Decreased soil multifunctionality is associated with altered microbial network properties under precipitation reduction in a semiarid grassland

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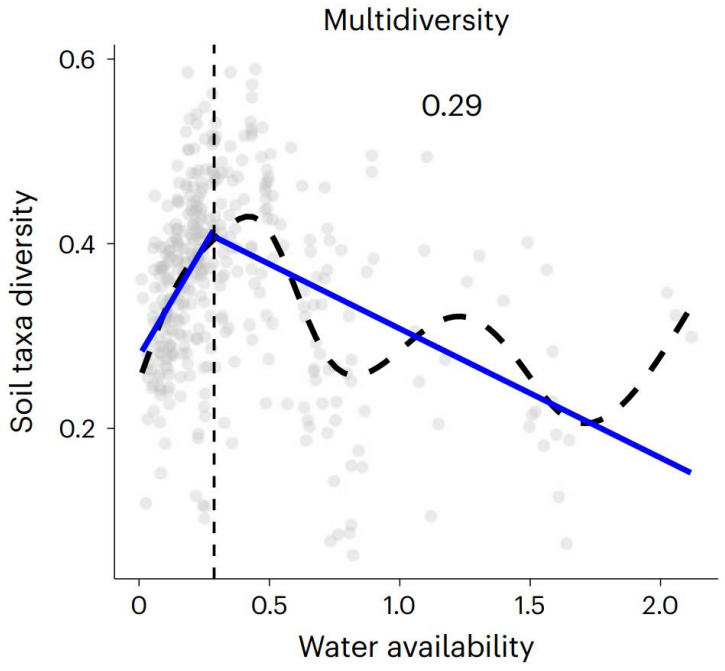
Altered precipitation affect soil microbial community structure

- Precipitation (water availability) shapes the distribution and diversity of soil microorganisms globally.
- It has become indisputable that global precipitation patterns are changing in the context of climate warming.
- Changing precipitation patterns are expected to strongly influence soil microbial community structure by altering water availability.



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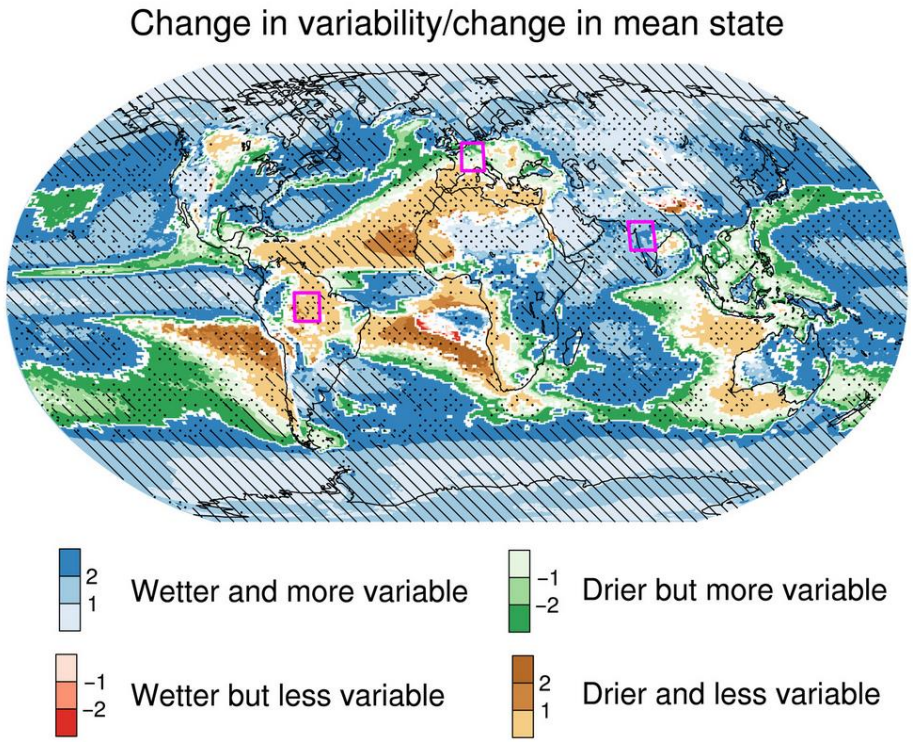

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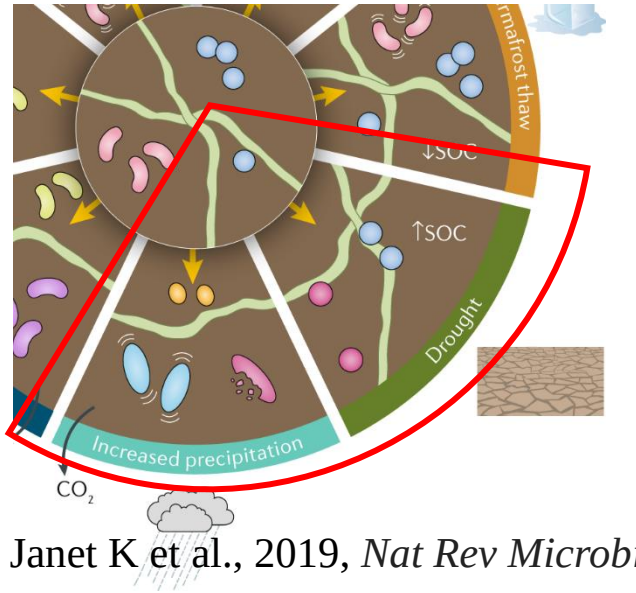

