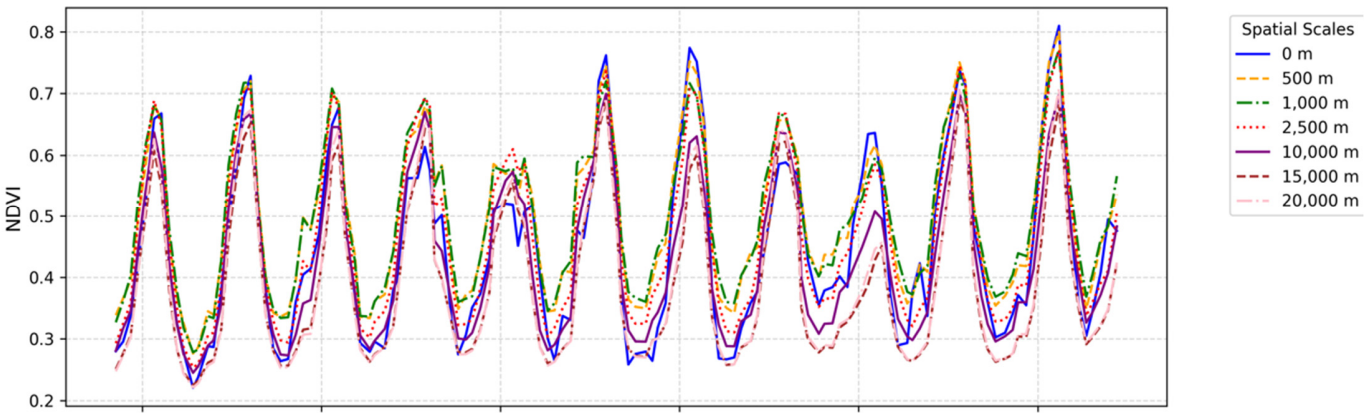
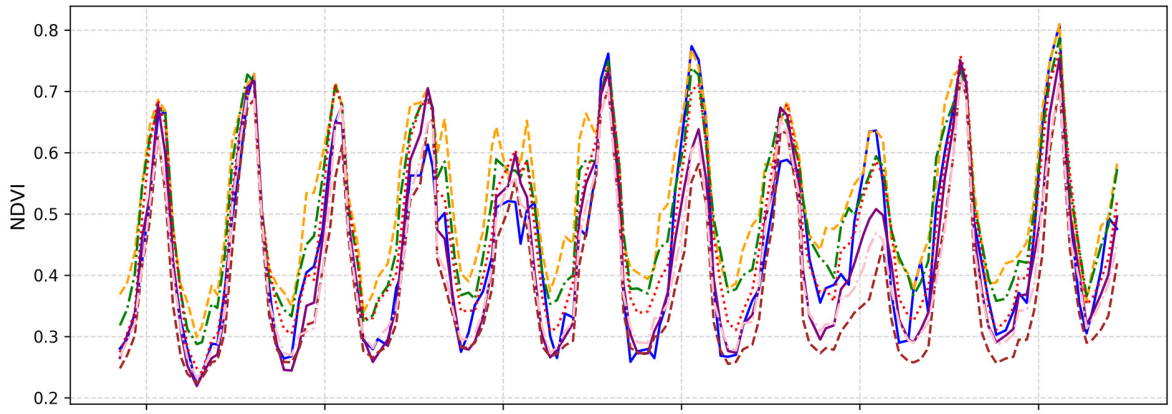
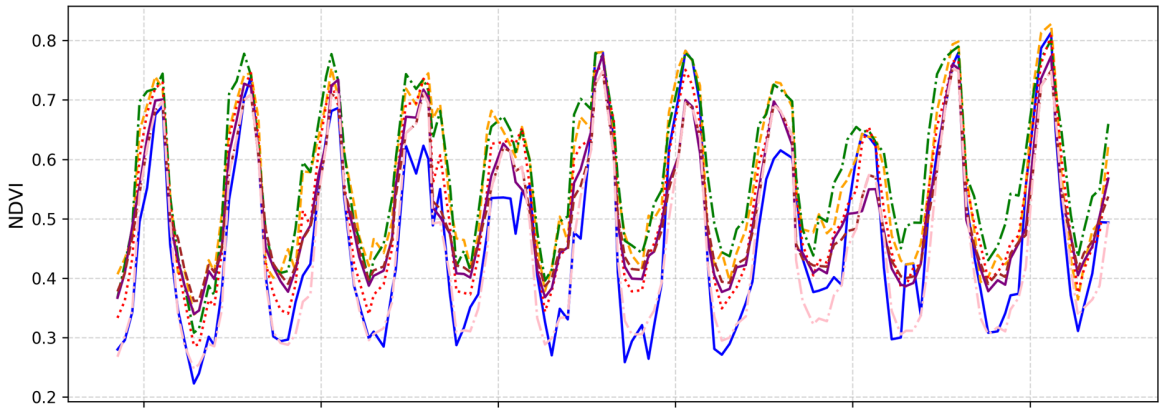

NDVI
0.8
0.7
0.6
0.5
0.4
0.3
0.2
Spatial Scales
0 m
500 m
1,000 m
2,500 m
10,000 m
15,000 m
20,000 m

