Supplemental information

Geographic patterns of co-occurrence network topological features for soil microbiota at continental scale in eastern China

Materials and Methods

Soil sampling and analysis

Each sample was collected from the surface horizon (0–15 cm) and was a composite of several individual soil cores taken along a 200-m transect. After sampling, the fresh soil samples were taken to the laboratory immediately in coolers with ice bags. Then, the samples were hand-picked to remove discrete plant residues, sieved to pass through a 2-mm plastic mesh, homogenized thoroughly, and then stored at 4 °C. A sub-sample from each of the 14 soil samples was collected and air-dried for physical and chemical properties analysis. The selected soil properties are shown in Table S1.

Briefly, soil pH, soil organic carbon (OC), available potassium (AK), soil texture, and water holding capacity (WHC) were determined according to the protocols in Agricultural Chemistry Committee of China. Total nitrogen (TN) was determined using a Flash 2000 NC Analyzers (Thermo Scientific, MA, USA). The amorphous and free sesquioxides were extracted with a dithionite-citrate solution buffered with NH_4-oxalate (pH 3.0) and $NaHCO_3$ solution in the dark, respectively. The soil samples were removed from 4°C storage and incubated at 21±1 °C in the dark with soil moisture contents of 40% WHC for 5 d, and aliquots taken for soil microbial biomass carbon (MBC) and water soluble organic carbon (WSOC) analyses. MBC was analyzed according to the chloroform-fumigation-extraction method (22). WSOC was extracted by ultra-pure water using a soil/water ratio of 1:5 (W/V) under reciprocal shaking at 200 revolutions per minute (rpm) and 25±1 °C for 1 h. The supernatants were centrifuged at 3500 g for 10 min, and then filtered through a 0.45-μm glass fiber filter. The total organic carbon (TOC) in the MBC and WSOC extracts were measured by an Apollo 9000 total organic carbon analyzer (Tekmar-Dohrmann, OH, USA) using a high temperature combustion method.

Table S1. Topological features description

Level	Topological features	Description
Node-level	Betweenness centrality	The number of shortest paths between any two nodes in the graph passing through that node.
	Closeness centrality	The average distance of this node to any other node
	Degree	The number of neighbors
	Transitivity	The probability that the adjacent nodes of a node are connected.
Network-level	Average nearest neighbor degree	The mean of degrees for all neighbors
	Average path	The shortest path between any two nodes is the single path with fewest edges between them. Alternative paths are feasible. The average shortest path length is the mean over all shortest paths between any two nodes in the network
	Betweenness centrality	The mean of betweenness centrality values for all nodes
	Closeness centralization	The mean of Closeness centrality values for all nodes
	Degree assortativity	The level of homophyly of the graph, based on some node labeling or values assigned to nodes
	Degree centralization	Creating a graph level centralization measure from the centrality scores of the nodes
	Density	The ratio of the number of edges and the number of possible edges
	Transitivity	The mean of cluster coefficient values for all nodes

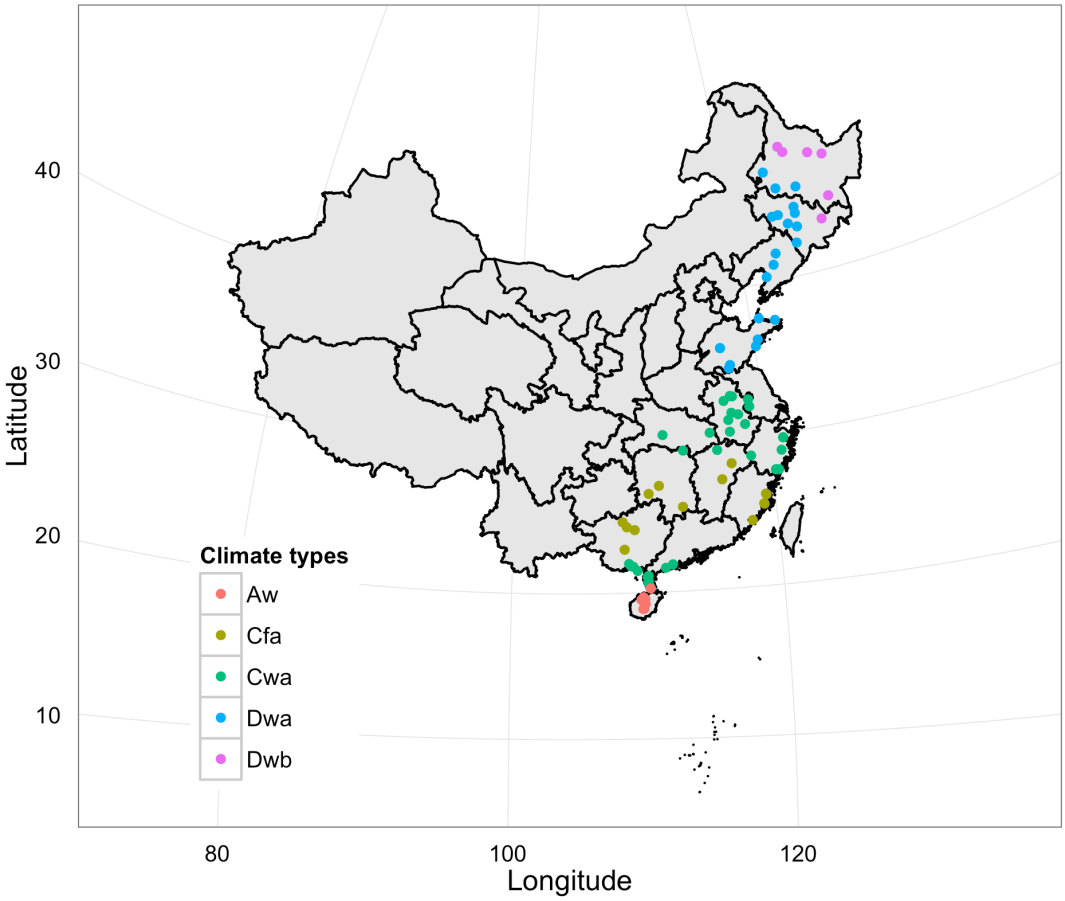

Figure S1. The distribution of sampling sites located in tropical wet and dry climates (Aw), warm temperate climates (Cfa and Cwa), warm summer continental climates (Dwb), and hot summer continental climates (Dwa).

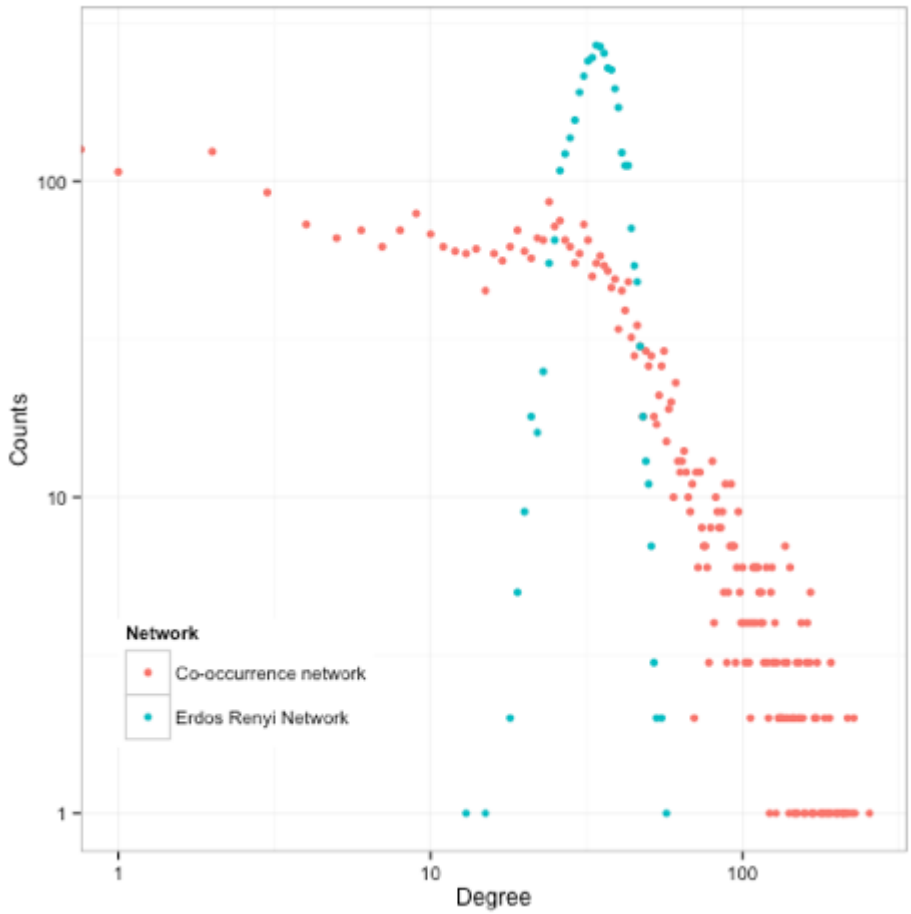

Figure S2. The distribution of degree for co-occurrence network (Red) and Erdos-Renyi network (Blue).

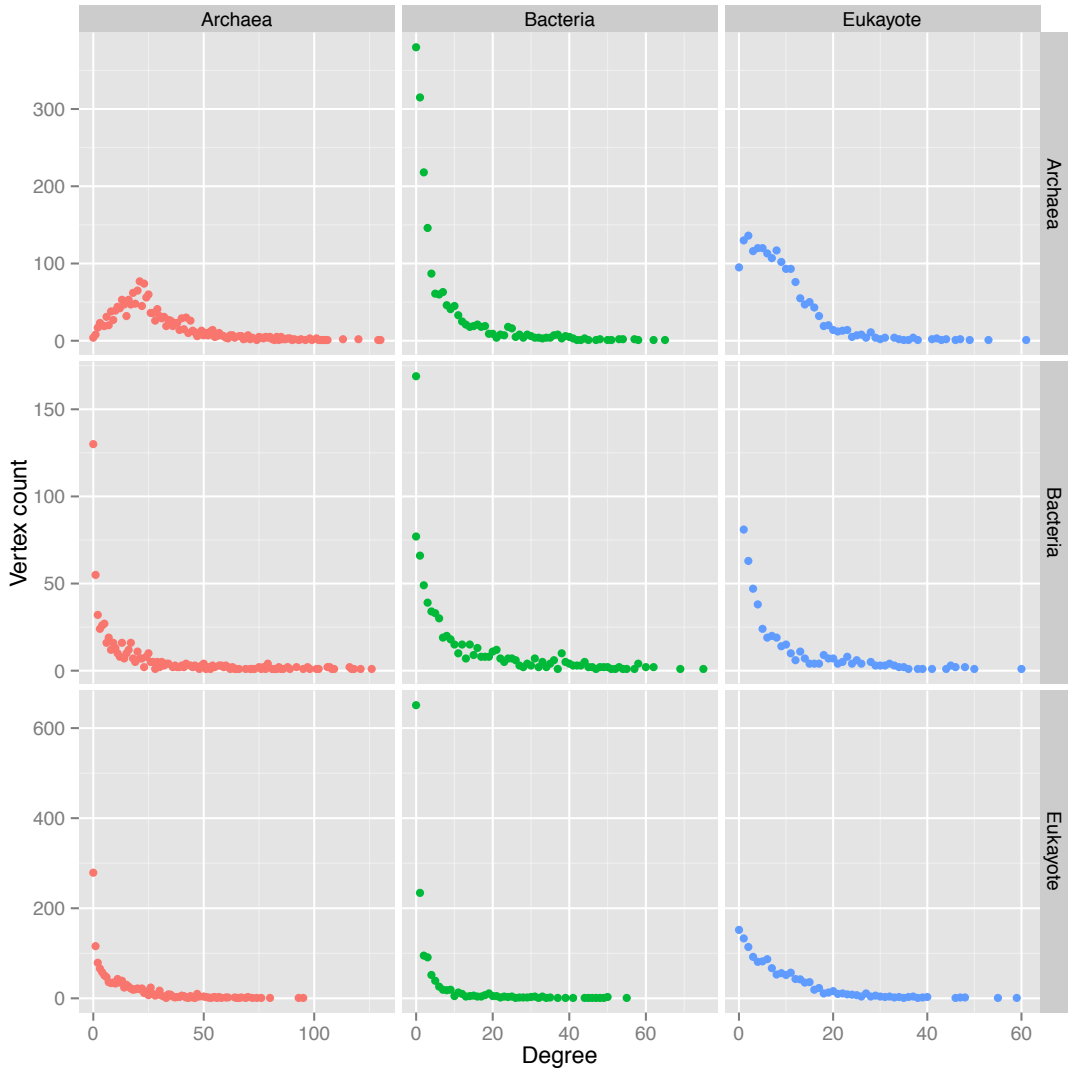

Figure S3. The distribution of degree classified by kingdoms.

