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Soil water flow behavior of abandoned farmland restored with different vegetation communities in the Loess Plateau of China

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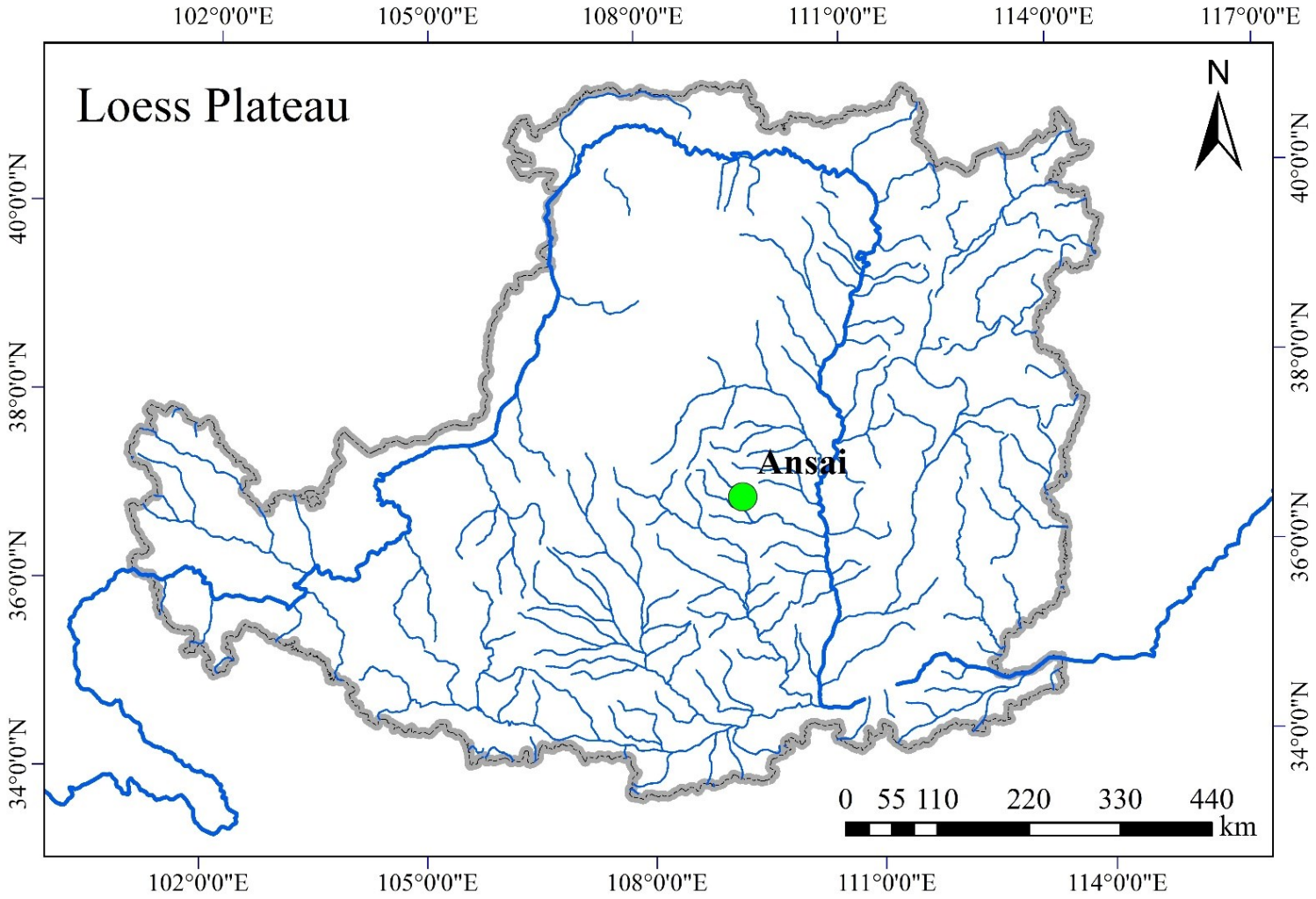
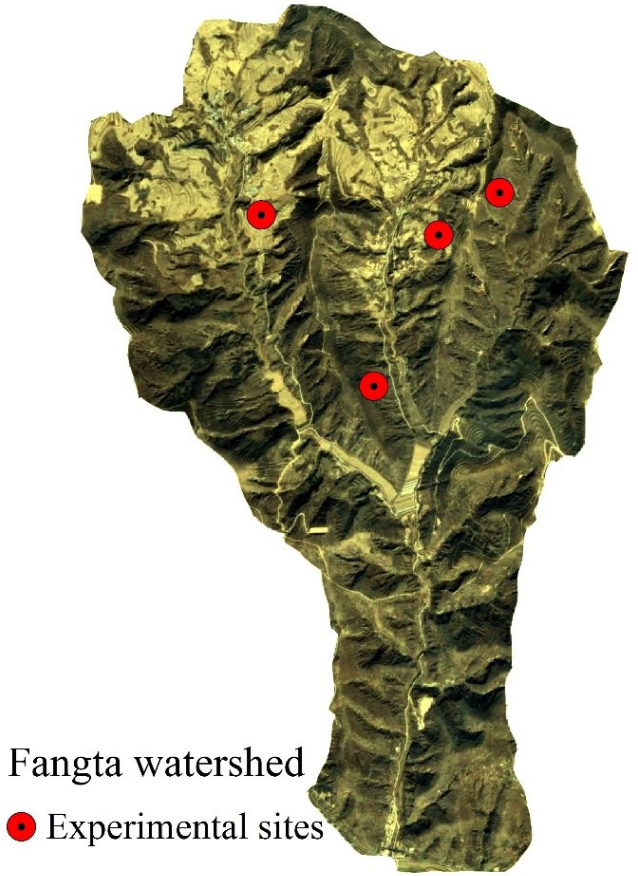
1. Background