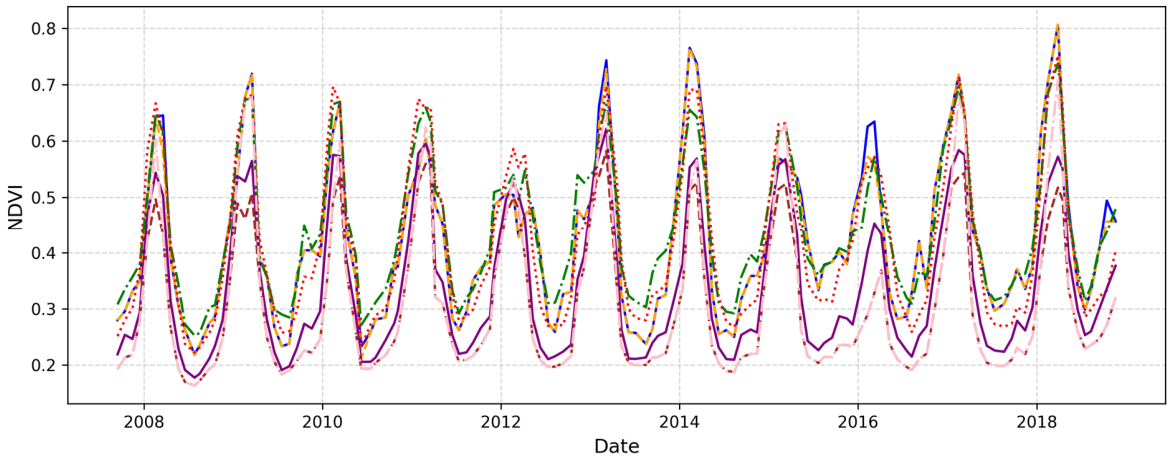
(a)


NDVI
0.8
0.7
0.6
0.5
0.4
0.3
0.2

(b)

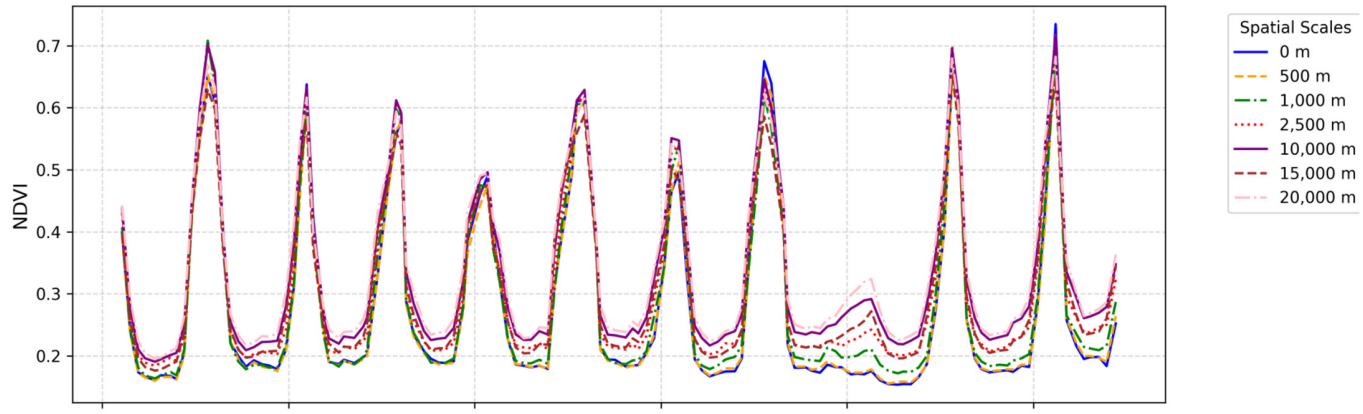

NDVI
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0.6
0.5
0.4
0.3
0.2

(c)

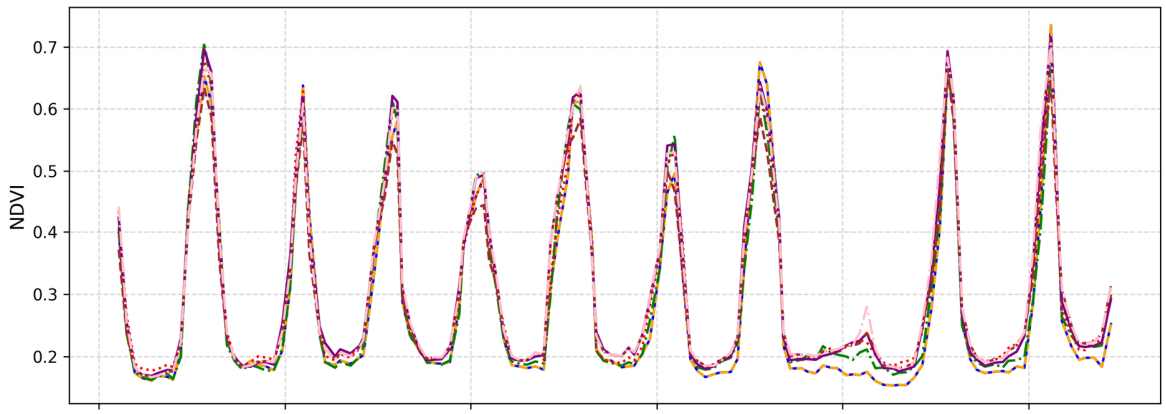


(d)

Figure S1. Temporal NDVI variations for well P2 across the different extraction scales. Monthly NDVI time series for the period 2009–2018 are shown for the seven extraction scales: 0 m, 500 m, 1,000 m, 2,500 m, 10,000 m, 15,000 m, and 20,000 m. Panels show: (a) mean NDVI; (b) median NDVI; (c) maximum NDVI; (d) minimum NDVI.



