XV WORLD FORESTRY CONGRESS
Building a Green, Healthy and Resilient Future with Forests
2–6 May 2022 | Coex, Seoul, Republic of Korea

Managing taxonomic and functional diversity is the key to sustain aboveground biomass and soil microbial diversity: A synthesis from long-term forest restoration of southern China

Md. Abu Hanif[1,2*], Weijun Shen[2]

[1]Department of Agroforestry and Environment, Hajee Mohammad Danesh Science and Technology University, Bangladesh
[2]South China Botanical Garden, Chinese Academy of Sciences, China; *Corresponding author: hanif_hstu@yahoo.com

Abstract

Exploring the biodiversity-ecosystem functioning relationship is one of the central goals of ecological research. Restoration is essential for supporting key ecosystem functions such as aboveground biomass production and managing soil microbial diversity. However, the relative importance of functional versus taxonomic diversity in explaining aboveground biomass and soil microbial diversity during restoration is poorly understood. Here, we used a trait-based approach to test for the importance of multiple plant diversity attributes in regulating aboveground biomass and soil microbial diversity in four 30-years-old restored subtropical forests in southern China. High-throughput Illumina sequencing was applied for detecting fungal and bacterial diversity. We show that both taxonomic and functional diversities are significant and positive regulators of aboveground biomass; however, functional diversity (FD) was more important than taxonomic diversity (TD) in controlling aboveground biomass. FD had the strongest direct effect on aboveground biomass compared with TD, soil properties, and community weighted mean (CWM) traits. Our results further indicate that leaf and root morphological traits and traits related to the nutrient content in plant tissues showed acquisitive resource use strategy which influenced aboveground biomass. In contrast to aboveground biomass, taxonomic diversity explained more of the soil microbial diversity than the FD and soil properties. Prediction of fungal richness was better than that of bacterial richness. In addition, root traits explained more variation of soil microbes than the leaf traits. Our results suggest that both TD and FD play a role in shaping aboveground biomass and soil microbial diversity; but FD is more important in supporting aboveground biomass while TD for belowground microbial diversity. These results imply that enhancing TD and FD is important to restoring and managing degraded forest landscapes.

Key words: Biodiversity-Ecosystem functions; soil microbial diversity, taxonomic diversity, functional diversity, forest restoration

Scope and main objectives

Forest degradation decreases forests ability to provide ecosystem services. Half of the world's degraded tropical forests are restored through reforestation or are converted to secondary plantation forests. The success of ecological restoration largely depends upon the interactions between above and belowground communities driving ecosystem processes. We lack empirical evidence on the contribution of biodiversity and functional attributes in explaining aboveground biomass and soil microbial diversity. Therefore, the study was designed to achieve the following objectives-

i) to decipher relative importance of plant functional diversity vs. taxonomic diversity for explaining aboveground biomass and soil microbial diversity

ii) to identify the key plant functional traits driving aboveground biomass and soil microbial diversity

Results

Structural equation modelling (SEM) accounted for 59% of the variation in aboveground biomass (Fig. 1). FD had the strongest positive direct relationship with aboveground biomass, followed by species richness and CWM traits.

The random forest model explained 33% of the variability in aboveground biomass. Plant functional traits related to carbon, nitrogen, and phosphorus were found to be the dominant predictors of aboveground biomass.

Plant taxonomic diversity alone explain 27% of fungal and 19% of bacterial diversity while FD explain 4% of fungal diversity (Fig. 2). FD alone had little explanatory power for bacterial communities; however, together with TD, it predicted 18% of the richness and diversity of bacterial communities.

Belowground plant functional traits explained more variation of soil microbial diversity than the aboveground traits.