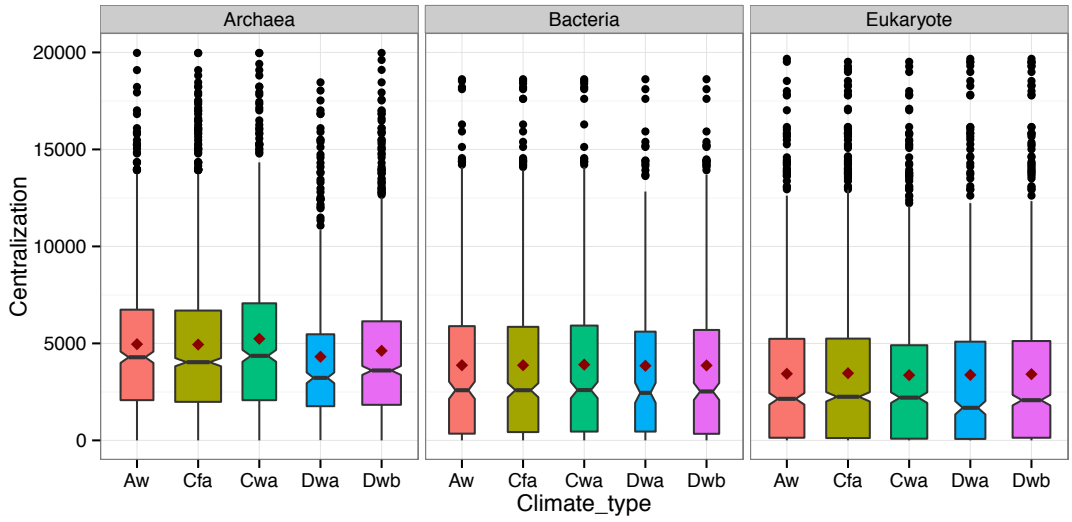

Figure S4. The centralization values for nodes from different kingdoms.

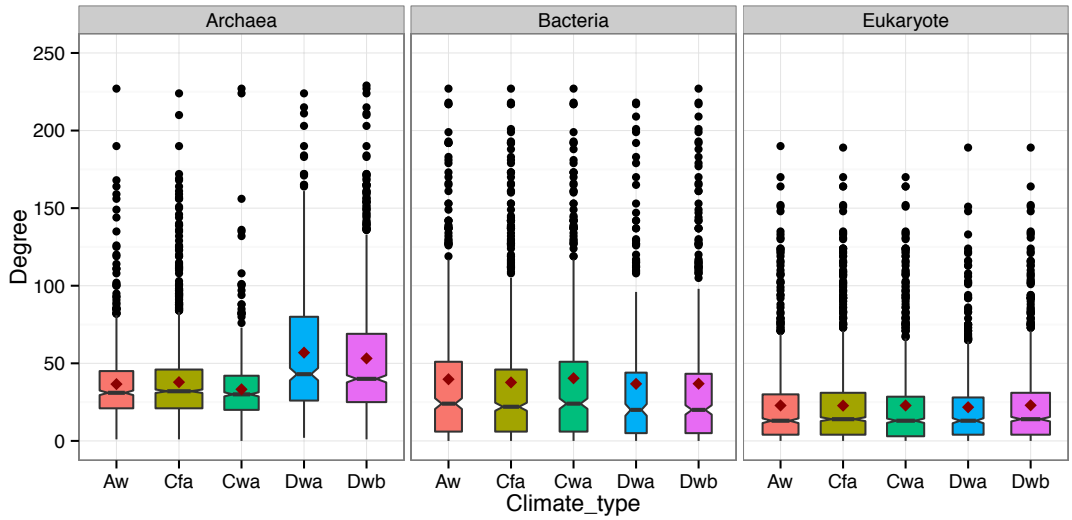

Figure S5. The degree for nodes from different kingdoms.

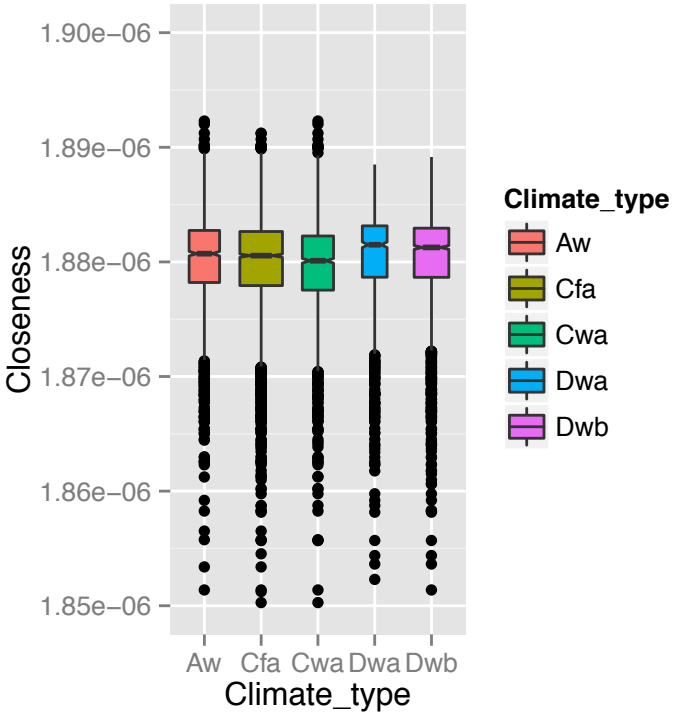

Figure S6. The closeness values for nodes in different climatic types.

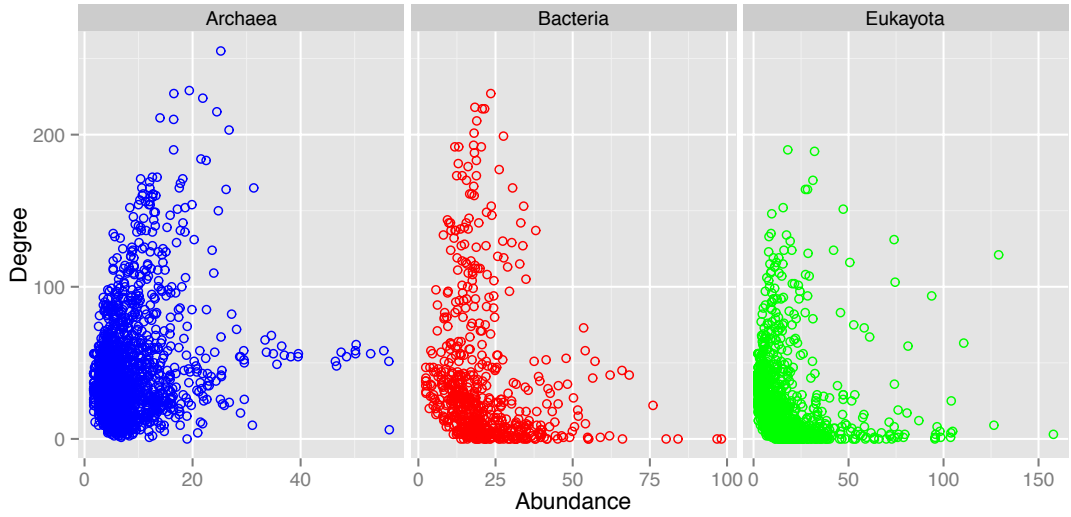

Figure S7. The relationship between relatively abundance and degree of nodes from different kingdoms.

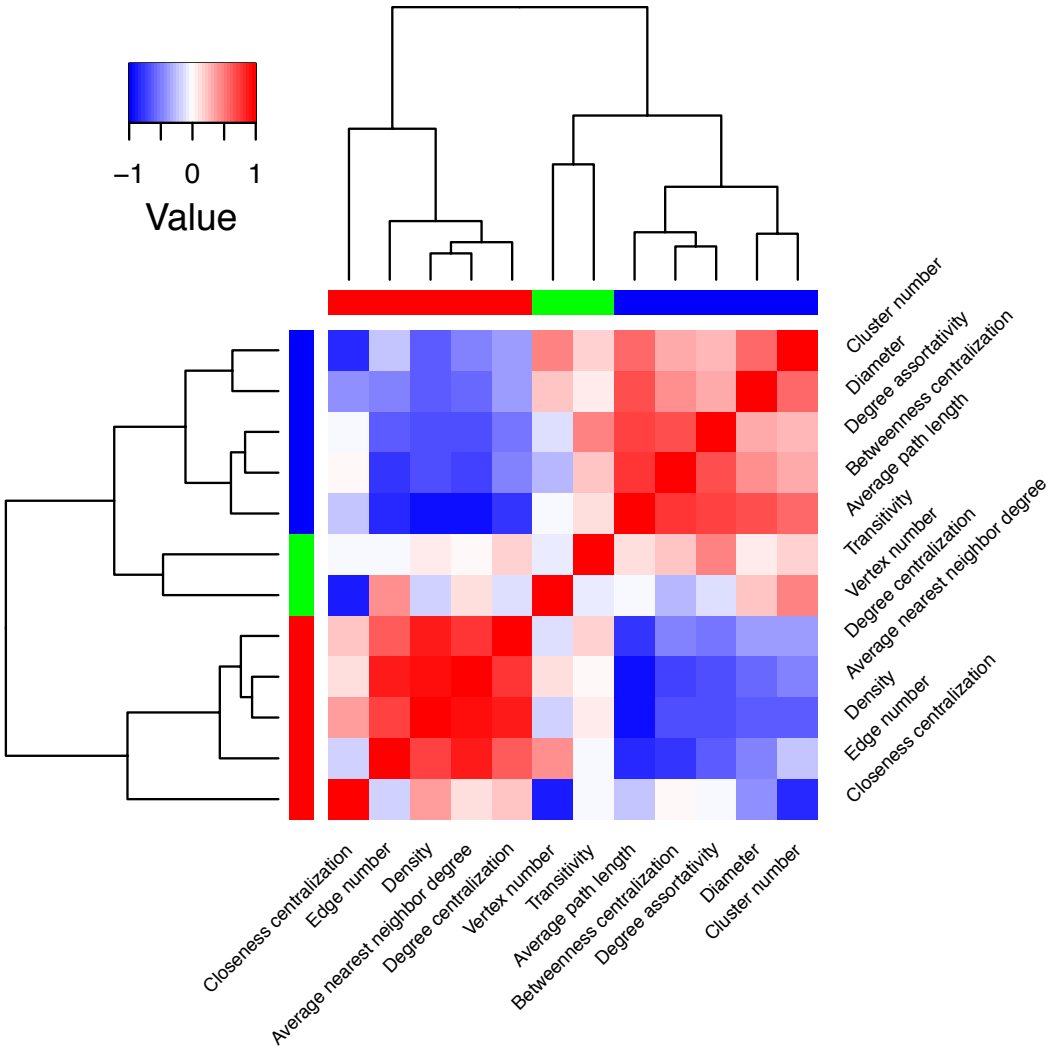

Figure S8. Heatmap of network-level topological features

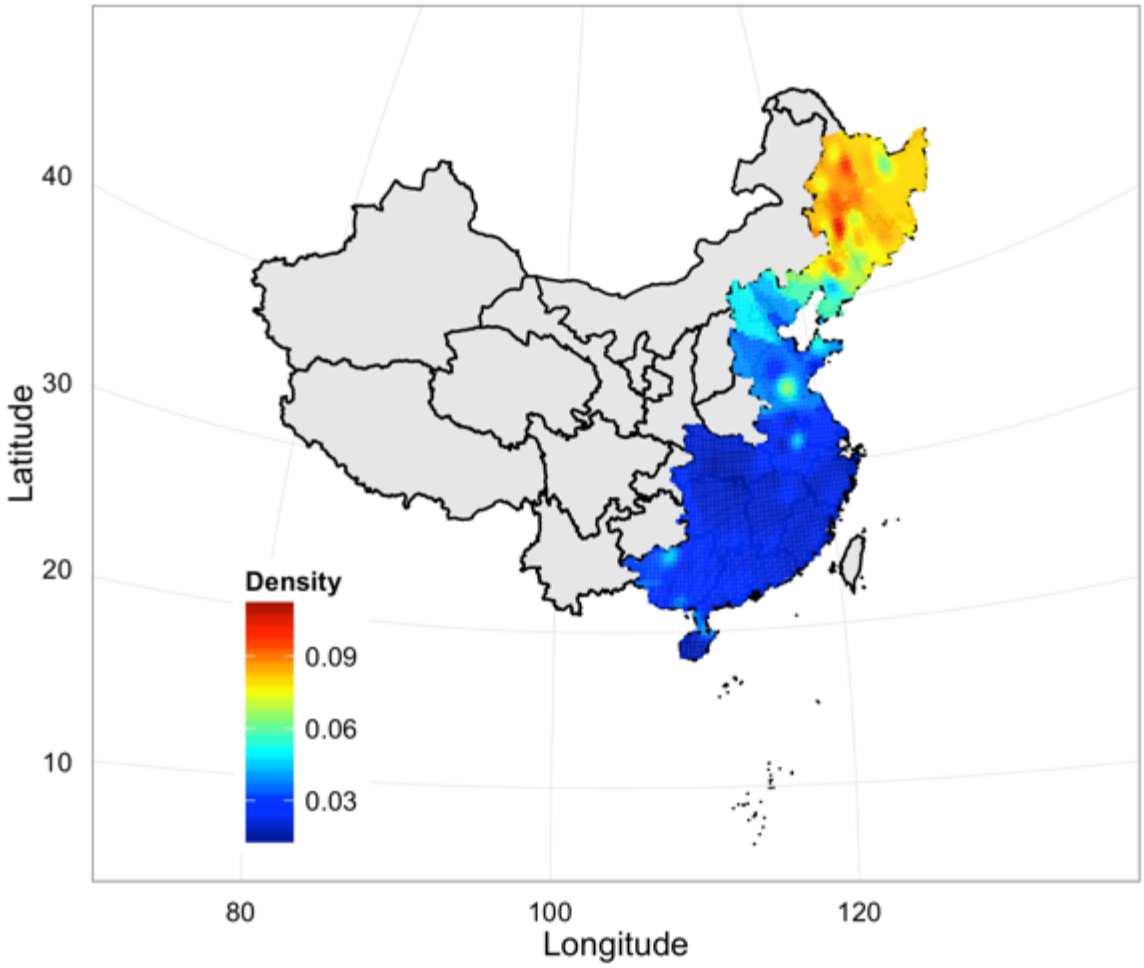

Figure S9. The predicted spatial distribution of network density.