(a)



(b)

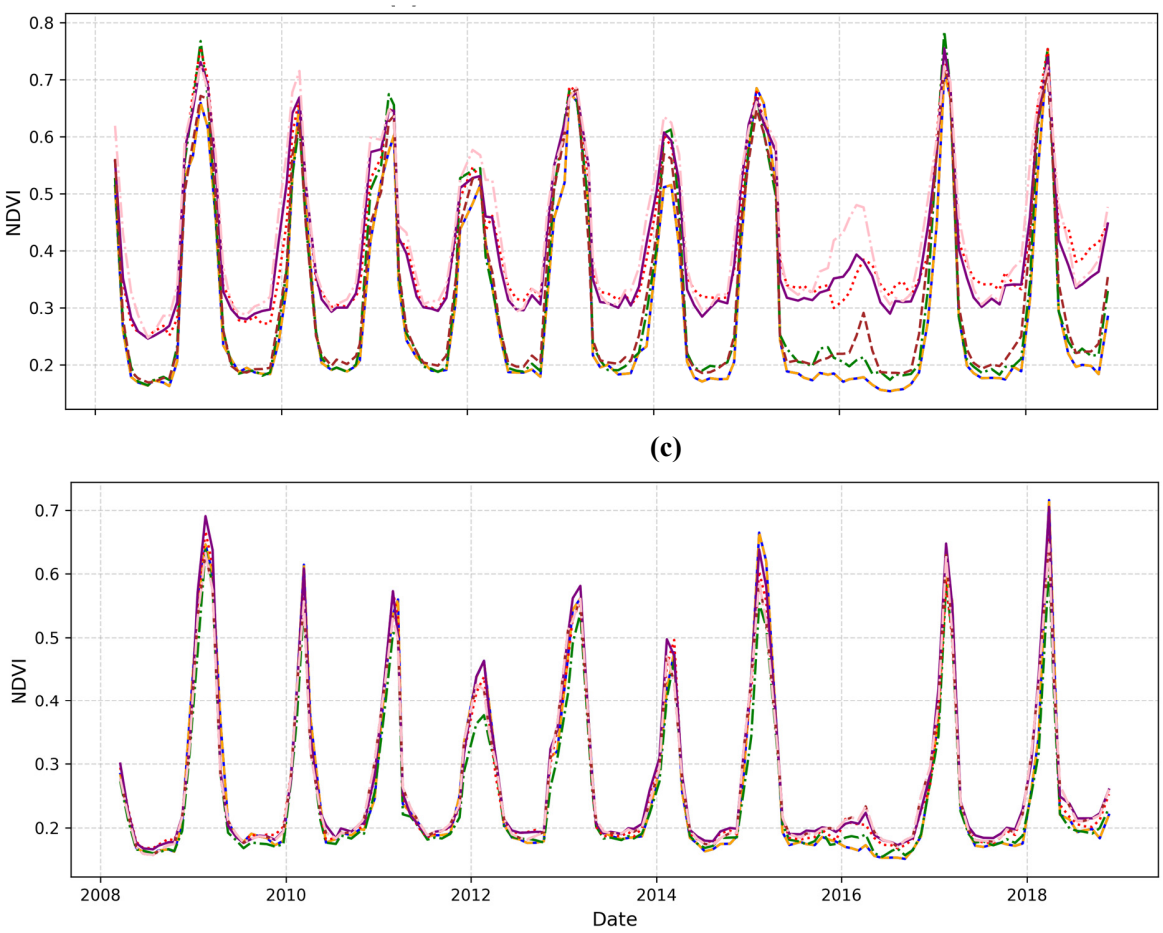
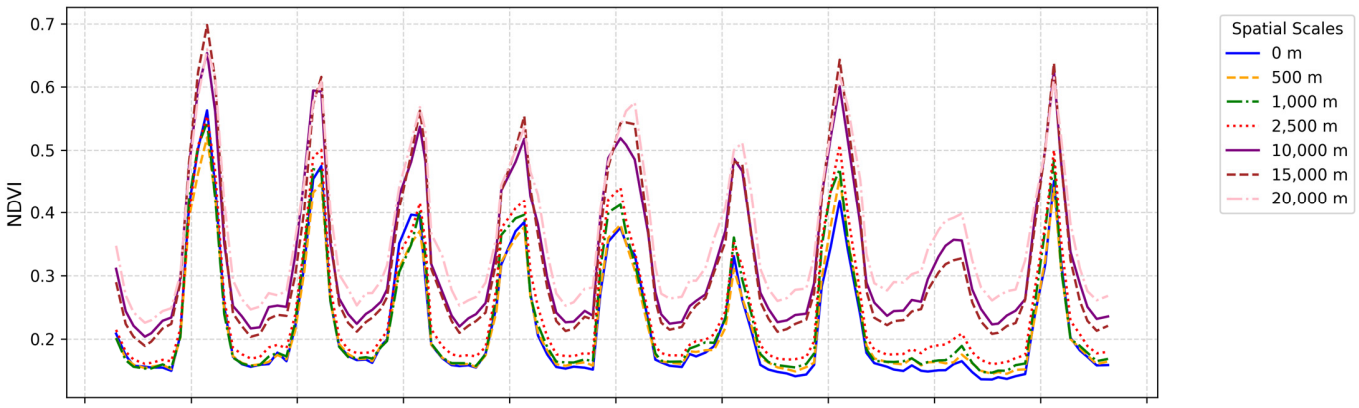


Figure S2. Temporal NDVI variations for well P3 across the different extraction scales. Monthly NDVI time series for the period 2009–2018 are shown for the seven extraction scales: 0 m, 500 m, 1,000 m, 2,500 m, 10,000 m, 15,000 m, and 20,000 m. Panels show: (a) mean NDVI; (b) median NDVI; (c) maximum NDVI; (d) minimum NDVI.



