

Urbanization drives divergence in functional diversity and composition of woody plant communities in remnant forest patches

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Urbanization drives divergence in functional diversity and composition of woody plant communities in remnant forest patches

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ABSTRACT

Urbanization has a profound impact on the ecological processes and plant diversity of remnant forests. To understand the relationship between urbanization and woody plant communities in remnant forests, we conducted a study in Guiyang, China, where we sampled 120 plots in 15 remnant forest patches along an urbanization gradient. We evaluated the functional diversity of woody plants based on four functional diversity indices and nine functional traits. We compared the functional diversity among different types of woody plants and between interior and edge communities, and analyzed the changes in functional diversity and individual functional traits along the urbanization gradient. Our results indicate that urbanization significantly decreases the functional diversity of woody plant communities. Additionally, urbanization leads to shifts in functional composition, particularly in shrub species, with an increase in leaf N content and a decrease in leaf C content, leaf C/N ratio, seed germination rate and seed mass. These findings suggest that increasing urbanization reduces the values of high resource-conserving traits of woody plants in remnant forests. Therefore, It is crucial to limit additional urban expansion around remnant forest patches to protect the functional diversity and crucial plant species with strong resource-conserving traits.

INTRODUCTION

Urbanization can alter plant communities in remnant forest patches.

The article examines whether increasing urbanization is associated with changes in the functional diversity and functional composition of woody plants.

The study focuses on adult trees, saplings/seedlings and shrubs across remnant forest patches.

Urbanization is represented by the percentage of impervious surface surrounding each forest patch.

The analysis considers functional traits to understand how plant communities respond along the urbanization gradient.

THEME

Urbanization, functional diversity and functional composition of woody plant communities.

CONTEXT

Remnant forest patches occur within an urbanizing landscape and can experience different levels of surrounding urban pressure.

KEY TERMS

Functional diversity: the diversity of ecological functions represented by species' traits.

Remnant forest patch: a small, surviving natural area of an original forest that remains.

Woody plant community: an ecological group dominated by perennial plants with hard, lignified stems, including trees, shrubs, and woody vines.

Functional trait: is a measurable characteristic of an organism that directly determines its survival, reproduction, and overall ecological impact.

Urbanization: is the growing spread of city areas, buildings, and roads around natural green spaces.

