Transdisciplinary assessments for circular city design: identifying systemic water-energy-food nexus hotspots in metropolitan Barcelona

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Green spaces are known to provide a number of benefits to urban areas. In order to make green spaces more accessible to people in urban regions, the EU has launched some important initiatives that place green infrastructure (GI) development as a top priority in urban planning, contributing to the paradigm of making more sustainable and smarter cities for everyone. However, some GI development might bring unexpected impacts that are observable only with a systemic analysis. For instance, an increased surface of green rooftops might serve as a source of local food production and reduce the need of the buildings’ air conditioning at the expense of increased water and fertilizer use. Despite this shift of focus in urban planning priorities, few studies assess tradeoffs between water, energy and food metabolism of different GI alternatives. An important reason for this gap is that current methods for the analysis of the water-energy-food (WEF) nexus in the urban metabolism lack a transdisciplinary approach.

To fill that gap, we propose using two system analysis methods: Life Cycle Assessment (LCA) and Multi-Scale Integrated Assessment of SocioEcosystem Metabolism (MuSIASEM), to assess the WEF nexus in an urban region in the context of GI. Furthermore, the WEF flows are georeferenced to understand their impact on the urban landscape. Based on this georeferenced analysis of land use and land use change, we 1) complete an inventory of functions associated to different land uses with their related inputs and outputs, 2) study function-related environmental pressures with LCA, and 3) assess the systemic impacts of relevant functions over domestic and alien ecosystems and WEF supply systems.

We develop this innovative approach using the municipality of Sant Climent de Llobregat, in the Metropolitan Area of Barcelona (AMB), as a case study. Sant Climent covers 1.6% of the AMB surface and is currently undergoing a GI restructuring process focused on recovering formal agricultural land (currently lost to forest) for highly profitable cherry production. We provide a systemic study that informs about the resource demand and environmental impacts these changes may imply. Data is compiled in collaboration with regional research centers, from local utility companies, planning offices of different towns, statistical yearbooks for Catalonia and Spain, and LCA databases. The work is an on-going collaboration with the AMB government as it develops.
the Urban Development Plant (PDU) that will set the land use related urbanism policy guidelines from 2021 on. We present a diagnose of the current state of the WEF metabolism in Sant Climent. We identify geographically explicit hotspots, where competition of the resources and unexpected domestic or alien environmental impacts arise. These hotspots are compared against land to be transformed to highlight the best and worst areas for transformation. We expect that in a later stage, these results will feed a scenario assessment of the systemic impacts of the proposed actions of the new PDU.

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