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Supplement of

Mapping 10 m global impervious surface area (GISA-10m) using multi-source geospatial data

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Figure S1. Spatial distribution of ISA at (a) a global scale and (b) in the rural regions. The pixels represent the ISA regions in the 0.01° grid, while the dotted lines denote the cumulative histograms.
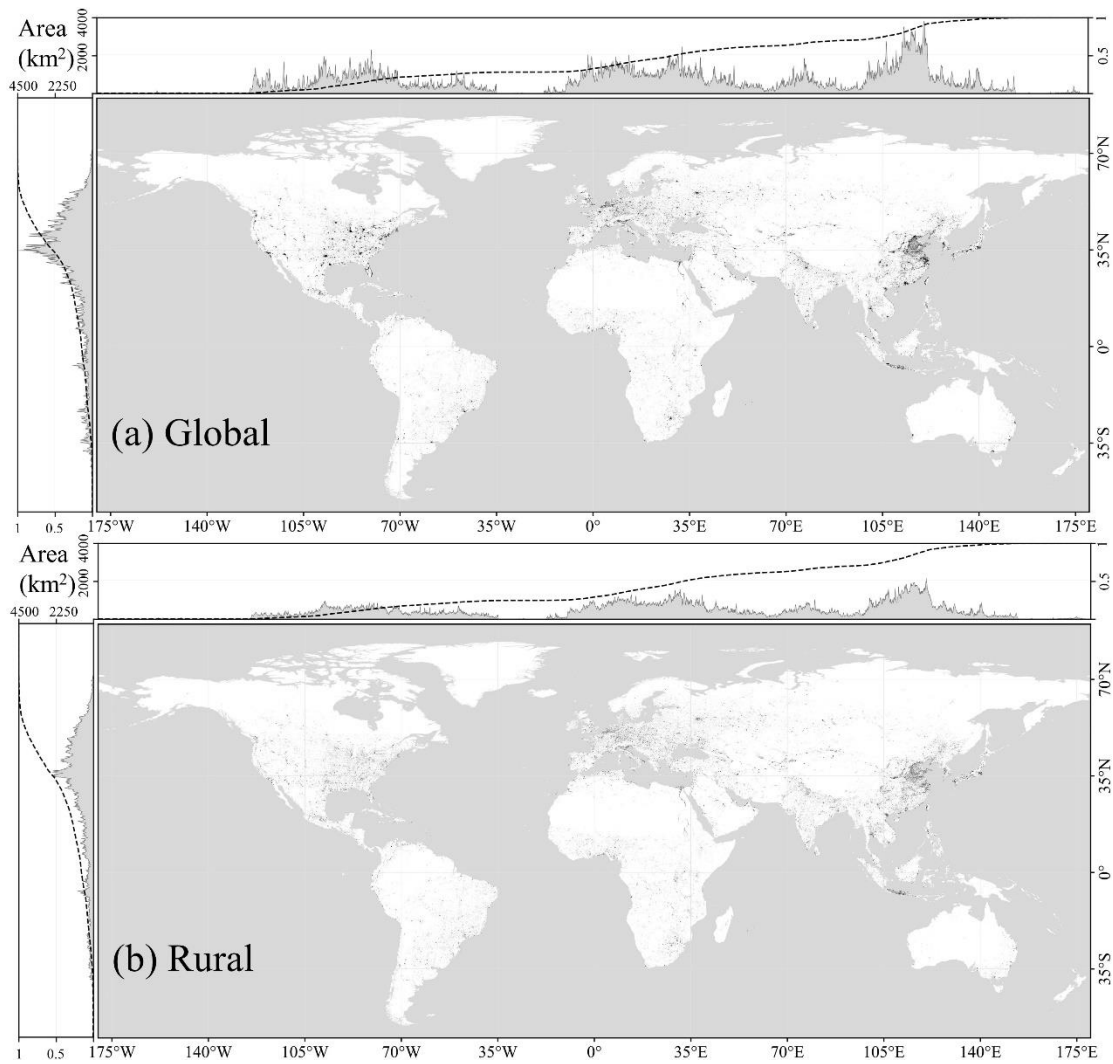
Figure S2. Global distribution of the (a) Sentinel-1 and (b) Sentinel-2 images for 2016.
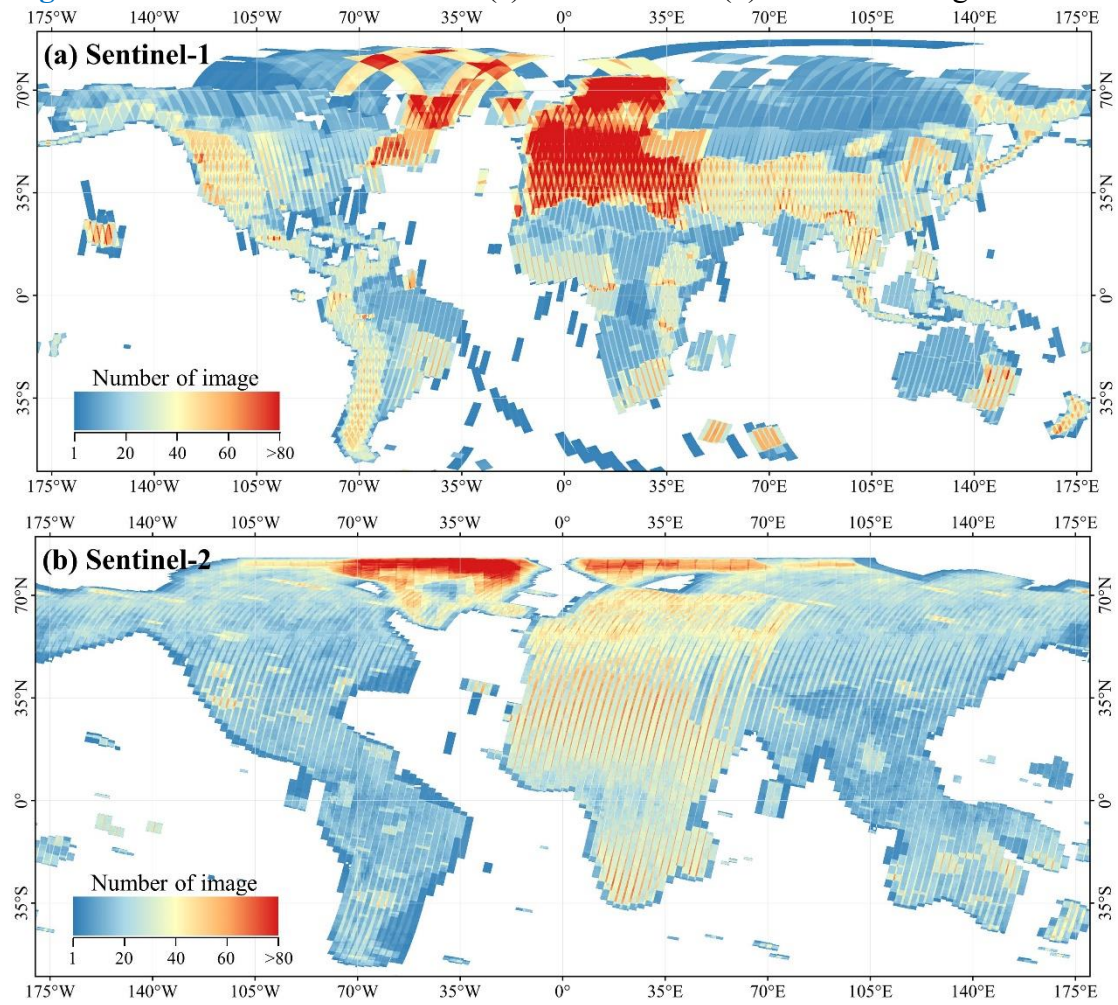
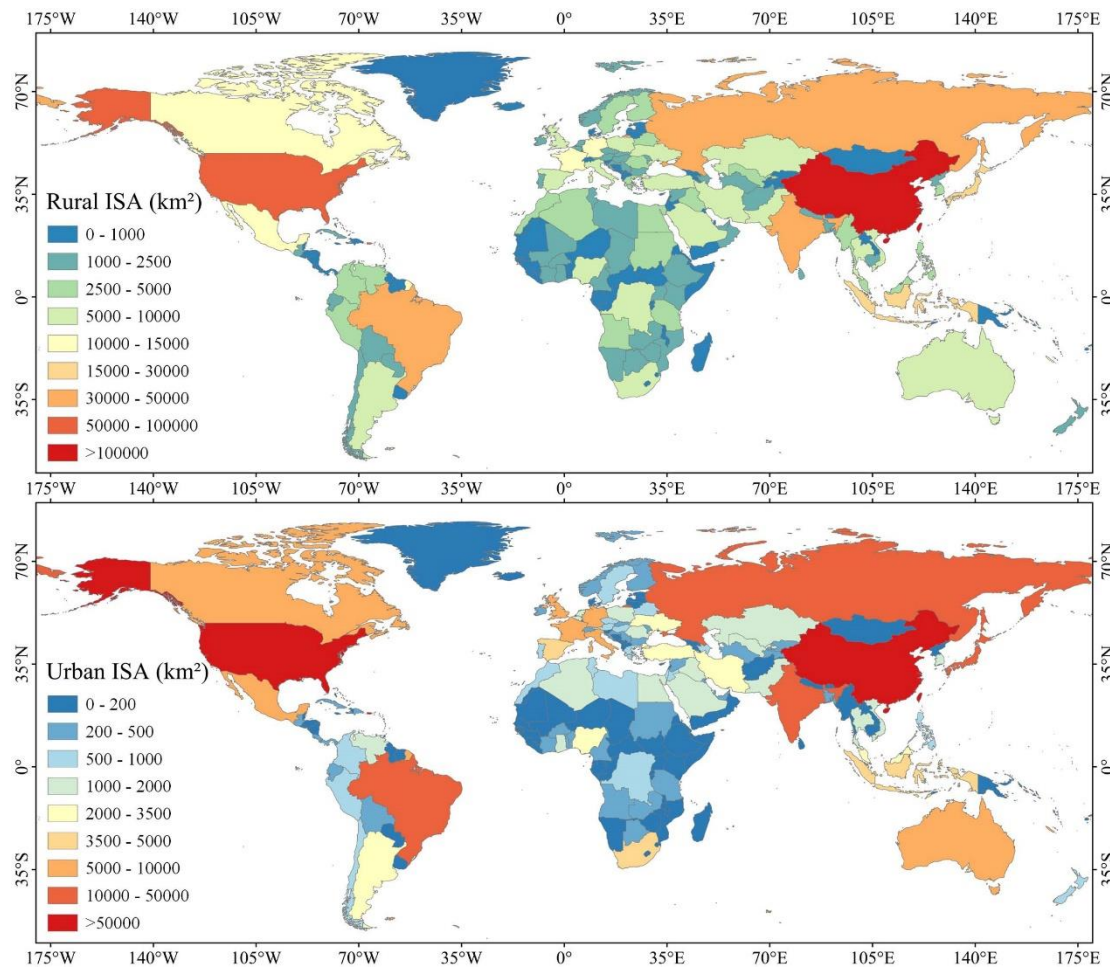**Figure S3**. Urban and rural ISA at the country scale based on GISA-10m.