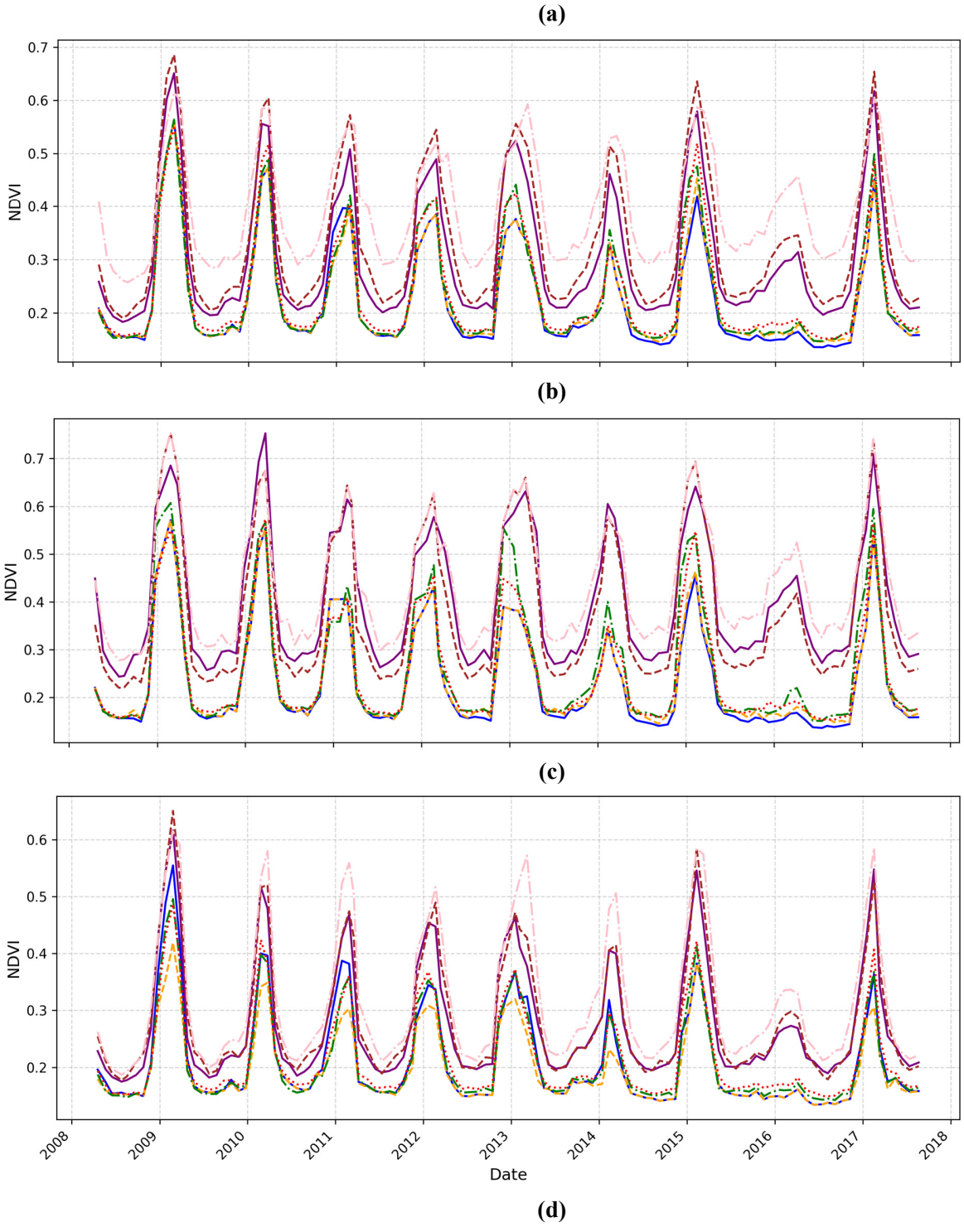
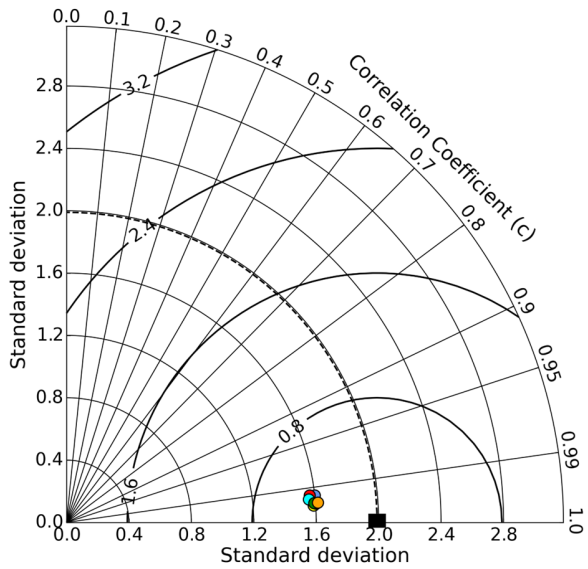
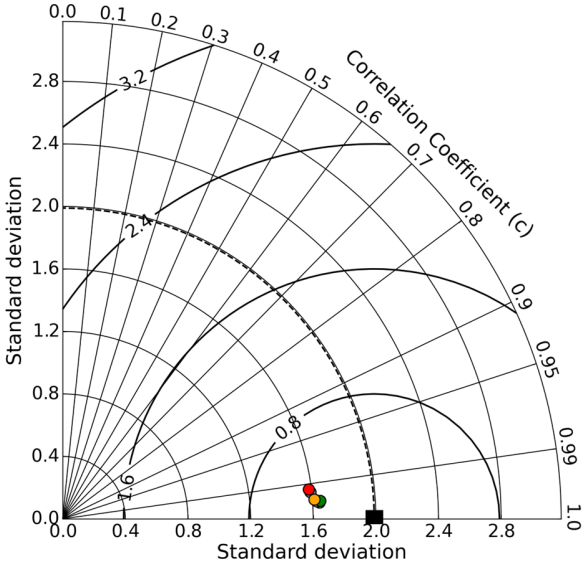

(a)
NDVI
0.7
0.6
0.5
0.4
0.3
0.2
(b)
NDVI
0.7
0.6
0.5
0.4
0.3
0.2
(c)
NDVI
0.6
0.5
0.4
0.3
0.2
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Date
(d)