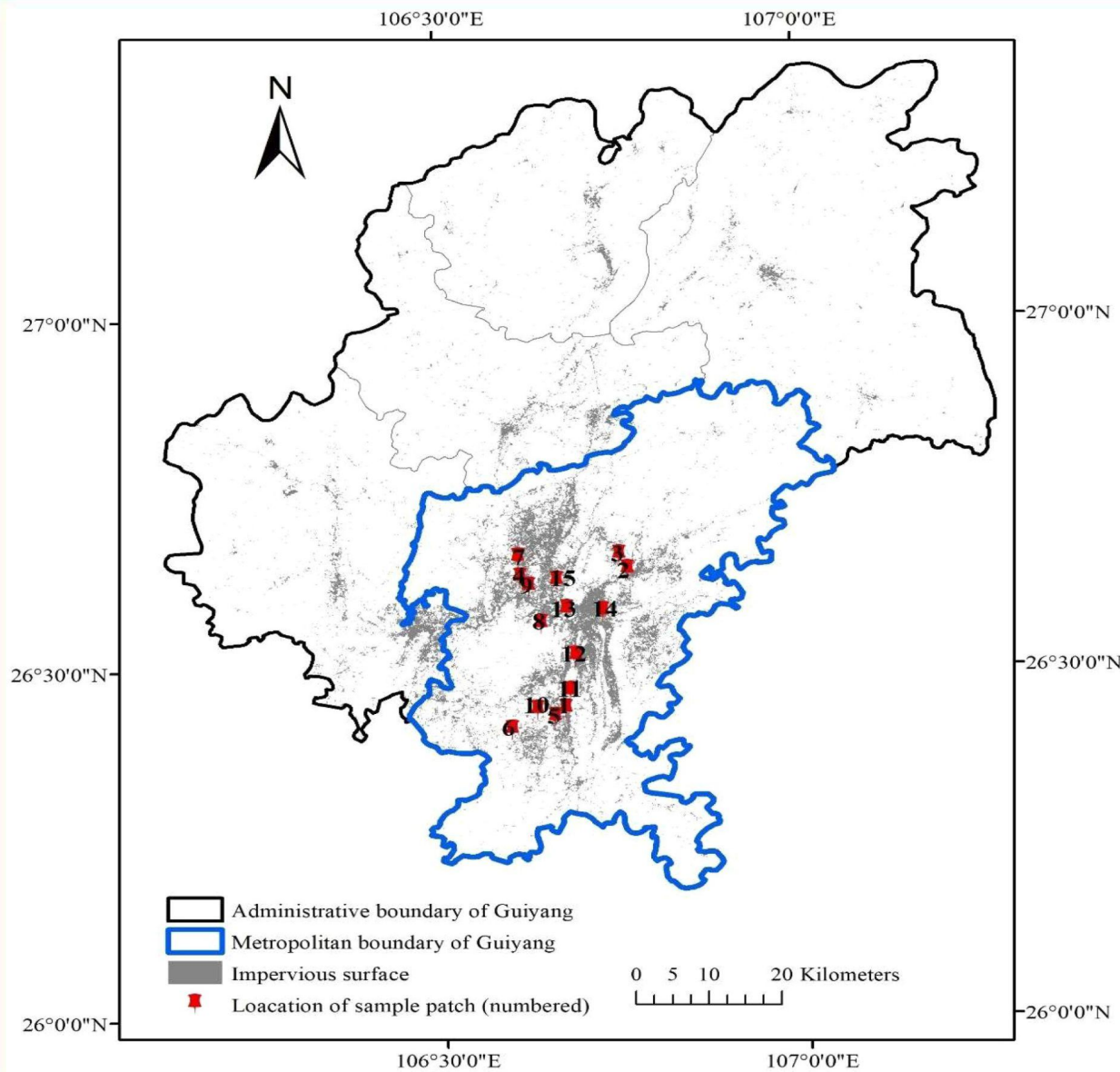
Impervious surface: areas surfaces that prevent water from infiltrating the soil.

RESEARCH PROBLEM

It remains unclear how an increasing urbanization gradient differently impacts the functional diversity, composition, and community-weighted traits of adult trees, saplings, and shrubs across interior and edge forest habitats.

OBJECTIVE

1. To investigate how urbanization is associated with functional diversity and functional composition of woody plant communities in remnant forest patches.
2. To compare functional responses among adult trees, saplings/seedlings and shrubs.
3. To examine functional differences between forest interior and edge habitats.
4. To identify changes in important community-weighted functional traits along the urbanization gradient.



Source : Yanjun Zheng , Jingyi Yang, 2023.

METHODOLOGY

Study area: 15 remnant forest patches in Guiyang, China.

Sampling: 120 plots were used to sample woody plant communities.

Groups: adult trees, saplings/seedlings and shrubs; interior and edge habitats were compared.

Functional traits included leaf nitrogen, leaf carbon, C/N ratio, leaf thickness, leaf area, specific leaf area, seed germination rate, seed mass and maximum plant height.

Urbanization was represented by the percentage of impervious surface within 500 m of each forest patch.

Analyses included functional diversity indices, community-weighted means, regression analyses, Wilcoxon signed-rank tests and PERMANOVA.

