Supplementary Materials

Method of Soil Sample Collection

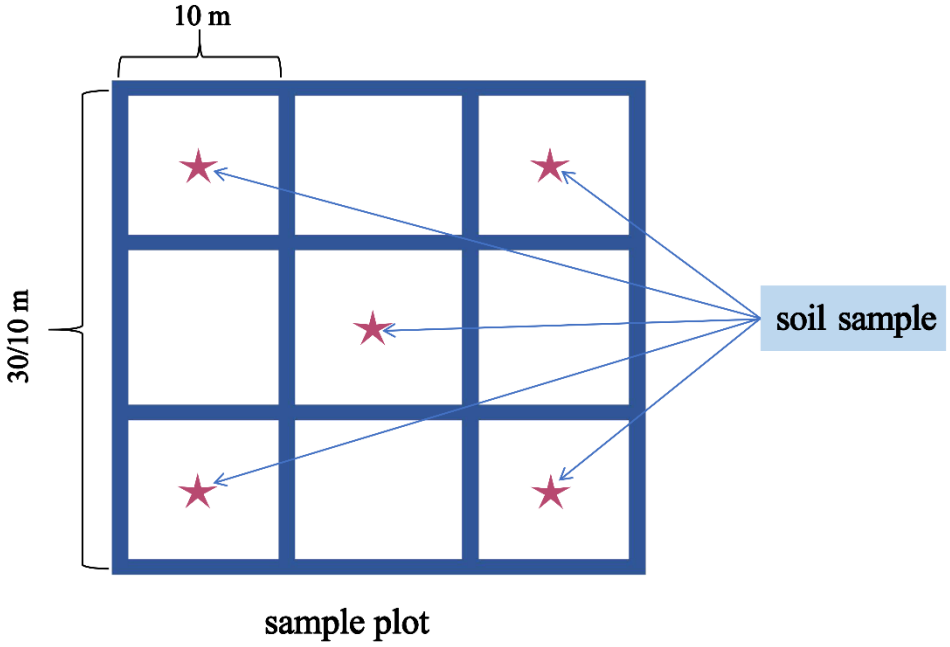

Figure S1. Diagram of the five-point sampling method. With the five-pointed star as the sampling point, 5 topsoil samples were taken from each sample site and mixed evenly (removing the topsoil litter), and visible rocks, impurities and plant debris in the soil were removed, with a total of 30 samples.

Calculation Method of Soil Multifunctionality

Currently, there are several common ways to quantify ecosystem multifunctionality, Such as average value method, factor analysis method, threshold method etc. There are advantages and disadvantages to different approaches. The mean value method was first proposed by Hooper and Vitousek [1], and was also the first to use a comprehensive index to quantitatively characterize multiple ecosystem processes. The method represents ecosystem multifunctionality by calculating the average standardized scores of different ecosystem functions (Z scores), which provides a direct and easy-to-interpret method for quantifying the ability to maintain multiple ecosystem functions simultaneously. However, this approach does not consider the interrelationship between the functions of different ecosystems[2]. The factor analysis method can obtain the multifunctionality index similar to the average method. Firstly, dimensionality reduction of function index parameters is carried out, factor analysis is performed, and then the scores of each factor are obtained, and then the scores of each factor are used to represent the multifunctionality. This method can measure the tradeoff relationship between various functions to a certain extent. Threshold method is a new framework for computing multifunctionality. In this framework, cluster analysis is performed to identify closely related functions assigned to the same cluster. Each cluster is then assigned the same weight, and the functions within the cluster are equally weighted. Then the function index is calculated according to the threshold method, and the function weight of each site exceeds a certain threshold value is calculated.

