

Article title:

Systematic review supports a spatial system framework for social ecological systems in urban sustainability science

Supplementary file:

Supplementary Table 1: Full version of main-text Table 1

Description:

This supplementary table provides the fuller version of Table 1 in the main manuscript, including additional examples and operational details for the second-level variables within the SESS framework for urban studies.

Framework Component	First-Level Core Systems	Second-Level Variables
External Drivers and Context	Socio-economic and Political Context (S)	S1 Economic globalization and trends.
		S2 Demographic trends and migration patterns.
		S3 Political stability and ideology.
		S4 National urban policies and market incentives.
		S5 Technological innovation rate.
	Spatial and Infrastructural Context (SC)	SC1 National/Global Infrastructure Networks (e.g., Transportation, Energy Grids, Digital Networks).
		SC2 Regional morphology and urban agglomeration dynamics.
		SC3 Position in the global urban hierarchy and supply chains.
		SC4 Spatial teleconnections and cross-border spatial planning.
Focal System Components	Ecological and Geophysical Context (ECO)	ECO1 Regional climate patterns and change.
		ECO2 Regional topography and geological constraints.
		ECO3 Flows into and out of the urban SESS (e.g., resource hinterlands, pollution flows).
	Spatial System (SP)	SP1 Spatial Configuration and Density (e.g., Connectivity, Centrality, Compactness, FAR, Network Topology)
		SP2 Land Use Patterns (e.g., Mix, Intensity, Fragmentation, Zoning)
		SP3 Material Stock and Infrastructure (e.g., Building Materials, Infrastructure Age/Condition, Durability, Embodied Energy)
		SP4 Urban Metabolism (e.g., Infrastructure-Mediated Resource Flows, Embodied Energy of Material Stock, Built-Environment Constraints on Energy/Water/Waste Pathways)
		SP5 Path Dependency and Lock-in (e.g., Infrastructure Inertia, Historical Layering, Slow Temporality, Replacement Costs)
		SP6 Cultural Heritage and Place Identity (e.g., Historic Designation, Symbolic Meaning, Collective Memory)
		SO1 Governance Structure (e.g., Centralization vs. Polycentricity, Administrative Levels, Participation Levels)
		SO2 Property Rights and Land Tenure (e.g., Ownership structure, Tenure Security, Land Markets, Informality)
		SO3 Rules and Policies (e.g., Operational rules, Planning Regulations, Environmental Policies)
		SO4 Actors and Stakeholders (e.g., Diversity of Users, Residents, Firms, Planners; Social Networks)
		SO5 Socioeconomic Attributes (e.g., Inequality, Demographics, Economic status)
		SO6 Norms and Social Capital (e.g., Trust, Reciprocity, Community Cohesion, Values)
		SO7 Knowledge and Information (e.g., Understanding of SESS dynamics, Information Sharing)

Ecological System (EC)	EC1 Ecosystem Condition and Type (e.g., Aquatic, Terrestrial, Atmospheric; Novel Ecosystems; Health Indicators)
	EC2 Biodiversity and Habitat Quality (e.g., Species Richness, Functional Diversity, Habitat Suitability)
	EC3 Landscape Structure (e.g., Fragmentation, Green/Blue Space Distribution, Connectivity)
	EC4 Ecosystem Services Provision (e.g., UHI Mitigation, Air Purification, Stormwater Regulation)
	EC5 Predictability and Resilience (e.g., Disturbance Regimes, Tipping Points, Ecological Thresholds)
Interactions (I)	I1 Socio-Spatial Interactions (e.g., Place-making, Spatial Justice/Segregation, Planning Processes)
	I2 Eco-Spatial Interactions (e.g., Impact of Urban Form on Biodiversity, UHI Effect Mechanisms)
	I3 Socio-Ecological Interactions (e.g., Resource Consumption Patterns, Environmental Justice)
Outcomes (O)	O1 Spatial Performance (e.g., Accessibility, Efficiency of Land Use, Cultural Continuity, Morphological Robustness)
	O2 Ecological Performance (e.g., Resilience, Biodiversity Conservation, Environmental Quality)
	O3 Social Performance (e.g., Equity, Quality of Life, Health, Accountability, Economic Vitality)