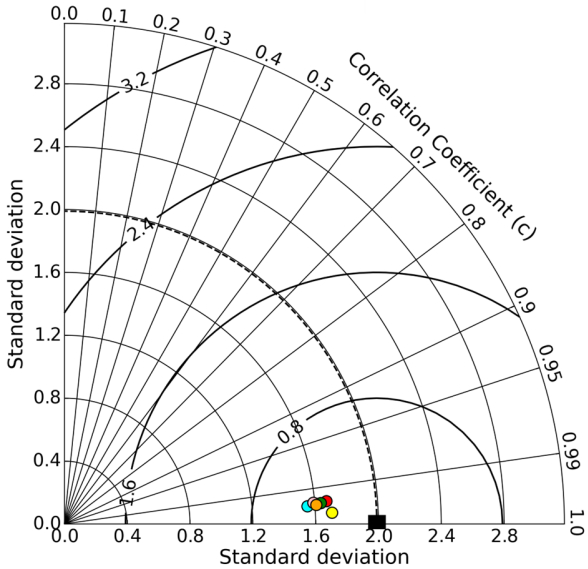
Figure S3. Temporal NDVI variations for well P4 across the different extraction scales. Monthly NDVI time series for the period 2009–2018 are shown for the seven extraction scales: 0 m, 500 m, 1,000 m, 2,500 m, 10,000 m, 15,000 m, and 20,000 m. Panels show: (a) mean NDVI; (b) median NDVI; (c) maximum NDVI; (d) minimum NDVI.

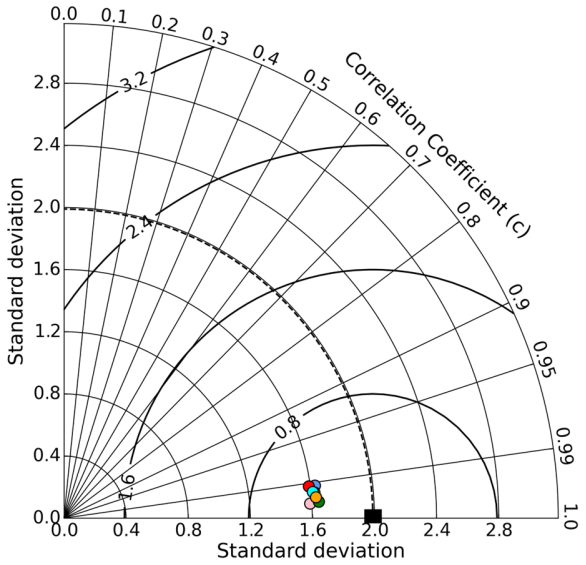


(a)



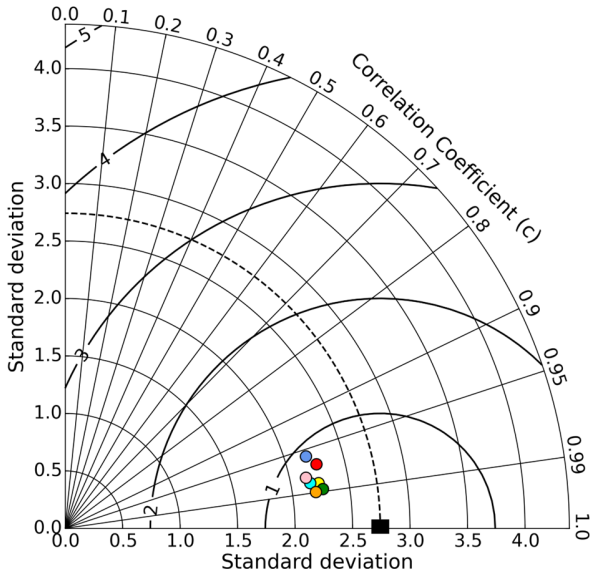
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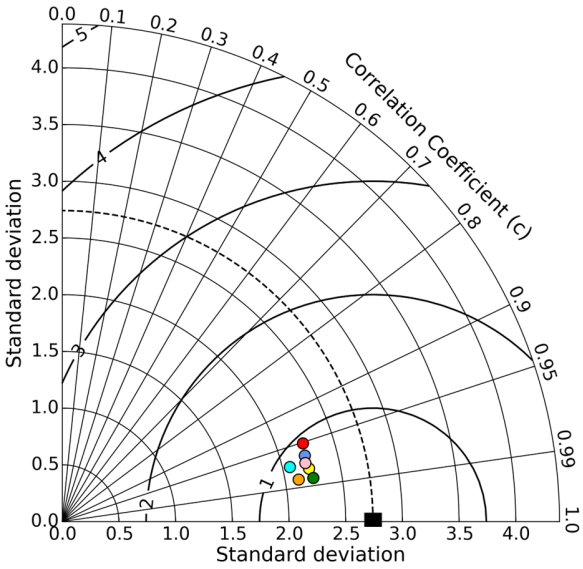




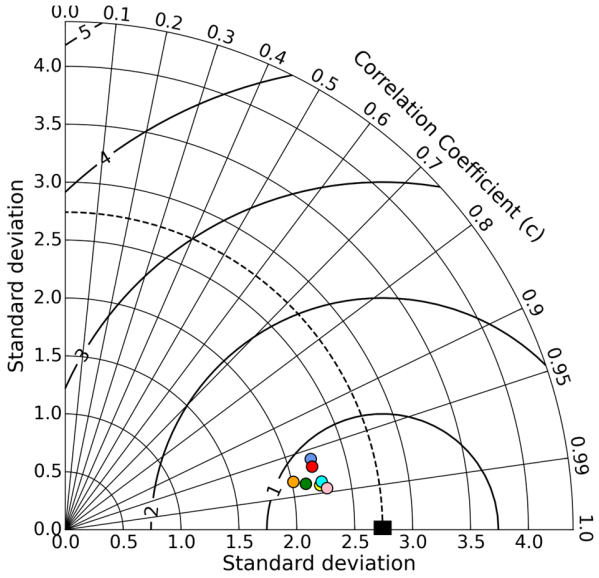
(c) (d)