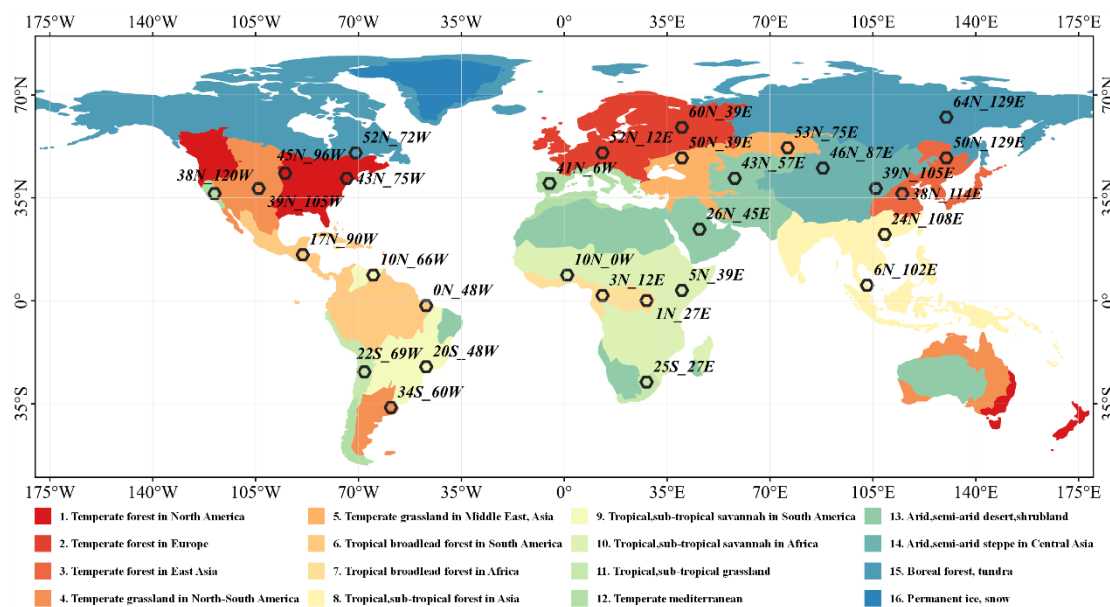**Figure S4**. Global distribution of the urban ecoregions and the 30 randomly selected grid cells.