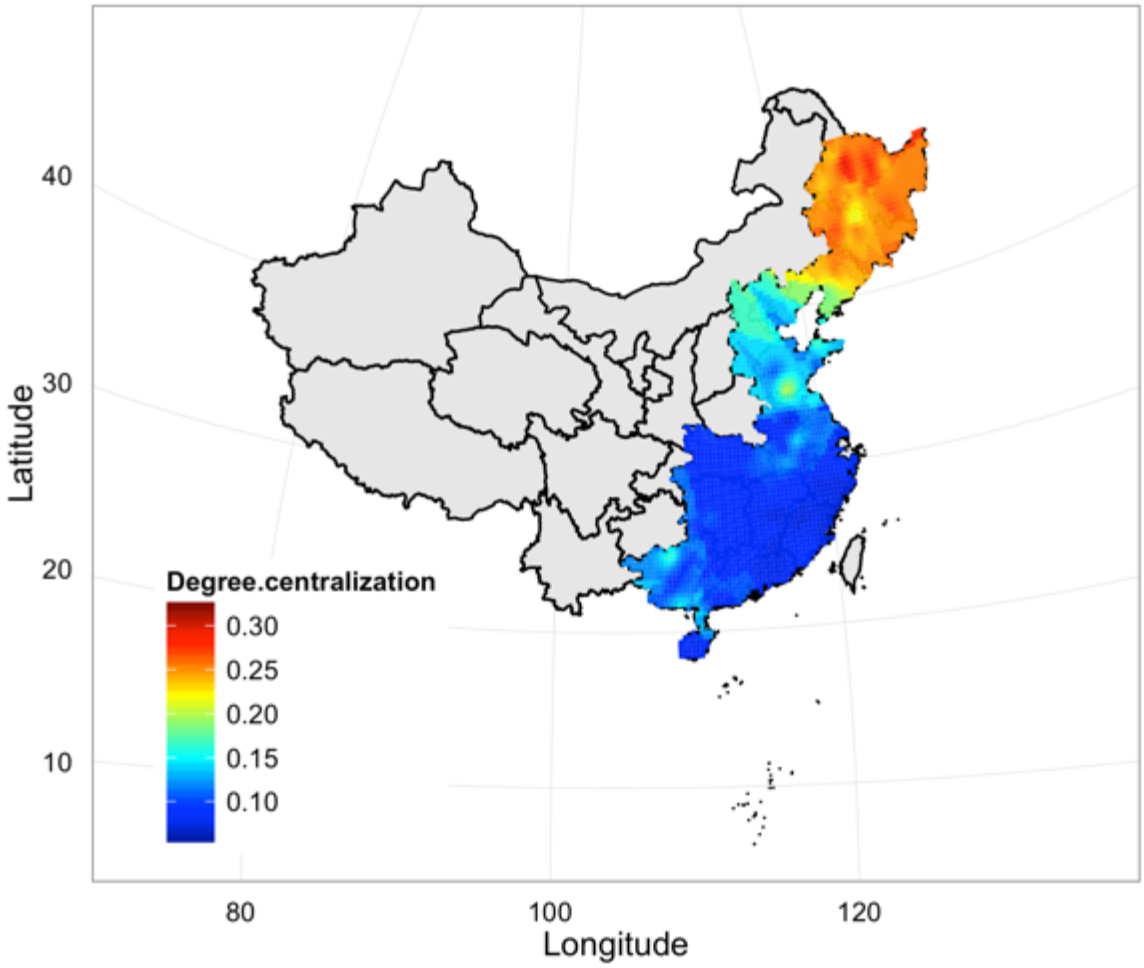

Figure S10. The predicted spatial distribution of network degree centralization.

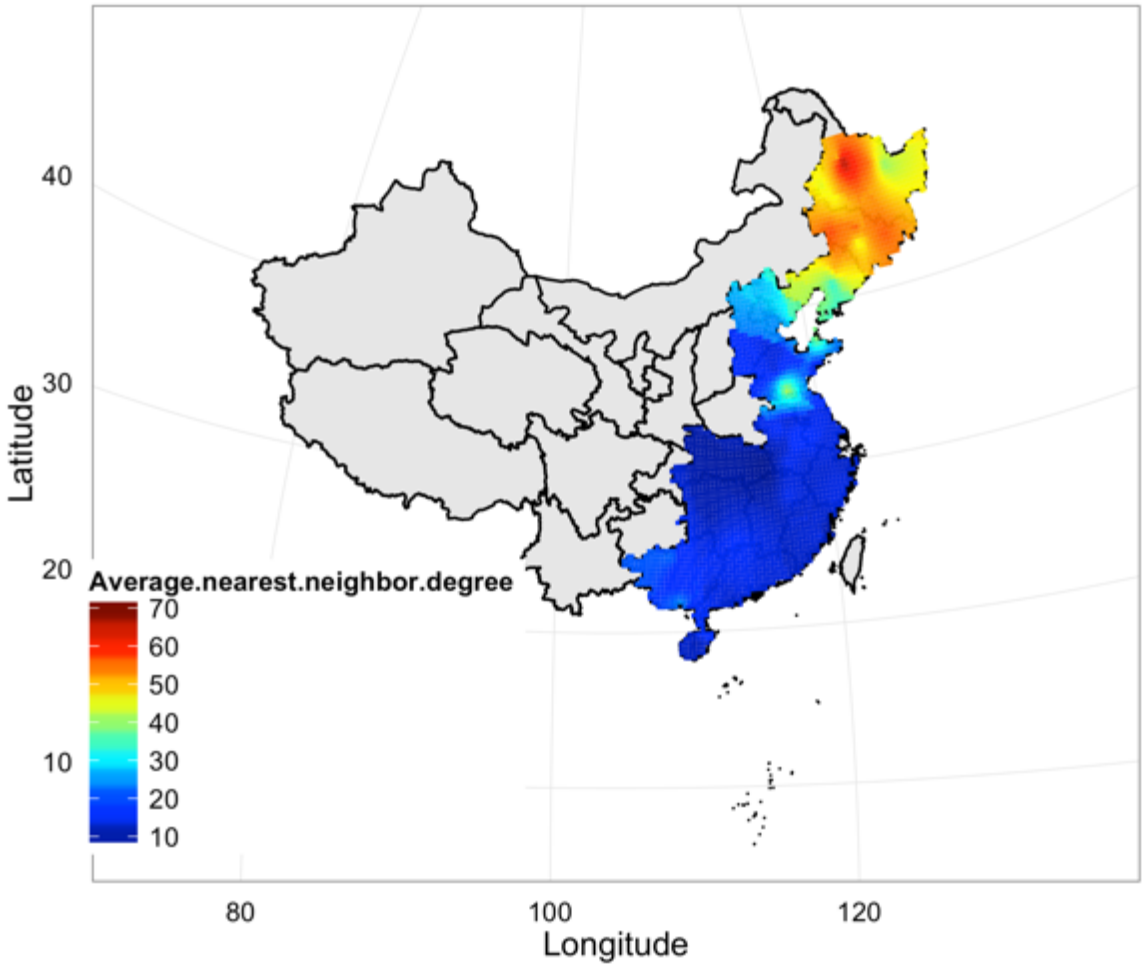

Figure S11. The predicted spatial distribution of network average nearest neighbor degree.

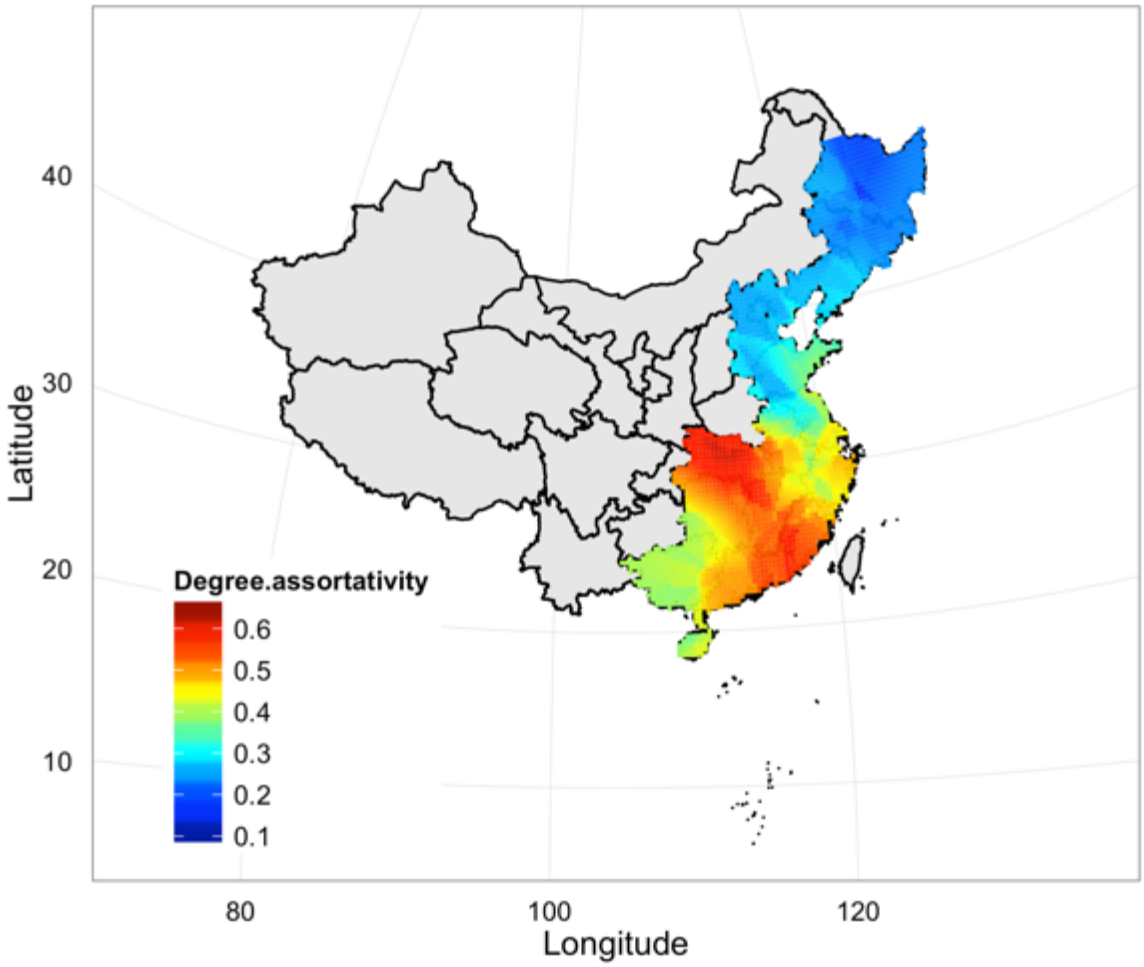

Figure S12. The predicted spatial distribution of network degree assortativity.