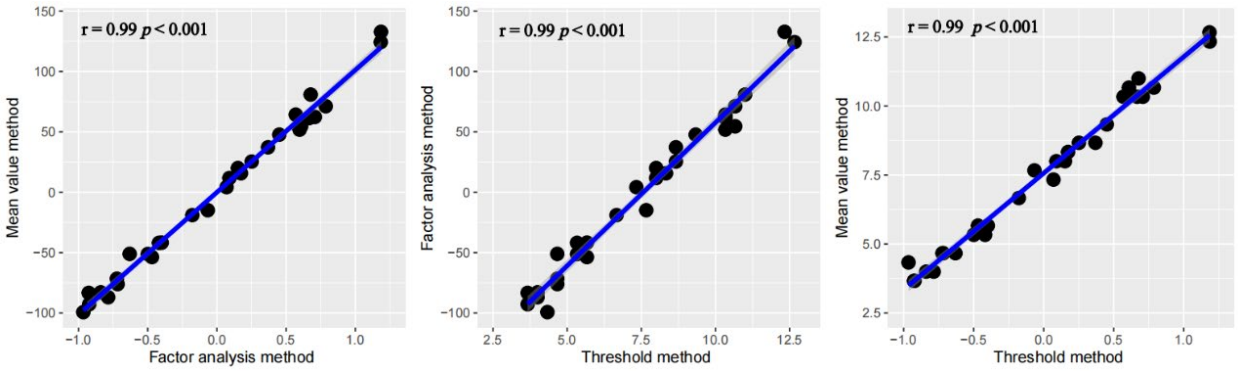

Figure S2. The linear relationship between soil multifunctional index was obtained based on mean value method, factor analysis method and threshold method.

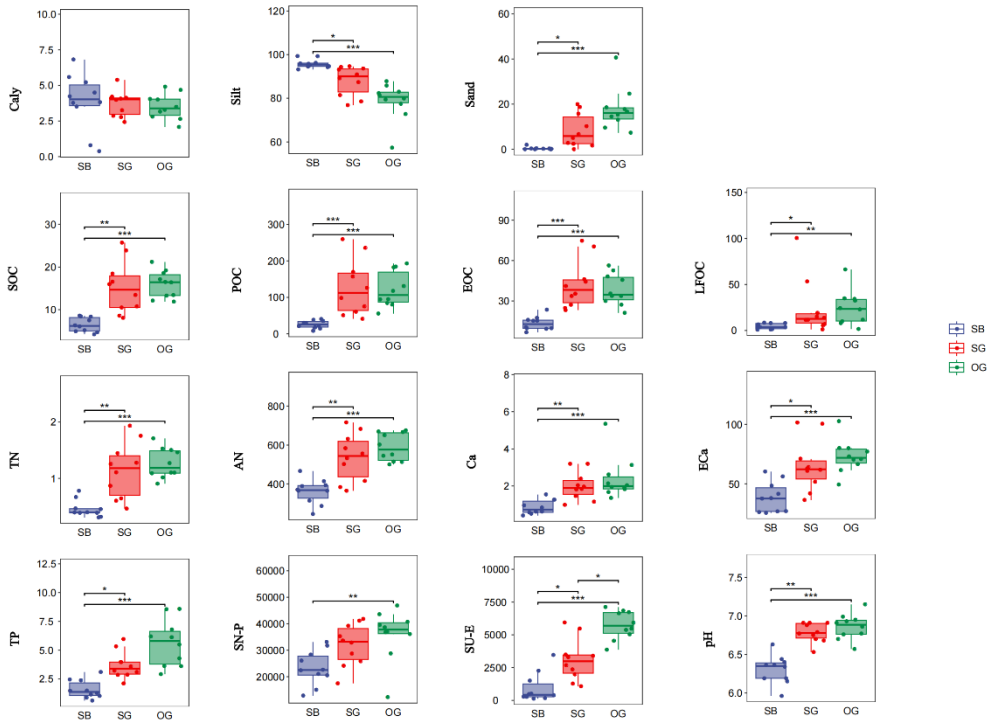

Figure S3. Changes in soil physico-chemical properties at different stages of restoration of degraded karst forests. The *p* value represents the total difference between groups and indicates the significance level of differences between groups (*, $p < 0.05$; **, $p < 0.01$; ***, $p < 0.001$).