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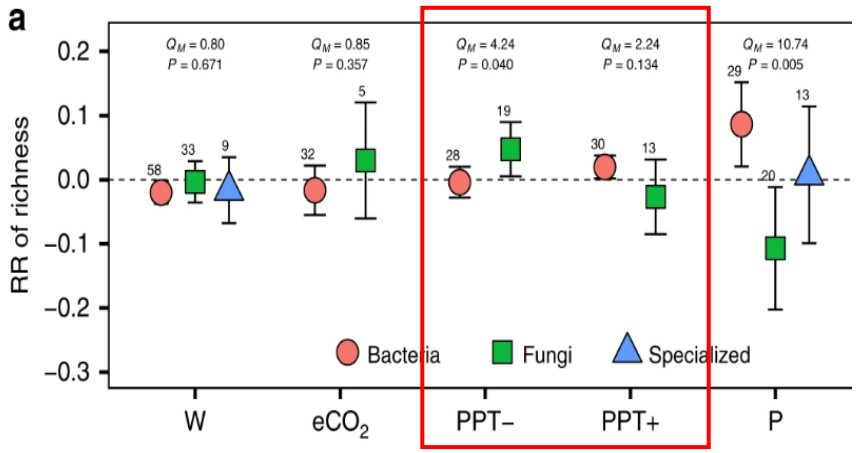

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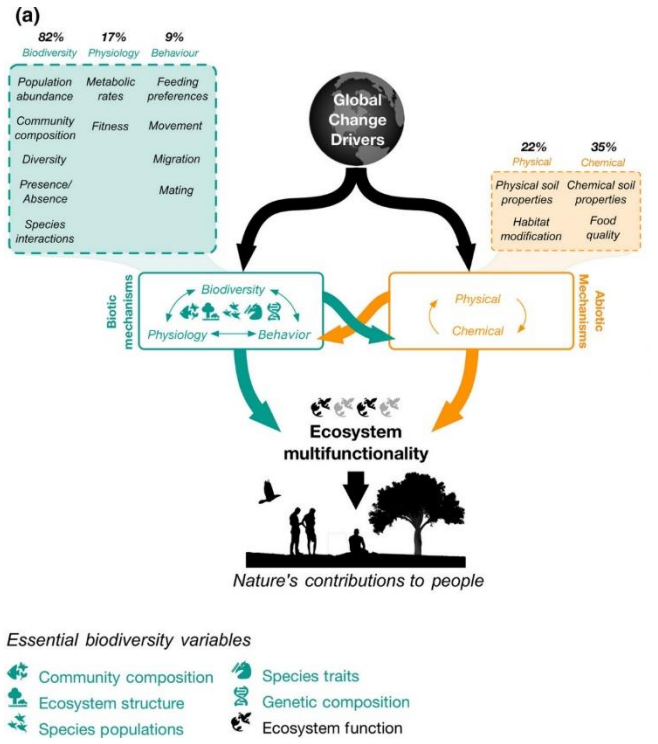
降水变化下微生物群落结构改变是否牵动了土壤多功能性的变化?

- Changing precipitation may affect ecosystem multifunctionality by changing microbial communities.
- Microbial network complexity has recently been considered a more important driver of multifunctionality.
- Network complexity strengthens the link between diversity and soil function.

Questions

- How altered precipitation patterns affect soil multifunctionality?
- How microbial diversity, assembly processes, and microbial network properties respond to altered precipitation and participate in regulating soil multifunctionality?



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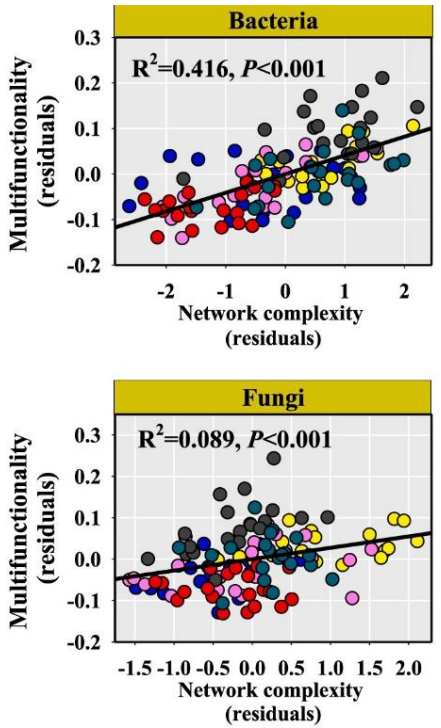

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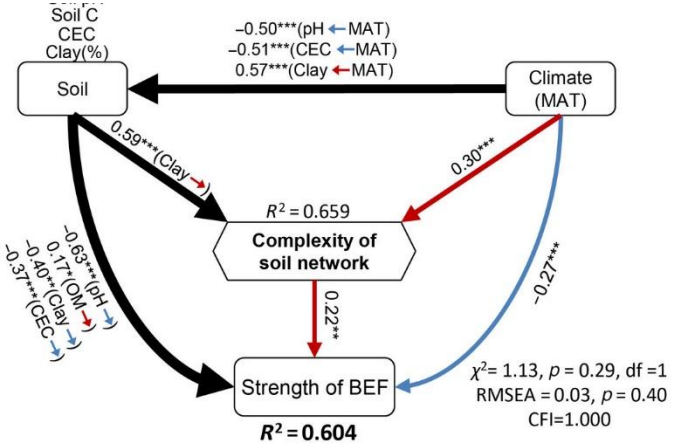