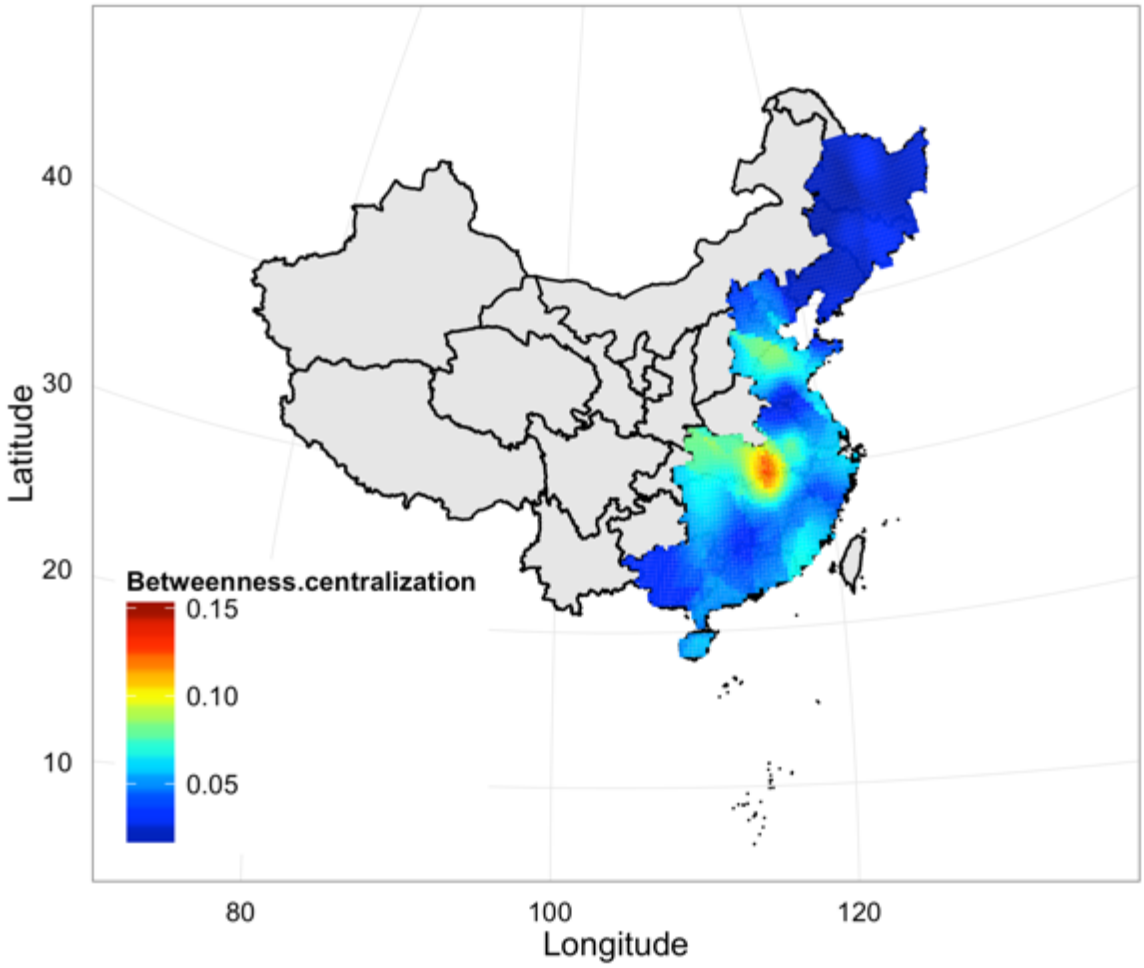

Figure S13. The predicted spatial distribution of network betweenness centralization.

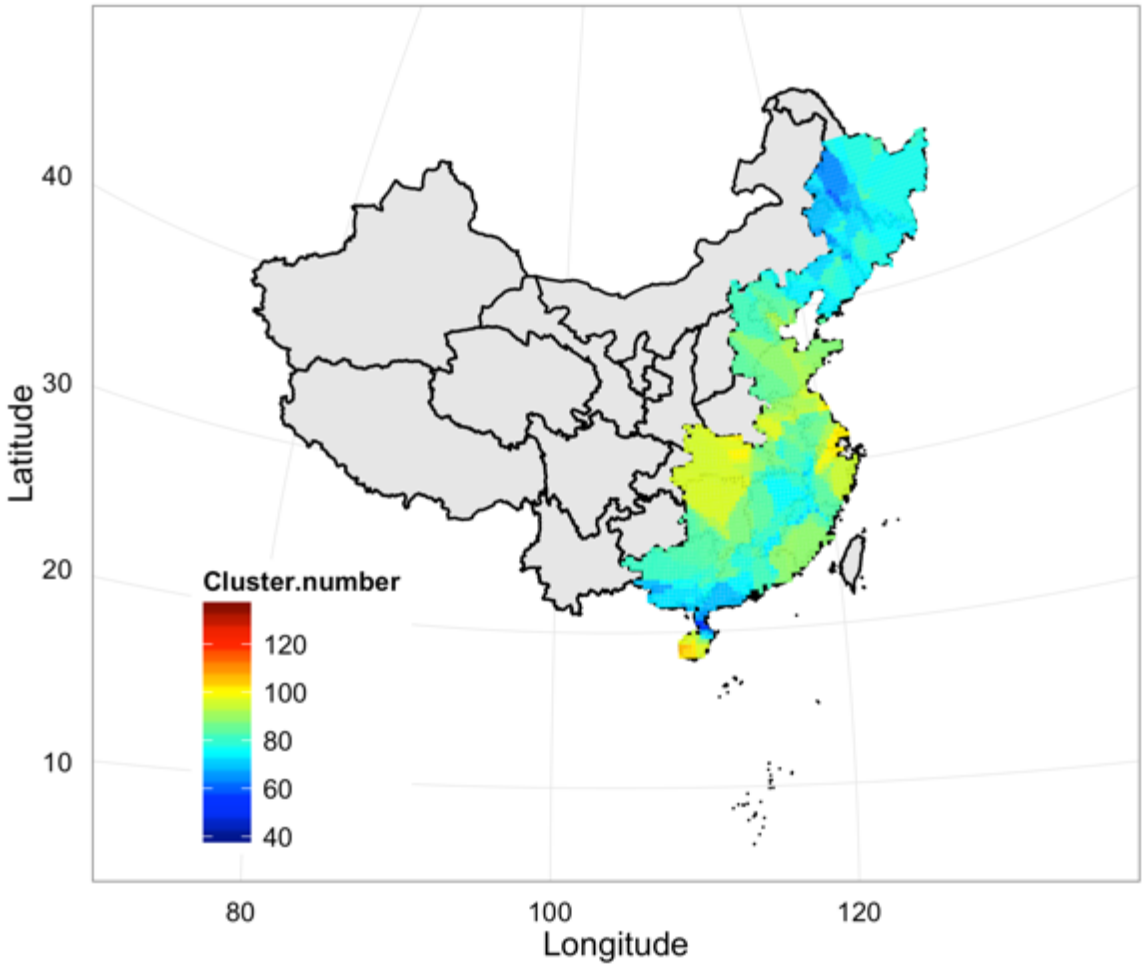

Figure S14. The predicted spatial distribution of network cluster number.

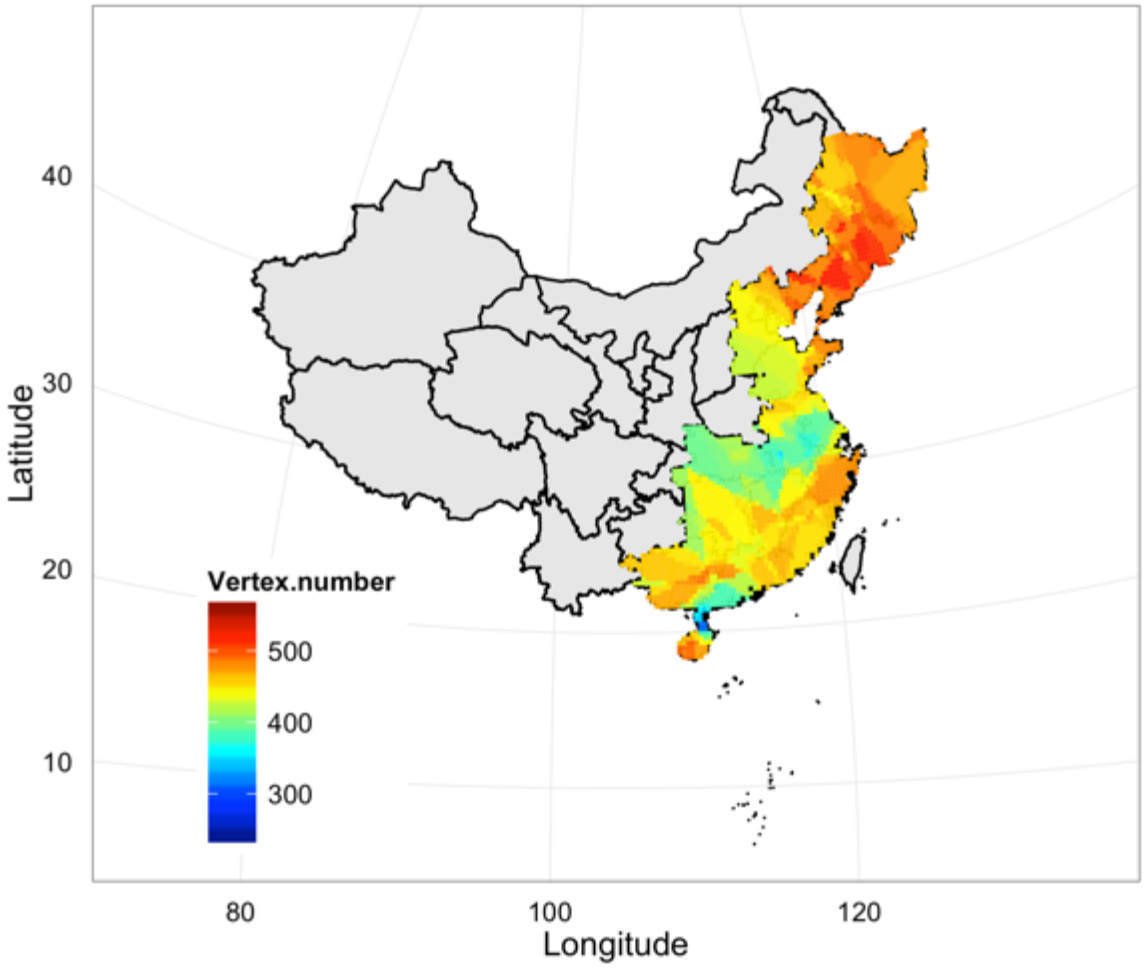

Figure S15. The predicted spatial distribution of network vertex number.

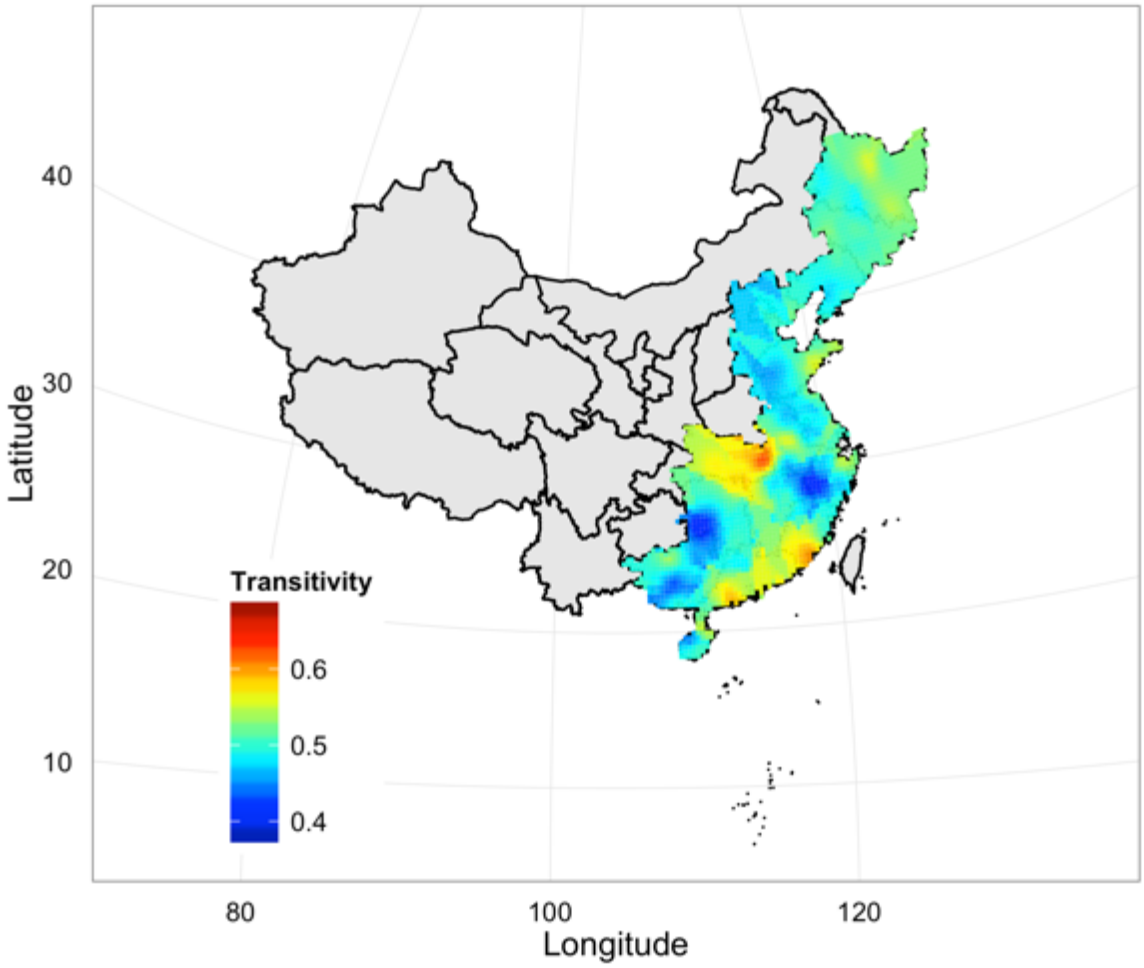

Figure S16. The predicted spatial distribution of network transitivity.