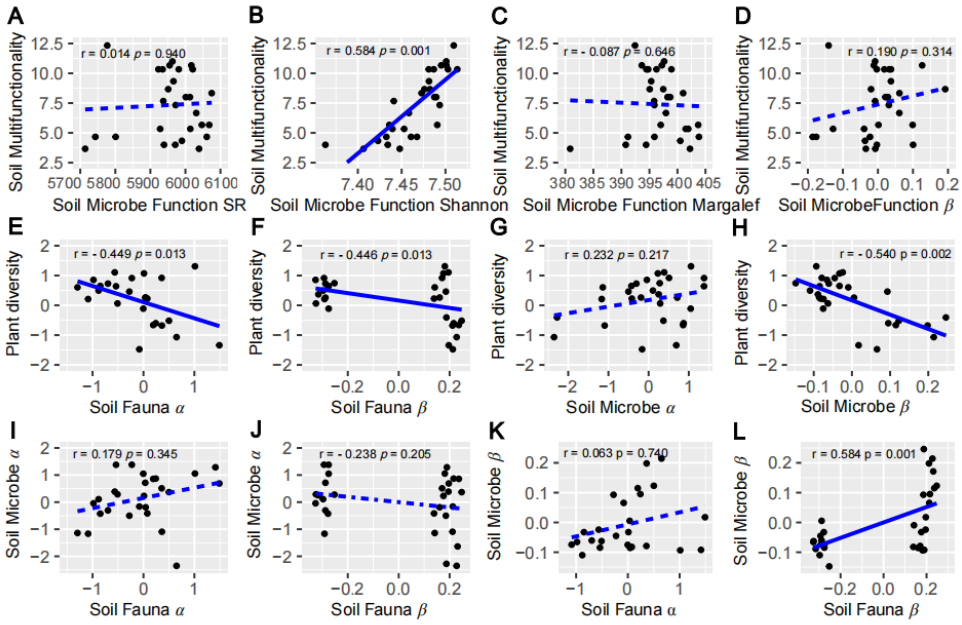

Figure S4. Relationship between soil microbial functional diversity index and soil multifunctionality; Relationship between soil fauna diversity and soil microbial diversity and plant diversity; Relationship between soil fauna diversity and soil microbial diversity. Plant diversity was obtained by dimensionality reduction of SR index, Shannon-Winner index and Margalef index. The α diversity of soil fauna was obtained by the dimensionality reduction of soil animal SR index, soil fauna Shannon-Winner index and soil fauna Margalef index. Soil microbial α diversity was obtained from soil microbial SR index, soil microbial Shannon-Winner index and soil microbial Margalef index.

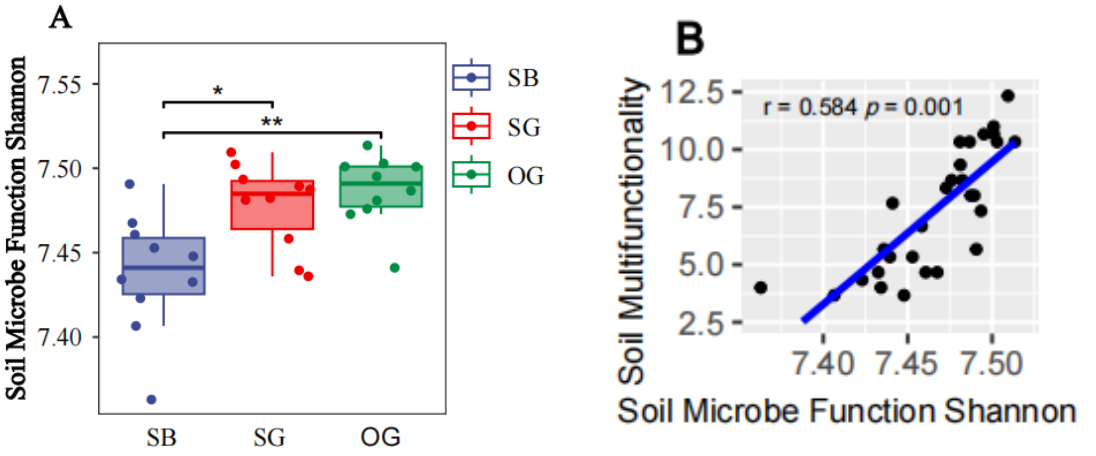

Figure S5. Responses of soil microbial function diversity to the restoration stage (**A**); Relationship between soil microbial function diversity and soil multifunctionality (**B**). The p value represents the total difference between groups and indicates the significance level of differences between groups (*, $p < 0.05$; **, $p < 0.01$).