Figure S5. Examples of Sentinel-1 VH backscatter, the standard deviation of NDVI from Sentinel-2 (S2_NDVIStd), the Sentinel-2 true-color composite, and GISA-10m at Paterson, New Jersey, US.
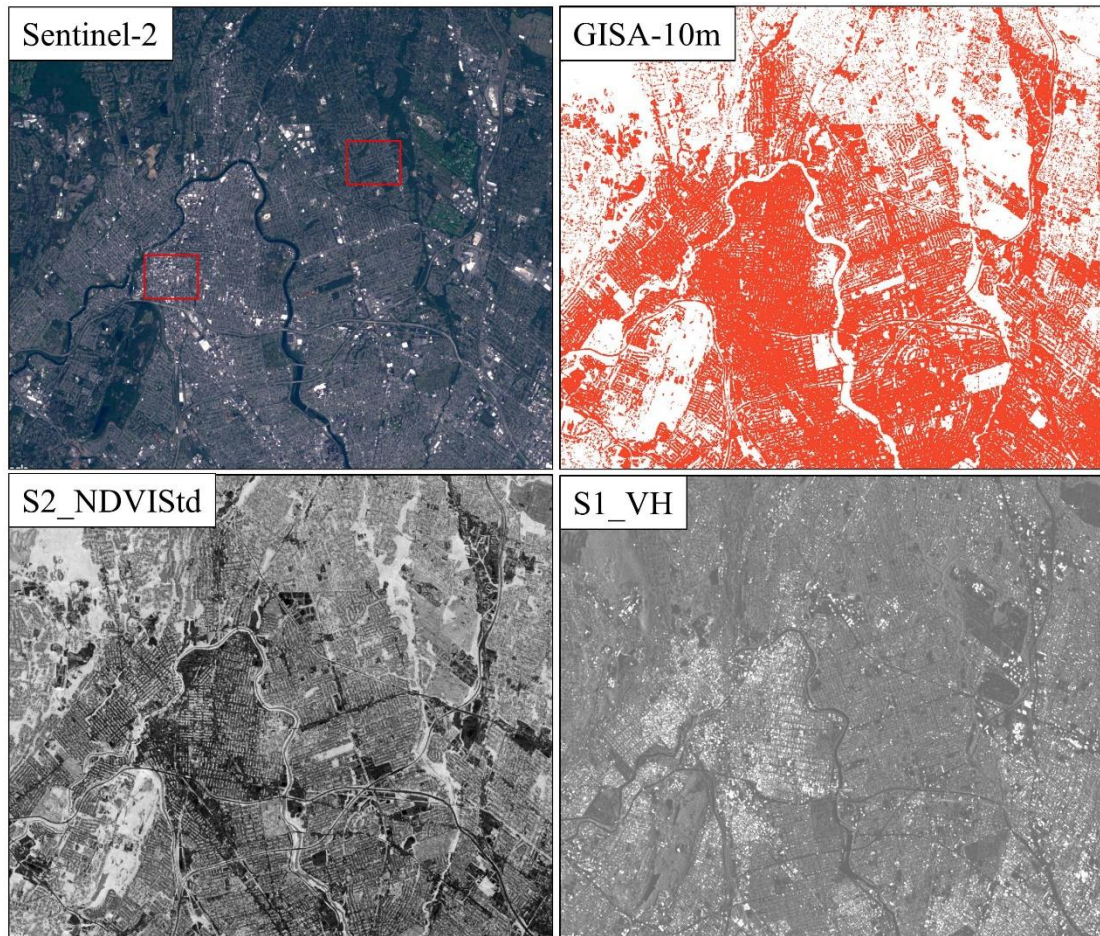
Figure S6. The F1-score as a function of the ISA_RS and ISA_OSM samples in the 30 randomly selected global grid cells.
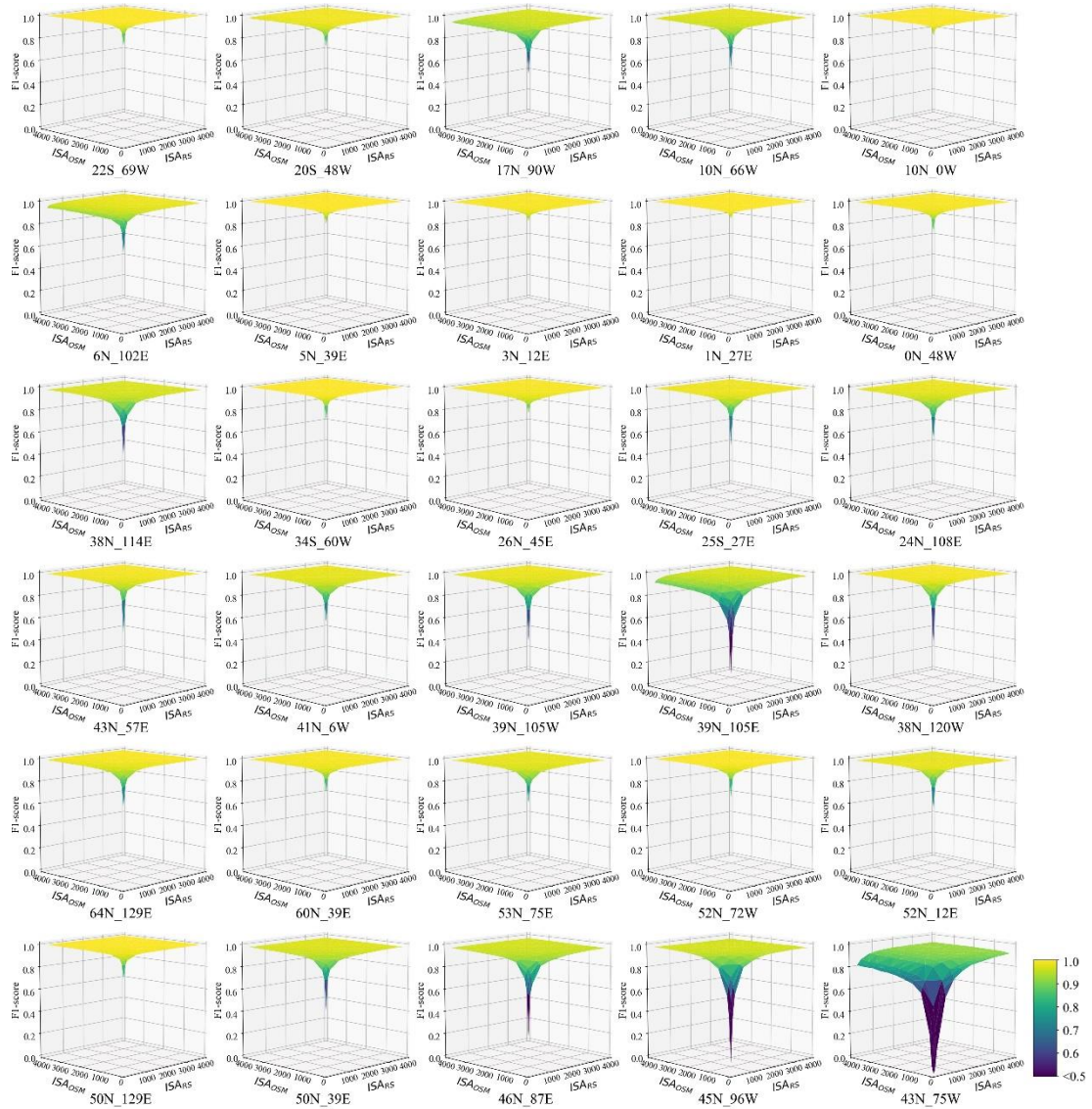
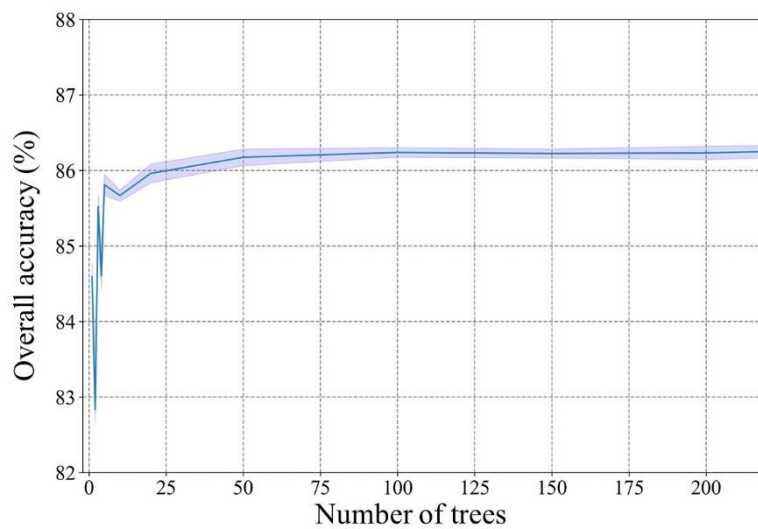**Figure S7**. The overall accuracy as a function of the number of trees.