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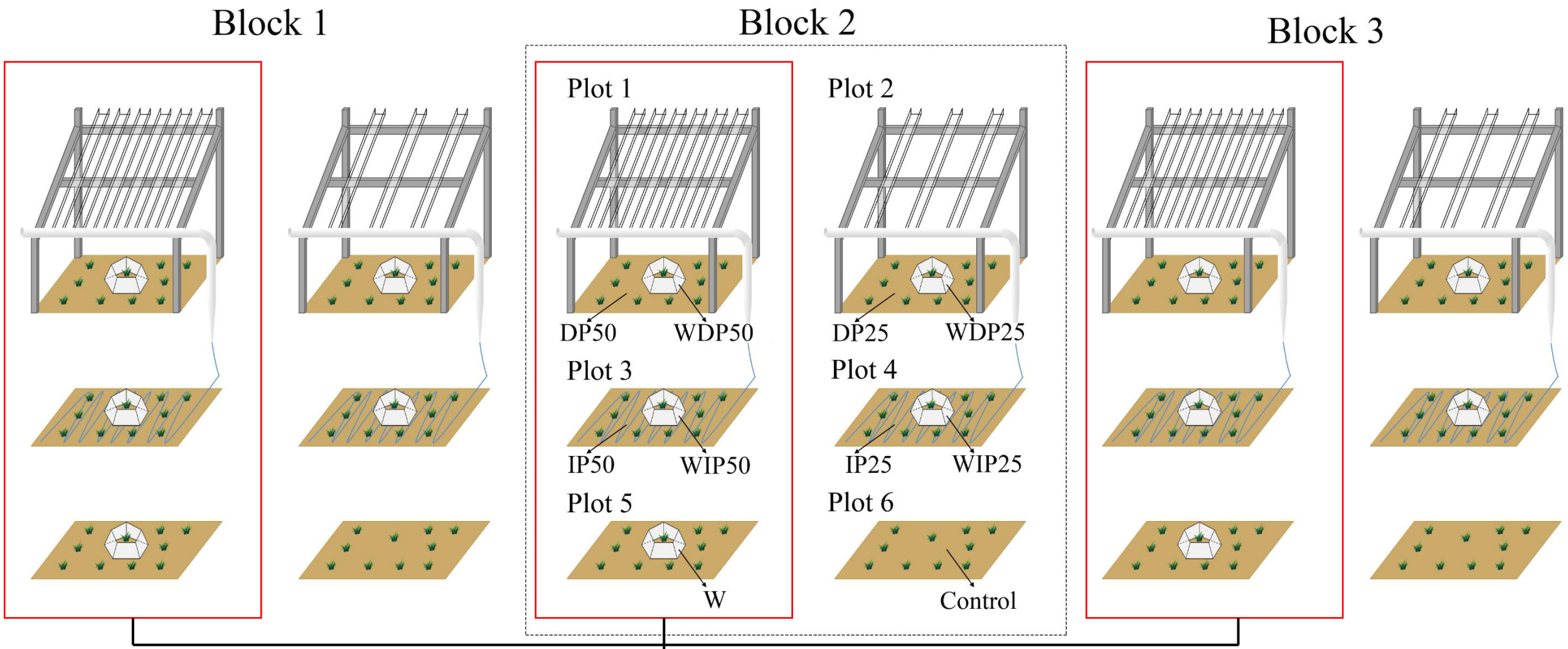
Methods

Based on the long-term field control experimental platform in loess hilly region.



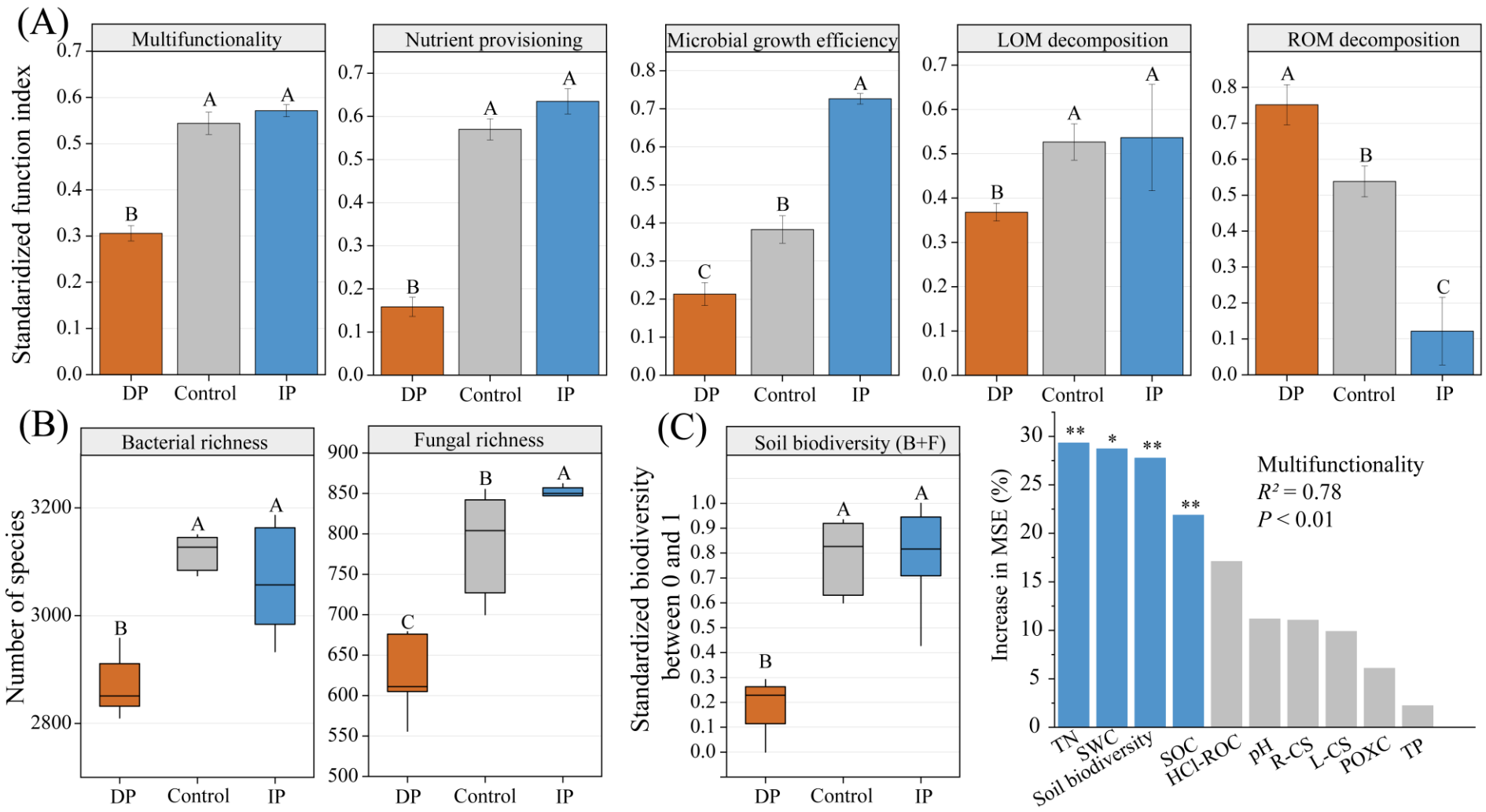
Bacterial and fungal community; network analysis; assembly process; network complexity.

