



Supplement of

OasisMap30: a 30 m annual land cover dataset of China's oases from 1987 to 2024

Peng Chen et al.

Correspondence to: Qiang Tang (qiangtang@swu.edu.cn)

The copyright of individual parts of the supplement might differ from the article licence.

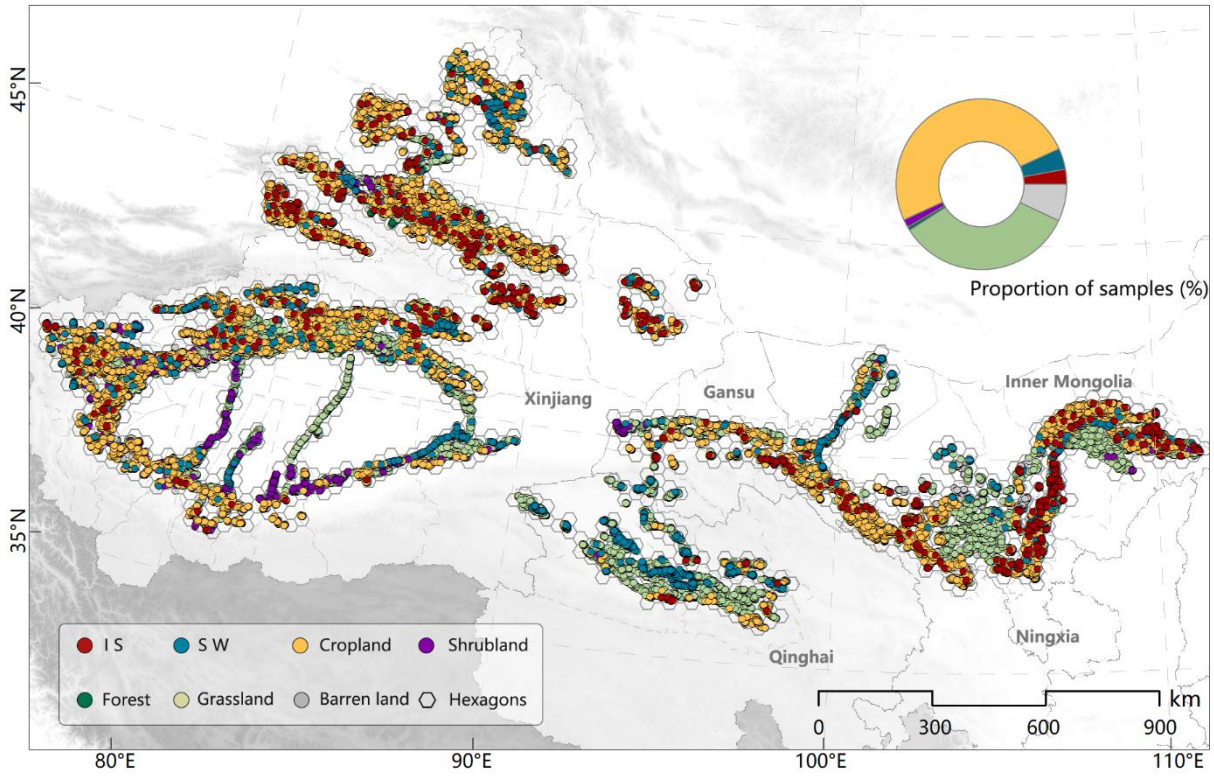


Figure S1: Spatial distribution of validation samples (taking the year 2024 as an example).

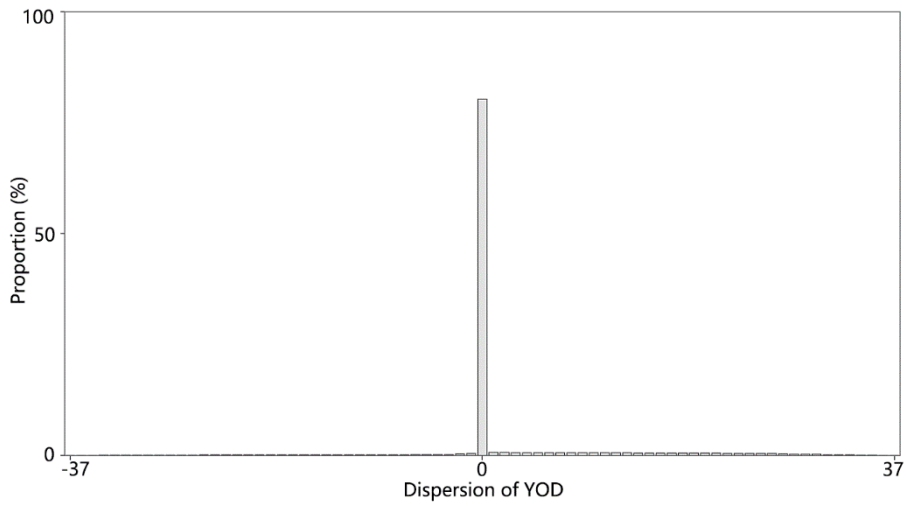


Figure S2: Dispersion of YOD for each indicator based on Landtrendr.

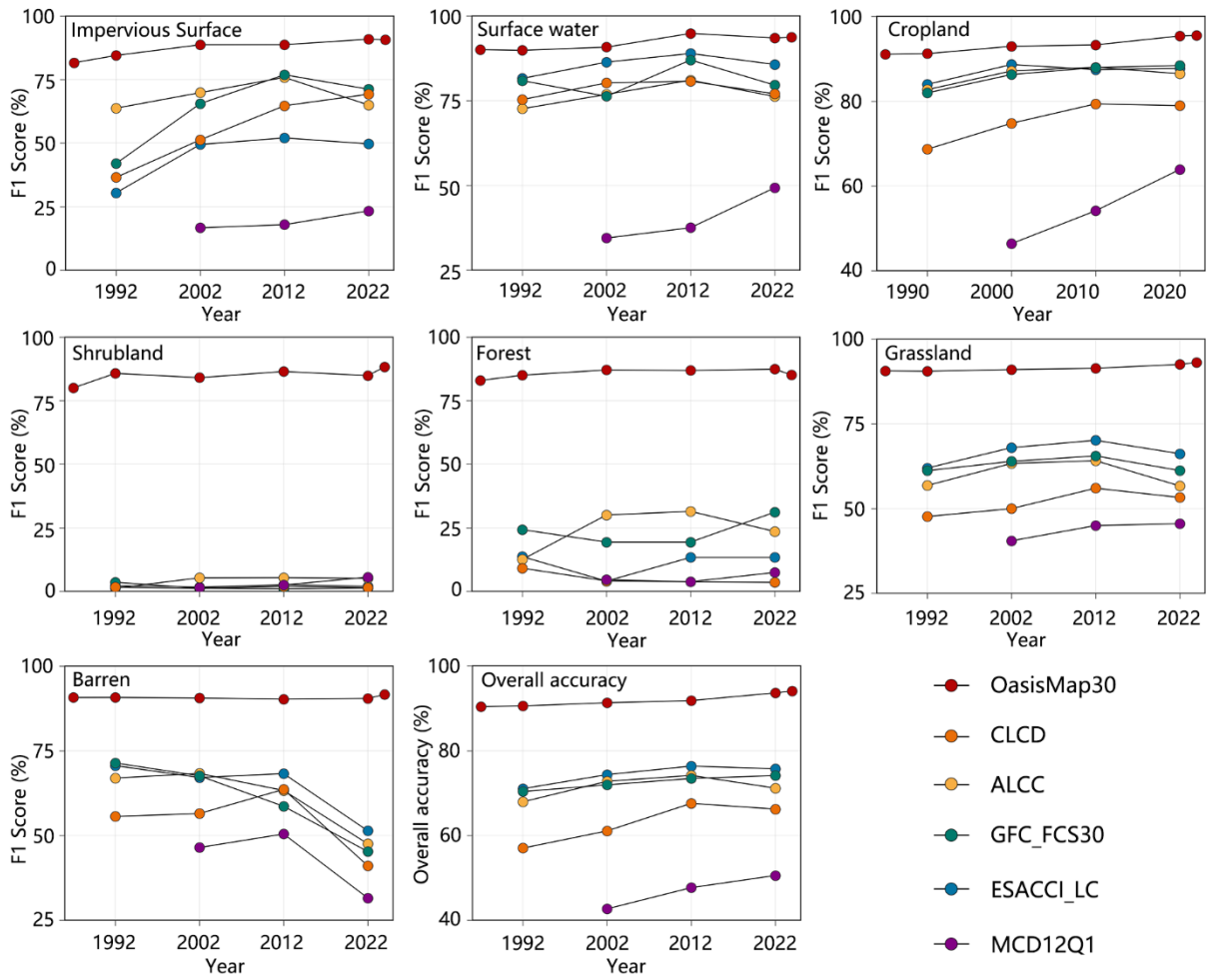


Figure S3: F1 score and overall accuracy for CLCD, ALCC, GLC_FCS30, ESACCI_LC, MCD12Q1 and OasisMap30 based on visually interpreted test samples.