RESULTS & DISCUSSION — FUNCTIONAL DIVERSITY

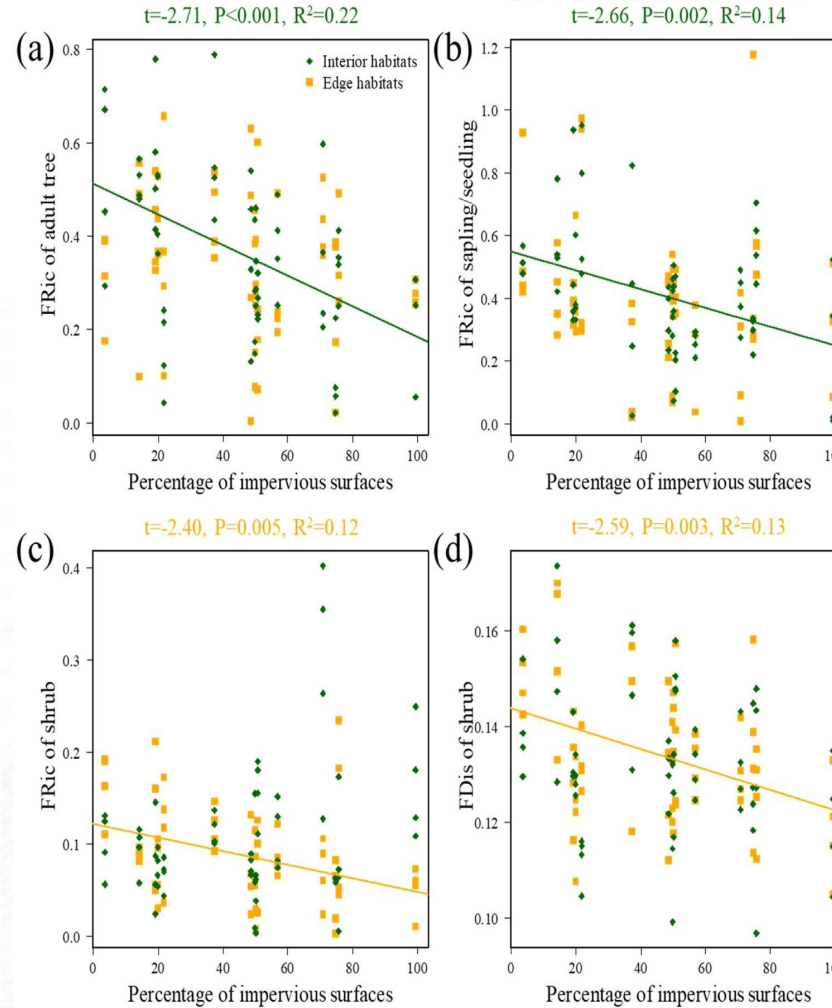
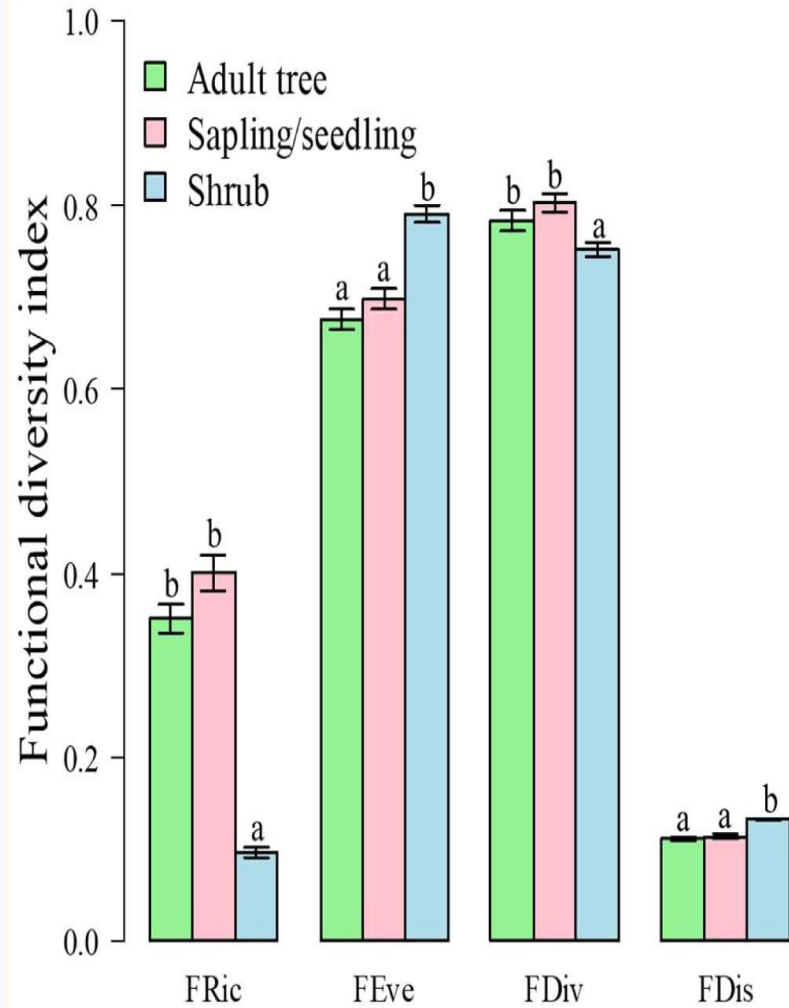


