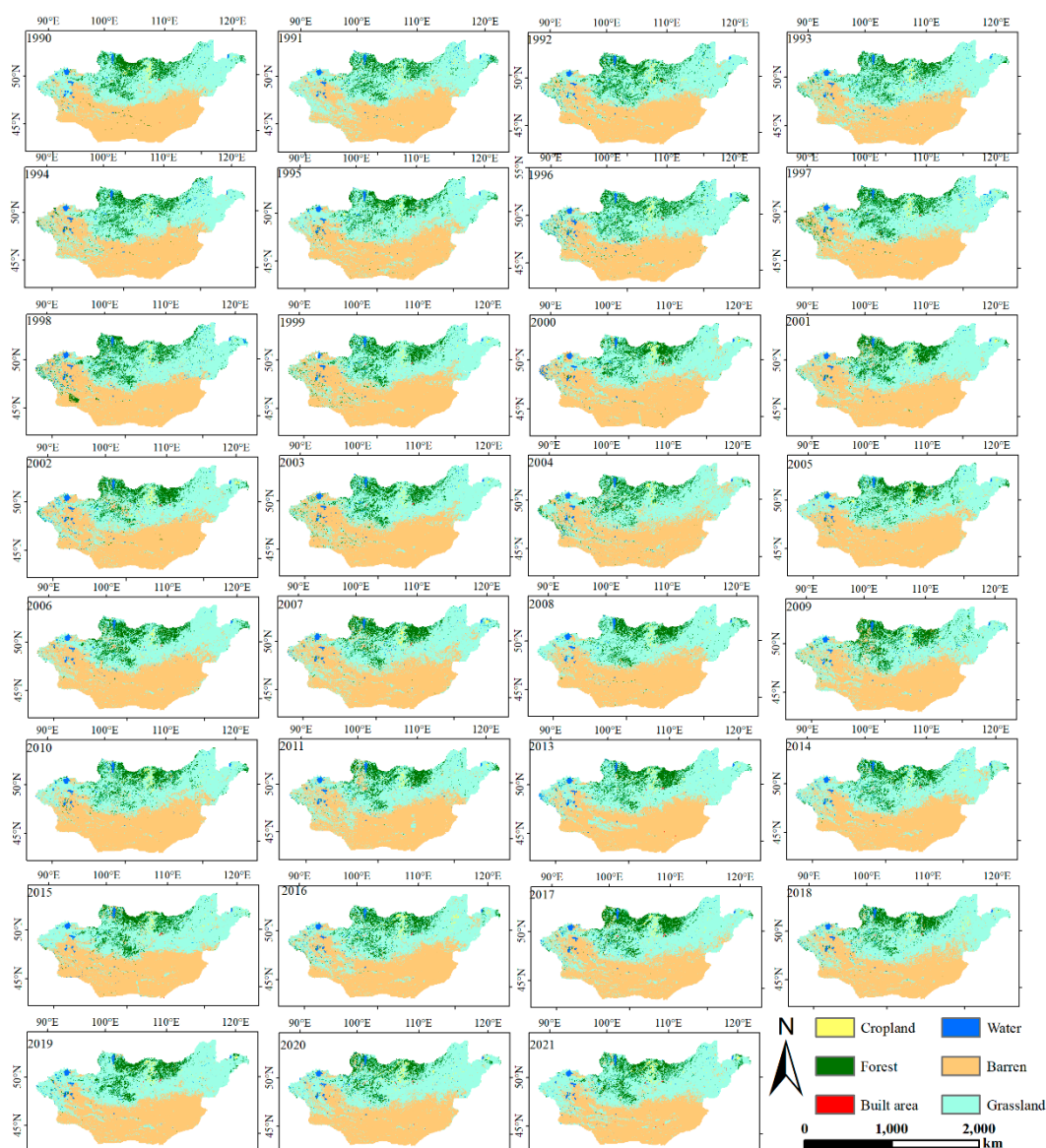




## Supplementary Materials



**Figure S1.** Spatial distribution of land use type in Mongolia from 1990 to 2021. The lack of land use type in 2012 is due to missing remote sensing images.

**Table S1.** Landsat5 and Landsat8 band parameters.

Landsat5		Landsat8
B1	Blue	(ultra-blue) surface reflectance
B2	Green	Blue
B3	Red	Green
B4	Near infrared (NIR)	Red
B5	Short-wave infrared (SWIR_1)	near infrared (NIR)
B6	Brightness temperature	Short-wave infrared (SWIR_1)
B7	Short-wave infrared (SWIR_2)	Short-wave infrared (SWIR_2)

**Table S2.** Reporting themes for accuracy results.

Reporting themes	Description
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Cropland gain	To cropland from any other class
Cropland loss	From cropland to any other class
Cropland—no change	Cropland across 2015 and 2020 eras
Forest gain	To forest from any other class
Forest loss	From forest to any other class
Forest—no change	Forest across 2015 and 2020 eras
Built area gain	To built area from any other class
Built area loss	From built area to any other class
Built area—no change	Built area across 2015 and 2020 eras
Water gain	To water from any other class
Water loss	From water to any other class
Water—no change	Water across 2015 and 2020 eras
Barren gain	To barren from any other class
Barren loss	From barren to any other class
Barren—no change	Barren across 2015 and 2020 eras
Grassland gain	To grassland from any other class
Grassland loss	From grassland to any other class
Grassland—no change	Grassland across 2015 and 2020 eras

Table S3. Verification of classification accuracy.