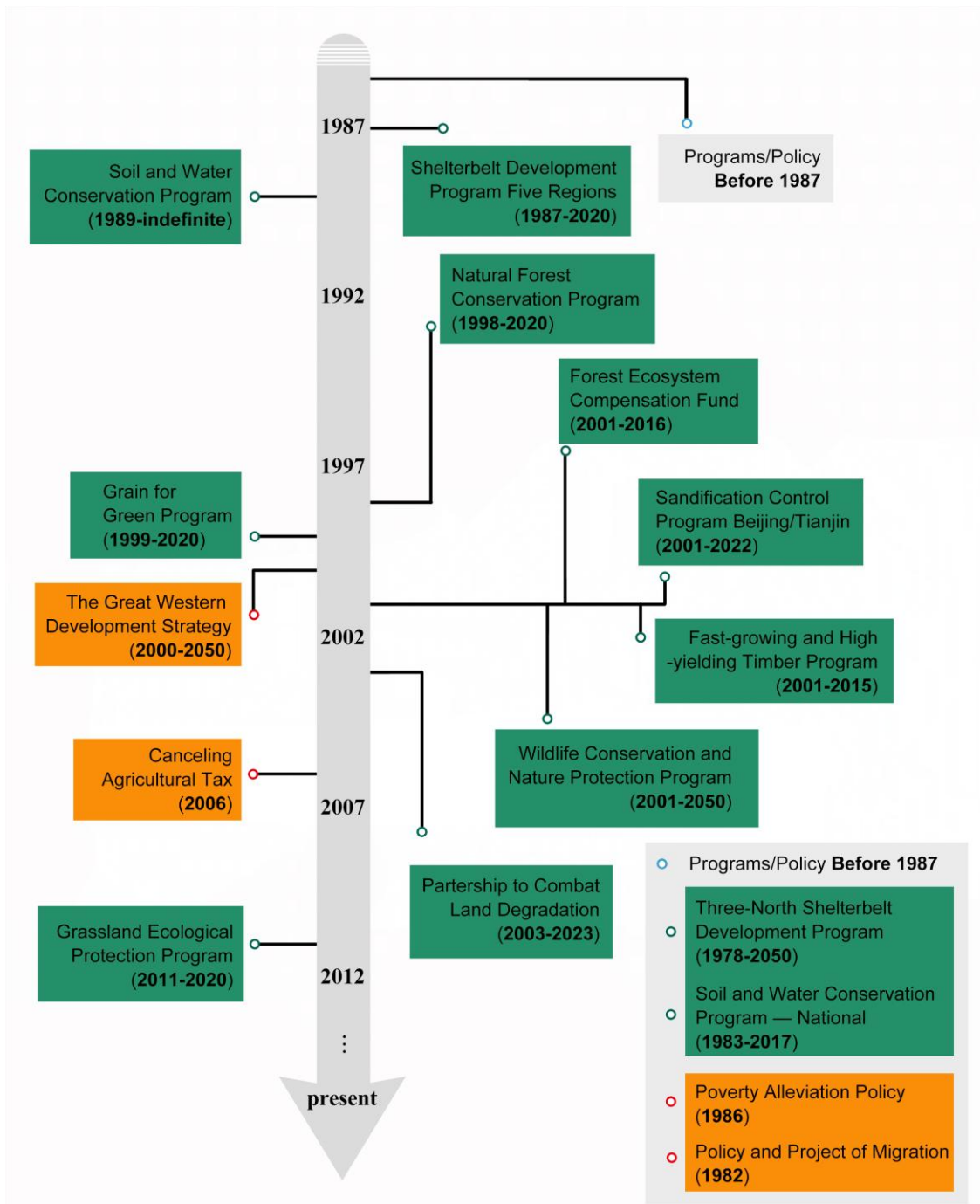


Figure S4: Major ecological projects and policies related to the Oasis region.

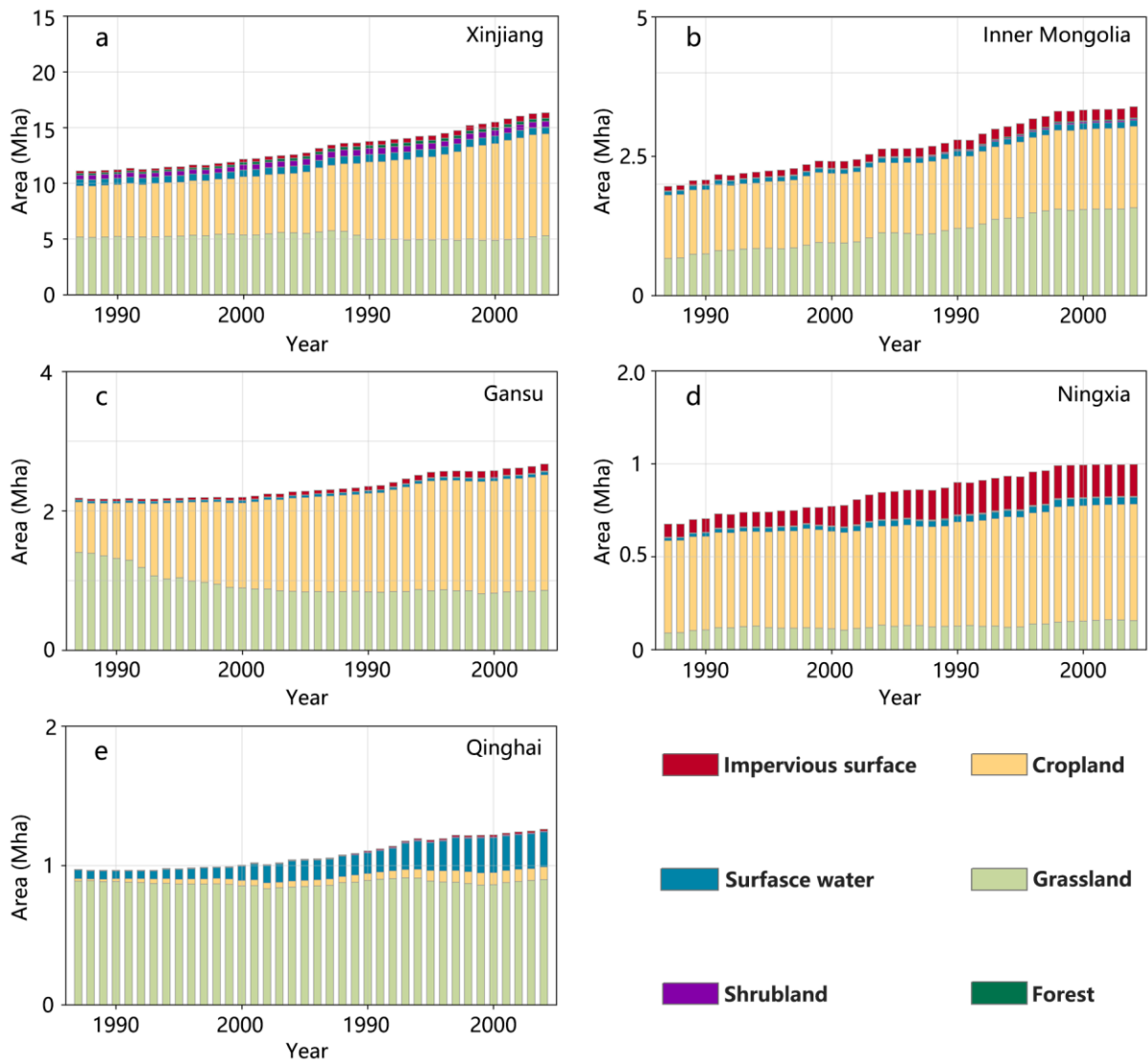


Figure S5: Changes in the spatial structure of oases at provincial/autonomous scales during 1987–2024.