Figure S4: Taylor diagrams showing model performance across NDVI extraction scales for wells P2; Panels show the results for well P1 using (a) mean NDVI, (b) median NDVI, (c) maximum NDVI, and (d) minimum NDVI;

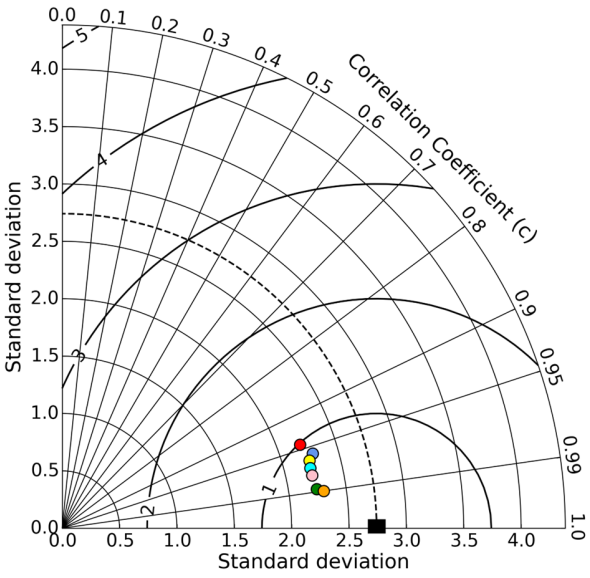




(a) (b)

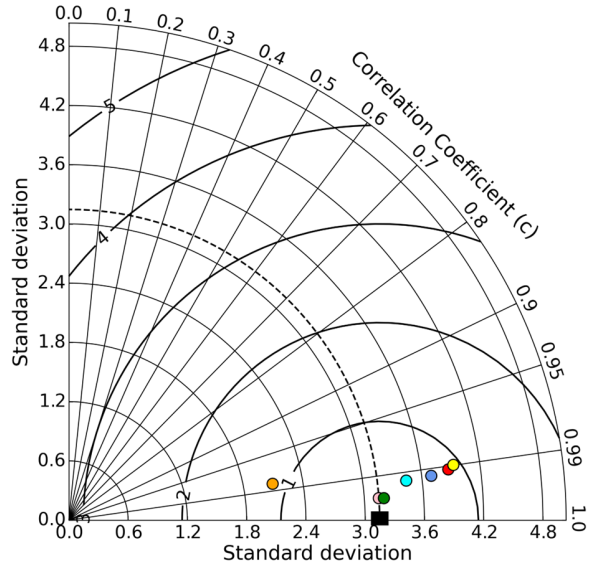


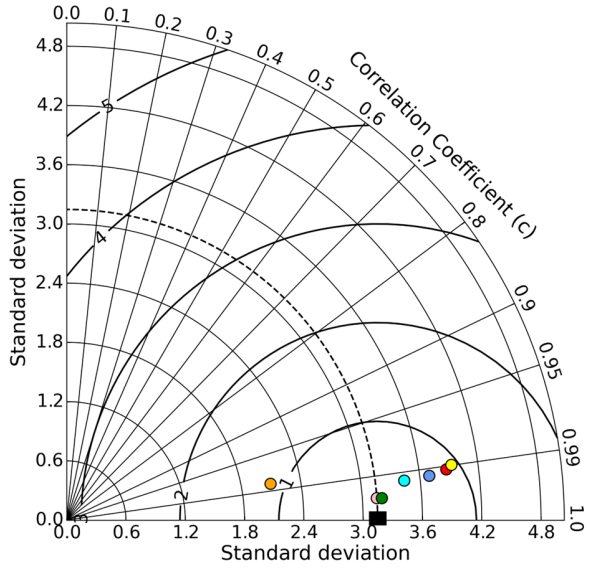
(c)



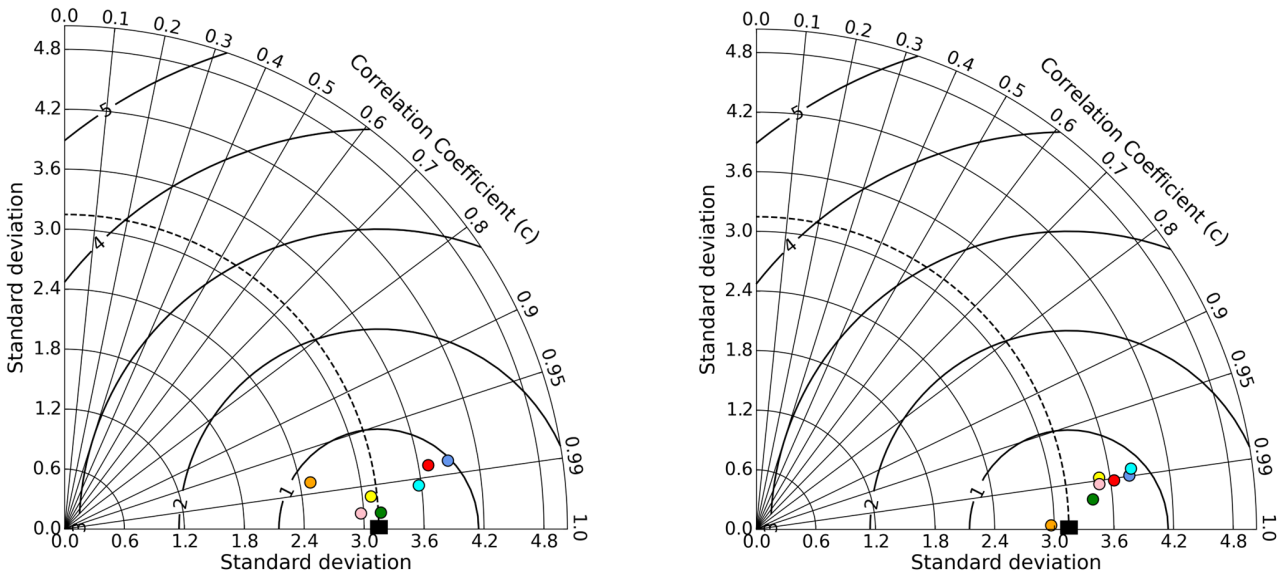
(d)