Location of the study area

1. Background

The four sites were restored by different plant communities of *Artemisia scoparia*, *Artemisia sacrorum*, *Bothriochloa ischaemum* and *Periploca sepium Bunge*, representing the succession sequence of the natural vegetation in this area

Site 1

Artemisia scoparia

Site 2

Artemisia scoparia

Site 3

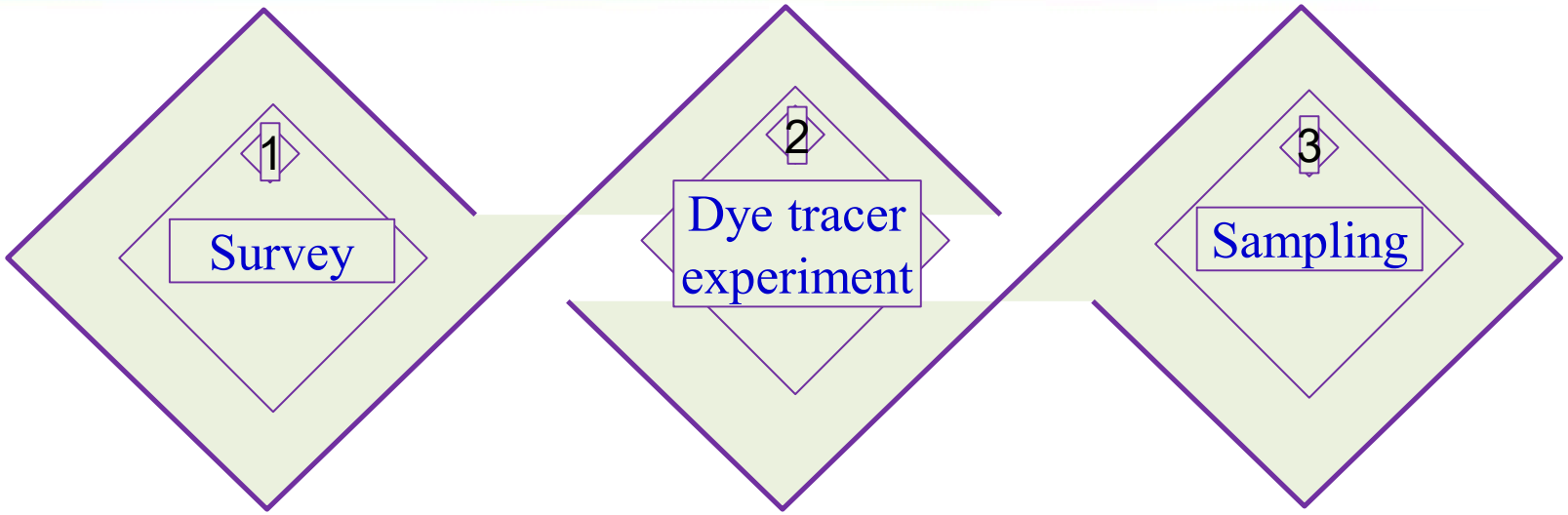
Bothriochloa ischaemum

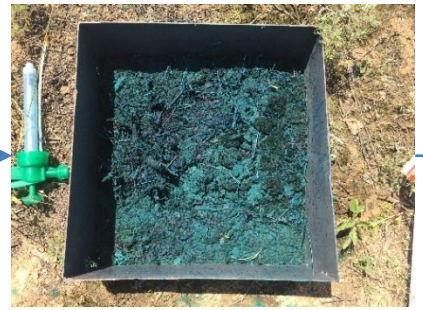
Site 4

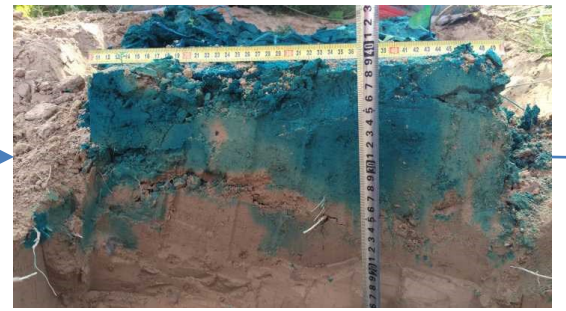
Periploca sepium Bunge

Site	Altitude (m)	Slope Aspect (°)	Slope Gradient (°)	Slope Length (m)	Vegetation Coverage (%)	Dominant Communities
Site 1	1157	NE80	11	43	35	Artemisia scoparia-Green bristle grass
Site 2	1233	NE55	18	55	44	Artemisia sacrorum-Artemisia argyi
Site 3	1254	NE65	20	66	37	Bothriochloa ischaemum-Artemisia sacrorum
Site 4	1287	NE30	16	58	47	Periploca sepium Bunge-Artemisia sacrorum