Six soil samples were collected two years later from subplots of DP50, control, and IP50, respectively.

Determination of 17 single functions for nutrient provisioning, microbial growth efficiency, LOM and ROM decomposition, and calculation of soil multifunctionality.

Results

Response of soil multifunctionality and microbial richness to altered precipitation.

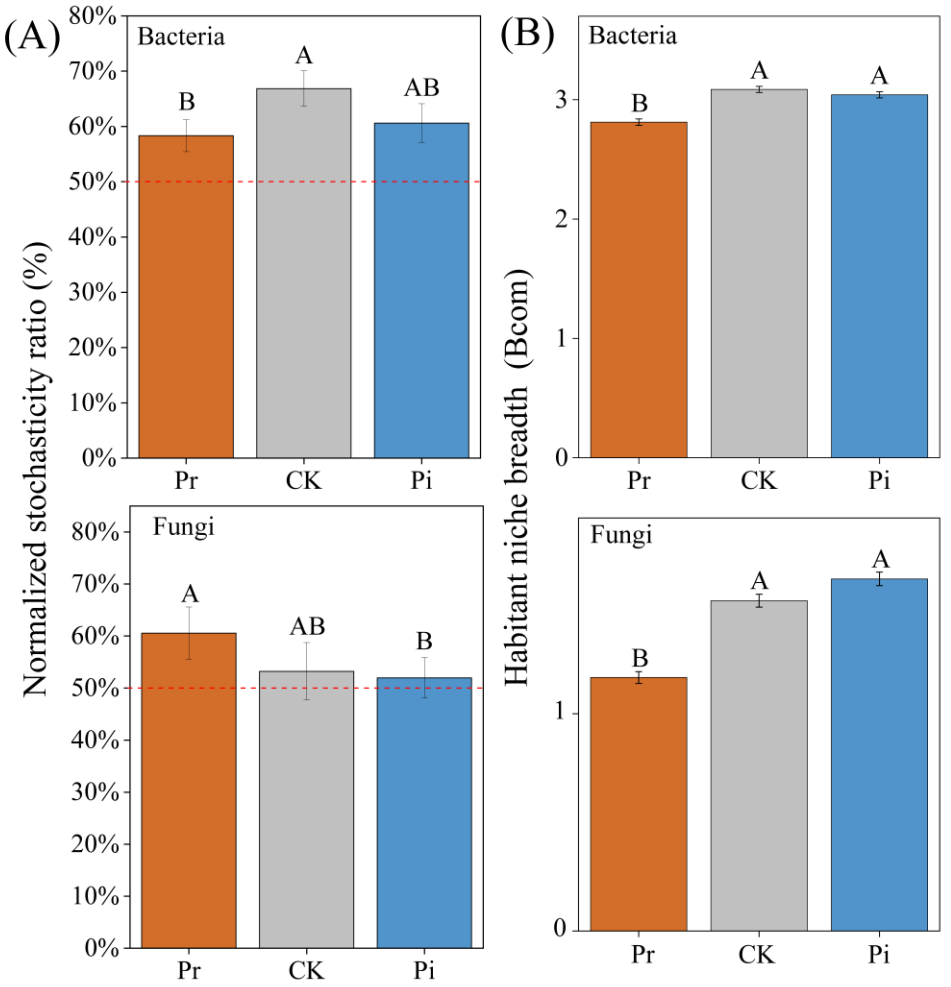


- Decreased precipitation significantly reduced soil multifunctionality and nutrient provisioning, microbial growth efficiency, LOM decomposition, and microbial richness.
- Increased precipitation had no significant effect on soil multifunctionality, but reduced ROM decomposition.
- Soil biodiversity remained a significant and important predictor of soil multifunctionality, even after accounting for multiple soil properties.

Results

Effects of altered precipitation on microbial community assembly and niche breadth.

- Decreased precipitation significantly reduced the stochasticity of bacterial assembly, while increased precipitation had no significant effect.
- Decreased precipitation increased the stochasticity of fungal community assembly, although not statistically significant.
- The neutral community model showed th the decreased precipitation significantly reduced the fungal migration, indicating that fungal community assembly may be more driven by dispersal limitation.