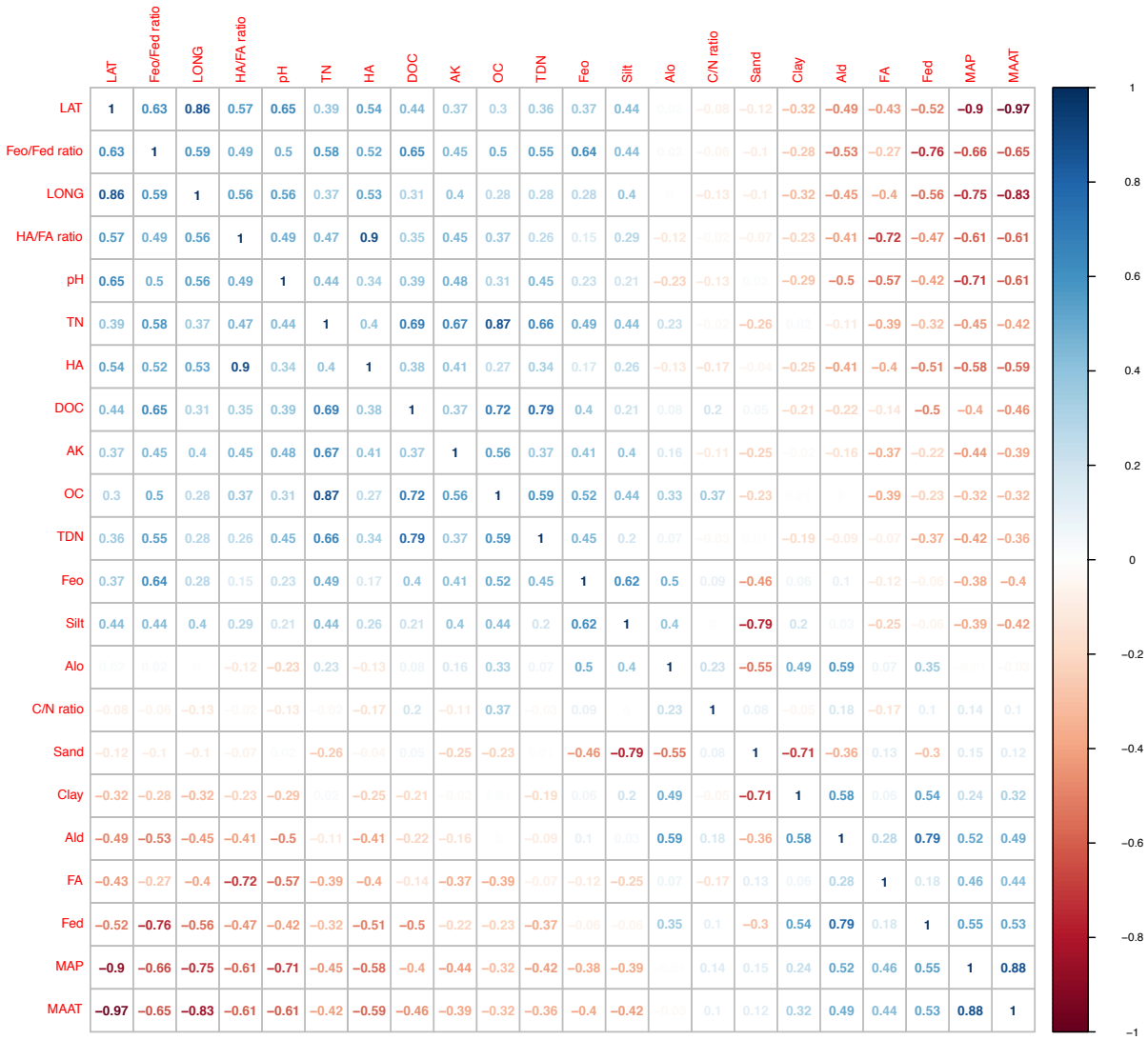

Figure S17. The correlation matrix between climatic factors, geographic factors and soil properties.

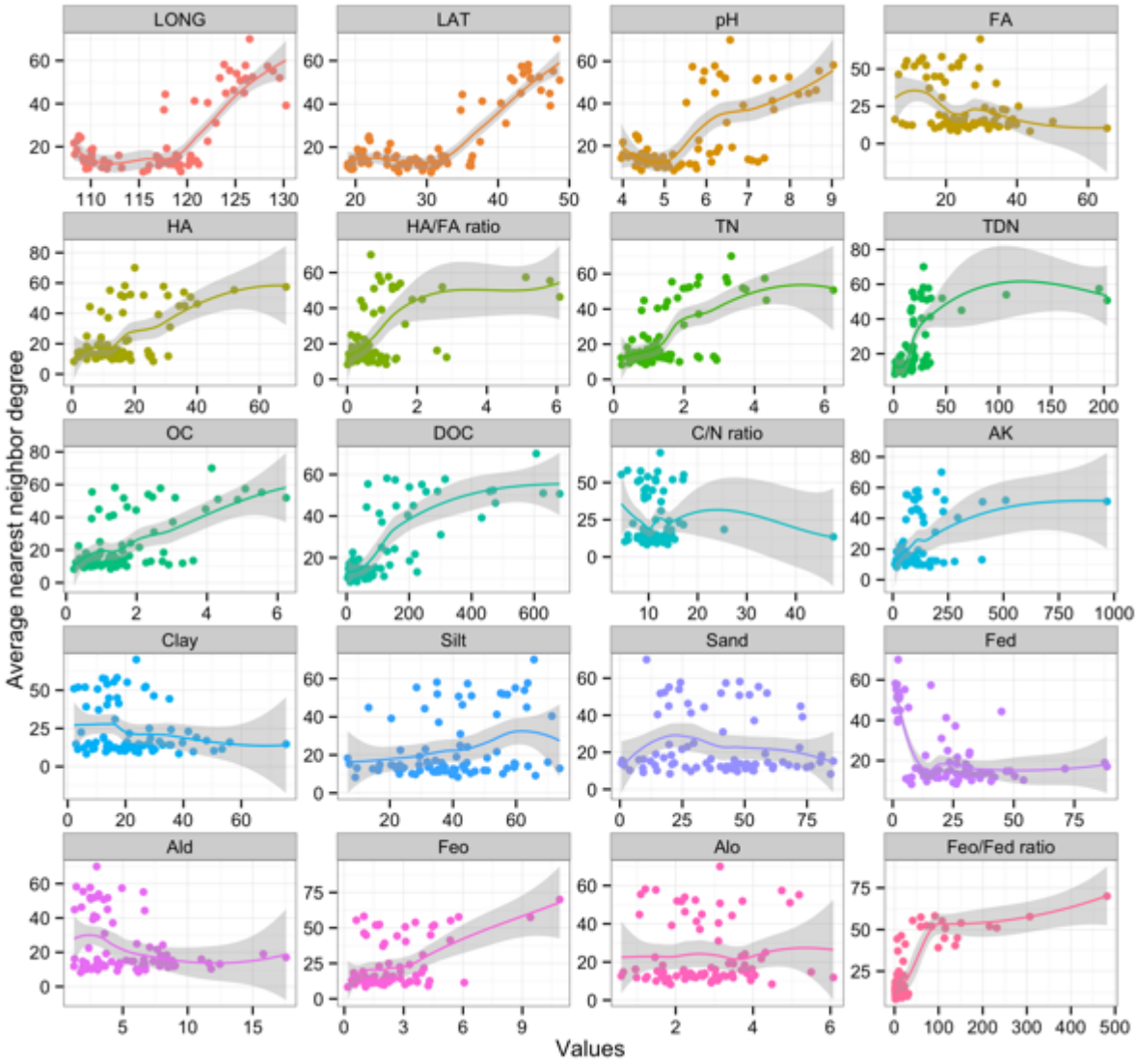

Figure S18. The relationship between average nearest neighbor degree and environmental factors.

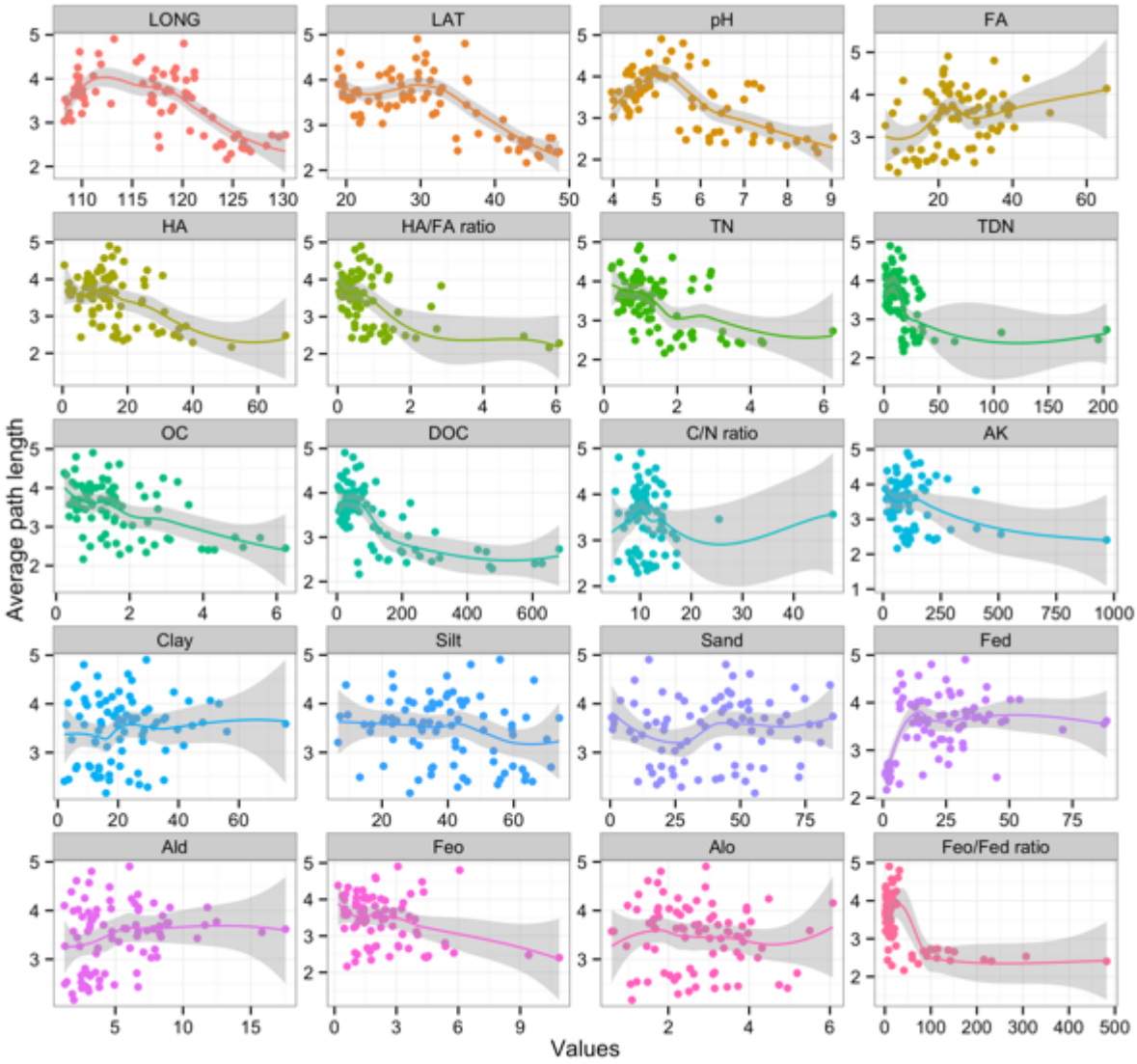

Figure S18. The relationship between average path length and environmental factors.