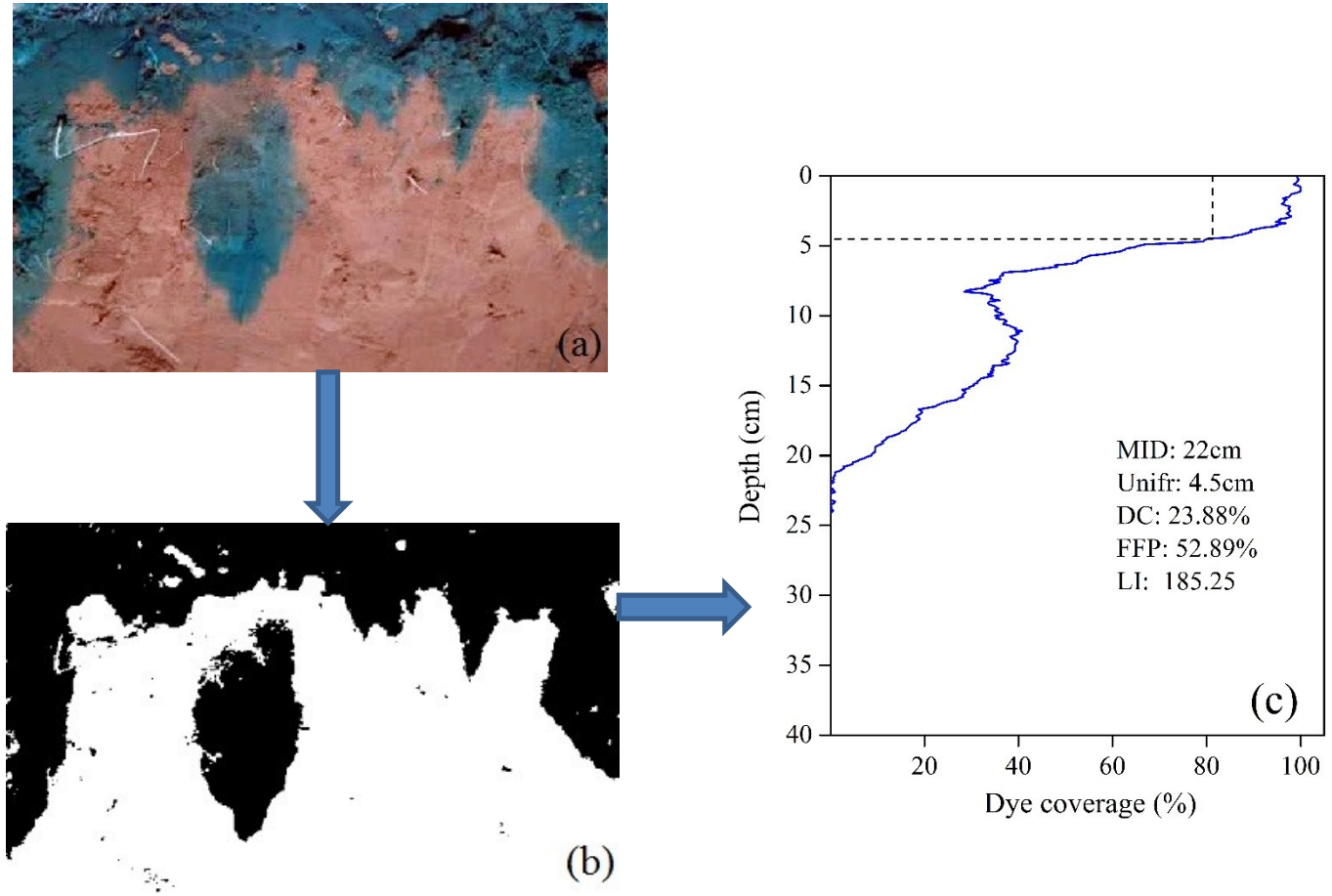
2. Method






2. Method



Preferential flow variables

MID (cm) : the maximum infiltration depth.

Unifr (cm): the uniform infiltration depth

DC (%): the dye coverage to the total soil profile region

FFP (%): the preferential flow proportion

