Trees do not have social media

Towards integrated social and ecological monitoring in outdoor recreation and nature-based tourism

Coen van Bendegom[a*], **Ina Hildeman**[b], **Leyi Xu**[c] & **Meng Xu**[b]

[a]Department of Economics, Law and Tourism, ETOUR, Mid Sweden University, [b]Department of Geosciences and Natural Resource Management, Landscape Architecture, Planning and Society, University of Copenhagen, [c]Department of Geosciences and Geography, Digital Geography Lab, University of Helsinki

Introduction. There is growing recognition that studying visitor behavior in natural landscapes requires integrated social and ecological perspectives (Buckley, 2011; Lischka et al., 2018; Stronza et al., 2019; Sumanapala & Wolf, 2019). These intertwined, dynamic human-nature interactions are increasingly conceptualized as social-ecological systems (Creany et al., 2024; Miller et al., 2022). Integration of social and ecological data can be challenging; mismatch persists in aligning data as social and ecological changes often occur across various spatial and temporal scales (Miller et al., 2022; Perry et al., 2020; Stronza et al., 2019). Crowdsourced visitor monitoring methods could potentially close this spatial and temporal scalability gap. We conducted an integrative review (n = 158) on four key crowdsourced visitor monitoring methods: social media, passive mobile data, public participation geographic information systems (PPGIS), and Global Navigation Satellite System (GNSS) based activity tracking and propose considerations for integrated social-ecological monitoring approaches.

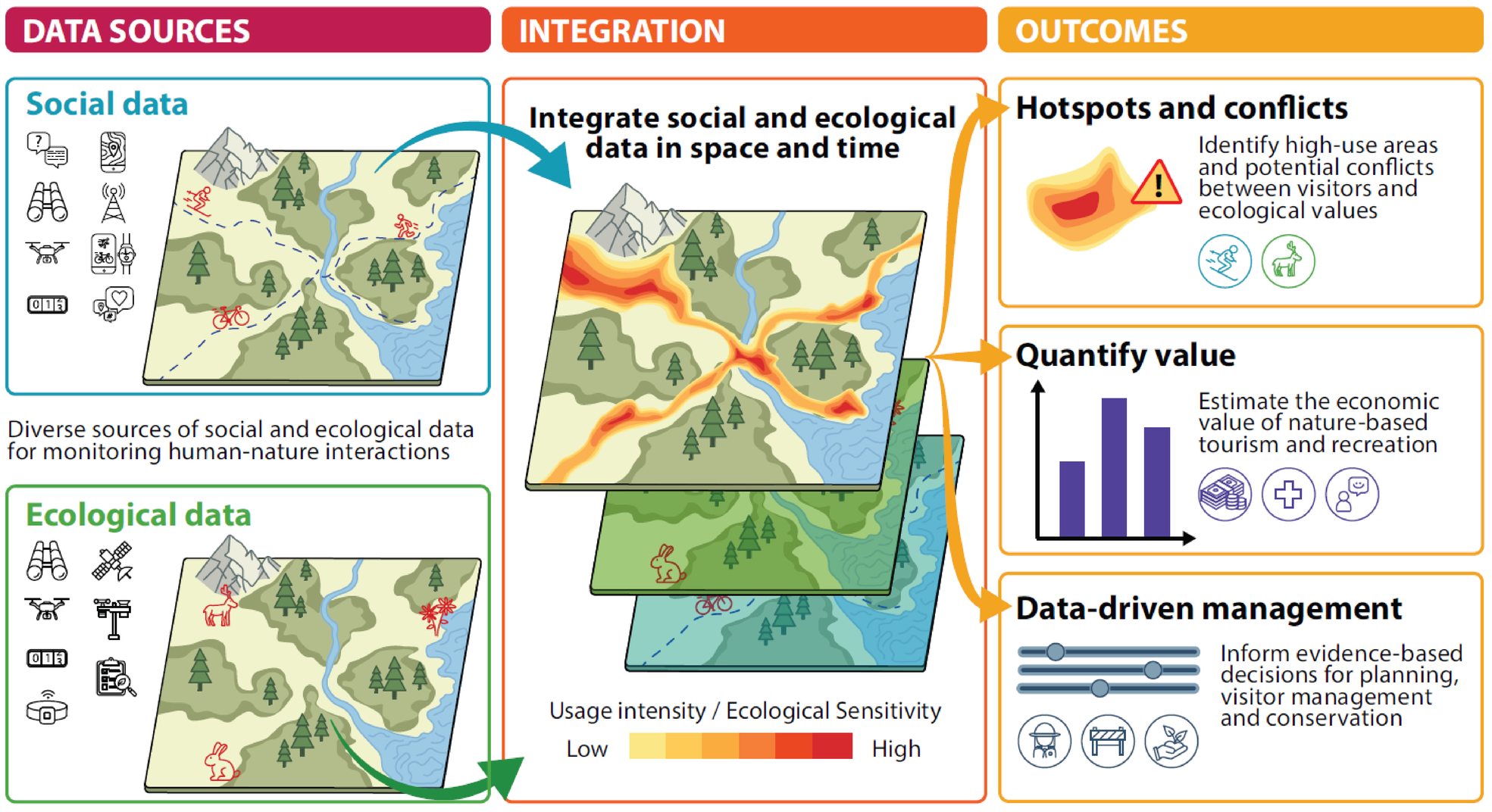


Table 1. Overview of Crowdsourced Visitor Data with their Spatial and Temporal Characteristics and Potential Integration with Ecological Data

Crowdsourced visitor data	Temporal characteristics	Spatial characteristics	Integration with ecological data
Social media	• Timestamped • Continuous / episodic • Daily / monthly aggregation	• Moderate precision • Geotags (point) • Local to global scales	• Cultural Ecosystem Services (CES) assessment • Visitor sentiments toward species/landscapes • Spatial drivers of visitation
Passive mobile data	• Continuous pings (cell tower / LBS) • Continuous / episodic • Hourly / daily aggregation	• Low/Moderate precision • Cell tower: 250m to >5km (grid) • LBS: Internal device sensors (point) • Regional to national scales	• Hotspot mapping • Environmental & weather drivers of visitation • Evaluate recreational pressure at landscape levels
PPGIS	• Single- or multi-wave • Static / discrete • Unspecified aggregation	• Moderate precision • User input (point, line, polygon) • Local to regional scales	• Mapping multi-use spatial conflicts • Relational value & CES mapping • Citizen science contributions
GNSS-based activity tracking	• High frequency (1–5s intervals) • Continuous / episodic • Hourly / daily aggregation	• High precision (5-10m accuracy) • Route trajectories (line) • Local to global scales	• Recreation intensity & off-trail mapping • Human-wildlife disturbances • Predict trail conditions and erosion

Conclusion. A review of 158 publications demonstrates that crowdsourced visitor monitoring methods provide rich, remotely collected spatiotemporal datasets for studying nature visitation through a social-ecological systems lens. However, only 58 studies (37%) combined social and ecological datasets – most evaluated social data in isolation or used ecological layers only for descriptive context.

Key challenge. Spatial overlap between visitor data and ecological data does not inherently mean social-ecological impacts. Impacts (positive and negative) are shaped by spatial overlap and temporal cycles (diurnal, seasonal, multi-year).

Towards integrated social-ecological monitoring. Bridging this spatiotemporal gap requires moving beyond static heatmaps toward multi-scalar research designs. Crowdsourced visitor data combined with high-resolution ecological data turns big data into actionable tools.

References & More information

Explore the interactive prototype

https://coenvanbendegom.github.io/mmv13-social-ecological-monitoring/

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