Spatial distribution of soil water and salt in a slightly salinized farmland

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Abstract

It is important to study the mechanisms associated with the spatial distribution of soil water and salt to control soil salinization and promote the sustainable development of farmland. In this study, six plots in gully farmland in the loess hilly region with different spatial locations were selected to determine the spatial distributions of soil water and salt and their correlation using the multifractal method. A grid method (15 m ? 15 m, 3,600 m2) was applied in the 0–20 and 20–40 cm soil layers where each sampling site was located at the center point coordinates. The results showed that the spatial variability of the soil water and salt were 1.41 and 1.73 times higher, respectively, in the upstream farmland than the downstream farmland. The uneven runoff and sediment distributions from gullies in the upstream farmland increased the spatial variability of the soil water and salt. In addition, the vulnerability of upstream farmland to waterlogging caused further in their spatial variability due to narrow landform features. Analysis using the joint multifractal method showed that the spatial variability of the soil water and salt was strongly correlated ($P < 0.05$) because of the coupling between soil water and salt. In addition, the spatial variability of the soil water and salt was strongly correlated in the 0-20 and 20-40 cm layers because of the spatial autocorrelations of the soil properties ($P < 0.05$), thereby indicating that the spatial distributions of soil water and salt in the whole soil layer could be represented by those in the 0-20 cm layer. Thus, we recommend using the 0-20 soil layer to sample the distributions of the soil water and salt. Our results provide a theoretical basis for studying the interactive mechanisms associated with the distributions of soil water and salt, and for optimizing the sampling method in the study area.