Figure S8. Box plots of the overall accuracy for GISA-10m in the six continents when using ISA$_{OSM}$ only.
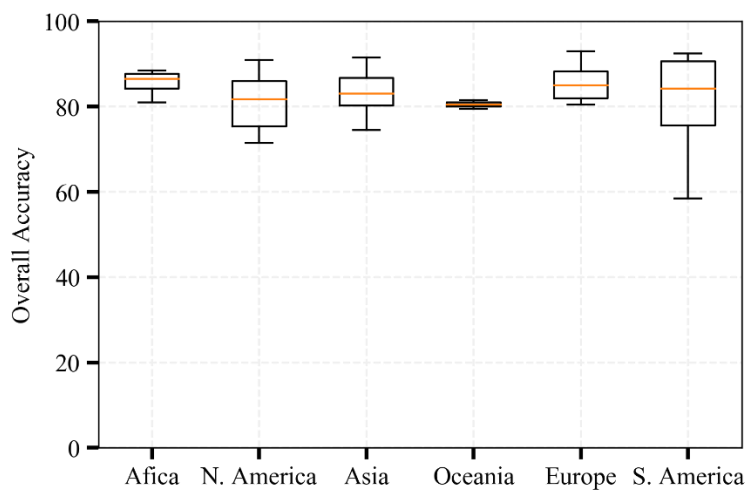
Table S1. Results of the quantitative accuracy assessment via the visually interpreted samples and ZY-3 samples between GISA-10m and the existing ISA datasets. UA denotes the user's accuracy while PA means producer's accuracy.