Figure S5: Taylor diagrams showing model performance across NDVI extraction scales for wells P3; Panels show the results for well P1 using (a) mean NDVI, (b) median NDVI, (c) maximum NDVI, and (d) minimum NDVI;





(a) (b)



(c) (d)

Figure S6: Taylor diagrams showing model performance across NDVI extraction scales for wells P4; Panels show the results for well P1 using (a) mean NDVI, (b) median NDVI, (c) maximum NDVI, and (d) minimum NDVI;

Table S1: Prediction performance metrics (RMSE, MAE, and R^2) for well P1 across six NDVI extraction scales and four statistical metrics

Scale (m)	RMSE Mean	RMSE Median	RMSE Max	RMSE Min	MAE Mean	MAE Median	MAE Max	MAE Min	R^2 Mean	R^2 Median	R^2 Max	R^2 Min
0	0.508	0.587	0.364	0.323	0.474	0.516	0.337	0.302	0.917	0.980	0.978	0.980
500	0.577	0.415	0.308	0.823	0.542	0.382	0.295	0.726	0.928	0.985	0.984	0.937
1000	0.474	0.401	0.351	0.362	0.424	0.370	0.332	0.337	0.947	0.980	0.983	0.993
2500	0.343	0.297	0.198	0.177	0.245	0.224	0.142	0.137	0.944	0.993	0.999	0.995
10000	0.267	0.283	0.125	0.246	0.219	0.236	0.099	0.217	0.928	0.988	0.999	0.994
15000	0.282	0.350	0.090	0.268	0.229	0.294	0.075	0.224	0.916	0.991	0.997	0.999
20000	0.210	0.385	0.257	0.231	0.184	0.323	0.210	0.215	0.929	0.986	0.999	0.801

Table S2: Mean performance metrics by extraction scale and NDVI metric for Well P1

Mean performance metrics by NDVI extraction scale			
Scale (m)	**Average RMSE (m)**	**Average MAE (m)**	**Average R^2**
0	0.446	0.407	0.964
500	0.531	0.486	0.959
1000	0.397	0.366	0.976
2500	0.254	0.187	0.983
10000	0.230	0.193	0.977
15000	0.248	0.206	0.976
20000	0.271	0.233	0.929
Mean performance metrics by NDVI statistical metric			
Metric	Average RMSE (m)	Average MAE (m)	Average R^2
Mean	0.380	0.331	0.929
Median	0.388	0.335	0.986
Maximum	0.242	0.202	0.992
Minimum	0.347	0.307	0.971

Table S3: Prediction performance metrics (RMSE, MAE, and R^2) for Well P2 across six NDVI extraction scales and four statistical metrics

Scale (m)	RMSE Mean	RMSE Median	RMSE Max	RMSE Min	MAE Mean	MAE Median	MAE Max	MAE Min	R^2 Mean	R^2 Median	R^2 Max	R^2 Min
0	0.977	0.886	0.991	0.944	0.599	0.561	0.610	0.531	0.867	0.891	0.864	0.876
500	0.820	1.128	0.893	0.988	0.516	0.686	0.578	0.625	0.907	0.823	0.889	0.864
1000	0.707	0.776	0.347	0.917	0.485	0.527	0.254	0.554	0.931	0.916	0.990	0.883
2500	0.803	0.871	0.904	0.910	0.569	0.652	0.677	0.576	0.910	0.895	0.886	0.885
10000	0.829	0.918	0.758	0.814	0.575	0.591	0.531	0.534	0.905	0.883	0.920	0.908
15000	0.771	0.735	0.443	0.660	0.554	0.504	0.357	0.465	0.917	0.925	0.968	0.940
20000	0.673	0.749	1.013	0.625	0.500	0.575	0.761	0.436	0.937	0.922	0.857	0.946

Table S4: Mean performance metrics by extraction scale and NDVI metric for Well P2

	Mean performance metrics by NDVI extraction scale		
Scale (m)	**Average RMSE (m)**	**Average MAE (m)**	**Average R^2**
0	0.950	0.575	0.875
500	0.957	0.601	0.871
1000	0.437	0.340	0.930
2500	0.872	0.619	0.894
10000	0.830	0.558	0.904
15000	0.652	0.470	0.938
20000	0.765	0.568	0.916
	Mean performance metrics by NDVI statistical metric		
Metric	**Average RMSE (m)**	**Average MAE (m)**	**Average R^2**
Mean	0.797	0.543	0.911
Median	0.866	0.585	0.894
Maximum	0.764	0.538	0.911
Minimum	0.837	0.531	0.900

Table S5: Prediction performance metrics (RMSE, MAE, and R^2) for Well P3 across six NDVI extraction scales and four statistical metrics

Scale (m)	*RMSE Mean*	*RMSE Median*	*RMSE Max*	*RMSE Min*	*MAE Mean*	*MAE Median*	*MAE Max*	*MAE Min*	*R^2 Mean*	*R^2 Median*	*R^2 Max*	*R^2 Min*
0	0.489	0.510	0.446	0.485	0.410	0.430	0.364	0.408	0.985	0.984	0.993	0.994
500	0.578	0.563	0.453	0.523	0.484	0.465	0.376	0.438	0.983	0.992	0.986	0.961
1000	0.511	0.407	0.753	0.482	0.398	0.310	0.510	0.397	0.982	0.981	0.921	0.990
2500	0.506	0.452	0.528	0.447	0.401	0.355	0.407	0.361	0.980	0.932	0.969	0.993
10000	0.473	0.478	0.499	0.553	0.366	0.364	0.396	0.423	0.974	0.993	0.989	0.989
15000	0.522	0.456	0.443	0.625	0.404	0.358	0.357	0.465	0.988	0.989	0.968	0.940
20000	0.451	0.459	0.447	0.660	0.345	0.345	0.348	0.436	0.974	0.947	0.971	0.946

Note: Well P3 uniquely performs best with minimum NDVI metric.

