

Table S1 Accuracy assessment of land use classification of five capitals in 2009

Table S2 Accuracy assessment of land use classification of five capitals in 2019

Table S3 The neighborhood weights for six land use types in five capitals

Table S4 Conversion cost matrix of land use pairs under three scenarios

Table S5 Two uncertainties in estimating carbon storage impacts of future land use change

Fig.S1. The used training samples in interpreting land use in GEE

Table S1 Accuracy assessment of land use classification in 2009. Note: The overall accuracies of land use classification of Ashkhabad, Bishkek, Dushanbe, Nur Sultan, and Tashkent are 92%, 89.7%, 92.7%, 92%, and 91.7%, respectively.

Capitals	Classified Data	Reference data						User's Accuracy	Producer's Accuracy
		Built-up land	Unused land	Forest	Cropland	Grassland	Water		
Ashkhabad (92%)	Built-up land	46	3	0	3	1	0	86.8%	100.0%
	Unused land	0	152	0	0	4	0	97.4%	96.2%
	Forest	0	0	1	0	0	0	100.0%	33.3%
	Cropland	0	2	2	60	5	0	87.0%	93.8%
	Grassland	0	1	0	1	15	0	88.2%	55.6%
	Water	0	0	0	0	2	2	50.0%	100.0%
Bishkek (89.7%)	Built-up land	34	5	0	1	2	0	81.0%	97.1%
	Unused land	0	47	2	4	0	0	88.7%	81.0%
	Forest	1	0	7	0	0	0	87.5%	50.0%
	Cropland	0	6	3	158	3	0	92.9%	95.8%
	Grassland	0	0	0	0	5	0	100.0%	50.0%
	Water	0	0	2	2	0	18	81.8%	100.0%
Dushanbe (92.7%)	Built-up land	38	3	1	1	2	0	84.4%	97.4%
	Unused land	0	134	0	0	2	0	98.5%	93.7%
	Forest	0	0	2	0	0	0	100.0%	66.7%
	Cropland	0	3	0	69	2	0	93.2%	98.6%
	Grassland	0	3	0	0	32	0	91.4%	84.2%
	Water	1	0	0	0	0	3	75.0%	100.0%
Nur Sultan (92%)	Built-up land	28	7	0	0	0	2	75.7%	100.0%
	Unused land	0	73	0	0	1	0	98.6%	84.9%
	Forest	0	0	0	0	0	0	0.0%	0.0%
	Cropland	0	4	0	108	8	0	90.0%	100.0%
	Grassland	0	2	0	0	60	0	96.8%	87.0%
	Water	0	0	0	0	0	7	100.0%	77.8%
Tashkent (91.7%)	Built-up land	121	5	1	2	0	0	93.8%	96.0%
	Unused land	0	7	0	1	0	0	87.5%	53.8%
	Forest	0	0	8	1	0	0	88.9%	80.0%
	Cropland	5	0	0	133	4	0	93.7%	95.7%
	Grassland	0	1	0	1	2	0	50.0%	25.0%
	Water	0	0	1	1	2	4	50.0%	100.0%

Table S2 Accuracy assessment of land use classification in 2019. Note: The overall accuracies of land use classification of Ashkhabad, Bishkek, Dushanbe, Nur Sultan, and Tashkent are 91.7%, 93.3%, 92.3%, 90.3%, and 90.7%, respectively.