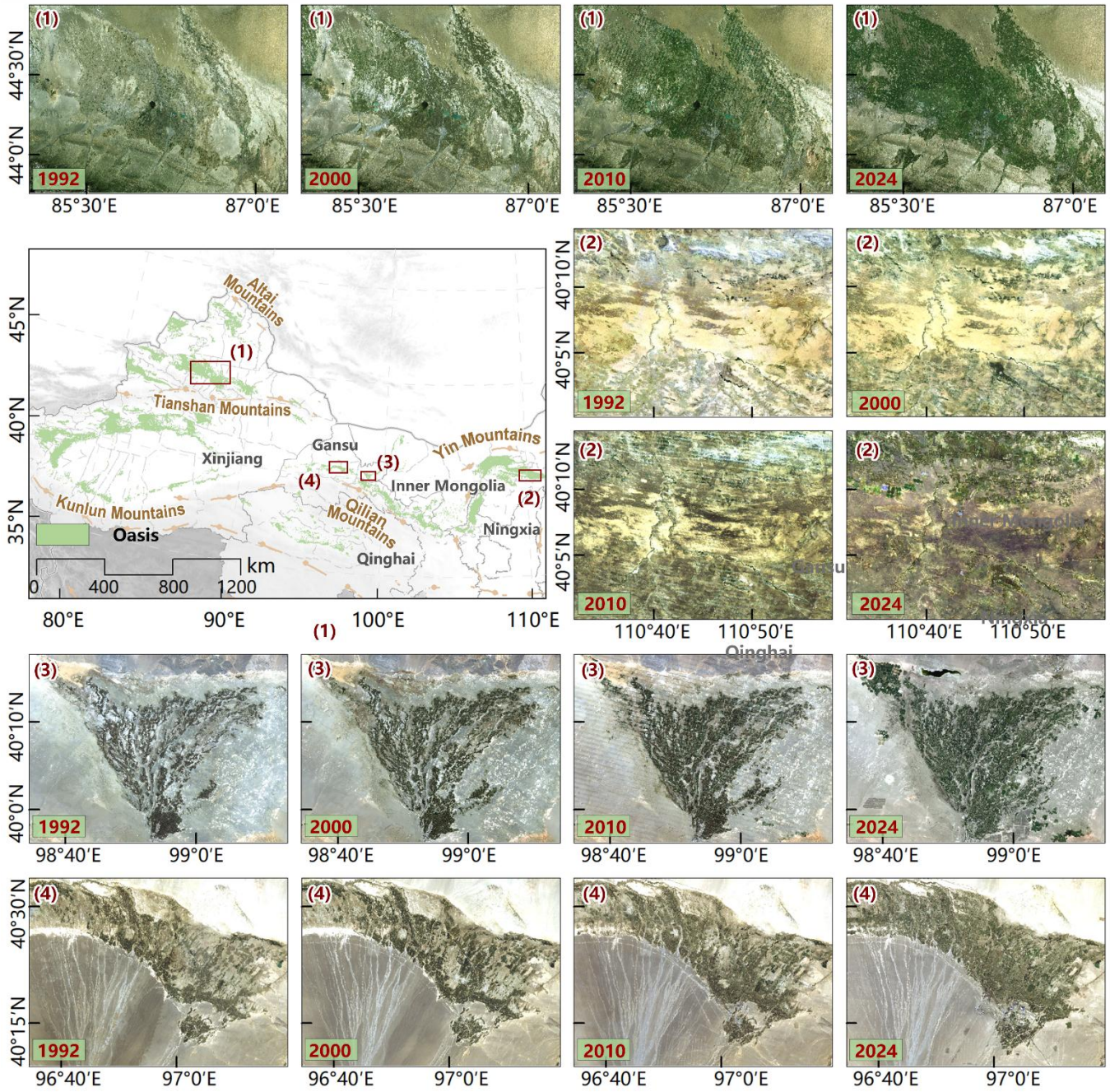


Figure S6: The Expansion Process of China's Oases. All the Landsat images are freely provided by USGS.

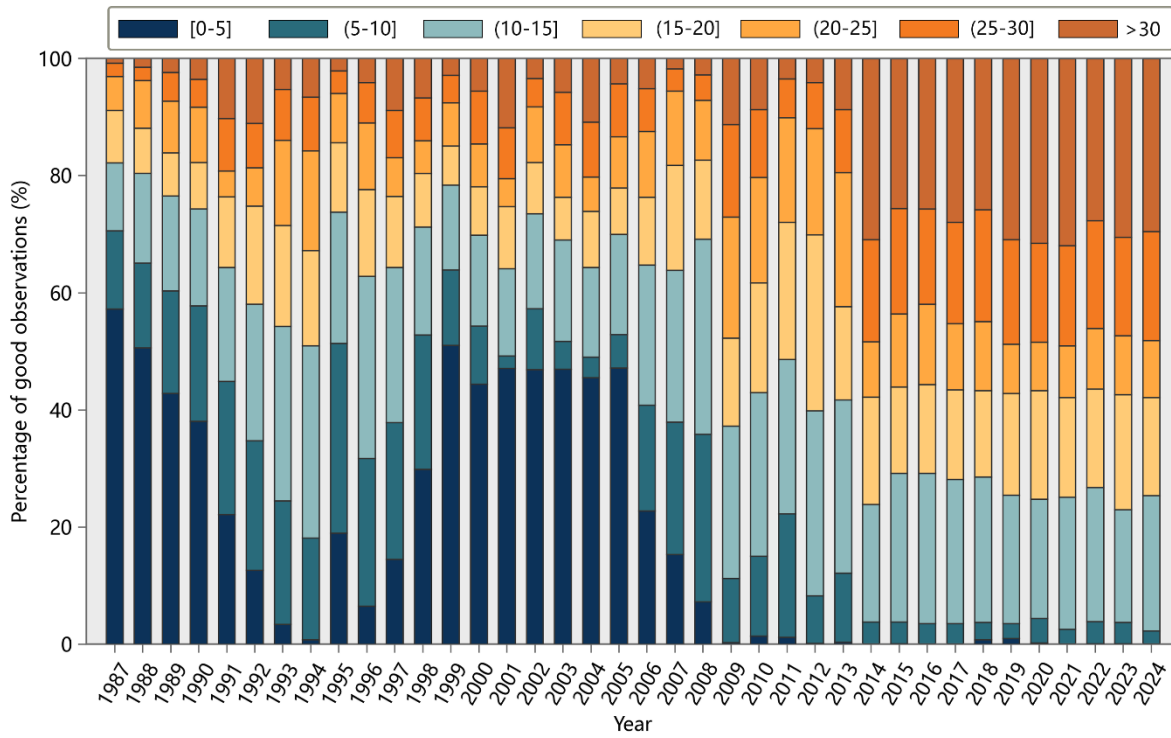


Figure S7: Percentage of good-quality observations during 1987–2024. Different colors indicate the number of Landsat images.