LUCC type	Accuracy type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Cropland	PA (%)	74	61	63	58	59	62	59	60	64	56	63
	UA (%)	94	95	93	94	95	94	95	98	95	96	92
Forest	PA (%)	80	80	76	78	76	75	82	82	84	82	78
	UA (%)	88	94	84	89	85	83	87	88	86	94	89
Built area	PA (%)	66	72	68	72	70	59	71	71	70	72	77
	UA (%)	100	98	99	98	98	100	98	98	98	98	95
Water	PA (%)	93	92	93	89	91	93	90	88	89	88	92
	UA (%)	98	94	96	95	97	97	96	93	95	99	96
Barren	PA (%)	88	83	85	81	89	83	85	83	86	88	87
	UA (%)	95	89	89	94	88	89	94	93	91	88	84
Grassland	PA (%)	91	91	89	92	86	88	90	90	88	90	83
	UA (%)	73	66	66	64	68	66	65	67	72	68	68
OA (%)	--	84.63	80.01	79.64	78.32	79.82	78.32	78.78	78.26	78.33	79.02	80.01
Kappa	--	0.7677	0.7492	0.7315	0.7117	0.7109	0.7127	0.7181	0.7112	0.7092	0.7220	0.7382

LUCC type	Accuracy type	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Cropland	PA (%)	64	63	63	64	59	59	64	61	63	64	59
	UA (%)	97	97	96	95	94	94	96	97	97	94	97
Forest	PA (%)	82	83	80	79	75	85	83	83	85	75	83
	UA (%)	91	92	91	89	84	86	92	91	88	85	89
Built area	PA (%)	73	71	69	77	61	71	71	72	71	61	71
	UA (%)	98	98	100	96	100	97	98	100	98	100	98
Water	PA (%)	91	92	92	91	93	89	92	89	91	94	92
	UA (%)	96	93	98	95	97	96	94	95	97	95	95
Barren	PA (%)	89	88	89	88	89	91	87	86	85	89	86
	UA (%)	88	87	81	85	88	87	83	89	84	89	85
Grassland	PA (%)	90	88	92	88	87	87	87	88	85	87	85

	UA (%)	72	71	71	70	68	68	71	69	68	69	69
OA (%)	--	80.21	82.18	83.30	81.21	79.94	76.07	80.16	79.92	79.12	80.63	79.79
Kappa	--	0.7331	0.7655	0.7795	0.7482	0.7349	0.7349	0.7011	0.7339	0.7246	0.7445	0.7337

LUCC type	Accuracy type	2013	2014	2015	2016	2017	2018	2019	2020	2021
Cropland	PA (%)	61	61	59	62	70	66	68	74	70
	UA (%)	97	96	93	97	97	97	95	96	94
Forest	PA (%)	82	82	82	83	89	87	84	83	86
	UA (%)	88	90	90	90	92	82	86	93	85
Built area	PA (%)	72	71	60	74	74	72	76	74	70
	UA (%)	99	100	100	100	98	98	98	98	98
Water	PA (%)	91	93	89	92	94	92	94	92	89
	UA (%)	95	95	94	99	98	98	98	97	99
Barren	PA (%)	90	88	85	87	85	84	88	86	83
	UA (%)	91	91	88	90	91	90	90	93	91
Grassland	PA (%)	88	90	87	90	91	91	90	94	87
	UA (%)	70	71	67	70	74	71	72	74	71
OA (%)	--	81.52	80.86	79.83	81.98	84.68	82.80	84.13	85.48	82.42
Kappa	--	0.7502	0.7467	0.7332	0.7621	0.7987	0.7731	0.7896	0.8090	0.7689

Table S4. UA and PA of LUCC.

	UA (%)	PA (%)
Cropland gain	57.88	62.09
Cropland loss	42.31	62.65
Cropland—no change	82.32	91.65
Forest gain	84.05	82.72
Forest loss	69.86	86.52
Forest—no change	88.06	81.96
Built area gain	71.03	77.97
Built area loss	71.85	71.28
Built area—no change	83.09	88
Water gain	40.07	40.13
Water loss	43.26	41.16
Water—no change	98.14	98.84
Barren gain	77.25	85.36
Barren loss	61.68	90.95
Barren—no change	88.26	85.57
Grassland gain	68.47	79.09
Grassland loss	82.42	72.69
Grassland—no change	88.98	81.09