LI: the length index

PIV(mm): the preferential infiltration volume

Con(%): the contribution of preferential infiltration volume to the total infiltration volume

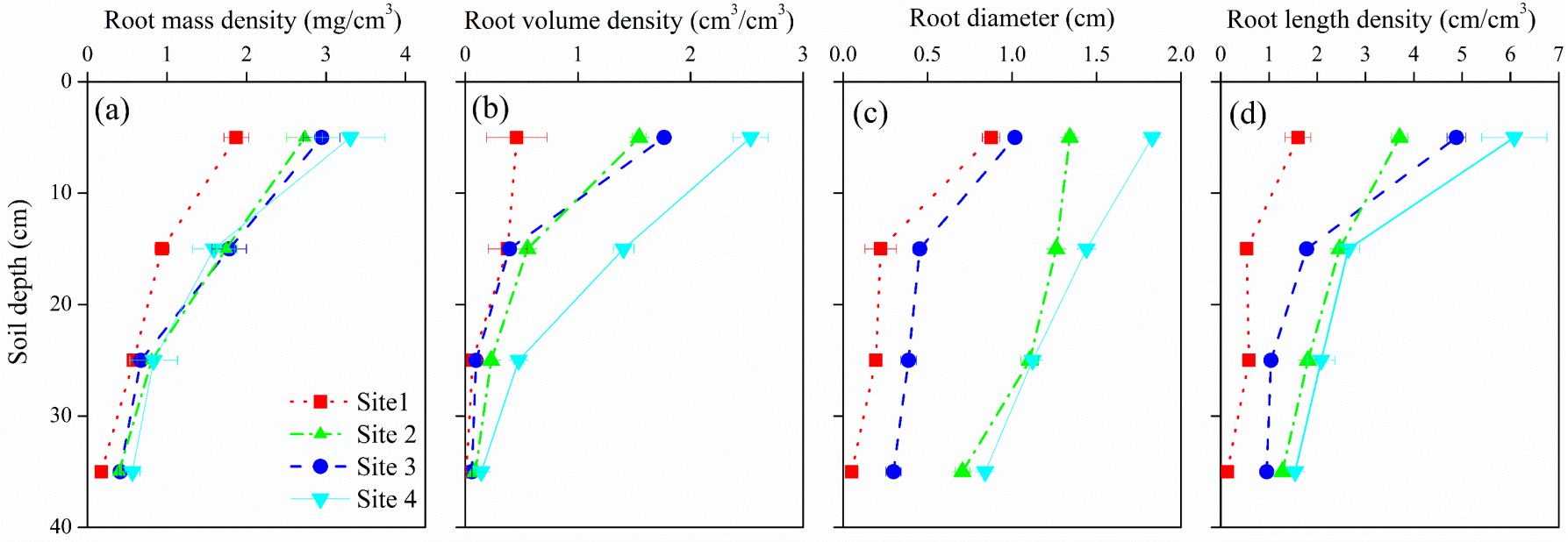
3. Results—soil and root characteristics

Soil properties

(mean value of 0-40cm soil layer depth)