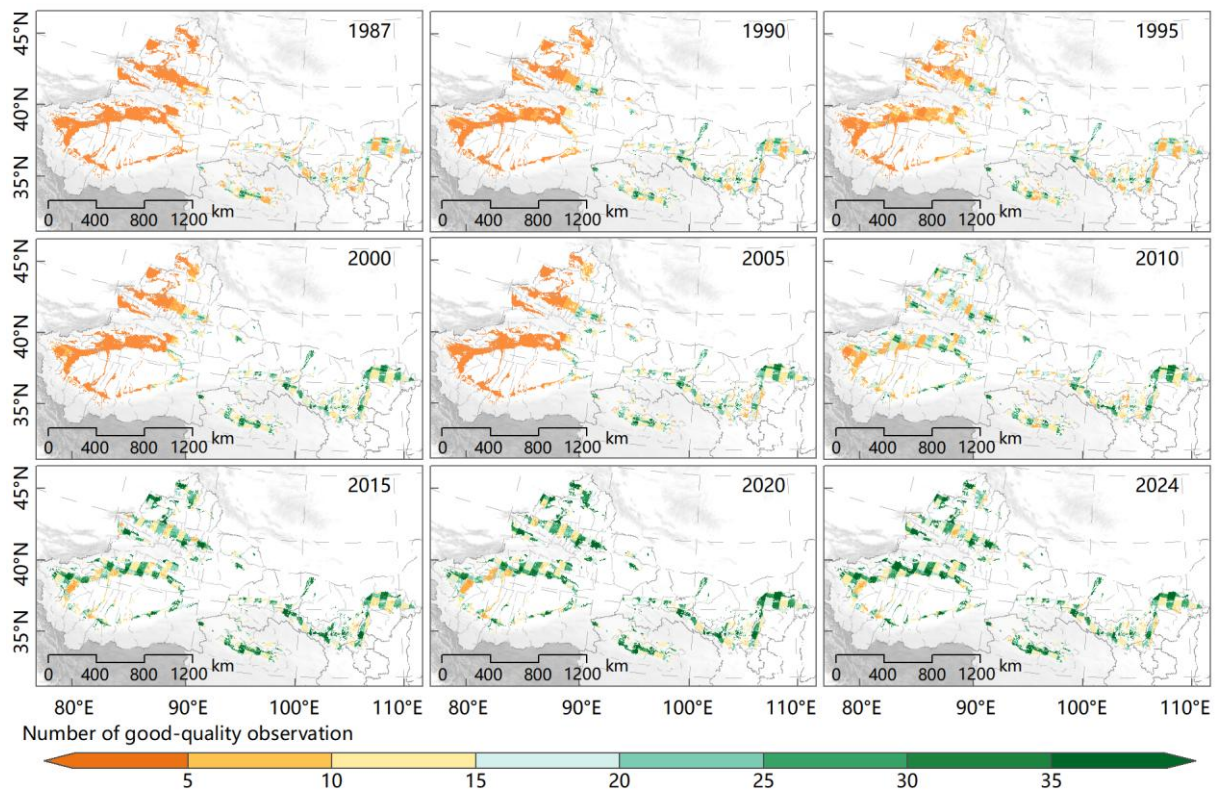


Figure S8: Spatial distribution of good-quality observations of Landsat data in China's oases.

Table S1. The features used for OasisMap30 mapping.

Features	Description
$\rho_{\text{Blue}}, \rho_{\text{Green}}, \rho_{\text{Red}}, \rho_{\text{Nir}}, \rho_{\text{SW11}}, \rho_{\text{SW12}}$	50th percentile value of surface reflectance derived from all available Landsat image.
NDVI	$\text{NDVI} = (\rho_{\text{Nir}} - \rho_{\text{Red}}) / (\rho_{\text{Nir}} + \rho_{\text{Red}})$
MNDWI	$\text{MNDWI} = (\rho_{\text{Green}} - \rho_{\text{SW11}}) / (\rho_{\text{Green}} + \rho_{\text{SW11}})$
NDBI	$\text{NDBI} = (\rho_{\text{SW11}} - \rho_{\text{Nir}}) / (\rho_{\text{SW11}} + \rho_{\text{Nir}})$
Wetness	<p>for Landsat 5 TM: $\text{Wetness} = 0.1509 \times \rho_{\text{Blue}} + 0.1973 \times \rho_{\text{Green}} + 0.3279 \times \rho_{\text{Red}} + 0.3406 \times \rho_{\text{Nir}} - 0.7112 \times \rho_{\text{SW11}} - 0.4572 \times \rho_{\text{SW12}}$</p> <p>for Landsat 7 ETM+: $\text{Wetness} = 0.2626 \times \rho_{\text{Blue}} + 0.2141 \times \rho_{\text{Green}} + 0.0926 \times \rho_{\text{Red}} + 0.0656 \times \rho_{\text{Nir}} - 0.7629 \times \rho_{\text{SW11}} - 0.5388 \times \rho_{\text{SW12}}$</p> <p>for Landsat 8 OLI: $\text{Wetness} = 0.1511 \times \rho_{\text{Blue}} + 0.1973 \times \rho_{\text{Green}} + 0.3283 \times \rho_{\text{Red}} + 0.3407 \times \rho_{\text{Nir}} - 0.7117 \times \rho_{\text{SW11}} - 0.4559 \times \rho_{\text{SW12}}$</p>
Soil brightness	<p>for Landsat 5 TM: $\text{Soil brightness} = 0.3037 \times \rho_{\text{Blue}} + 0.2793 \times \rho_{\text{Green}} + 0.4743 \times \rho_{\text{Red}} + 0.5585 \times \rho_{\text{Nir}} + 0.5082 \times \rho_{\text{SW11}} + 0.1863 \times \rho_{\text{SW12}}$</p> <p>for Landsat 7 ETM+: $\text{Soil brightness} = 0.3561 \times \rho_{\text{Blue}} + 0.3972 \times \rho_{\text{Green}} + 0.3904 \times \rho_{\text{Red}} + 0.6966 \times \rho_{\text{Nir}} + 0.2286 \times \rho_{\text{SW11}} + 0.1596 \times \rho_{\text{SW12}}$</p> <p>for Landsat 8 OLI: $\text{Soil brightness} = 0.3029 \times \rho_{\text{Blue}} + 0.2786 \times \rho_{\text{Green}} + 0.4733 \times \rho_{\text{Red}} + 0.5599 \times \rho_{\text{Nir}} + 0.508 \times \rho_{\text{SW11}} + 0.1872 \times \rho_{\text{SW12}}$</p>
Greenness	<p>for Landsat 5 TM: $\text{Greenness} = -0.2848 \times \rho_{\text{Blue}} - 0.243 \times \rho_{\text{Green}} - 0.5436 \times \rho_{\text{Red}} + 0.7243 \times \rho_{\text{Nir}} + 0.0840 \times \rho_{\text{SW11}} - 0.1800 \times \rho_{\text{SW12}}$</p> <p>for Landsat 7 ETM+: $\text{Greenness} = -0.3344 \times \rho_{\text{Blue}} - 0.3544 \times \rho_{\text{Green}} - 0.4556 \times \rho_{\text{Red}} + 0.6966 \times \rho_{\text{Nir}} - 0.0242 \times \rho_{\text{SW11}} - 0.2630 \times \rho_{\text{SW12}}$</p> <p>for Landsat 8 OLI: $\text{Greenness} = -0.2941 \times \rho_{\text{Blue}} - 0.243 \times \rho_{\text{Green}} + 0.5424 \times \rho_{\text{Red}} + 0.7276 \times \rho_{\text{Nir}} + 0.0713 \times \rho_{\text{SW11}} - 0.1608 \times \rho_{\text{SW12}}$</p>
Elevation, Slope, Aspect, and Hillshade	Elevation, Slope, Aspect, and Hillshade calculated from SRTM elevation.

Table S2. LandTrendr parameter settings

Parameter	Setting	Description
maxSegments	8	Maximum number of segments to be fitted on the time series
spikeThreshold	0.9	Threshold for dampening the spikes (1.0 means no dampening)
vertexCountOvershoot	3	The initial model can overshoot the maxSegments + 1 vertices by this amount. Later, it will be pruned down to maxSegments + 1
preventOneYearRecovery	ture	Prevent segments that represent one year recoveries
recoveryThreshold	0.25	If a segment has a recovery rate faster than 1/recoveryThreshold (in years), then the segment is disallowed
pvalThreshold	0.05	If the p-value of the fitted model exceeds this threshold, then the current model is discarded and another one is fitted using the Levenberg-Marquardt optimizer
bestModelProportion	0.75	Takes the model with most vertices that has a p-value that is at most this proportion away from the model with lowest p-value
minObservationsNeeded	6	Min observations needed to perform output fitting

Table S3. Cross-walking table between different datasets.