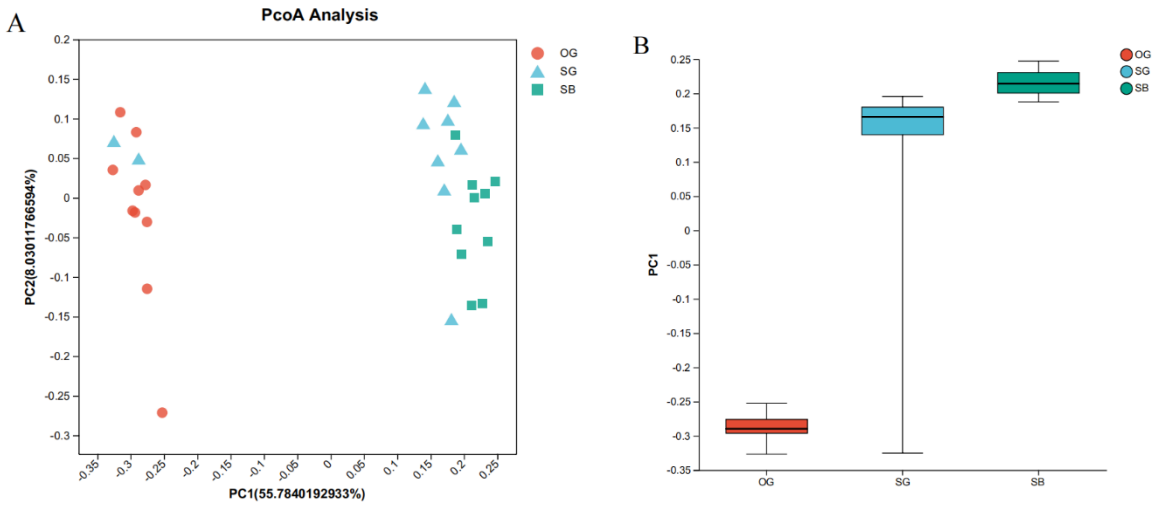

Figure S6. PCoA analyses of the three natural recovery stages, where the distances of the points represent the distances of the samples, and samples in the same area on the plane are shown to be similar. PC1 and PC2 represent the first two principal component factors influencing the functional composition of the samples (**A**); The box-and-line plot represents the discrete distribution of samples on the PC1 axis for different grouping conditions (**B**).

Table S1. Number and proportion of deciduous species during natural restoration.

Restoration Stage	Number of Deciduous Species	Proportion Of Deciduous Species
SB	22	28.95%
SG	36	21.56%
OG	38	23.17%

Table S2. OTU data form for soil fauna (The form provided is an Excel spreadsheet, please double click on the form to view it).

species	SB1	SB2	SB3	SB4	SB5	SB6
OTU1	32	26	50	52	22	14
OTU2	0	0	2	0	0	0
OTU3	0	0	0	2	0	0
OTU4	8	2	0	0	0	0
OTU5	4	22	4	8	2	0
OTU6	0	2	4	2	6	10
OTU7	0	0	4	0	0	0
OTU8	0	0	0	0	0	4
OTU9	20	4	0	0	0	2

Table S3. OTU data form for soil microorganisms (The form provided is an Excel spreadsheet, please double click on the form to view it).

species	SB1	SB2	SB4	SB4	SB5	SB6
OUT1	0	0	0	4	0	0
OUT2	6	0	8	0	18	10
OUT3	2	6	10	14	20	4
OUT4	36	50	62	46	88	56
OUT5	0	0	0	0	0	0
OUT6	0	0	0	0	0	0
OUT7	20	0	14	4	2	0
OUT8	2	0	4	4	0	0
OUT9	26	48	56	76	26	80

Table S4. Biodiversity index data (The form provided is an Excel spreadsheet, please double click on the form to view it).

Stage	Plant SR	ant Shannc	ant Margal	Fauna Nur	oil Fauna S	Fauna Shar
SB1	9.48	2.21	3.46	4748	224	3.682026
SB2	10.65	2.11	3.68	5750	252	3.784845
SB3	6.23	1.68	2.19	5210	249	3.717481
SB4	11.64	2.78	5.19	5716	231	3.55612
SB5	10.03	2.5	5.05	6656	241	3.757202
SB6	11.84	2.77	5.57	5786	232	3.562924
SB7	11.72	2.76	5.03	6242	235	3.490591
SB8	5.44	1.28	2.96	5216	259	3.91907
SB9	12.02	2.9	6.47	4010	199	3.541739

Table S5. Level of soil fauna classification (The form provided is an Excel spreadsheet, please double click on the form to view it).

Domain	Kingdom	Phylum	Class	Order	Family	Genus
d__Eukaryc	k__Metazo	p__Annelic	c__Clitellat	o__Enchytr	f__Enchytra	g__Enchytr
d__Eukaryc	k__Metazo	p__Annelic	c__Clitellat	o__Hirudin	f__Glossiph	g__Helobd
d__Eukaryc	k__Metazo	p__Annelic	c__Polycha	o__Capitell	f__Capitelli	g__Capitell
d__Eukaryc	k__Metazo	p__Annelic	c__Polycha	o__Phyllod	f__Nereidic	g__Platyne
d__Eukaryc	k__Metazo	p__Arthrop	c__Arachni	o__Aranea	f__Araneid	g__Araneu
d__Eukaryc	k__Metazo	p__Arthrop	c__Arachni	o__Aranea	f__Eresidae	g__Stegod
d__Eukaryc	k__Metazo	p__Arthrop	c__Arachni	o__Aranea	f__Nephilic	g__Trichon
d__Eukaryc	k__Metazo	p__Arthrop	c__Arachni	o__Aranea	f__Theraph	g__Haplop
d__Eukaryc	k__Metazo	p__Arthrop	c__Arachni	o__Aranea	f__Theridiic	g__Paraste

Table S6. Level of classification of soil microorganisms (The form provided is an Excel spreadsheet, please double click on the form to view it).