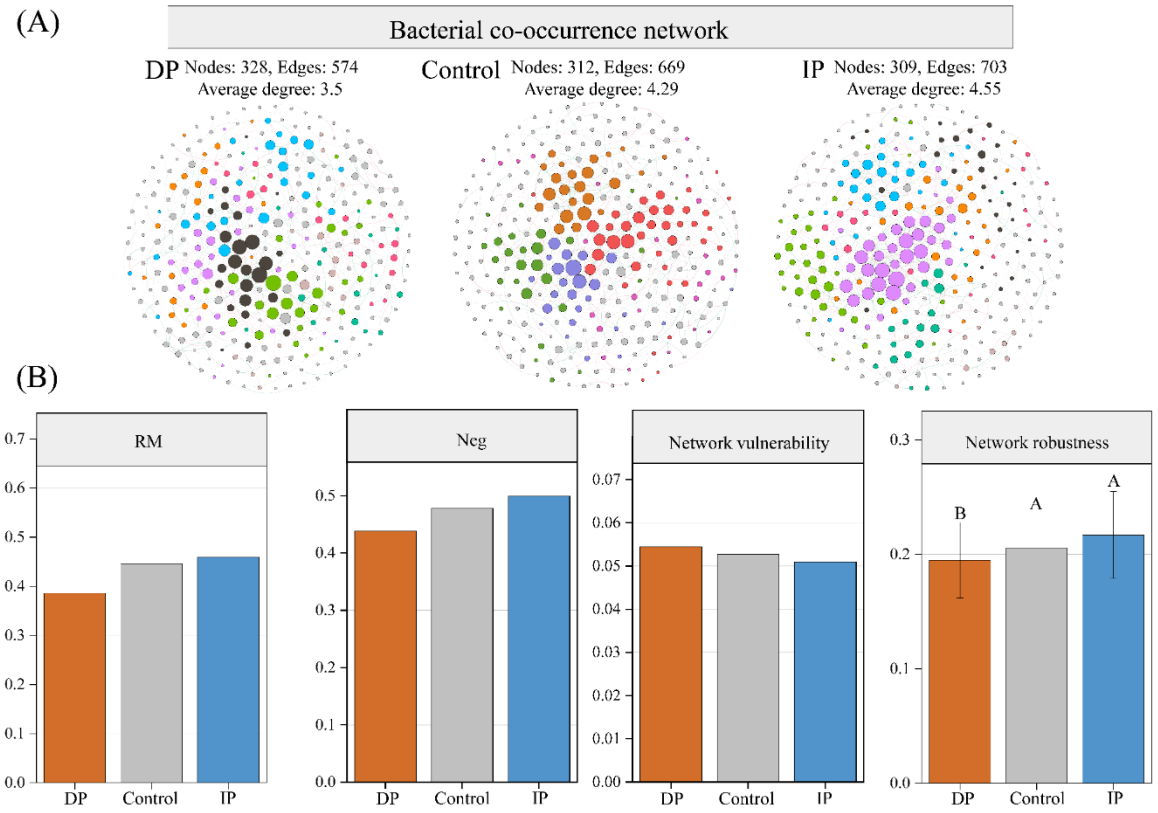
(C)

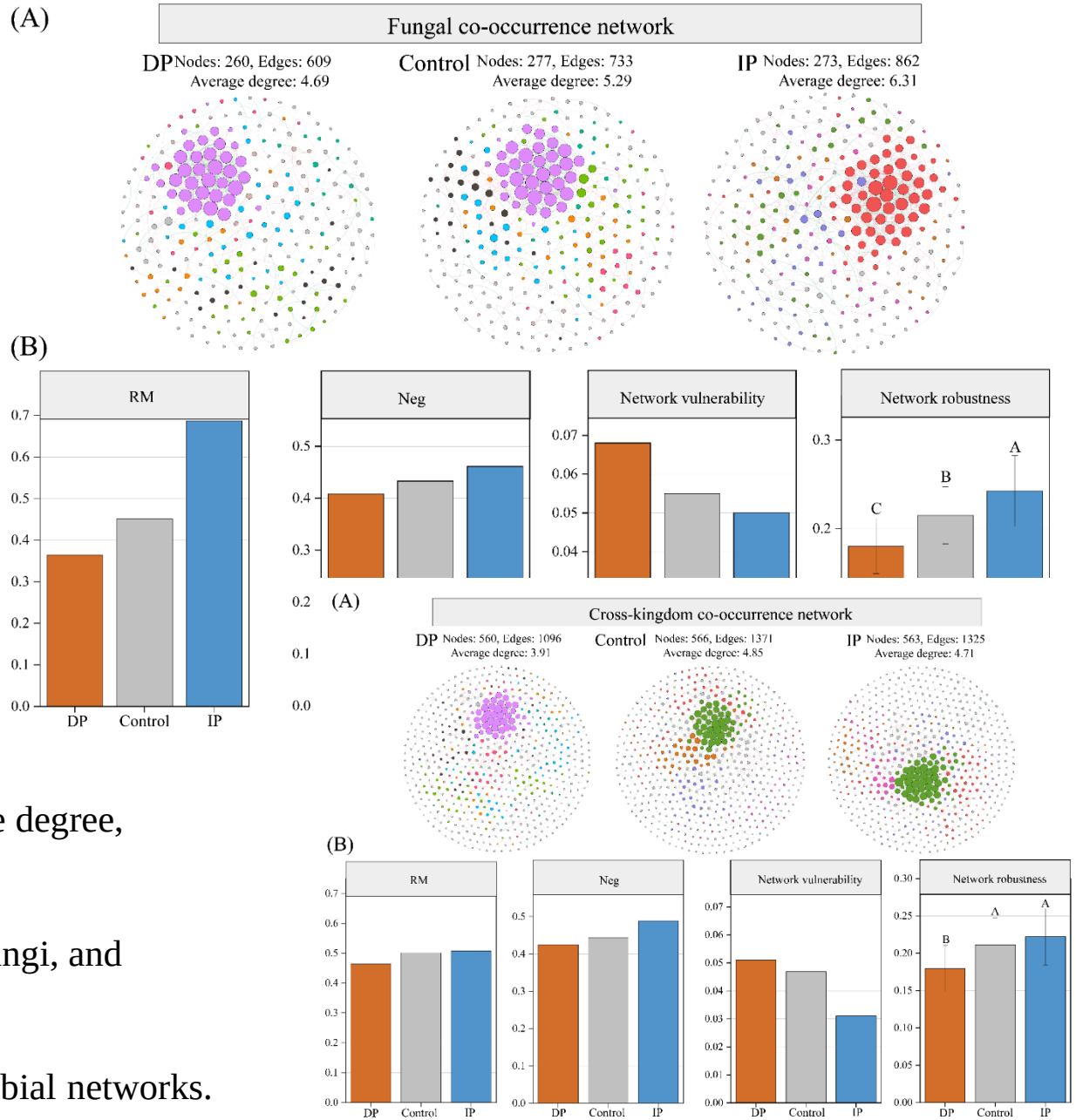
Treatments	Bacteria		Fungi	
	m	R^2	m	R^2
DP	1.56	0.68	0.07	0.46
Control	1.63	0.65	0.15	0.45
IP	1.64	0.66	0.25	0.56