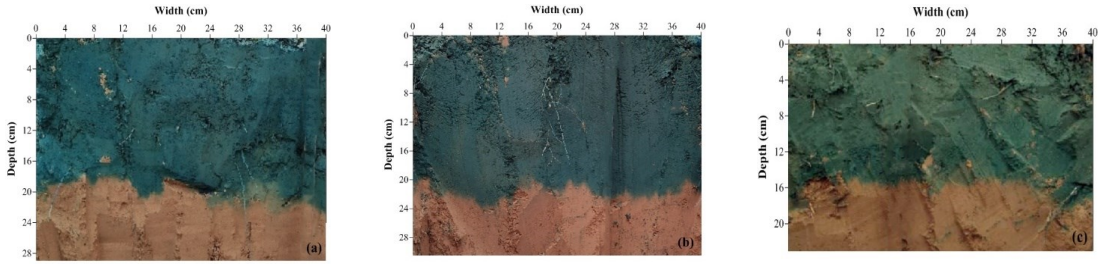
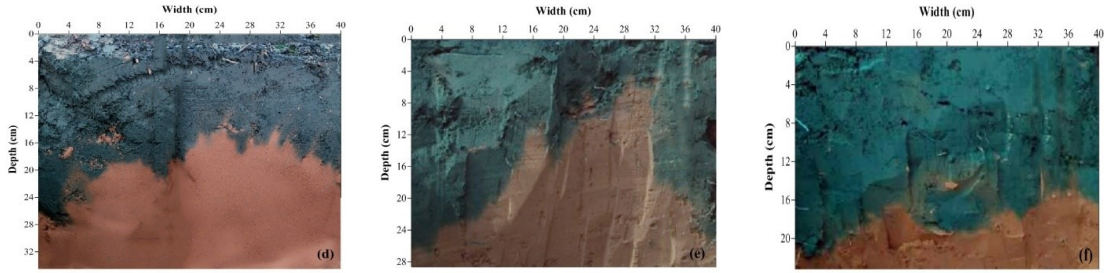
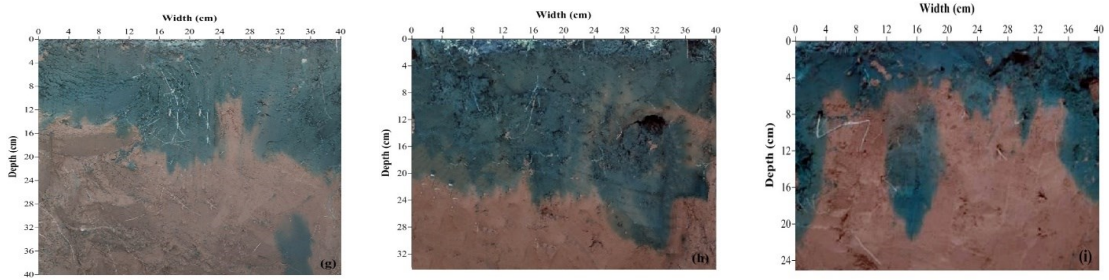
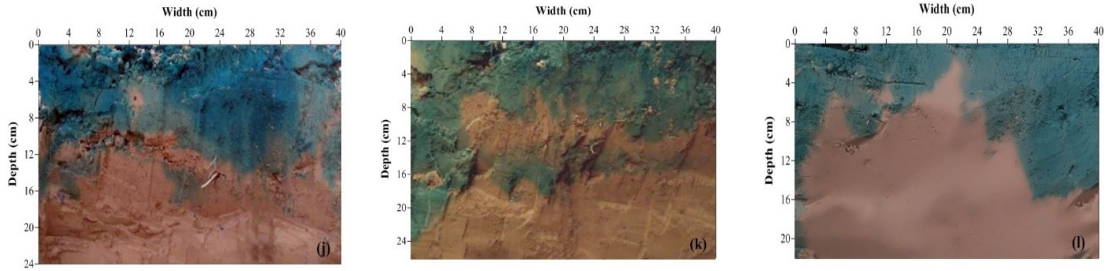
Site	Bulk density (g/cm³)	Initial soil water content (%)	Soil organic matter (g/kg)	Water-stable aggregate content > 0.25mm (%)	Soil particle size distribution		
					Clay (%)	Silt (%)	Sand (%)
Site 1	1.31±0.03a	10.07±0.05b	4.67±0.03b	29.45±1.46c	10.73±0.01a	23.15±0.23ba	66.12±0.73a
Site 2	1.27±0.01b	11.02±0.08a	4.60±0.05b	39.44±1.93b	10.80±0.01a	23.55±0.09a	65.66±0.16a
Site 3	1.22±0.01c	9.34±0.06c	4.87±0.05b	46.64±1.62a	11.25±0.01a	24.62±0.54a	65.13±0.51a
Site 4	1.14±0.01d	10.68±0.01a	5.28±0.08a	48.26±2.16a	11.54±0.12a	25.23±1.09a	64.23±1.58a