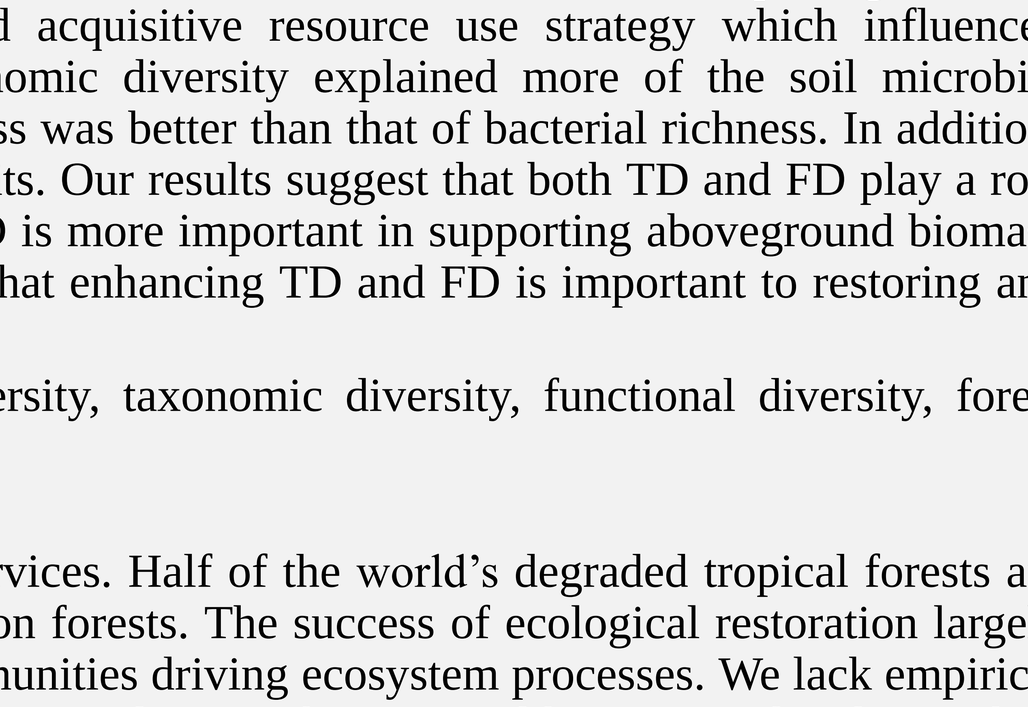

Fig. 1 The structural equation modelling showed how plant diversity attributes and soil nutrients drive aboveground biomass

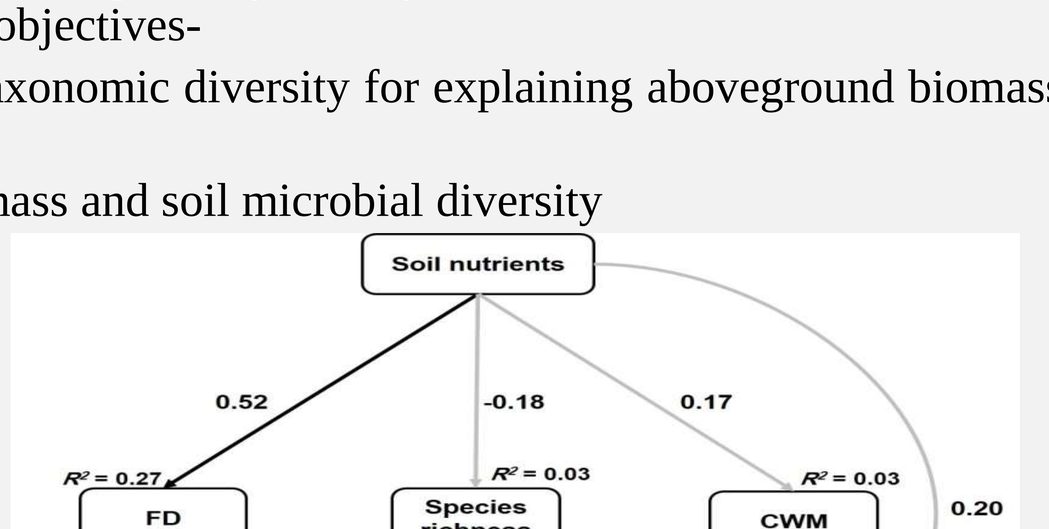

Fig. 2 Variance partitioning analysis showing contribution of biodiversity attributes and soil properties in explaining fungal and bacterial diversity

Conclusion

This study enriched our understanding of the significant biodiversity metrics and plant functional traits that influence ecosystem functioning and can guide successful management of forests in tropical and subtropical regions.