- Decreased precipitation significantly reduced the bacterial and fungal habitat niche breadth. Species with higher niche breadth had more flexible metabolism at the community level. Therefore, decreased precipitation may increase the vulnerability of microorganisms to environmental changes and the risk of diversity loss by inhibiting their metabolic capacity.
- In contrast, increased precipitation had no significant effect on bacterial and fungal habitat niche breadth, and this insensitivity may be related to historical climate features.

Results

Decreased precipitation reduces the stability of the microbial co-occurrence network.

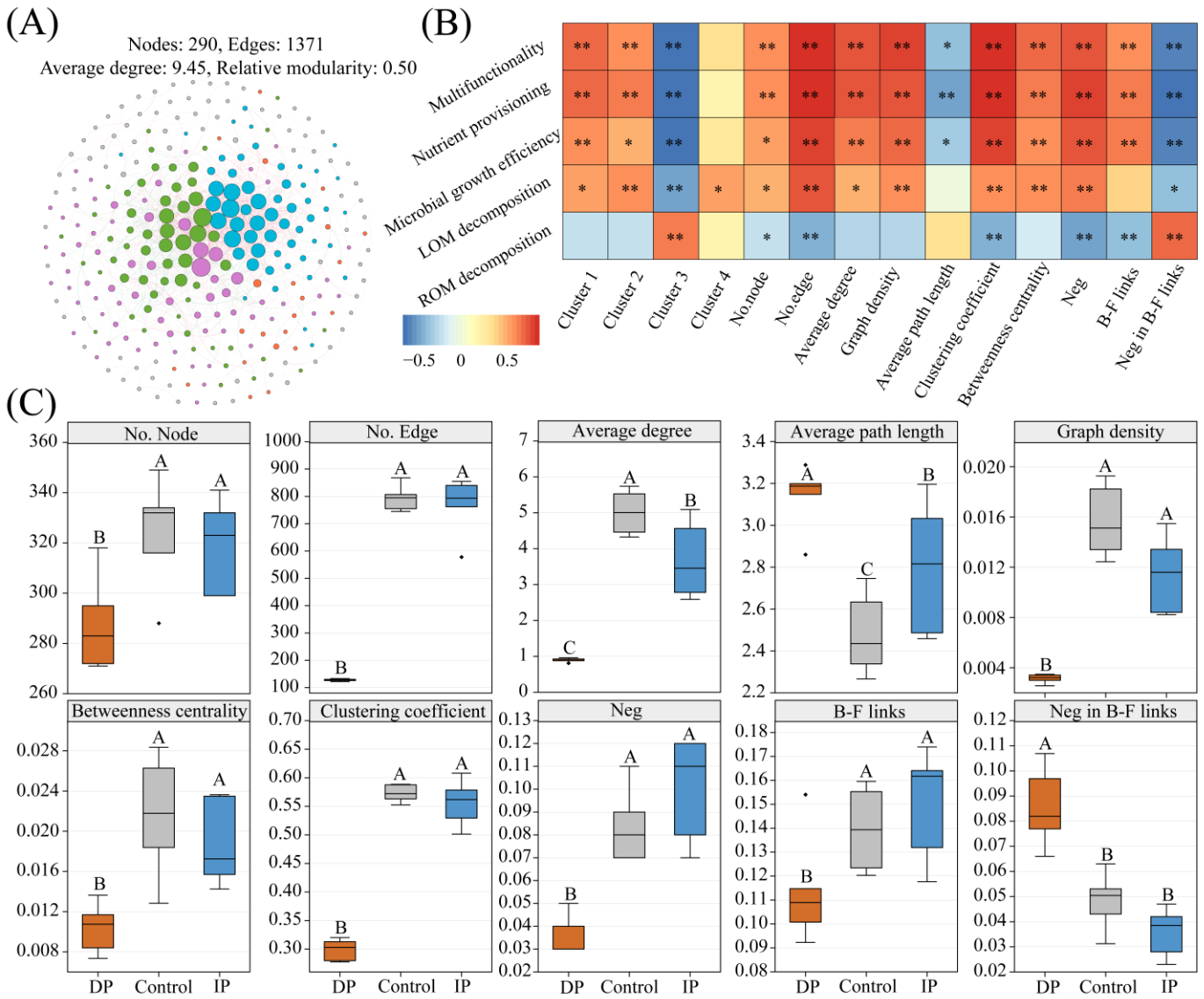




- Decreased precipitation reduces the number of nodes and edges, average degree, relative modularity and negative correlation ratio of the network.
- Decreased precipitation significantly reduced the stability of bacteria, fungi, and cross-kingdom networks, resulting in more fragile networks.