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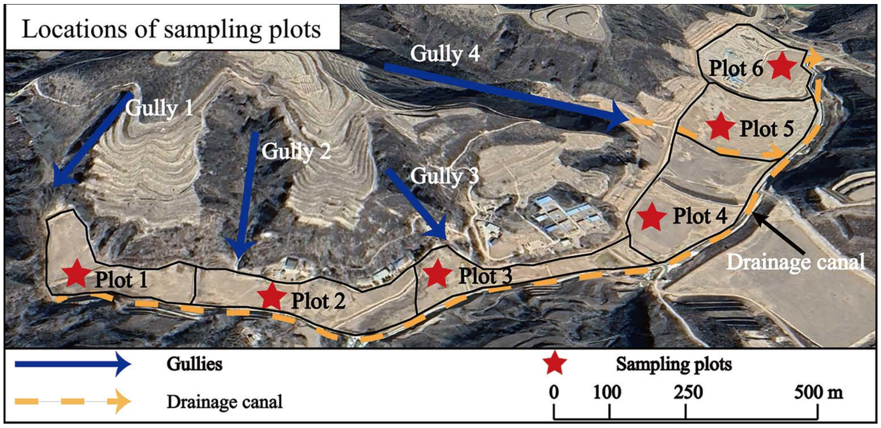
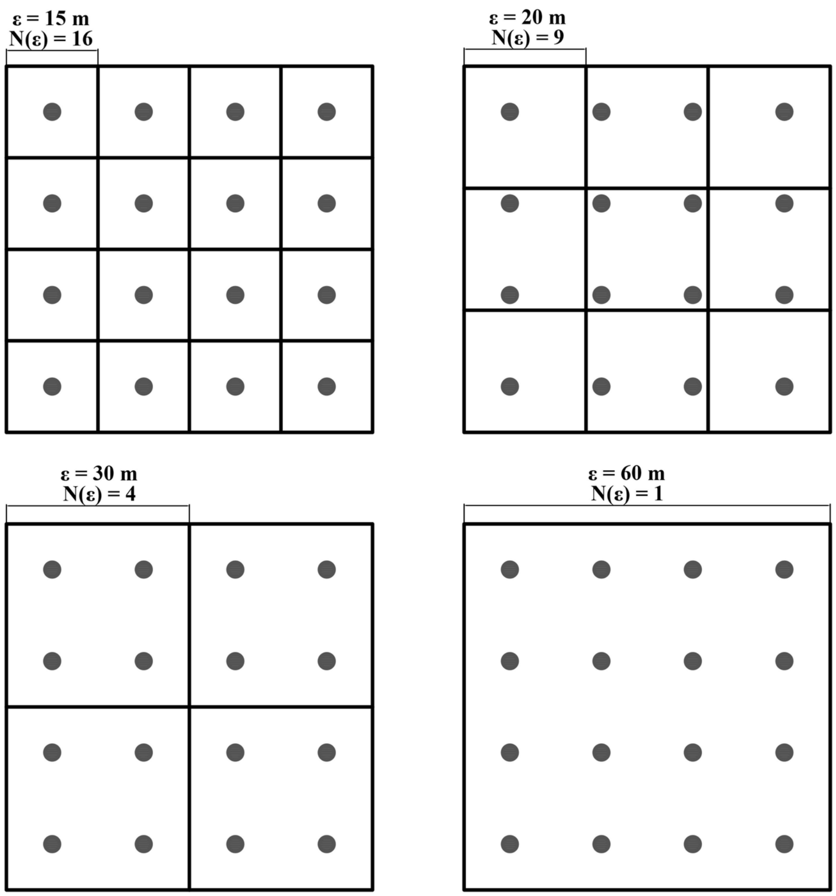