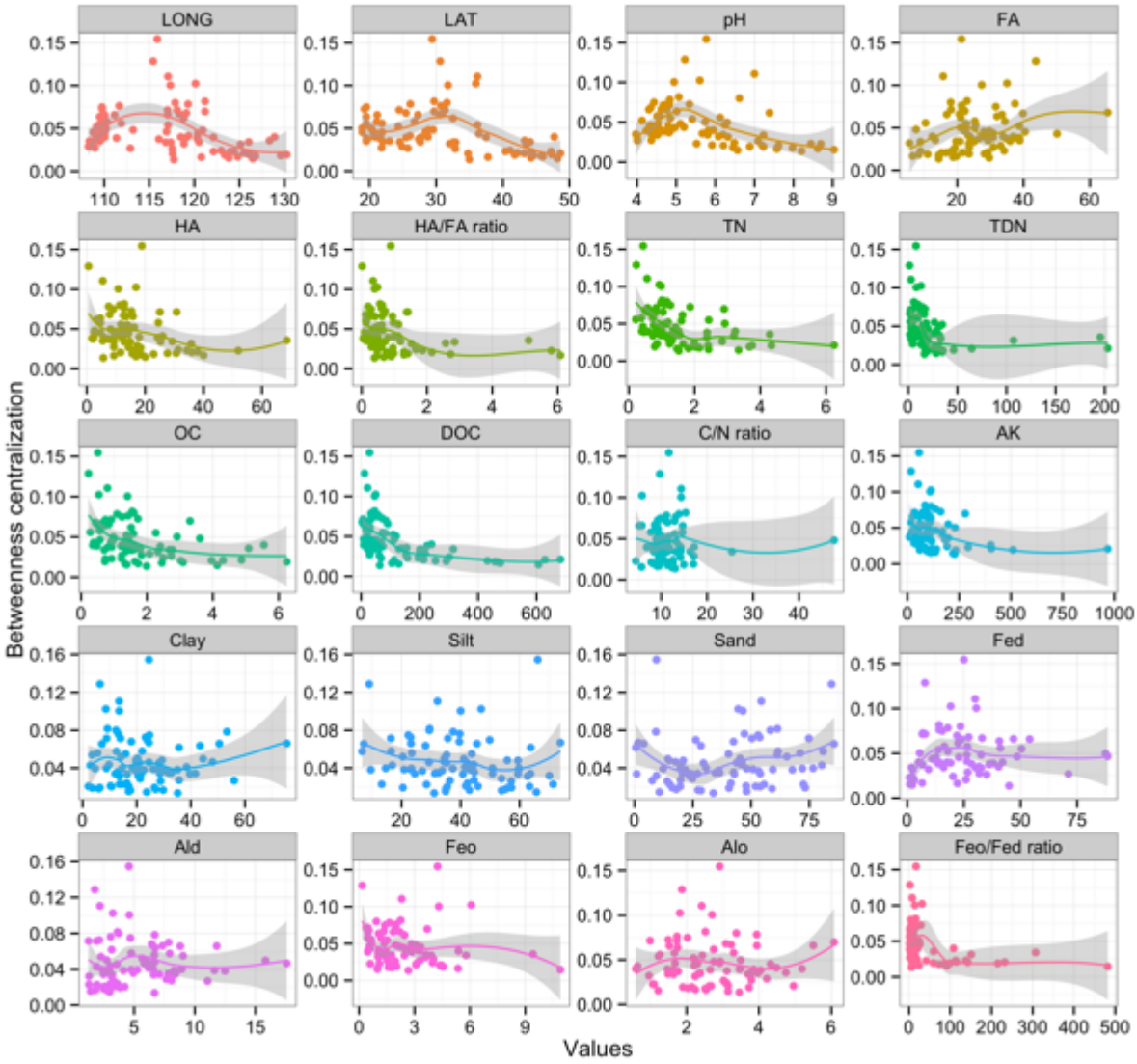

Figure S19. The relationship between betweenness centralization and environmental factors.

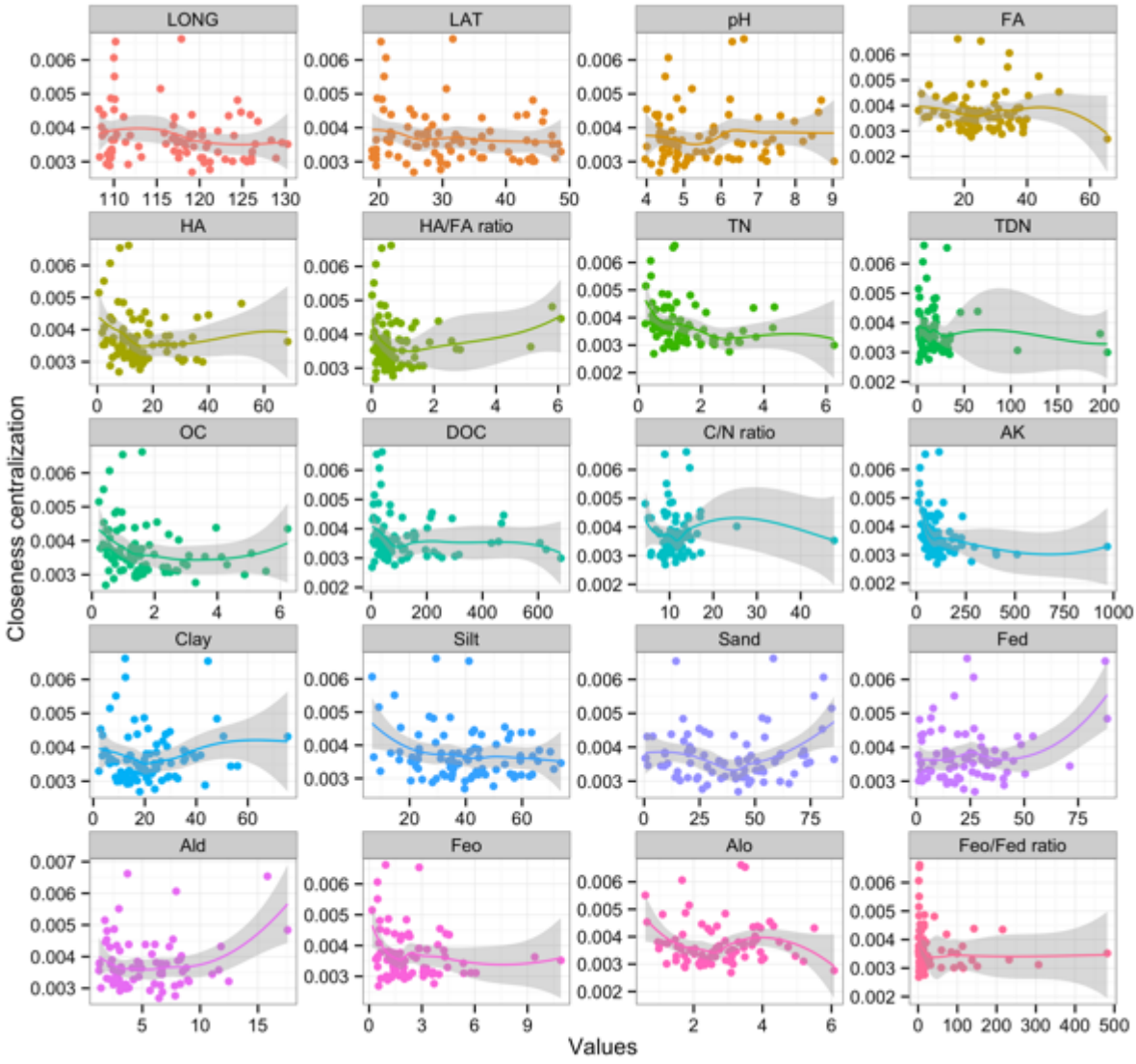

Figure S20. The relationship between closeness centralization and environmental factors.

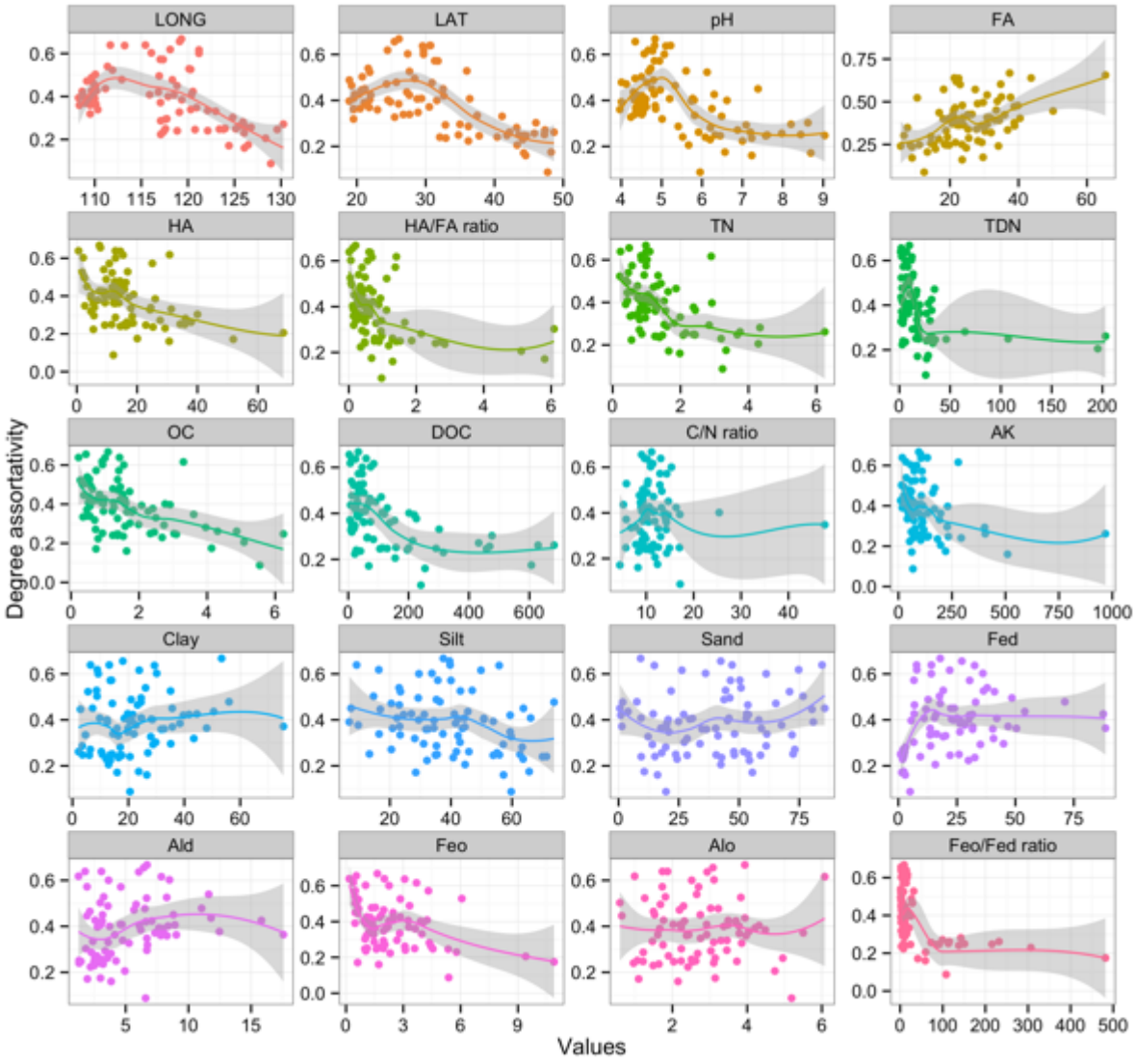

Figure S21. The relationship between degree assortatovoty and environmental factors.