- Increased precipitation had no significant effect on the stability of microbial networks.

Results

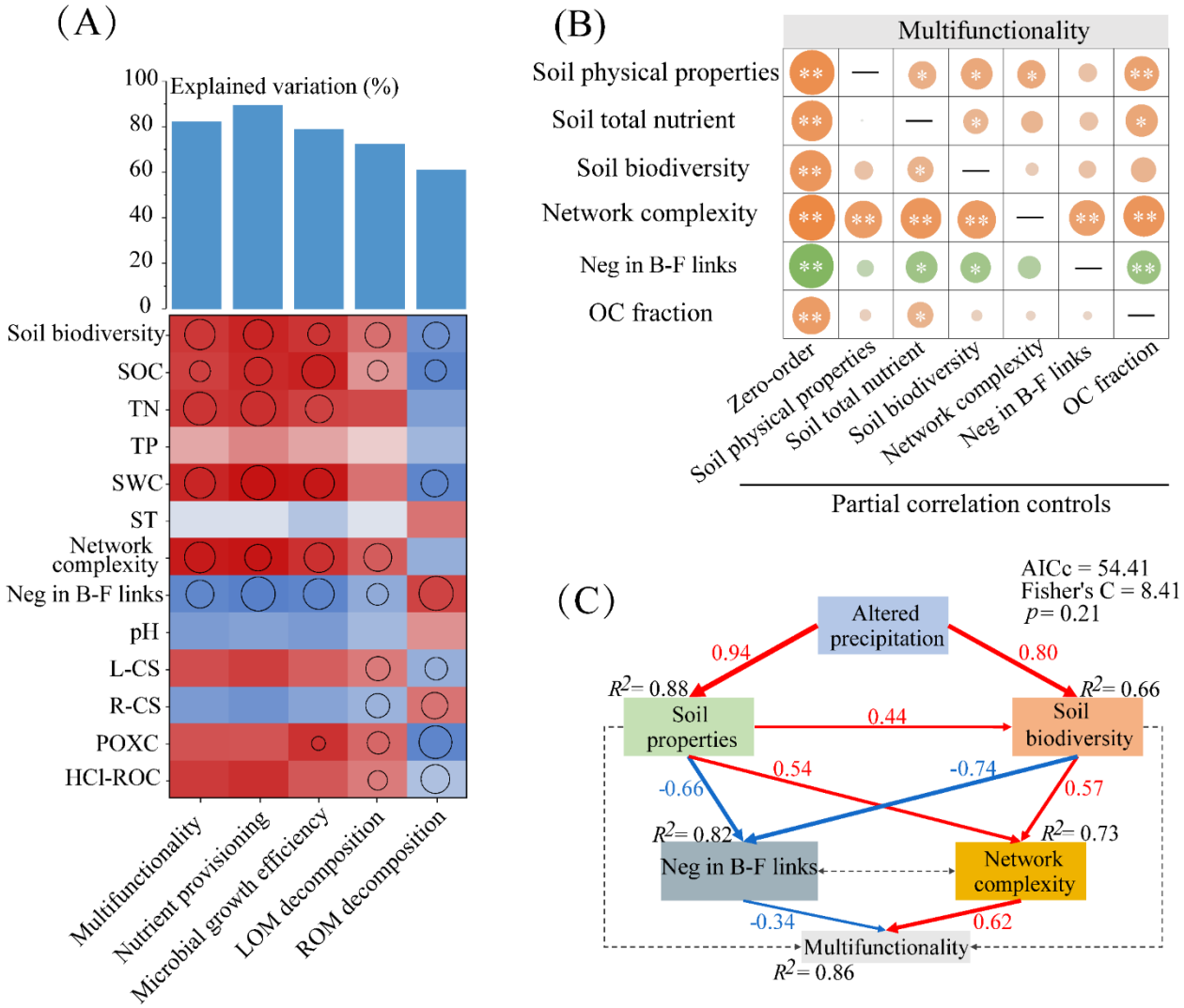
Decreased precipitation reduces the microboal network complexity.



- A metacommunity co-occurrence network was constructed, followed by subnetwork extraction for each sample and analysis of the topological features
- Soil multifunctionality was significantly positively correlated with the abundance of the first two network clusters and negatively correlated with the abundance of the third cluster.
- Actinobacteria, Proteobacteria, and Ascomycota were the main representative taxa in the first two clusters, whereas Acidobacteria were predominant in cluster 3.
- Decreased precipitation significantly reduced the topological features characterizing network complexity, which also exhibited a positive correlation with soil multifunctionality.