Target type			Source type		
OasisMap30	CLCD	ALLC	GLC_FCS30	ESACCI_LC	MCD12Q1 (IGBP)
Impervious surface	Impervious	Impervious surfaces	Impervious surface	Urban areas	Urban and built-up lands
Surface water	Water	Water	Water body	Water bodies	Water bodies
Cropland	Cropland	Cropland	Rainfed cropland; Herbaceous cover cropland; Tree or shrub cover (Orchard) cropland; Irrigated cropland;	Cropland, rainfed; Cropland, irrigated or post-flooding; Mosaic cropland (>50%) / natural vegetation (tree, shrub, herbaceous cover) (<50%); Mosaic natural vegetation (tree, shrub, herbaceous cover) (>50%/cropland);	Croplands; Cropland / natural vegetation mosaics;
Shrubland	Shrub	Shrubland	Shrubland; Evergreen shrubland; Deciduous shrubland; Sparse shrubland ($fc < 0.15$);	Shrubland	Closed shrublands; Open shrublands;
Forest	Forest	Forest	Open evergreen broadleaved forest; Closed evergreen broadleaved forest; Open deciduous broadleaved forest ($0.15 < fc < 0.4$); Closed deciduous broadleaved forest ($fc > 0.4$); Open evergreen needle-leaved forest ($0.15 < fc < 0.4$); Closed evergreen needle-leaved forest ($fc > 0.4$); Open deciduous needle-leaved forest ($0.15 < fc < 0.4$); Closed deciduous needle-leaved forest ($0.15 < fc < 0.4$); Open mixed leaf forest (broadleaved and needle-leaved); Closed mixed leaf forest (broadleaved and needle-leaved)	Tree cover, broadleaved, evergreen, closed to open (>15%); Tree cover, broadleaved, deciduous, closed to open (>15%); Tree cover, broadleaved, deciduous, closed (>40%); Tree cover, broadleaved, deciduous, open (15-40%); Tree cover, needleleaved, evergreen, closed to open (>15%); Tree cover, needleleaved, evergreen, closed (>40%); Tree cover, needleleaved, evergreen, open (15-40%); Tree cover, needleleaved, deciduous, closed to open (>15%); Tree cover, needleleaved, deciduous, closed (>40%); Tree cover, needleleaved, deciduous, open (15-40%); Tree cover, mixed leaf type (broadleaved and needleleaved); Mosaic tree and shrub (>50%) / herbaceous cover (<50%); Mosaic herbaceous cover (>50%) / tree and shrub (<50%);	Evergreen needleleaf forests; Evergreen broadleaf forests; Deciduous needleleaf forests; Deciduous broadleaf forests; Mixed forests; Woody savannas; Savannas;
Grassland	Grassland	Grassland	Grassland; Lichens and mosses; Sparse vegetation ($fc < 0.15$); Sparse herbaceous ($fc < 0.15$);	Grassland; Sparse vegetation (tree, shrub, herbaceous cover) (<15%); Lichens and mosses;	Grasslands
Barren land	Barren	Bare land	Bare areas; Consolidated bare areas; Unconsolidated bare areas;	Bare areas	Barren

Table S4. Pixel-wise accuracy of OasisMap30 calculated based on the annual visually interpreted samples.

Year	OA	Kappa
1987	90.40	0.864
1988	90.43	0.865
1989	90.47	0.867
1990	90.45	0.868
1991	90.51	0.868
1992	90.55	0.866
1993	90.67	0.870
1994	90.71	0.872
1995	90.74	0.871
1996	90.82	0.875
1997	90.91	0.876
1998	91.03	0.878
1999	91.13	0.876
2000	91.12	0.877
2001	91.20	0.876
2002	91.32	0.877
2003	91.47	0.878
2004	91.43	0.879
2005	91.48	0.879
2006	91.59	0.880
2007	91.52	0.881
2008	91.63	0.882
2009	91.67	0.882
2010	91.72	0.882
2011	91.77	0.883
2012	91.82	0.883
2013	91.96	0.883
2014	91.85	0.883
2015	92.04	0.885
2016	92.38	0.886
2017	92.51	0.889
2018	92.90	0.891
2019	92.88	0.890
2020	93.09	0.893
2021	93.34	0.896
2022	93.64	0.899
2023	93.85	0.899
2024	94.05	0.902

Note: OA: overall accuracy; Kappa: Kappa coefficient.

Table S5. Comparison of mapping accuracy, area, uncertainty based on visually interpreted for OasisMap30, CLCD, ALCC, GLC_FCS30, ESACCI_LC, and MCD12Q1.