Domain	Kingdom	Phylum	Class	Order	Family	Genus
d__Bacteria	k__unclassi	p__Firmicu	c__Bacilli	o__Bacillale	f__Bacillace	g__Terriba
d__Archaea	k__unclassi	p__Euryarc	c__Haloba	o__Halofer	f__Halorub	g__Haloru
d__Bacteria	k__unclassi	p__Proteob	c__Betapro	o__Neisser	f__Neisseri	g__Neisser
d__Bacteria	k__unclassi	p__Acidob	c__unclassi	o__unclass	f__unclassi	g__unclass
d__Bacteria	k__unclassi	p__Candid	c__unclassi	o__unclass	f__unclassi	g__unclass
d__Bacteria	k__unclassi	p__Firmicu	c__Clostrid	o__Clostric	f__Lachnos	g__Coproc
d__Bacteria	k__unclassi	p__Firmicu	c__Bacilli	o__Bacillale	f__Bacillace	g__Bacillus
d__Bacteria	k__unclassi	p__Proteob	c__Gamma	o__Oceanc	f__Halomo	g__Cobetia
d__Bacteria	k__unclassi	p__Proteob	c__Deltapr	o__Desulfo	f__Desulfov	g__Desulfo

Table S7. Results of PCoA analyses of soil fauna (The form provided is an Excel spreadsheet, please double click on the form to view it).

Name	PC1	PC2	PC3	PC4	PC5	
SB1	0.212522	0.015888	0.0442	0.056693	-0.0115	
SB2	0.196707	-0.07115	-0.03183	0.029191	-0.07121	
SB3	0.189473	-0.0396	-0.02967	-0.04945	-0.04683	
SB4	0.236172	-0.05561	-0.06255	0.044014	-0.00097	
SB5	0.227712	-0.13359	-0.12878	0.017561	-0.0136	
SB6	0.21587	#######	0.063999	0.135082	-0.03781	
SB7	0.21143	-0.1361	-0.13014	-0.07631	0.003823	
SB8	0.231428	0.005545	0.036256	0.085867	0.06368	
SB9	0.187504	0.079396	-0.0055	0.014052	0.037315	

Table S8. Results of PCoA analyses of soil microorganisms (The form provided is an Excel spreadsheet, please double click on the form to view it).

Name	PC1	PC2	PC3	PC4	PC5	
SB1	0.065601	#######	0.059179	-0.03469	-0.02454	
SB2	0.017526	-0.00774	0.037282	-0.02393	-0.00584	
SB3	-0.09216	0.070078	0.023455	0.029247	-0.00255	
SB4	0.115067	0.166802	-0.0266	-0.04624	0.096028	
SB5	0.21434	0.066692	-0.07779	-0.04468	-0.02691	
SB6	0.095275	0.027999	0.087875	0.042626	0.017398	
SB7	0.19821	-0.10922	0.035373	0.072949	-0.01149	
SB8	0.171334	0.098162	-0.0043	-0.02688	-0.06053	
SB9	0.246199	-0.07739	-0.04754	0.052305	-0.00882	

Table S9. Basic information on the vegetation of the sample site.

Stage	Average Height (m)	Average DBH (CM)	Number of Species	Main Dominant Species
OG	6.388	6.56	152	*Lindera communis*; *Celtis sinensis*
SG	5.694	5.5	172	*Platycarya strobilacea*; *Cornus parviflorus*
SB	4.344	3.399	72	*Acer wangchii*; *Boniodendron minus*

References

1. Hooper, D.U.; Vitousek, P.M. Effects of plant composition and diversity on nutrient cycling. *Ecol. Monogr.* **1998**, *68*, 121-149, doi:10.1890/0012-9615(1998)068[0121:EOPCAD]2.0.CO;2.
2. Gamfeldt, L.; Hillebrand, H.; Jonsson, P.R. Multiple functions increase the importance of biodiversity for overall ecosystem functioning. *Ecology* **2008**, *89*, 1223-1231, doi:10.1890/06-2091.1.