Root characteristics

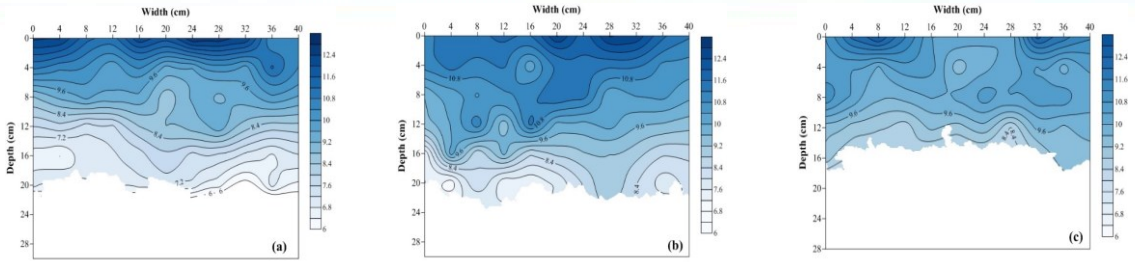
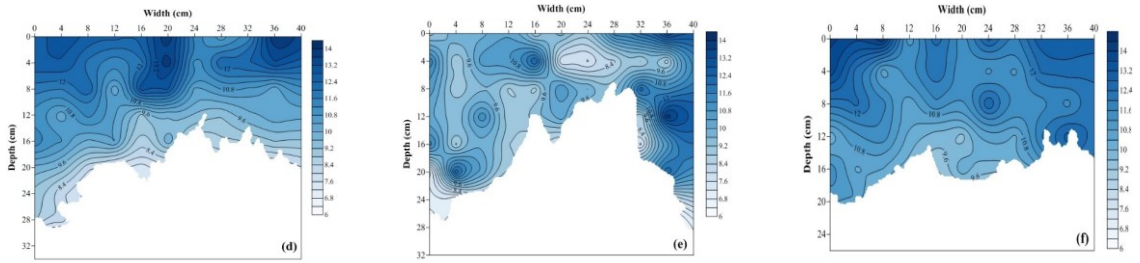
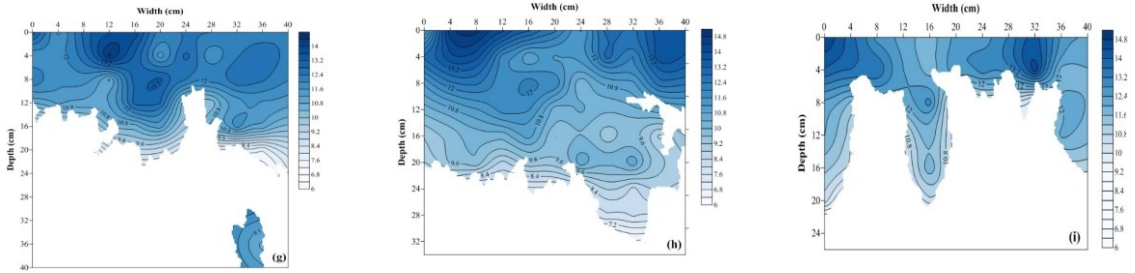
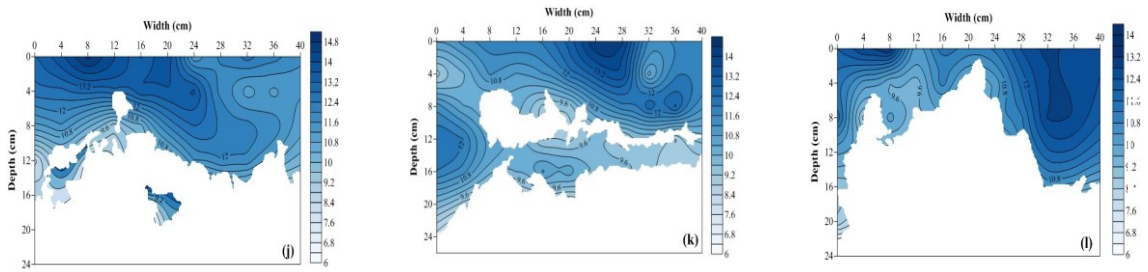