Datasets	LUCC	1992		2002		2012		2022	
		UA (%)	Area (Mha)	UA (%)	Area (Mha)	UA (%)	Area (Mha)	UA (%)	Area (Mha)
OasisMap30	I S	83.65±6.6	0.41±0.042	87.85±5.89	0.6±0.045	87.93±4.59	0.8±0.05	90.86±4.08	0.96±0.051
	S W	90.37±4.25	0.75±0.047	90.28±4.09	0.9±0.049	93.93±3.14	1.01±0.041	93.66±2.91	1.09±0.047
	Cropland	93.3±1.09	7.33±0.137	93.52±1.00	8.38±0.131	93.18±0.95	10.5±0.141	95.76±0.68	12.81±0.133
	Shrubland	86.21±6.73	0.42±0.041	84.03±6.06	0.5±0.049	88.16±4.75	0.58±0.049	86.6±6.21	0.55±0.05
	Forest	87.18±9.67	0.17±0.027	88.1±9.19	0.25±0.031	86±9.1	0.3±0.035	88.24±8.31	0.29±0.034
	Grassland	90.02±1.21	8.16±0.149	90.85±1.17	8.27±0.145	91.6±1.14	8.11±0.144	91.78±1.13	8.48±0.134
	Barren land	89.32±1.29	8.08±0.144	90.08±1.35	6.43±0.132	90.08±1.67	4.02±0.109	90.61±2.54	1.12±0.063
CLCD	I S	20.19±6.15	0.12±0.04	42.06±7.29	0.25±0.075	44.25±5.89	0.52±0.078	47.43±5.36	0.79±0.184
	S W	82.54±5.2	0.7±0.084	85.41±4.77	0.81±0.082	84.12±4.77	0.91±0.085	82.94±4.38	0.89±0.142
	Cropland	94.58±0.91	8.56±0.26	93.38±0.97	9.11±0.243	93.73±0.85	11.34±0.329	90.7±0.93	12.17±0.324
	Shrubland	1.15±1.29	0±0.012	0.84±1.16	0±0.003	1.32±1.48	0±0.003	1.03±1.42	0±0.016
	Forest	7.69±7.24	0.01±0.013	2.38±1.74	0.04±0.029	8±5.01	0.05±0.021	7.84±5.22	0.05±0.067
	Grassland	63.07±1.6	12.64±0.471	72.66±1.51	13.4±0.477	71.55±1.62	12.67±0.492	63.08±1.71	12.07±0.709
	Barren land	64.54±1.83	18.77±0.438	60.42±2.02	17.18±0.447	62.56±2.46	15.29±0.464	59.61±3.02	14.84±0.692
ALCC	I S	62.5±7.54	0.4±0.069	61.68±8.32	0.78±0.084	71.26±6.07	0.97±0.084	88.57±3.38	1.09±0.184
	S W	88.56±3.81	0.76±0.103	91.36±3.3	0.92±0.108	88.79±3.66	0.85±0.113	94.05±2.34	0.83±0.293
	Cropland	96.65±0.71	11.23±0.25	96.06±0.74	11.15±0.241	96.06±0.68	12.28±0.3	87.89±1.04	13.42±0.396
	Shrubland	1.15±0.26	0.3±0.068	4.2±0.97	0.44±0.084	3.95±0.9	0.57±0.1	6.19±1	0.58±0.112
	Forest	7.69±5.12	0.16±0.023	21.43±9.03	0.15±0.031	22±8.74	0.16±0.032	19.61±6	0.18±0.077
	Grassland	54.83±1.62	8.11±0.421	61.36±1.67	8.5±0.431	59.95±1.76	8.88±0.469	47.69±1.78	8.72±0.604
	Barren land	59.06±1.87	18.07±0.407	62.71±1.99	17.1±0.417	60.23±2.34	15.31±0.463	62.88±2.74	14.24±0.651
GLC_FCS30	I S	41.35±6.21	0.4±0.091	71.03±6.73	0.78±0.119	76.44±5.56	0.97±0.088	72±5.6	1.09±0.14
	S W	77.72±5.83	0.76±0.077	77.3±5.25	0.92±0.125	82.72±4.86	0.85±0.097	71.04±5.34	0.83±0.103
	Cropland	94.19±0.92	11.23±0.272	91.13±1.09	11.15±0.263	93.14±0.9	12.28±0.294	93.42±0.79	13.42±0.294
	Shrubland	2.3±0.91	0.3±0.048	0.84±0.24	0.44±0.078	0.66±0.15	0.57±0.12	1.03±0.26	0.58±0.208
	Forest	30.77±6.53	0.16±0.069	21.43±5.26	0.15±0.064	18±4.93	0.16±0.053	27.45±7.43	0.18±0.049
	Grassland	57.83±1.69	8.11±0.398	61.55±1.68	8.5±0.416	64.42±1.69	8.88±0.486	52.97±1.81	8.72±0.657
	Barren land	67.09±1.78	18.07±0.395	66.71±1.85	17.1±0.418	55.5±2.29	15.31±0.472	60.26±2.7	14.24±0.66
ESACCI_LC	I S	24.04±7.26	0.08±0.03	37.38±8.37	0.11±0.034	50±7.15	0.24±0.035	66.86±5.93	0.55±0.094
	S W	77.11±5.5	0.79±0.095	81.09±5.04	0.83±0.092	74.3±5.52	0.86±0.08	73.02±4.96	0.92±0.142
	Cropland	81.45±1.39	10.96±0.401	86.49±1.18	12.12±0.385	88.37±1.06	13.45±0.371	82.03±1.16	13.64±0.442
	Shrubland	1.15±0.38	0.37±0.074	0.84±0.21	0.37±0.103	1.32±0.33	0.37±0.128	1.03±0.33	0.37±0.165
	Forest	5.13±4.9	0.03±0.021	2.38±1.88	0.03±0.031	2±2.24	0.03±0.027	1.96±1.7	0.04±0.023
	Grassland	46.06±1.49	12.31±0.457	47.55±1.53	12.92±0.455	52.86±1.66	13.17±0.472	49.86±1.61	13.26±0.636
	Barren land	50.44±1.71	16.26±0.435	51.26±1.88	14.42±0.416	60.86±2.33	12.69±0.416	48.25±2.74	12.02±0.591
MCD12Q1	I S	/	/	14.95±2.95	0.42±0.095	13.79±2.6	0.43±0.081	20±3.15	0.44±0.112
	S W	/	/	24.87±4.69	0.49±0.091	26.64±4.74	0.46±0.095	34.53±5.48	0.48±0.1
	Cropland	/	/	35.19±1.67	4.86±0.274	43.63±1.63	6.79±0.317	53.76±1.53	8.19±0.404
	Shrubland	/	/	0.84±0.42	0.12±0.044	1.32±0.85	0.04±0.038	3.09±1.89	0.06±0.091
	Forest	/	/	2.38±4.61	0.001±0.013	2±2.74	0.001±0.019	3.92±5.33	0.001±0.013
	Grassland	/	/	49.46±1.24	14.51±0.524	53.64±1.34	14.4±0.543	51.89±1.36	14.41±0.707
	Barren land	/	/	51.09±1.55	17.36±0.515	63.54±1.82	15.63±0.533	57.64±2.11	14.18±0.707

Note: 95% confidence intervals were used to estimate uncertainty. I S: Impervious surface; S W: Surface water.

Table S6. Confusion matrix of OasisMap30 in 1987 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	82	0	6	2	0	4	5	99	82.83
S W	1	149	2	1	0	4	10	167	89.22
Cropland	2	4	1617	3	3	42	98	1769	91.41
Shrubland	3	0	7	72	1	2	3	88	81.82
Forest	1	0	2	2	34	0	0	39	87.18
Grassland	6	5	104	9	5	1901	93	2123	89.54
Barren land	7	6	44	3	0	121	1897	2078	91.29
Sum	102	164	1782	92	43	2074	2106	6363	Kappa= 0.86
PA (%)	80.39	90.85	90.74	78.26	79.07	91.66	90.08		OA= 90.40%

Note: I S: Impervious surface; S W: Surface water.

Table S7. Confusion matrix of OasisMap30 in 1992 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	87	3	4	1	0	4	5	104	83.65
S W	0	150	4	0	0	8	4	166	90.36
Cropland	4	2	1670	3	3	61	47	1790	93.30
Shrub	1	0	4	75	0	6	1	87	86.21
Forest	0	0	2	1	34	2	0	39	87.18
Grassland	2	6	93	8	4	1921	99	2134	90.02
Barren land	8	6	94	0	0	110	1824	2042	89.32
Sum	102	167	1871	88	41	2112	1981	6362	Kappa=0.87
PA (%)	85.29	89.82	89.26	85.23	82.93	90.96	92.07		OA=90.55%

Note: I S: Impervious surface; S W: Surface water.

Table S8. Confusion matrix of OasisMap30 in 2002 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	94	1	4	1	0	1	6	107	87.85
S W	1	167	3	2	0	5	7	185	90.27
Cropland	1	0	1993	2	1	90	44	2131	93.52
Shrub	2	0	7	100	1	7	2	119	84.03
Forest	0	0	1	2	37	2	0	42	88.10
Grassland	2	7	83	8	3	1947	93	2143	90.85
Barren land	5	8	66	4	1	85	1534	1703	90.08
Sum	105	183	2157	119	43	2137	1686	6430	Kappa=0.88
PA (%)	89.52	91.26	92.40	84.03	86.05	91.11	90.98		OA=91.32%

Note: I S: Impervious surface; S W: Surface water.

Table S9. Confusion matrix of OasisMap30 in 2012 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	153	0	3	0	0	3	15	174	87.93
S W	1	201	4	1	0	2	5	214	93.93
Cropland	3	3	2364	3	1	125	38	2537	93.18
Shrub	2	0	7	134	0	7	2	152	88.16
Forest	0	1	1	1	43	4	0	50	86.00
Grassland	4	4	101	13	3	1887	48	2060	91.60
Barren land	8	1	51	6	2	43	1008	1119	90.08
Sum	171	210	2531	158	49	2071	1116	6306	Kappa=0.88
PA (%)	89.47	95.71	93.40	84.81	87.76	91.12	90.32		OA=91.82%

Note: I S: Impervious surface; S W: Surface water.

Table S10. Confusion matrix of OasisMap30 in 2022 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	159	0	3	1	0	5	7	175	90.86
S W	0	236	7	1	0	7	1	252	93.65
Cropland	4	3	3069	4	2	107	16	3205	95.76
Shrub	0	1	10	84	1	1	0	97	86.60
Forest	0	1	3	0	45	2	0	51	88.24
Grassland	9	10	121	9	4	1944	21	2118	91.78
Barren land	3	2	16	2	0	20	415	458	90.61
Sum	175	253	3229	101	52	2086	460	6356	Kappa=0.90
PA (%)	90.86	93.28	95.04	83.17	86.54	93.19	90.22		OA=93.64%

Note: I S: Impervious surface; S W: Surface water.

Table S11. Confusion matrix of OasisMap30 in 2024 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	199	1	8	2	2	5	4	221	90.05
S W	0	230	0	1	0	17	1	249	92.37
Cropland	4	1	3113	7	1	142	0	3268	95.26
Shrub	2	1	6	124	2	5	0	140	88.57
Forest	0	0	7	1	57	2	0	67	85.07
Grassland	6	9	114	6	4	2141	4	2284	93.70
Barren land	7	0	2	0	0	3	114	126	90.48
Sum	218	242	3250	141	66	2315	123	6355	Kappa=0.90
PA (%)	91.28	95.04	95.78	87.94	86.36	92.48	92.68		OA=94.05%

Note: I S: Impervious surface; S W: Surface water.

