indicators in comparison with other sustainability metrics, highlighting their potential to provide a more systemic perspective on livestock's role within food systems.