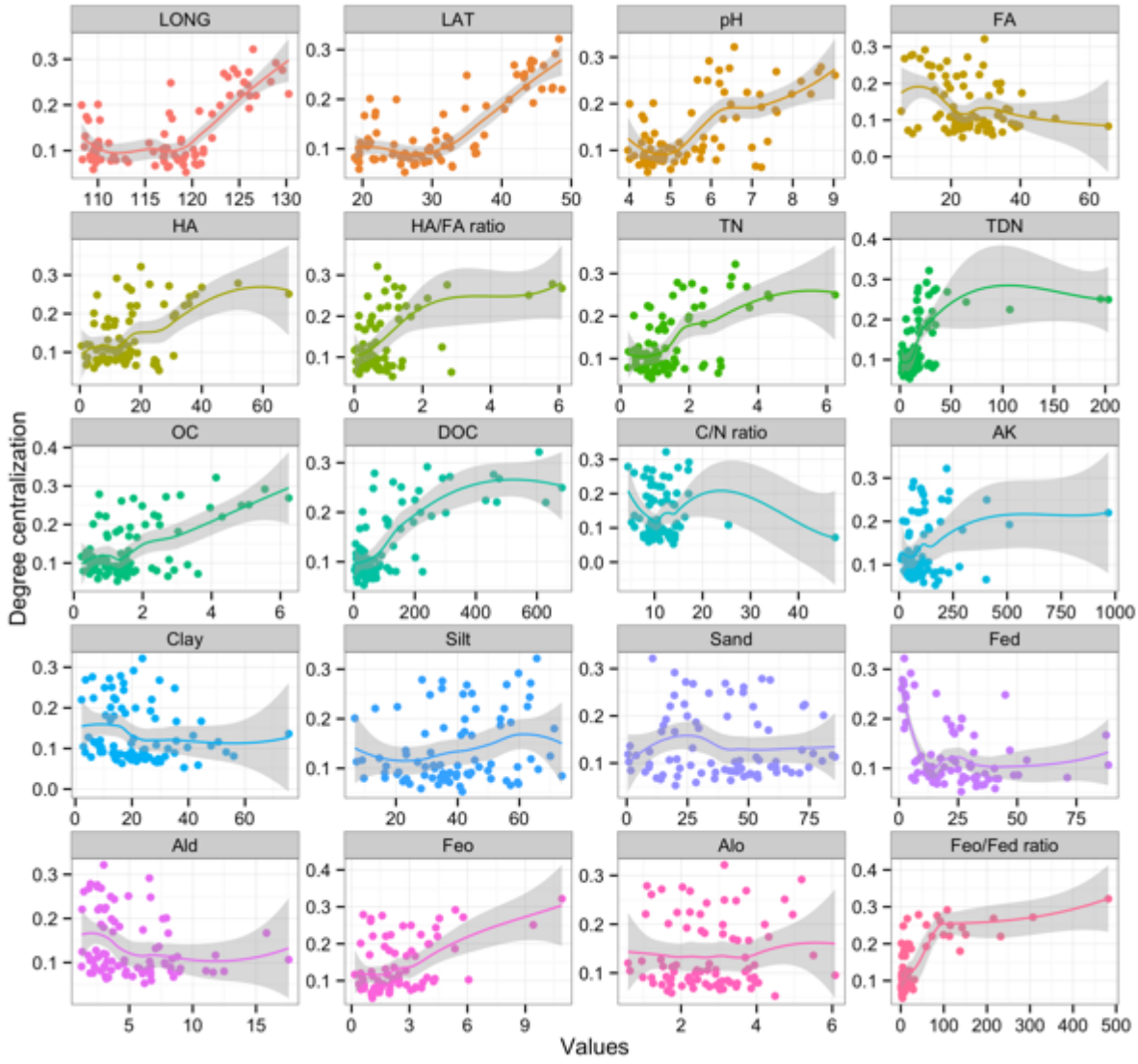

Figure S22. The relationship between degree centralization and environmental factors.

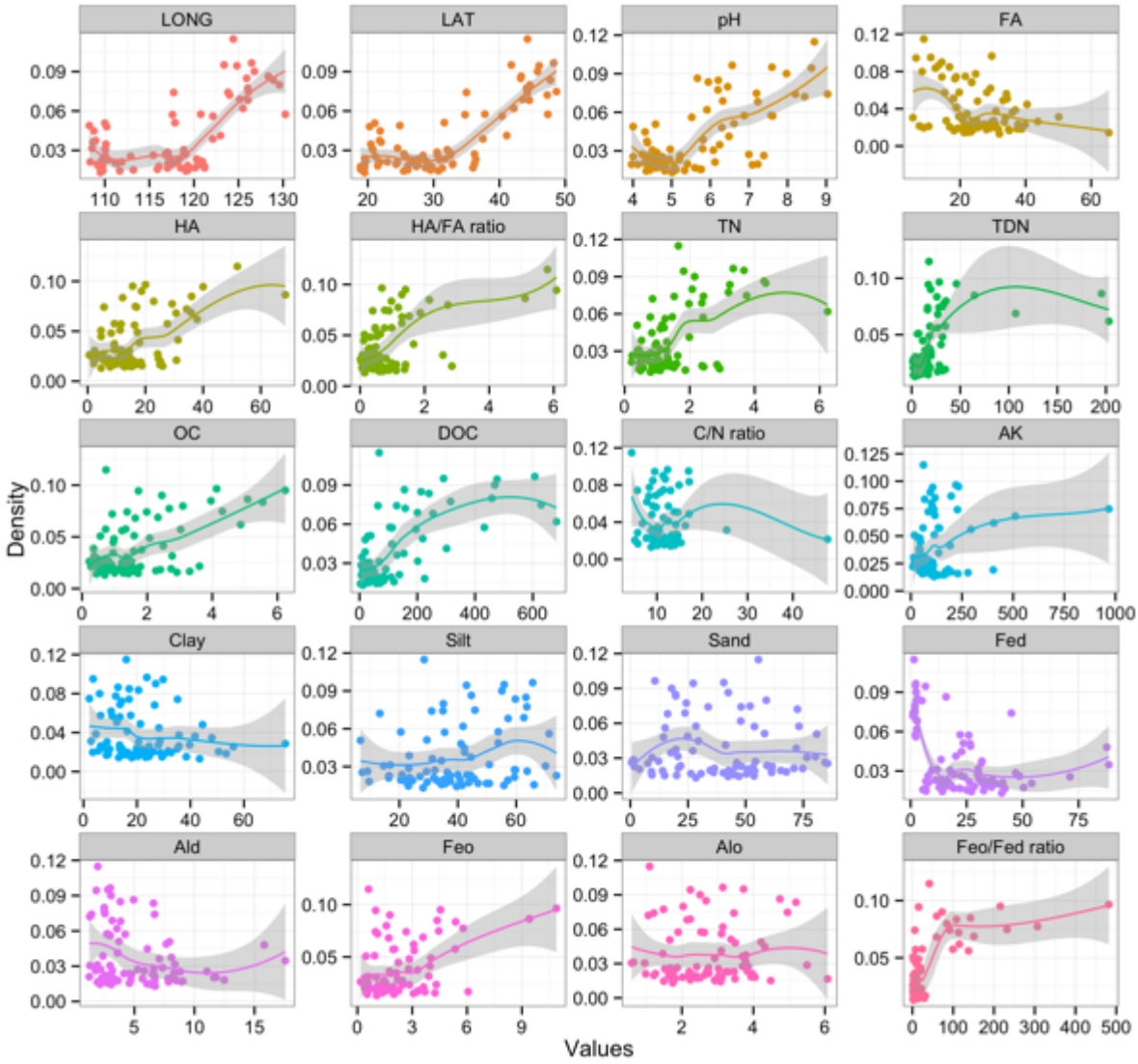

Figure S23. The relationship between density and environmental factors.

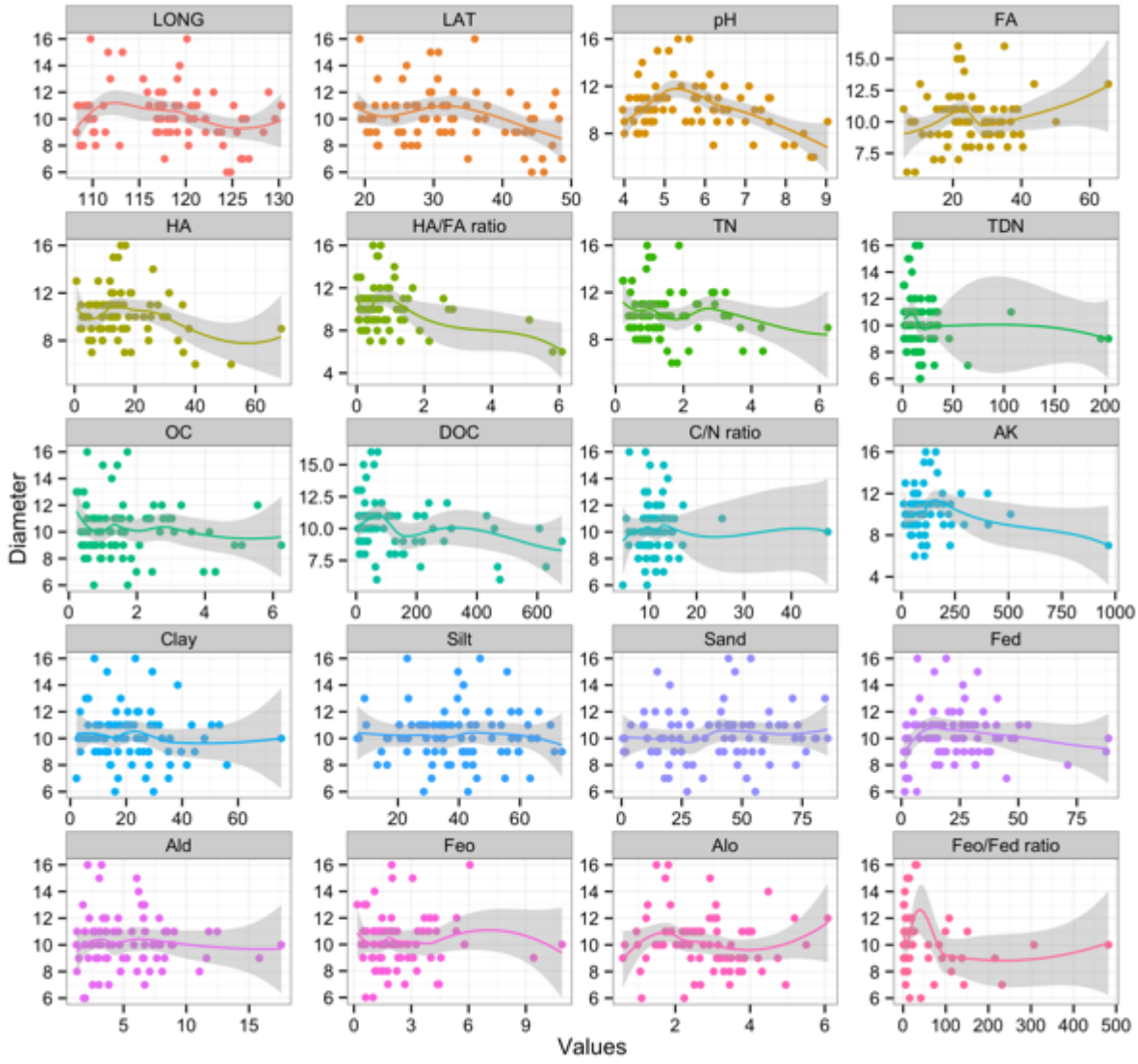

Figure S24. The relationship between diameter and environmental factors.

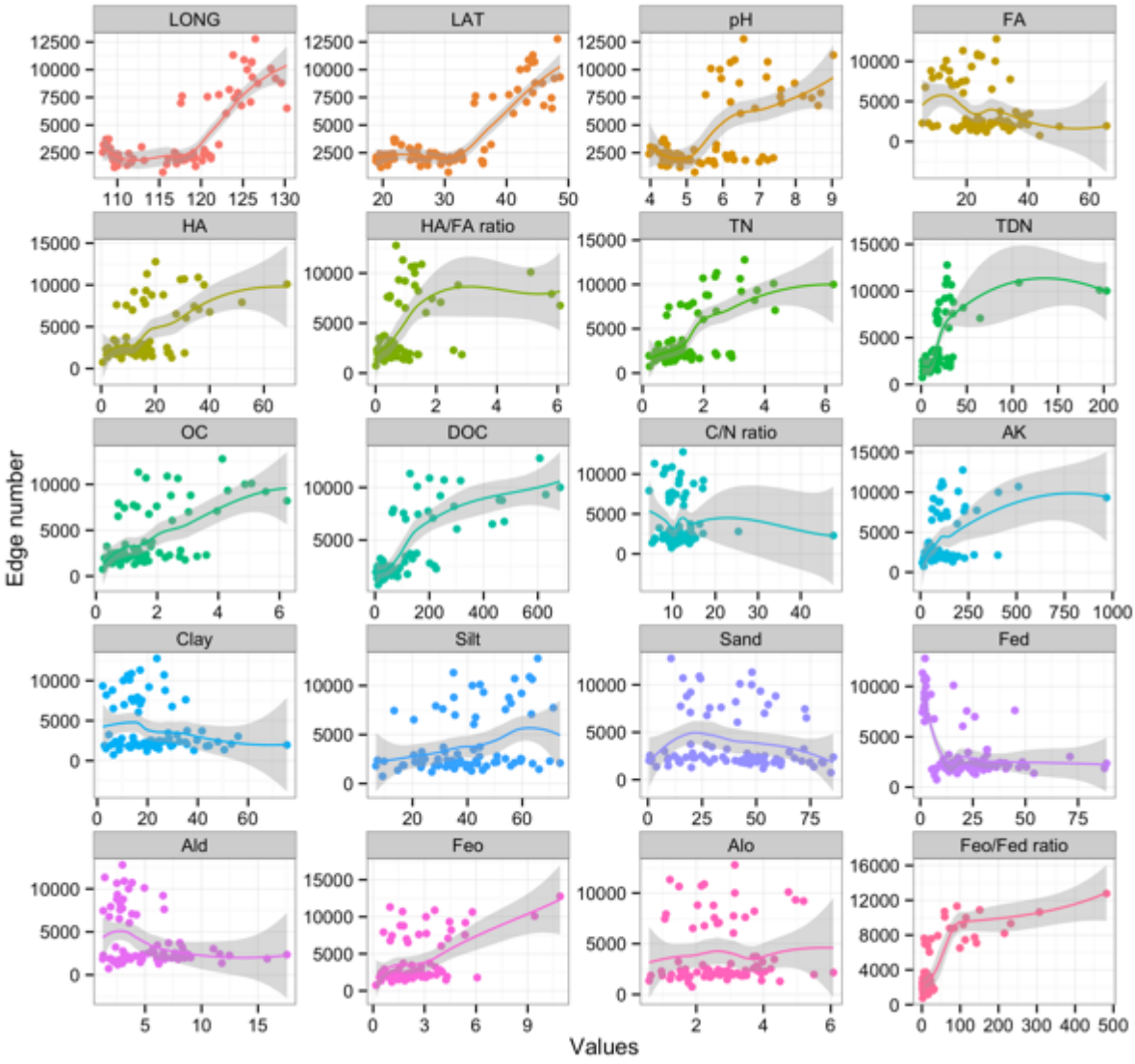

Figure S25. The relationship between degree number and environmental factors.