Table S12. Confusion matrix of CLCD in 1992 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	21	0	29	0	0	35	19	104	20.19
S W	0	137	5	0	0	16	8	166	82.53
Cropland	2	0	1693	0	2	90	3	1790	94.58
Shrub	1	0	35	1	0	48	2	87	1.15
Forest	0	1	26	2	3	7	0	39	7.69
Grassland	10	26	408	1	0	1346	343	2134	63.07
Barren land	0	6	46	0	0	672	1318	2042	64.54
Sum	34	170	2242	4	5	2214	1693	6362	Kappa=0.58
PA (%)	61.76	80.59	75.51	25.00	60.00	60.79	77.85		OA=71.03%

Note: I S: Impervious surface; S W: Surface water.

Table S13. Confusion matrix of CLCD in 2002 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	45	0	15	0	0	37	10	107	42.06
S W	0	158	7	0	0	8	12	185	85.41
Cropland	2	0	1990	0	1	132	6	2131	93.38
Shrub	1	5	30	1	1	75	6	119	0.84
Forest	0	0	26	2	1	13	0	42	2.38
Grassland	23	8	248	0	5	1557	302	2143	72.66
Barren land	4	10	42	0	0	618	1029	1703	60.42
Sum	75	181	2358	3	8	2440	1365	6430	Kappa=0.63
PA (%)	60.00	87.29	84.39	33.33	12.50	63.81	75.38		OA=74.35%

Note: I S: Impervious surface; S W: Surface water.

Table S14. Confusion matrix of CLCD in 2012 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	77	0	17	0	0	62	18	174	44.25
S W	1	180	9	0	0	11	13	214	84.11
Cropland	4	0	2378	0	2	150	3	2537	93.73
Shrub	9	2	33	2	2	98	6	152	1.32
Forest	2	0	25	2	4	17	0	50	8.00
Grassland	29	2	360	0	2	1474	193	2060	71.55
Barren land	0	7	79	0	0	333	700	1119	62.56
Sum	122	191	2901	4	10	2145	933	6306	Kappa=0.65
PA (%)	63.11	94.24	81.97	50.00	40.00	68.72	75.03		OA=76.36%

Note: I S: Impervious surface; S W: Surface water.

Table S15. Confusion matrix of CLCD in 2022 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	83	1	9	0	0	63	19	175	47.43
S W	8	209	4	0	0	17	14	252	82.94
Cropland	7	3	2907	0	1	282	5	3205	90.70
Shrub	7	0	36	1	0	52	1	97	1.03
Forest	2	2	34	0	4	9	0	51	7.84
Grassland	46	17	421	2	3	1336	293	2118	63.08
Barren land	6	4	12	0	1	162	273	458	59.61
Sum	159	236	3423	3	9	1921	605	6356	Kappa=0.61
PA (%)	52.20	88.56	84.93	33.33	44.44	69.55	45.12		OA=75.72%

Note: I S: Impervious surface; S W: Surface water.

Table S16. Confusion matrix of ALCC in 1992 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	65	2	19	1	0	10	7	104	62.50
S W	0	147	5	0	0	9	5	166	88.55
Cropland	9	3	1730	0	0	43	5	1790	96.65
Shrub	3	3	39	1	1	39	1	87	1.15
Forest	2	1	23	0	3	8	2	39	7.69
Grassland	19	67	469	68	5	1170	336	2134	54.83
Barren land	2	16	107	3	0	708	1206	2042	59.06
Sum	100	239	2392	73	9	1987	1562	6362	Kappa=0.55
PA (%)	65.00	61.51	72.32	1.37	33.33	58.88	77.21		OA=67.93%

Note: I S: Impervious surface; S W: Surface water.

Table S17. Confusion matrix of ALCC in 2002 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	66	0	14	0	0	22	5	107	61.68
S W	0	169	6	0	0	3	7	185	91.35
Cropland	7	3	2047	0	1	67	6	2131	96.06
Shrub	0	10	38	5	2	57	7	119	4.20
Forest	0	0	19	3	9	11	0	42	21.43
Grassland	7	57	373	53	6	1315	332	2143	61.36
Barren land	2	16	70	9	0	538	1068	1703	62.71
Sum	82	255	2567	70	18	2013	1425	6430	Kappa=0.61
PA (%)	80.49	66.27	79.74	7.14	50.00	65.33	74.95		OA=72.77%

Note: I S: Impervious surface; S W: Surface water.

Table S18. Confusion matrix of ALCC in 2012 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	124	1	14	0	0	26	9	174	71.26
S W	0	190	7	0	0	8	9	214	88.79
Cropland	8	3	2437	0	2	81	6	2537	96.06
Shrub	1	7	38	6	2	85	13	152	3.95
Forest	0	3	17	3	11	15	1	50	22.00
Grassland	19	40	406	55	5	1235	300	2060	59.95
Barren land	1	11	81	8	0	344	674	1119	60.23
Sum	153	255	3000	72	20	1794	1012	6306	Kappa=0.62
PA (%)	81.05	74.51	81.23	8.33	55.00	68.84	66.60		OA=74.17%

Note: I S: Impervious surface; S W: Surface water.

Table S19. Confusion matrix of ALCC in 2022 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	155	1	9	0	0	5	5	175	88.57
S W	2	237	4	0	0	3	6	252	94.05
Cropland	76	4	2817	5	8	270	25	3205	87.89
Shrub	1	5	32	6	5	41	7	97	6.19
Forest	4	5	21	0	10	10	1	51	19.61
Grassland	58	96	396	126	10	1010	422	2118	47.69
Barren land	6	22	31	1	1	109	288	458	62.88
Sum	302	370	3310	138	34	1448	754	6356	Kappa=0.56
PA (%)	51.32	64.05	85.11	4.35	29.41	69.75	38.20		OA=71.16%

Note: I S: Impervious surface; S W: Surface water.

Table S20. Confusion matrix of GLC_FCS30 in 1992 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	43	0	20	0	0	21	20	104	41.35
S W	0	129	8	0	1	23	5	166	77.71
Cropland	22	0	1686	0	13	62	7	1790	94.19
Shrub	3	0	45	2	2	31	4	87	2.30
Forest	3	0	12	0	12	12	0	39	30.77
Grassland	24	15	420	19	31	1234	391	2134	57.83
Barren land	6	9	133	4	1	519	1370	2042	67.09
Sum	101	153	2324	25	60	1902	1797	6362	Kappa=0.58
PA (%)	42.57	84.31	72.55	8.00	20.00	64.88	76.24		OA=70.36%

Note: I S: Impervious surface; S W: Surface water.

Table S21. Confusion matrix of GLC_FCS30 in 2002 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	76	0	10	0	0	10	11	107	71.03
S W	0	143	0	0	0	38	4	185	77.30
Cropland	7	0	1942	0	14	141	27	2131	91.13
Shrub	2	2	48	1	4	49	13	119	0.84
Forest	3	0	15	1	9	14	0	42	21.43
Grassland	17	15	265	37	22	1319	468	2143	61.55
Barren land	20	30	90	10	2	415	1136	1703	66.71
Sum	125	190	2370	49	51	1986	1659	6430	Kappa=0.60
PA (%)	60.80	75.26	81.94	2.04	17.65	66.41	68.47		OA=71.94%

Note: I S: Impervious surface; S W: Surface water.

Table S22. Confusion matrix of GLC_FCS30 in 2012 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	133	0	18	0	0	13	10	174	76.44
S W	1	177	3	0	0	29	4	214	82.71
Cropland	4	0	2363	0	10	138	22	2537	93.14
Shrub	6	3	54	1	4	62	22	152	0.66
Forest	1	0	17	0	9	23	0	50	18.00
Grassland	25	3	309	54	20	1327	322	2060	64.42
Barren land	2	10	72	15	0	399	621	1119	55.50
Sum	172	193	2836	70	43	1991	1001	6306	Kappa=0.61
PA (%)	77.33	91.71	83.32	1.43	20.93	66.65	62.04		OA=73.44%

Note: I S: Impervious surface; S W: Surface water.