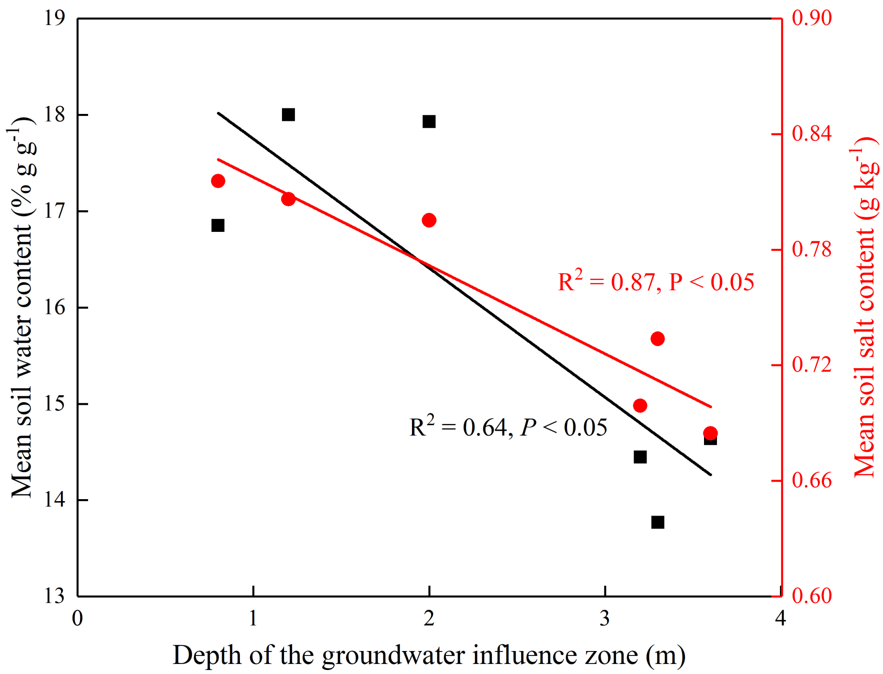
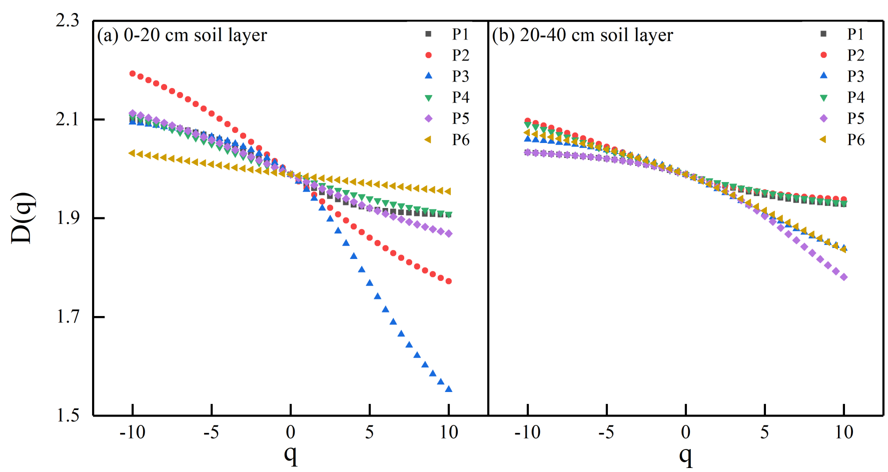
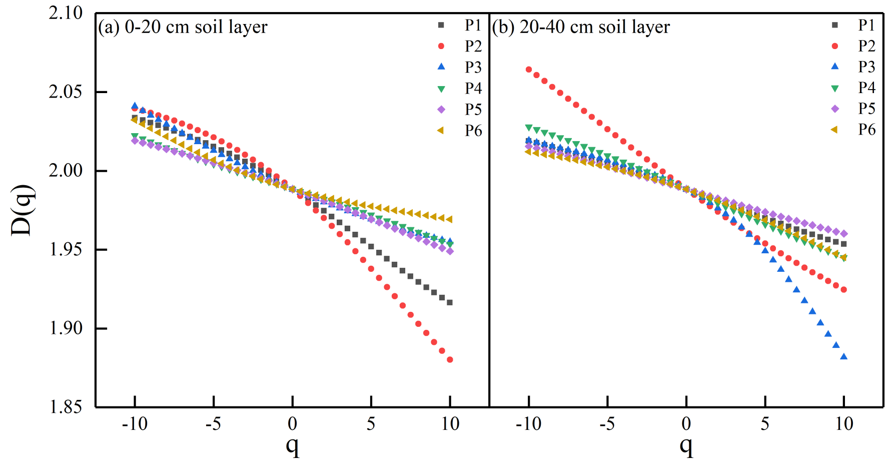
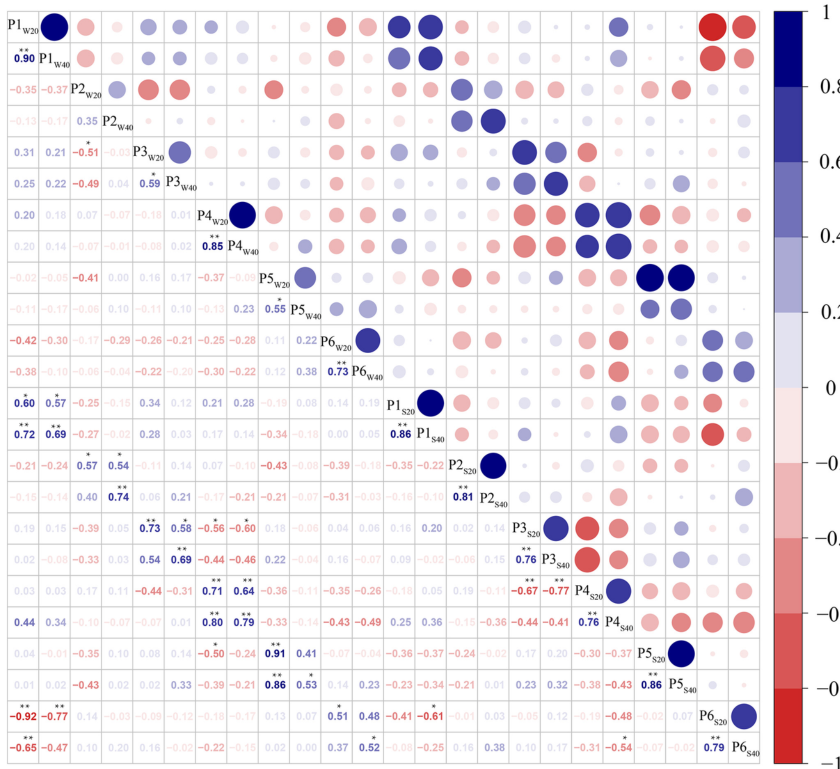