Global	Visually interpreted samples (n = 10800)				ZY-3 samples (n = 68368)			
	UA of ISA (%)	PA of ISA (%)	UA of NISA (%)	PA of NISA (%)	UA of ISA (%)	PA of ISA (%)	UA of NISA (%)	PA of NISA (%)
GISA-10m	86.13	81.30	86.01	91.25	81.87	71.35	87.87	92.92
GHSL 2018	90.20	69.74	79.96	95.14	74.44	76.12	89.19	88.29
GLCFCS	88.40	69.11	79.30	93.85	77.96	69.84	87.09	91.15
WSF2015	89.00	72.13	81.00	94.11	74.55	80.36	90.88	87.71
FROM_GLC10	89.35	57.07	73.98	95.55	75.83	69.25	86.74	90.11
GISA	90.97	57.75	74.34	96.24	77.09	76.21	89.40	89.86
GAUD	92.18	53.19	72.53	97.05	79.16	72.53	88.14	91.45
GAIA	90.78	53.25	72.48	96.47	72.89	78.06	89.85	86.99

Table S2. Results of the quantitative accuracy assessment via the visually interpreted samples and ZY-3 samples in rural regions between GISA-10m and the existing ISA datasets. UA denotes the user's accuracy while PA means producer's accuracy.