Table S6: Mean performance metrics by extraction scale and NDVI metric for well P3

	Mean performance metrics by NDVI extraction scale		
Scale (m)	**Average RMSE (m)**	**Average MAE (m)**	**Average R^2**
0	0.483	0.403	0.989
500	0.529	0.441	0.981
1000	0.538	0.404	0.969

2500	0.483	0.381	0.969
10000	0.501	0.387	0.986
15000	0.512	0.396	0.971
20000	0.504	0.369	0.960
	Mean performance metrics by NDVI statistical metric		
Metric	**Average RMSE (m)**	**Average MAE (m)**	**Average R^2**
Mean	0.504	0.401	0.981
Median	0.475	0.375	0.974
Maximum	0.510	0.394	0.971
Minimum	0.539	0.418	0.973

Note: Minimum NDVI's success for P3 suggests vegetation stress indicators provide valuable information.

Table S7: Prediction performance metrics (RMSE, MAE, and R^2) for well P4 across six NDVI extraction scales and four statistical metrics

Scale (m)	**RMSE Mean**	**RMSE Median**	**RMSE Max**	**RMSE Min**	**MAE Mean**	**MAE Median**	**MAE Max**	**MAE Min**	**R^2 Mean**	**R^2 Median**	**R^2 Max**	**R^2 Min**
0	1.063	1.166	1.359	0.952	0.823	0.809	0.959	0.581	0.860	0.832	0.888	0.772
500	1.034	1.213	1.602	1.181	0.639	0.898	1.386	0.977	0.868	0.818	0.828	0.683
1000	0.997	1.032	1.473	1.112	0.622	0.683	1.437	0.935	0.877	0.869	0.847	0.732
2500	0.970	0.894	1.213	0.936	0.842	0.604	1.061	0.533	0.884	0.901	0.892	0.818
10000	0.549	1.450	0.509	1.082	0.502	1.388	0.457	0.936	0.963	0.740	0.855	0.968
15000	0.220	0.352	0.168	0.411	0.157	0.280	0.142	0.234	0.994	0.985	0.979	0.997
20000	1.318	2.026	0.822	0.580	1.181	1.435	0.761	0.558	0.786	0.493	0.958	0.917

Table S8: Mean performance metrics by extraction scale and NDVI metric for well P4

	Mean performance metrics by NDVI extraction scale		
Scale (m)	**Average RMSE (m)**	**Average MAE (m)**	**Average R^2**
0	1.135	0.793	0.838
500	1.258	0.975	0.799
1000	1.154	0.919	0.831
2500	1.003	0.760	0.874
10000	0.898	0.821	0.882
15000	0.288	0.203	0.989
20000	1.187	0.984	0.789
	Mean performance metrics by NDVI statistical metric		
Metric	**Average RMSE (m)**	**Average MAE (m)**	**Average R^2**
Mean	0.879	0.681	0.890
Median	1.162	0.871	0.806
Maximum	1.021	0.886	0.893
Minimum	0.893	0.679	0.841

Note: Well P4 demonstrates strongest scale dependence, with dramatic performance improvement at 15,000 m.

Table S9: Evolution of irrigated area by extraction scale and drought period for wells P2, P3, and P4

	Well P2 - Irrigated Area (km²) where NDVI > 0.45				
Scale (m)	**2001-07-28**	**2005-07-12**	**2010-07-12**	**2017-07-28**	**Average**
500	0.145	0.218	0.695	0.702	0.440
1000	1.0	1.7	2.8	2.9	2.1
2500	7.9	12.5	15.8	15.2	12.9
10000	82.3	145.2	184.1	188.5	150.0
15000	146.8	260.1	356.8	375.3	284.8
20000	198.5	364.2	487.9	515.6	391.6
	Well P3 - Irrigated Area (km²) where NDVI > 0.45				
Scale (m)	**2001-07-28**	**2005-07-12**	**2010-07-12**	**2017-07-28**	**Average**
500	0.156	0.235	0.728	0.738	0.464
1000	1.05	1.85	2.95	2.98	2.21
2500	8.2	12.9	16.2	15.6	13.2
10000	84.6	148.5	188.2	191.8	153.3
15000	149.3	264.2	360.5	379.6	288.4
20000	200.1	367.8	492.3	520.2	395.1
	Well P4 - Irrigated Area (km²) where NDVI > 0.45				
Scale (m)	**2001-07-28**	**2005-07-12**	**2010-07-12**	**2017-07-28**	**Average**
500	0.168	0.251	0.785	0.782	0.497
1000	1.15	1.95	3.05	3.02	2.29
2500	8.8	13.7	17.0	16.3	13.9
10000	87.8	152.3	192.8	196.4	157.3
15000	153.5	269.5	367.3	386.8	294.3
20000	204.6	373.9	499.8	528.1	401.6

Note: All values represent areas where NDVI > 0.45 during major drought periods. Dates selected as driest July periods during 2000-2020. Average column shows mean across four dates.