Locations of sampling plots
Gully 1
Gully 2
Gully 3
Gully 4
Plot 1
Plot 2
Plot 3
Plot 4
Plot 5
Plot 6
Drainage canal
Gullies
Drainage canal
Sampling plots
0
100
250
500 m

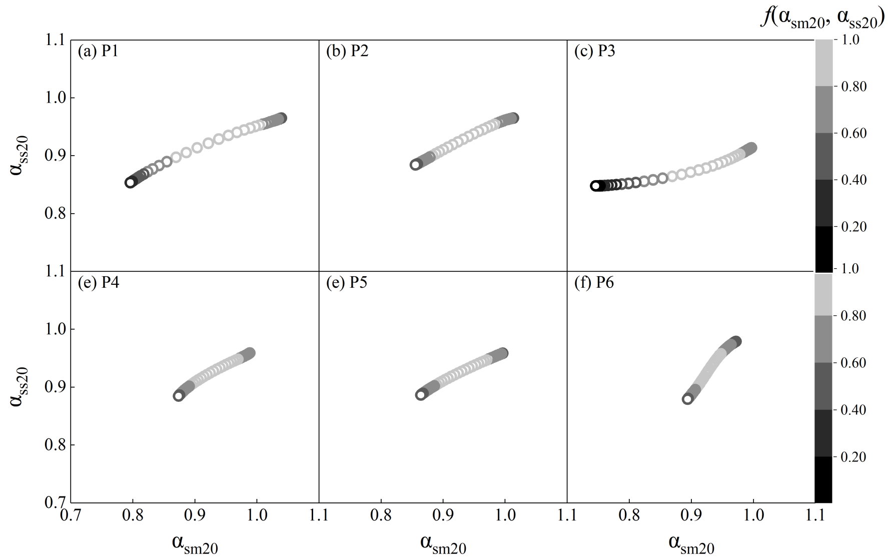

ε = 15 m
N(ε) = 16
ε = 20 m
N(ε) = 9
ε = 30 m
N(ε) = 4
ε = 60 m
N(ε) = 1

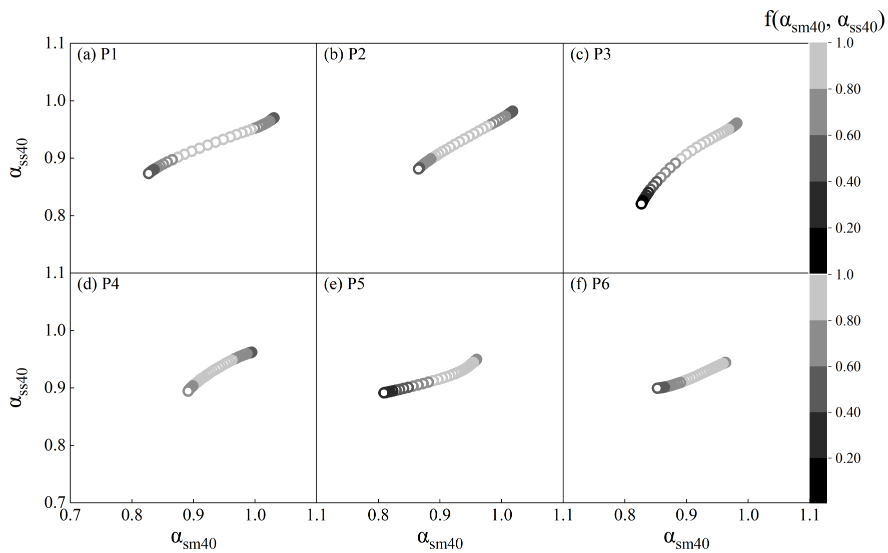

Mean soil water content (% g g^{-1})
Mean soil salt content (g kg^{-1})
Depth of the groundwater influence zone (m)
R^2 = 0.87, P < 0.05
R^2 = 0.64, P < 0.05