Figure 2: Shrubs had lower functional richness and functional divergence than adult trees and saplings/seedlings, but higher functional evenness and functional dispersion.

Figure 3: Functional richness of adult trees, saplings/seedlings and shrubs declined as impervious surface increased.

The negative relationships in **Figure 3** are statistically significant for the reported models.

Interpretation: increasing urbanization is associated with reduced functional diversity, with clear responses in shrubs.

Source : Yanjun Zheng , Jingyi Yang, 2023.

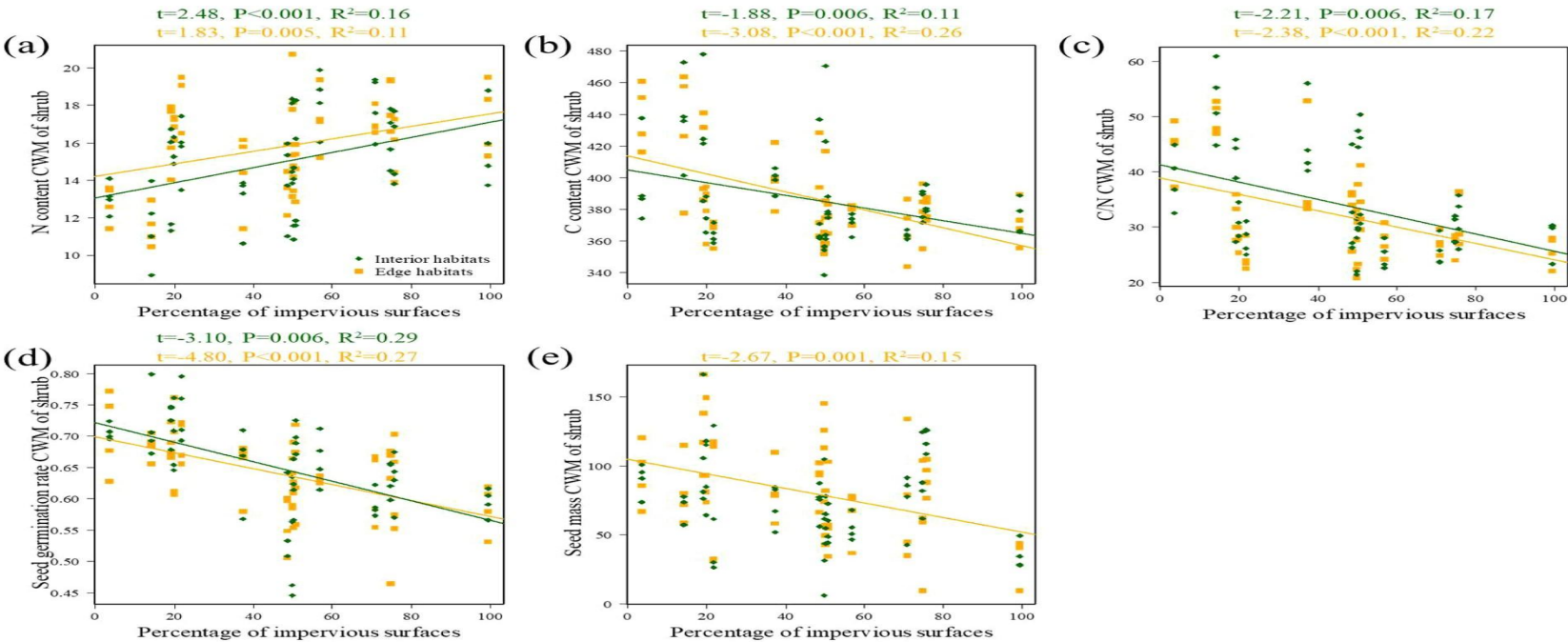
RESULTS & DISCUSSION — COMPOSITION AND TRAITS

Table 1
Significant differences in functional diversity between the interior and edge sites of each patch according to the Wilcoxon Signed-Rank test.