3. Results—infiltration pattern

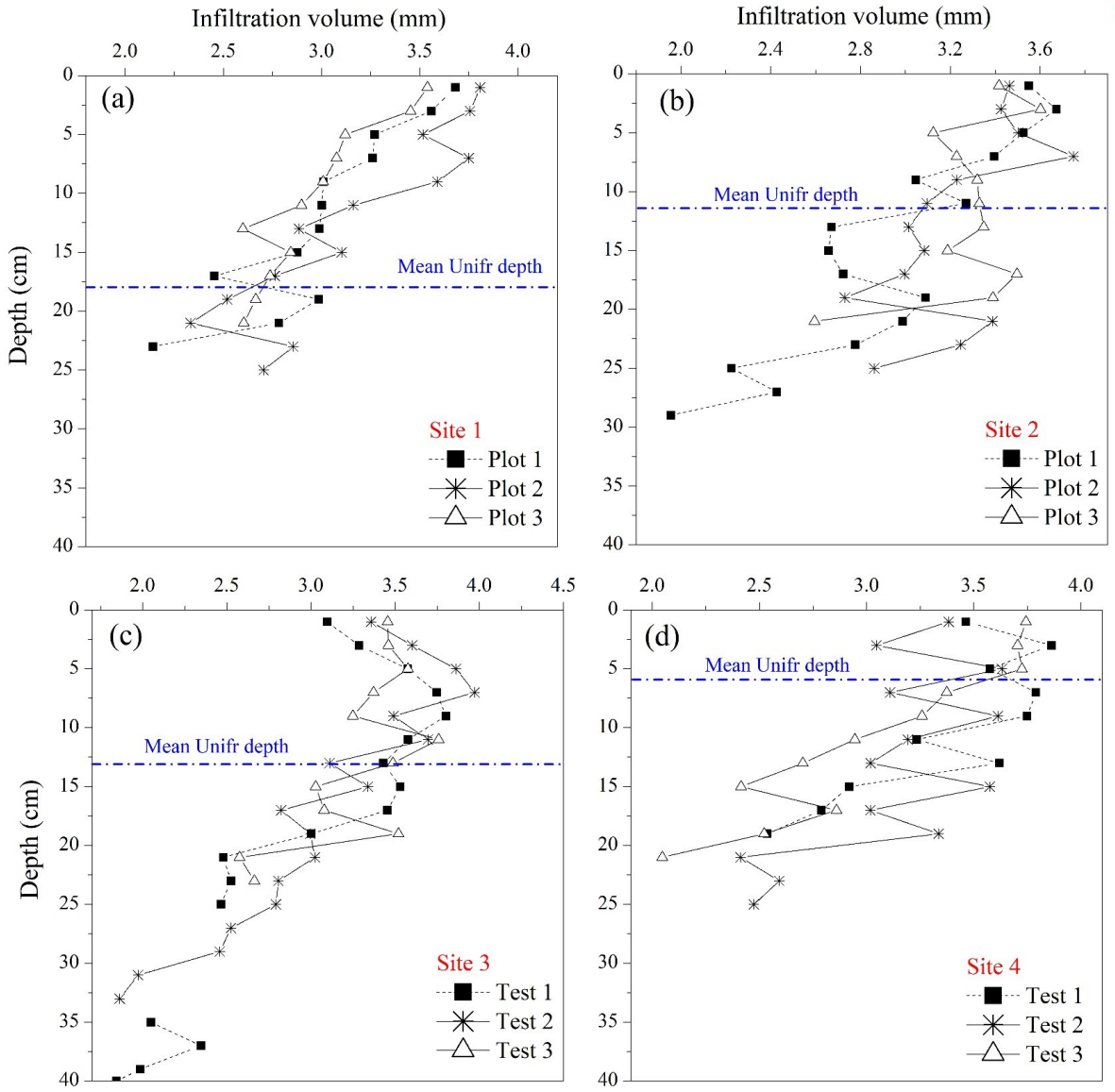
Preferential flow variables

		Infiltration Time (min)	MID (cm)	Unifr (cm)	DC (%)	FFP (%)	LI	PIV (mm)	Con (%)
Site 1		30.31 ±0.98c	22.57 ±1.19a	17.9 ±3.50a	46.95 ±10.52a	4.2 ±3.35b	293.75 ±16.97a	5.26 ±1.46b	17.22 ±7.99b
Site 2		24.63 ±2.64b	24.63 ±4.58a	11.5 ±3.54a	39.41 ±3.86a	27.79 ±16.02a	301.83 ±69.14a	14.36 ±3.97a	43.45 ±8.95a
Site 3		38.01 ±2.40a	26.9 ±5.46a	12.9 ±8.35a	41.19 ±16.00a	27.95 ±24.27a	316.25 ±79.41a	14.36 ±3.97a	43.45 ±8.95a
Site 4		23.35 ±2.96b	21.77 ±3.66a	5.90 ±3.10c	28.76 ±6.45a	30.81 ±10.78a	336.33 ±27.32a	21.48 ±10.93a	64.56 ±19.85a

3. Results—soil water distribution

		Semivariograms parameters					
		Nugget (C_0)	Sill ($C_0 + C$)	A (cm)	$C_0/(C + C_0)$ (%)	R^2	RSS
Site 1		0.1745 ± 0.1460 a	2.24 ± 1.23 b	25.63 ± 4.22 b	6.54 ± 2.39 a	0.943	0.0016
Site 2		0.1258 ± 0.0303 a	2.48 ± 1.07 b	38.86 ± 9.70 b	5.82 ± 2.30 a	0.897	0.0016
Site 3		0.0565 ± 0.0054 b	3.22 ± 1.04 a	40.85 ± 7.98 a	2.60 ± 1.32 a	0.897	0.0016
Site 4		0.0466 ± 0.0039 b	3.49 ± 1.02 a	41.88 ± 11.65 a	1.51 ± 1.26 b	0.892	0.0029

3. Results—soil water infiltration volume



- Some water infiltration volume remained mostly below the Unifr depth than above.
- Compared to Site 1, the preferential infiltration volume in Site 2, Site 3 and Site 4 increased by 1.73 times, 1.94 times and 4.09 times, respectively.

3. Results——Relationship between the water flow and the soil and root features

Person coefficients between preferential water flow parameters and soil and plant root characteristics

Items	Soil							Root			
	BD	SWC	SOM	WR0.25	Clay	Silt	Sand	RMD	RVD	RD	RLD