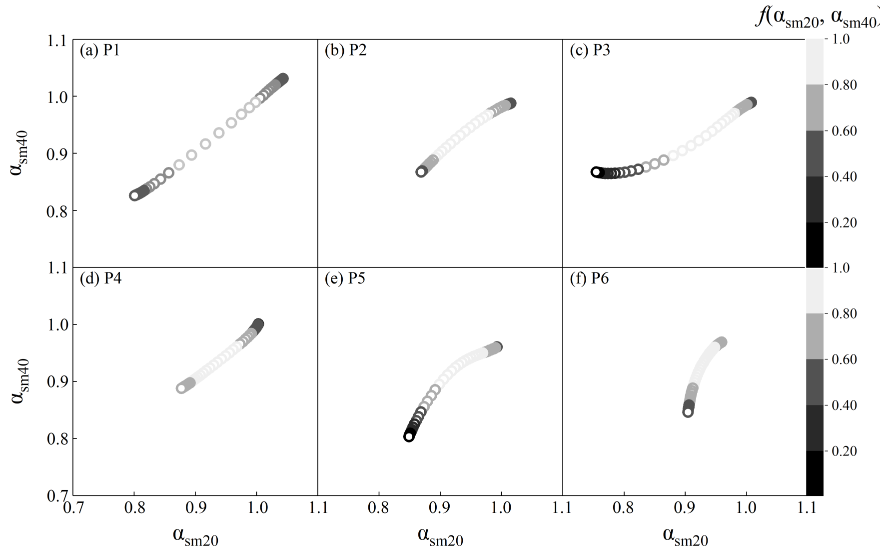

(a) 0-20 cm soil layer
(b) 20-40 cm soil layer
P1
P2
P3
P4
P5
P6
D(q)
q

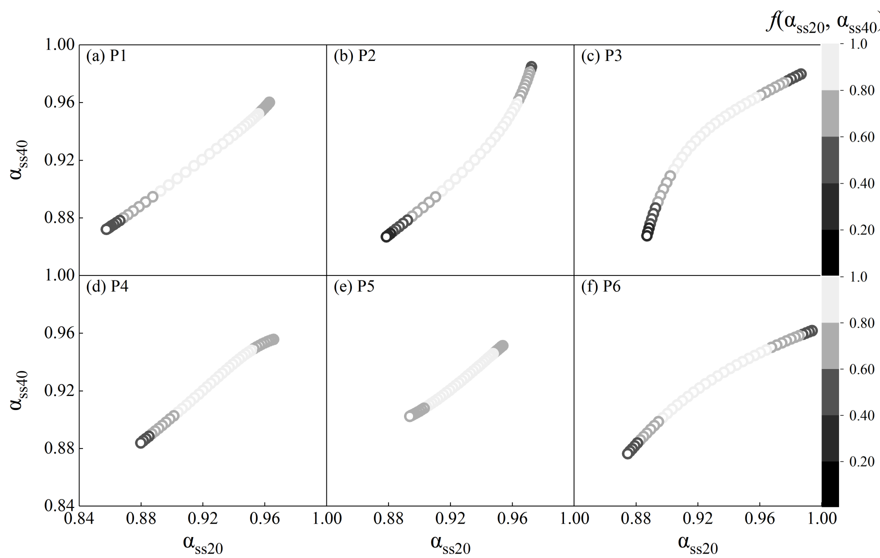

(a) 0-20 cm soil layer
(b) 20-40 cm soil layer
P1
P2
P3
P4
P5
P6
D(q)
q
2.10
2.05
2.00
1.95
1.90
1.85
-10
-5
0
5
10


P1W20
P1W40
P2W20
P2W40
P3W20
P3W40
P4W20
P4W40
P5W20
P5W40
P6W20
P6W40
P1S20
P1S40
P2S20
P2S40
P3S20
P3S40
P4S20
P4S40
P5S20
P5S40
P6S20
P6S40
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1


$f(\alpha_{sm20}, \alpha_{ss20})$
(a) P1
(b) P2
(c) P3
(e) P4
(e) P5
(f) P6
α_{ss20}
α_{sm20}


$f(\alpha_{sm40}, \alpha_{ss40})$
(a) P1
(b) P2
(c) P3
(d) P4
(e) P5
(f) P6
α_{ss40}
α_{sm40}


(a) P1
(b) P2
(c) P3
(d) P4
(e) P5
(f) P6
α_{sm40}
α_{sm20}
$f(\alpha_{sm20}, \alpha_{sm40})$


(a) P1
(b) P2
(c) P3
(d) P4
(e) P5
(f) P6
α_{ss40}
α_{ss20}
$f(\alpha_{ss20}, \alpha_{ss40})$