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Moving toward sustainable urban landscapes: assessing and optimizing urban vegetation change in Central Arizona

Land cover and management practices through urban greening have been widely promoted to enhance landscape sustainability by maximizing ecosystem services, reducing disservices, and supporting long-term human well-being. Urban greening, however, continues to encounter challenges. Many greening programs focus on a single environmental objective while ignoring critical ecosystem service trade-offs (e.g., water conservation vs. heat mitigation) and unintended consequences. Municipal greening efforts also frequently prioritize environmental goals over social constraints and outcomes, and few incorporate fine-scale strategies to determine where greening or landscape changes should occur. To address these gaps, this study develops innovative spatial optimization models to design urban vegetation distributions that balance the trade-offs between vegetative cooling performances and irrigate demands while addressing greening equity. By embedding different socio-ecological priorities into objective functions and constraints, the models can generate solutions that maximize overall benefits. In particular, two separate spatial optimization models are constructed: one to evaluate current vegetation distribution, and the other to identify optimal locations for future greening and landscape changes. Both models aim to maximize vegetation-driven cooling (i.e., reduction in mean radian temperature) and minimize irrigation costs using different water resources (i.e., potable vs. reclaimed water) while accounting for varying land-use contexts (e.g., municipal-managed vs. residential areas) and ensuring greening in low-income neighborhoods. Municipal greening targets will be integrated to generate scenario-based trade-off solutions and evaluate associated socio-ecological outcomes. This study contributes to CAP LTER by creating a solution-oriented spatial optimization tool to support long-term decision-making in urban greening efforts in central Arizona.

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