Patch number	Levels of urbanization (%)	Vegetation layer	Indicator	Wilcoxon W	P value	Values in interior habitats	Values in edge habitats
10	0.04	Adult tree	FD _{is}	0	0.03*	0.132 ± 0.005	0.114 ± 0.002
6	0.14	Adult tree	FD _{is}	0	0.03*	0.131 ± 0.001	0.104 ± 0.015
		Sapling/seedling	FD _{is}	0	0.03*	0.159 ± 0.006	0.117 ± 0.006
11	0.20	Adult tree	FD _{iv}	16	0.03*	0.829 ± 0.010	0.883 ± 0.019
8	0.22	Sapling/seedling	FD _{is}	16	0.03*	0.097 ± 0.004	0.128 ± 0.001
		Shrub	FD _{is}	16	0.03*	0.112 ± 0.003	0.132 ± 0.003
15	0.71	Sapling/seedling	FD _{iv}	0	0.03*	0.906 ± 0.011	0.718 ± 0.065
		Shrub	FR _{ic}	0	0.03*	0.287 ± 0.060	0.070 ± 0.018
		Shrub	FE _{ve}	16	0.03*	0.859 ± 0.009	0.980 ± 0.014
14	0.99	Sapling/seedling	FE _{ve}	16	0.03*	0.708 ± 0.027	0.842 ± 0.023
		Shrub	FR _{ic}	0	0.03*	0.167 ± 0.031	0.050 ± 0.014

Table 2
Divergence of functional composition along levels of urbanization based on PERMANOVA test.

Vegetation layer	F	R ²	P value
Adult tree	0.357	0.003	0.628
Sapling/seedling	0.367	0.003	0.639
Shrub	5.096	0.041	0.022*



Source : Yanjun Zheng , Jingyi Yang, 2023.

Table 2: functional composition changed significantly with urbanization for shrubs ($F = 5.096$, $R^2 = 0.041$, $P = 0.022$), but not for adult trees or saplings/seedlings.

Figure 4: with increasing urbanization, shrub community-weighted leaf N increased, while leaf C, C/N ratio, seed germination rate and seed mass decreased.

Table 1: interior–edge differences varied among forest patches; significant differences occurred in a subset of patches.

Overall, shrubs showed the clearest functional-composition and trait response to urbanization.

MOST RELEVANT CONCLUSIONS

- ❖ Urbanization was associated with declines in several measures of functional diversity.
- ❖ Shrubs showed particularly clear changes in functional composition along the urbanization gradient.
- ❖ Urbanization was associated with a shift in shrub functional traits toward higher resource-acquisition characteristics and lower resource-conserving characteristics, as discussed by the authors.
- ❖ The results demonstrate that remnant forest patches can show functional changes even when vegetation remains present.
- ❖ The authors emphasize controlling further urban expansion around remnant forest patches to reduce additional loss of functional diversity.

Urbanization acts as a strict environmental filter. It decreases overall functional diversity and forces shrub species to abandon resource-conserving traits in favor of fast-growing resource-acquisition traits, leading to functional homogenization.

Implications & Recommendations

It is crucial to limit additional urban expansion (impervious surfaces) immediately around remnant forest patches to protect species with high resource-conserving traits (slow growth, longevity).

Personal Opinion

Highly valuable for utilizing continuous functional traits rather than categorical ones, providing a nuanced, process-driven understanding of how urban plants adapt at a mechanical level.

Limitations

Findings are specific to a subtropical mountainous city (Guiyang) and may vary in different biomes or non-mountainous topographies.

Research Gap

Future research requires examining the spatial-temporal impacts of urban landscapes on the evolutionary attributes of remnant vegetation over longer time scales.



THANK YOU