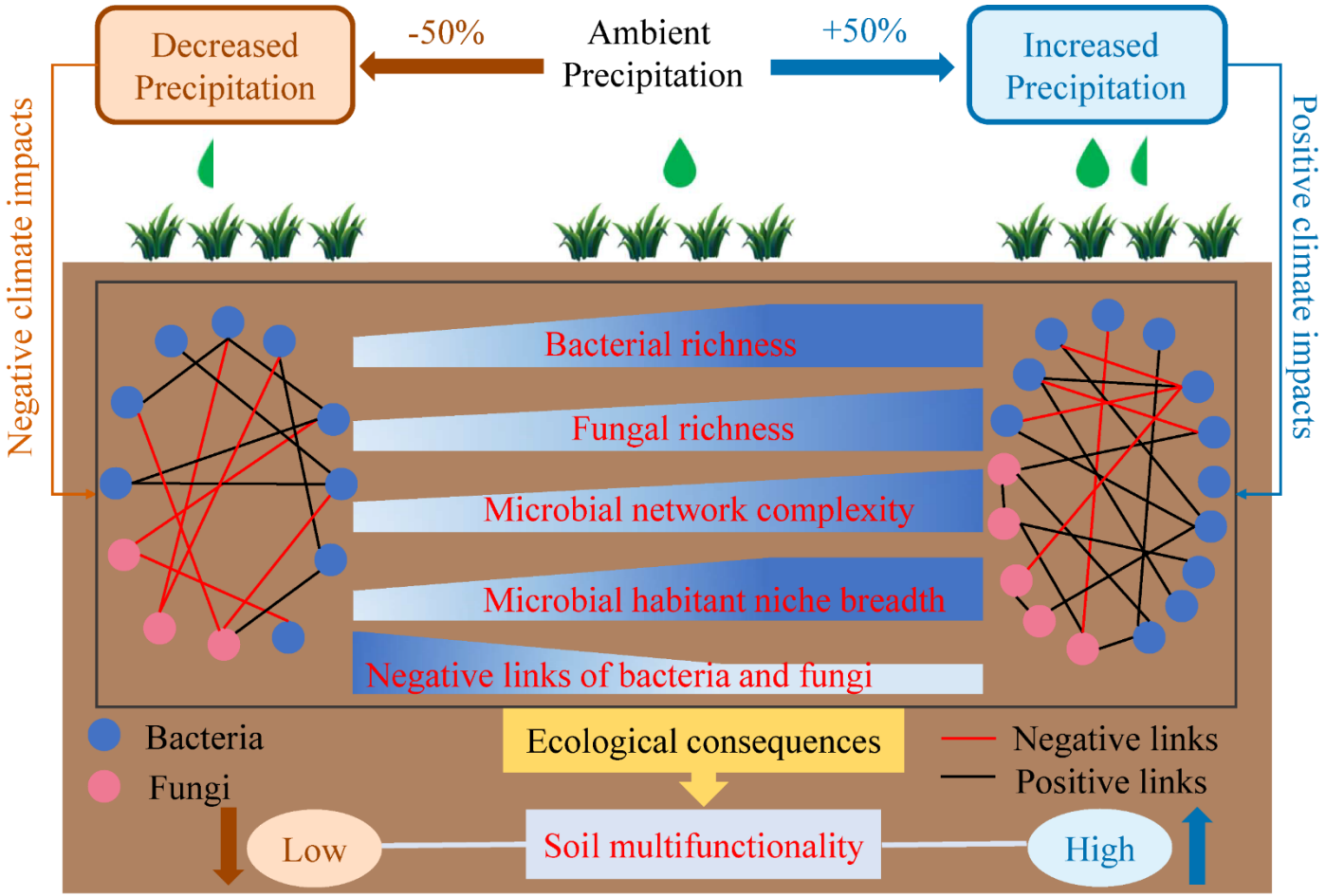
Results

Microbial network complexity directly mediates soil multifunctionality.



- Microbial diversity, network complexity and negative bacterial-fungal links ratio as important biological factors influencing soil multifunctionality.
- SWC, SOC and TN are important abiotic factors affecting soil multifunctionality
- Partial correlation analysis revealed a significant and robust effect of network complexity on soil multifunctionality, and was least affected by other factors.
- Piecewise structural equation modeling analysis further demonstrated that network complexity and negative bacterial-fungal links ratio directly positively and negatively regulated the soil multifunctionality, respectively.

Conclusion



- Decreased precipitation weakens soil multifunctionality, as compared with ambient control.
- Decreased precipitation reduces microbial richness, microbial community niche width, and network complexity, but increases potential negative bacterial-fungal interactions.
- Microbial networks complexity and the potential negative interaction between bacteria and fungi play an important role in directly regulating soil multifunctionality.

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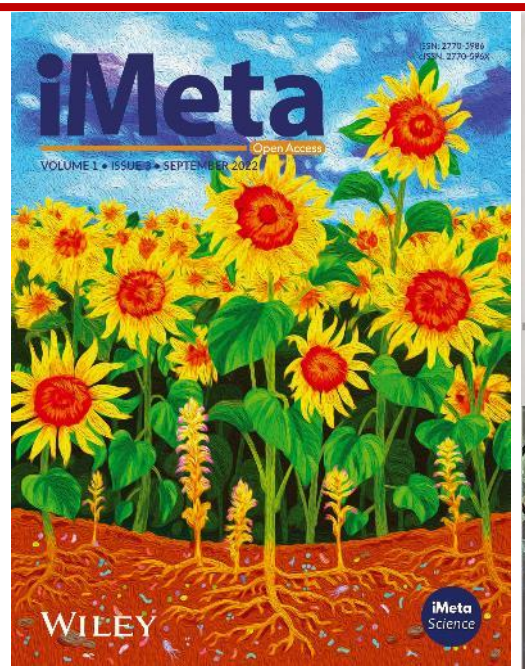

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