Table S23. Confusion matrix of GLC_FCS30 in 2022 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	126	0	8	0	0	18	23	175	72.00
S W	1	179	3	0	0	59	10	252	71.03
Cropland	28	0	2994	1	10	138	34	3205	93.42
Shrub	1	0	39	1	4	48	4	97	1.03
Forest	1	2	23	0	14	11	0	51	27.45
Grassland	19	15	488	48	11	1122	415	2118	52.97
Barren land	3	2	12	11	0	154	276	458	60.26
Sum	179	198	3567	61	39	1550	762	6356	Kappa=0.59
PA (%)	70.39	90.40	83.94	1.64	35.90	72.39	36.22		OA=74.13%

Note: I S: Impervious surface; S W: Surface water.

Table S24. Confusion matrix of ESACCI_LC in 1992 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	25	2	22	0	0	45	10	104	24.04
S W	0	128	8	0	0	14	16	166	77.11
Cropland	2	0	1458	0	3	219	108	1790	81.45
Shrub	1	3	38	1	0	35	9	87	1.15
Forest	1	0	16	0	2	18	2	39	5.13
Grassland	4	32	600	26	0	983	489	2134	46.06
Barren land	0	9	314	9	0	680	1030	2042	50.44
Sum	33	174	2456	36	5	1994	1664	6362	Kappa=0.39
PA (%)	75.76	73.56	59.36	2.78	40.00	49.30	61.90		OA=57.01%

Note: I S: Impervious surface; S W: Surface water.

Table S25. Confusion matrix of ESACCI_LC in 2002 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	40	1	26	0	0	35	5	107	37.38
S W	0	150	6	1	0	17	11	185	81.08
Cropland	4	3	1843	0	2	223	56	2131	86.49
Shrub	0	5	45	1	0	54	14	119	0.84
Forest	2	1	18	4	1	14	2	42	2.38
Grassland	2	17	638	36	3	1019	428	2143	47.55
Barren land	1	12	221	20	1	575	873	1703	51.26
Sum	49	189	2797	62	7	1937	1389	6430	Kappa=0.44
PA (%)	81.63	79.37	65.89	1.61	14.29	52.61	62.85		OA=61.07%

Note: I S: Impervious surface; S W: Surface water.

Table S26. Confusion matrix of ESACCI_LC in 2012 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	87	1	45	0	0	37	4	174	50.00
S W	0	159	11	2	0	26	16	214	74.30
Cropland	3	3	2242	2	2	254	31	2537	88.37
Shrub	0	2	49	2	0	76	23	152	1.32
Forest	1	1	23	1	1	20	3	50	2.00
Grassland	4	10	661	31	0	1089	265	2060	52.86
Barren land	0	4	81	23	1	329	681	1119	60.86
Sum	95	180	3112	61	4	1831	1023	6306	Kappa=0.52
PA (%)	91.58	88.33	72.04	3.28	25.00	59.48	66.57		OA=67.57%

Note: I S: Impervious surface; S W: Surface water.

Table S27. Confusion matrix of ESACCI_LC in 2022 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	117	2	27	1	0	25	3	175	66.86
S W	0	184	11	1	0	36	20	252	73.02
Cropland	19	2	2629	6	3	490	56	3205	82.03
Shrub	0	4	47	1	0	41	4	97	1.03
Forest	4	1	28	0	1	16	1	51	1.96
Grassland	22	28	675	21	2	1056	314	2118	49.86
Barren land	1	5	37	9	0	185	221	458	48.25
Sum	163	226	3454	39	6	1849	619	6356	Kappa=0.46
PA (%)	71.78	81.42	76.11	2.56	16.67	57.11	35.70		OA=66.22%

Note: I S: Impervious surface; S W: Surface water.

Table S28. Confusion matrix of MCD12Q1 in 2002 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	16	0	42	0	0	29	20	107	14.95
S W	0	46	8	0	0	64	67	185	24.86
Cropland	35	2	750	6	0	1132	206	2131	35.19
Shrub	3	2	12	1	0	63	38	119	0.84
Forest	1	0	9	0	1	19	12	42	2.38
Grassland	20	24	199	8	1	1060	831	2143	49.46
Barren land	10	8	83	1	0	731	870	1703	51.09
Sum	85	82	1103	16	2	3098	2044	6430	Kappa=0.18
PA (%)	18.82	56.10	68.00	6.25	50.00	34.22	42.56		OA=42.67%

Note: I S: Impervious surface; S W: Surface water.

Table S29. Confusion matrix of MCD12Q1 in 2012 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	24	0	72	0	0	61	17	174	13.79
S W	1	57	21	0	0	83	52	214	26.64
Cropland	45	3	1107	4	0	1173	205	2537	43.63
Shrub	3	1	21	2	0	60	65	152	1.32
Forest	1	0	10	0	1	27	11	50	2.00
Grassland	18	24	268	3	2	1105	640	2060	53.64
Barren land	2	5	53	1	0	347	711	1119	63.54
Sum	94	90	1552	10	3	2856	1701	6306	Kappa=0.26
PA (%)	25.53	63.33	71.33	20.00	33.33	38.69	41.80		OA=47.68%

Note: I S: Impervious surface; S W: Surface water.

Table S30. Confusion matrix of MCD12Q1 in 2022 based on visually-interpreted test samples.

Ground Reference	Classification							Sum	UA (%)
	I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land		
I S	35	0	63	0	0	64	13	175	20.00
S W	0	87	26	0	0	69	70	252	34.52
Cropland	67	2	1723	1	0	1233	179	3205	53.76
Shrub	2	0	14	3	0	61	17	97	3.09
Forest	3	0	18	0	2	24	4	51	3.92
Grassland	16	10	317	5	1	1099	670	2118	51.89
Barren land	2	2	27	2	0	161	264	458	57.64
Sum	125	101	2188	11	3	2711	1217	6356	Kappa=0.26
PA (%)	28.00	86.14	78.75	27.27	66.67	40.54	21.69		OA=50.55%

Note: I S: Impervious surface; S W: Surface water.

Table S31. Comparison of mapping accuracy based on Geo-Wiki test samples for OasisMap30, CLCD, GLC_FCS30, ESACCI_LC, and MCD12Q1.

Datasets		Geo-Wiki							OA (%)
		I S	S W	Cropland	Shrubland	Forest	Grassland	Barren land	
OasisMap30	PA (%)	52.43	100	83.16	43.75	72.00	53.87	87.80	74.36
	UA (%)	83.08	97.09	77.94	9.59	36.73	78.04	79.70	
	F1 (%)	64.29	98.52	80.47	15.73	48.65	63.74	83.56	
CLCD	PA (%)	47.83	100.00	69.16	0.00	0.00	40.70	54.21	56.73
	UA (%)	50.77	97.09	57.89	0.00	0.00	86.92	42.80	
	F1 (%)	49.25	98.52	63.03	0.00	0.00	55.44	47.84	
ALCC	PA (%)	55.26	91.74	66.58	0.00	75.00	52.63	65.20	64.31
	UA (%)	64.62	97.09	61.90	0.00	6.12	65.42	82.29	
	F1 (%)	59.57	94.34	64.16	0.00	0.00	58.33	72.76	
GLC_FCS30	PA (%)	47.06	100.00	75.00	0.00	100.00	62.25	46.46	60.90
	UA (%)	61.54	97.09	63.91	0.00	2.04	72.43	60.52	
	F1 (%)	53.33	98.52	69.01	0.00	4.00	66.95	52.56	
ESACCI_LC	PA (%)	62.50	100.00	52.23	0.00	100.00	28.09	57.62	50.85
	UA (%)	23.08	97.09	67.42	0.00	2.04	42.52	44.65	
	F1 (%)	33.71	98.52	58.86	0.00	4.00	33.83	50.31	
MCD12Q1	PA (%)	32.34	0.00	75.07	0.00	0.00	13.19	52.17	50.09
	UA (%)	100	0.00	70.93	0.00	0.00	11.21	79.70	
	F1 (%)	48.87	0.00	72.94	0.00	0.00	12.12	63.07	

Note: I S: Impervious surface; S W: Surface water.