Capitals	Classified Data	Reference data						User's Accuracy	Producer's Accuracy
		Built-up land	Unused land	Forest	Cropland	Grassland	Water		
Ashkhabad (91.7%)	Built-up land	54	4	0	4	1	0	85.7%	98.2%
	Unused land	0	155	0	0	5	0	96.9%	94.5%
	Forest	0	0	1	0	0	0	100.0%	100.0%
	Cropland	1	4	0	53	4	0	85.5%	93.0%
	Grassland	0	1	0	0	9	0	90.0%	45.0%
	Water	0	0	0	0	1	3	75.0%	100.0%
Bishkek (93.3%)	Built-up land	63	2	2	0	0	0	94.0%	98.4%
	Unused land	0	59	0	3	1	0	93.7%	85.5%
	Forest	0	0	0	0	0	0	0.0%	0.0%
	Cropland	1	7	1	137	0	0	93.8%	96.5%
	Grassland	0	1	0	2	11	0	78.6%	91.7%
	Water	0	0	0	0	0	10	100.0%	100.0%
Dushanbe (92.3%)	Built-up land	75	1	0	0	0	0	98.7%	98.7%
	Unused land	0	105	0	1	9	0	91.3%	91.3%
	Forest	0	0	2	0	0	0	100.0%	100.0%
	Cropland	0	5	0	49	1	0	89.1%	96.1%
	Grassland	0	4	0	1	43	0	89.6%	81.1%
	Water	1	0	0	0	0	3	75.0%	100.0%
Nur Sultan (90.3%)	Built-up land	47	4	1	0	2	0	87.0%	97.9%
	Unused land	1	25	0	0	0	0	96.2%	61.0%
	Forest	0	0	7	1	0	0	87.5%	87.5%
	Cropland	0	9	0	98	4	0	88.3%	98.0%
	Grassland	0	2	0	1	65	3	91.5%	91.5%
	Water	0	1	0	0	0	29	96.7%	90.6%
Tashkent (90.7%)	Built-up land	158	3	1	16	1	0	88.3%	100.0%
	Unused land	0	3	0	0	0	0	100.0%	50.0%
	Forest	0	0	6	0	0	0	100.0%	66.7%
	Cropland	0	0	2	94	4	0	94.0%	84.7%
	Grassland	0	0	0	0	2	0	100.0%	28.6%
	Water	0	0	0	1	0	9	90.0%	100.0%

Table S3 The neighborhood weights for six land use types in five capitals

Capitals	Built-up land	Unused land	Forest	Cropland	Grassland	Water
Ashkhabad	0.75	0.5	0.1	0.5	0.25	0.1
Bishkek	0.75	0.1	0.4	0.75	0.25	0.25
Dushanbe	0.75	0.1	0.4	0.75	0.5	0.25
Nur Sultan	0.75	0.25	0.4	0.75	0.5	0.4
Tashkent	0.75	0.25	0.25	0.25	0.1	0.25

Table S4 Conversion cost matrix of land use pairs under three scenarios

Scenario	Land use type	Built-up land	Unused land	Forest	Cropland	Grassland	Water
BDS	Built-up land	1	1	1	1	1	1
	Unused land	1	1	1	1	1	1
	Forest	1	1	1	1	1	1
	Grassland	1	1	1	1	1	1
	Water	1	1	1	1	1	1
CPS	Built-up land	1	1	1	1	1	1
	Unused land	1	1	1	1	1	1
	Forest	1	1	1	1	1	1
	Grassland	1	1	1	1	1	1
	Water	1	1	1	1	1	1
EPS	Built-up land	1	1	1	1	1	1
	Unused land	1	1	1	1	1	1
	Forest	1	1	1	1	1	1
	Grassland	1	1	1	1	1	1
	Water	0	0	0	0	0	1

Table S5 Two scenarios of uncertainty in estimating carbon storage impact of future land use change (Tg). Note: A and B refers to using carbon densities of built-up land and unused land (0-3m) from Li et al. (2015) to estimate uncertainties of carbon storage change, respectively.

	Capitals	2019	BDS		CPS		EPS	
			Carbon storage	Change	Carbon storage	Change	Carbon storage	Change
A	Ashkhabad	13.27	14.57	1.29	13.91	0.64	14.62	1.34
	Bishkek	14.95	16.26	1.31	15.53	0.58	16.05	1.10
	Dushanbe	13.45	15.28	1.83	14.32	0.87	14.90	1.45
	Nur Sultan	14.16	15.06	0.91	14.86	0.70	14.68	0.52
	Tashkent	20.92	22.63	1.71	21.12	0.20	22.60	1.68
	Capitals	2019	BDS		CPS		EPS	
			Carbon storage	Change	Carbon storage	Change	Carbon storage	Change
B	Ashkhabad	10.86	10.31	-0.55	10.60	-0.26	10.43	-0.43
	Bishkek	8.40	7.61	-0.79	7.90	-0.50	7.67	-0.73
	Dushanbe	9.62	8.74	-0.88	9.10	-0.52	8.75	-0.87
	Nur Sultan	8.12	7.66	-0.46	7.68	-0.44	8.02	-0.10
	Tashkent	3.74	2.66	-1.08	3.32	-0.42	3.01	-0.73

Fig.S1. The used training samples in interpreting land use in GEE. Notes: The images within study areas are raw images. The training samples were defined from December 2th, 2019 to December 10th, 2019.