IT	0.357	0.527	−0.401	−0.085	−0.308	−0.212	0.112	−0.358	−0.597 *	−0.493	−0.416
MID	0.199	−0.176	−0.332	−0.565 *	0.268	0.253	−0.237	0.542 *	**0.804 ** **	0.613 *	−0.503 *
Unifr	**0.707 ** **	−0.059	−0.638 *	**−0.721 ** **	0.267	0.396	−0.306	**−0.738 ** **	**−0.780 ** **	−0.290	**−0.674 ** **
DC	0.306	−0.108	−0.342	−0.424	−0.377	0.298	0.239	−0.342	−0.155	−0.485	−0.341
FFP	**−0.715 ** **	0.082	**0.652 ** **	**0.686 ** **	0.151	0.236	−0.178	**0.873 ** **	**0.805 ** **	0.537 *	0.612 *
LI	−0.601 *	−0.083	0.562 *	**0.726 ** **	0.213	0.144	−0.258	0.783 **	0.648 *	0.572 *	0.589 *
PIV	**−0.713 ** **	−0.076	0.573 *	0.621 *	0.152	0.294	−0.214	**0.818 ** **	**0.733 ** **	**0.659 ** **	**0.711 ** **
Con	**−0.675 ** **	−0.078	0.537	0.656 *	0.155	0.286	−0.192	0.778 **	**0.735 ** **	0.607 *	**0.728 ** **

4. Conclusions

The dye tracer experiment and the image analysis indicated that the mean FFP, PIV, LI and Con of Site 4 restored by shrub (*Periploca sepium Bunge*) were 7.34 times, 4.09 times, 1.17 times and 3.75 times greater than that of Site 1 restored by annual grass (*Artemisia scoparia*).

The spatial variability of the soil water through the vertical soil profiles and the contribution of the preferential flow to the total infiltration increased from Site 1 to Site 4 with increasing degree of preferential flow.

The plant roots and their morphometric features exhibited a greater effect on the preferential flow in comparison with the soil properties.

The improvement of the preferential flow in the abandoned farmland during natural vegetation restoration helped soil water storage in the deep soil layer.


Thanks for attention !