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RESEARCH ARTICLE

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An integrated urban metabolism and ecosystem service assessment

The case study of Lima, Peru

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Abstract

Against the backdrop of urbanization and its environmental impacts, this study expands urban metabolism research by integrating knowledge from the ecosystem service (ES) concept. A framework was put forward to capitalize on ES knowledge in metabolic studies and material flow analysis in particular while supporting dynamic analysis of ES supply and demand flows through factors such as pressure, state, and drivers. This framework is tested in the city of Lima, Peru, to evaluate six ESs and express their contribution in a standard economy-wide material flow analysis of the city. Moreover, simulations were deployed to forecast spatiotemporal variations of resource flows and emissions until the year 2050. Findings indicate a gap between the city's ES demand and the availability of its local natural resources. Demand exceeds local supply ES flows in Lima, with the exception of surface water provision and canemats for construction materials, representing 141% and 128% of the total supply, respectively. However, they are projected to reduce by the year 2050: 19% and 22% respectively. Carbon sequestration supply represents 0.01% of the total demand (carbon emissions). Peri-urban agriculture production represents 4.3% of the total food consumption. Our findings offer a new perspective on the role of nature in cities and highlight the need to implement urban sustainability policies that can help overcome metabolic deficiencies while prioritizing resource efficiency, decarbonization, and conservation/generation of green infrastructure in the city.

KEYWORDS
ecosystem services, industrial ecology, material flow accounting, urban ecosystem, urban metabolism, urban ecology

1 | INTRODUCTION

A growing body of knowledge advocates the need for a more integrated understanding of the interlinkages between socioeconomic and ecological processes in cities and their environments, resulting in complex interactions, synergies, and tradeoffs (Gandy, 2021; Perrotti, 2020; Wachsmuth, 2012). These activities have been largely studied across multi- and, sometimes, inter-disciplinary scientific communities concerned with the study of urban metabolism (UM), including urban, industrial, and political ecology (Bahers et al., 2022; Broto et al., 2012; Newell & Cousins, 2014). From the perspective endorsed in this article, UM studies characterize and assess the production, use, and dismissal of anthropogenic flows such as water, material, energy, waste, and emissions. Past research has underlined the need to expand traditional UM approaches and accounting