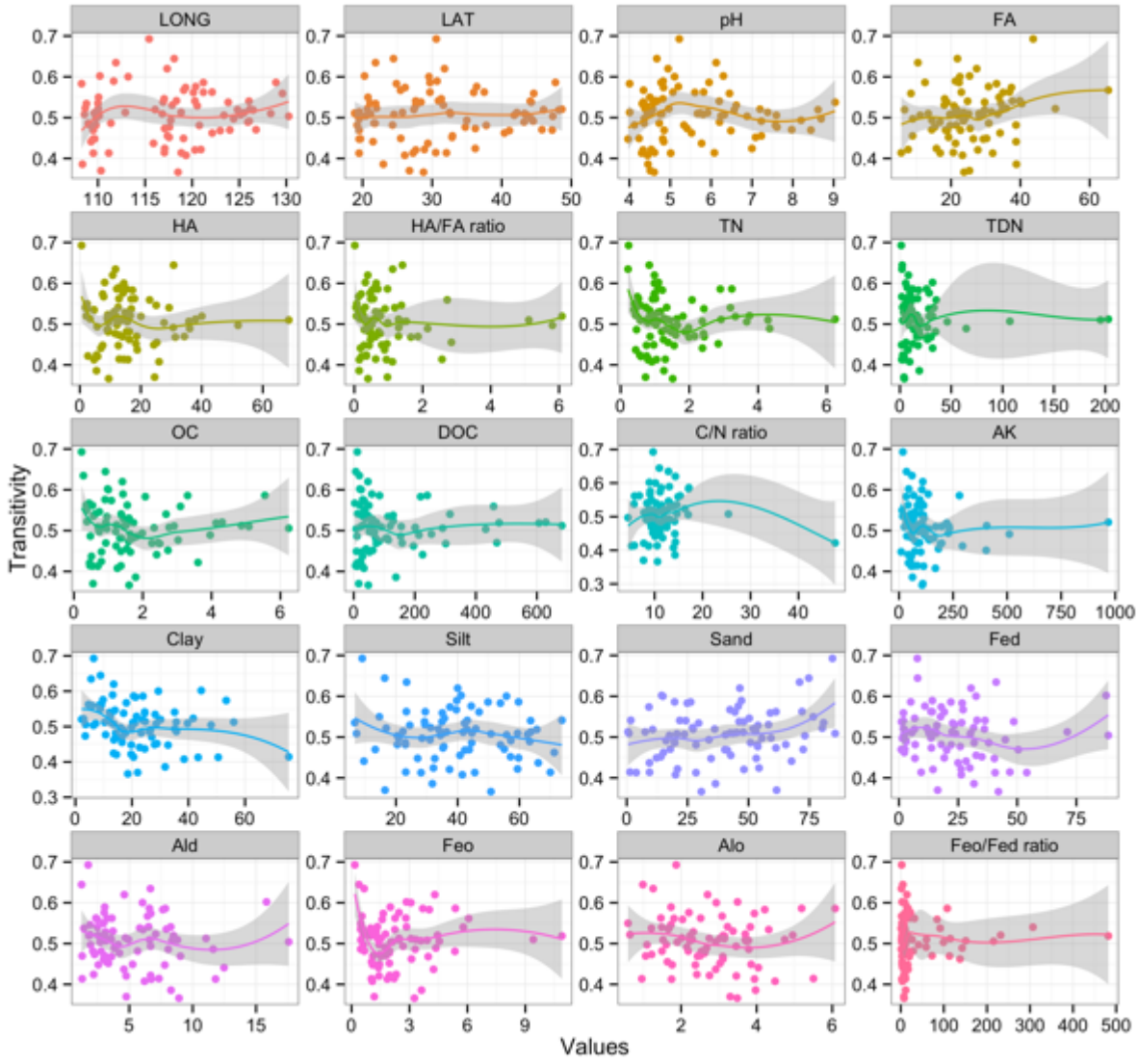

Figure S26. The relationship between transitivity and environmental factors.

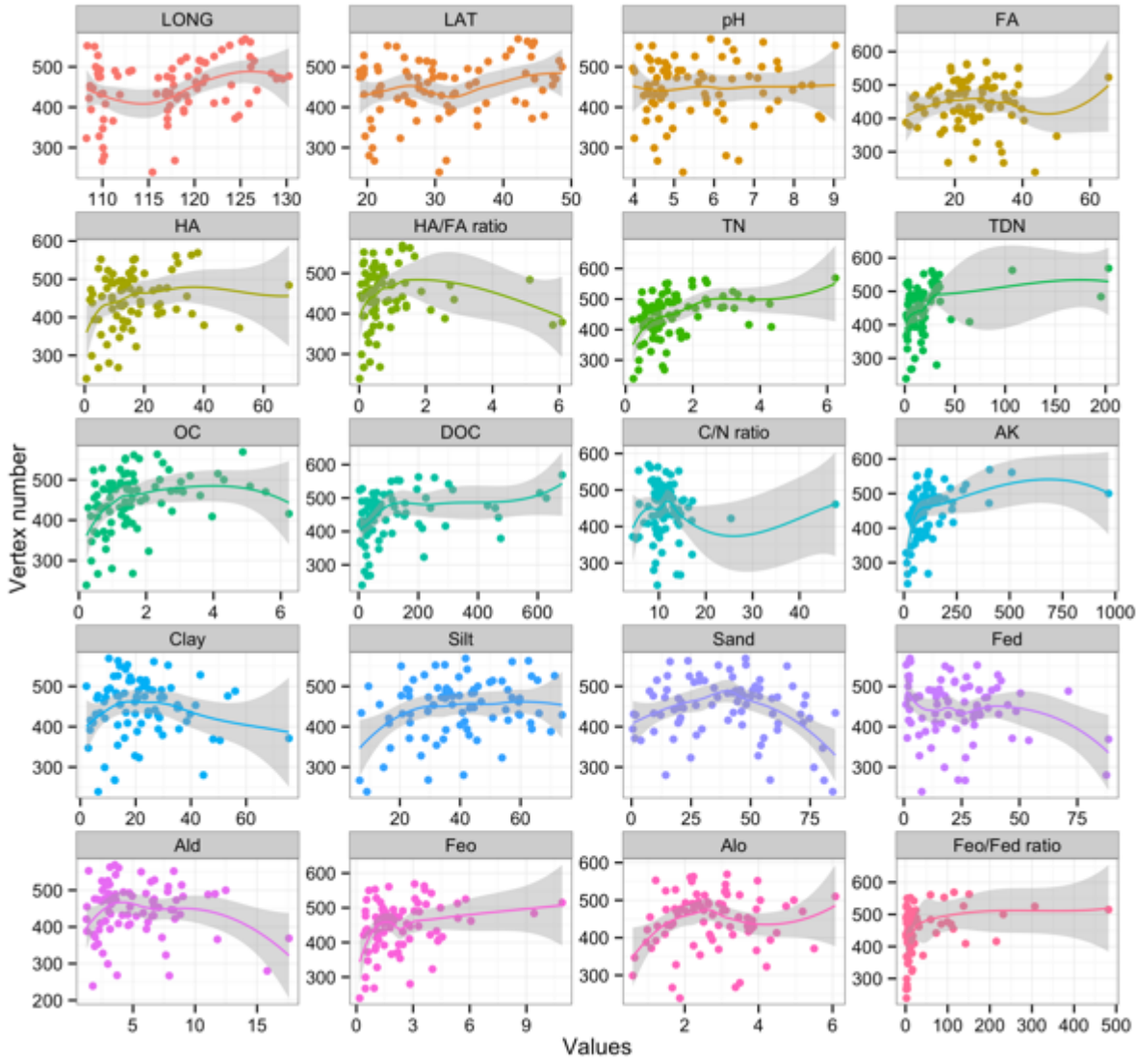

Figure S27. The relationship between vertex number and environmental factors.

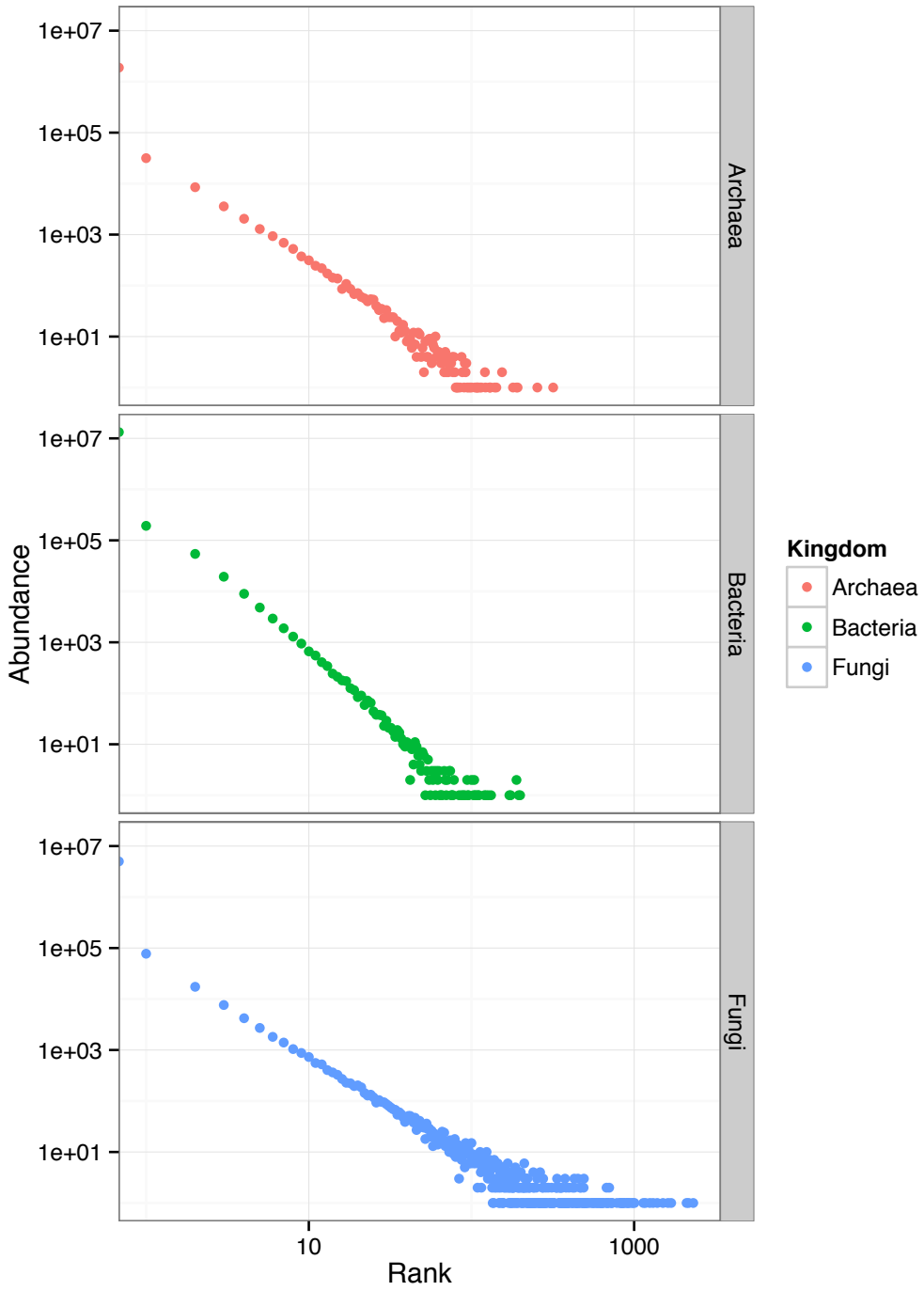

Figure S28 The rank-abundance relationship for archaeal, bacterial, and fungal communities