Rural regions	Visually interpreted samples (n = 9547)				ZY-3 samples (n = 43950)			
	UA of ISA (%)	PA of ISA (%)	UA of NISA (%)	PA of NISA (%)	UA of ISA (%)	PA of ISA (%)	UA of NISA (%)	PA of NISA (%)
GISA-10m	81.11	75.04	88.29	92.79	67.60	42.86	92.73	97.26
GHSL 2018	87.66	63.04	84.11	96.5	53.12	52.52	93.67	93.81
GLCFCS	84.86	59.79	82.79	95.56	57.13	41.87	92.51	95.81
WSF2015	85.83	60.78	83.23	95.91	55.74	47.09	93.08	95.01
FROM_GLC10	84.34	43.14	77.77	96.78	52.04	39.77	92.21	95.11
GISA	88.11	37.42	76.28	98.03	62.12	34.86	91.79	97.16
GAUD	91.17	30.87	74.61	98.88	66.68	24.99	90.76	98.33
GAIA	88.43	28.45	73.94	98.57	54.88	33.82	91.60	96.29

Table S3. Results of the quantitative accuracy assessment via the visually interpreted samples and ZY-3 samples in arid regions between GISA-10m and the existing ISA datasets. UA denotes the user's accuracy while PA means producer's accuracy.

Arid regions	Visually interpreted samples (n = 1020)				ZY-3 samples (n = 10827)			
	UA of ISA (%)	PA of ISA (%)	UA of NISA (%)	PA of NISA (%)	UA of ISA (%)	PA of ISA (%)	UA of NISA (%)	PA of NISA (%)
GISA-10m	90.93	81.67	83.42	93.60	78.77	81.17	93.50	92.53
GHSL 2018	93.33	79.84	81.83	95.16	75.74	61.18	87.56	93.31
GLCFCS	92.33	71.08	76.17	94.77	68.59	76.78	91.73	87.99
WSF2015	90.66	73.12	77.24	93.41	78.69	74.49	91.45	93.11
FROM_GLC10	90.79	58.25	69.79	95.35	69.30	67.09	88.88	89.85
GISA	93.31	65.38	73.52	96.32	75.11	77.39	92.20	91.24
GAUD	94.37	58.04	69.78	97.09	81.31	71.99	90.80	94.35
GAIA	92.48	60.08	70.61	95.93	70.94	74.75	91.22	89.54

Table S4. Results of the quantitative accuracy assessment via the visually interpreted samples and ZY-3 samples in urban regions between GISA-10m and the existing ISA datasets. OA represents the overall accuracy.

Urban regions	Visually interpreted samples (n = 2253)				ZY-3 samples (n = 24418)			
	OA (%)	Kappa	F1-score of ISA (%)	F1-score of NISA (%)	OA (%)	Kappa	F1-score of ISA (%)	F1-score of NISA (%)
GISA-10m	**85.49**	**0.30**	**91.93**	**38.26**	77.96	**0.52**	82.71	**69.61**
GHSL 2018	76.61	0.20	86.02	31.41	76.56	0.47	82.38	64.99
GLCFCS	78.43	0.18	87.51	27.96	75.75	0.48	80.98	66.55
WSF2015	83.58	0.23	90.73	32.76	**78.36**	0.49	**84.64**	63.38
FROM_GLC10	75.32	0.21	85.15	31.66	74.78	0.45	80.35	64.80
GISA	82.96	0.24	90.41	33.15	78.09	0.49	84.25	63.98
GAUD	81.49	0.22	89.49	31.06	78.20	0.50	84.07	65.48
GAIA	84.02	0.20	91.07	29.57	75.77	0.41	83.30	55.83

Table S5. Percentage of detected buildings in arid regions between GISA-10m and the existing ISA datasets.

GISA-10m	GHSL 2018	GLCFCS	WSF2015	FROM_GLC10	GISA	GAUD	GAIA
92.68%	88.28%	86.85%	90.92%	77.44%	84.66%	74.11%	77.34%

Table S6. Results of the quantitative accuracy assessment for the three levels of cities: Level 1 (population < 250,000), Level 2 (250,000 to 1,000,000), and Level 3 (> 1,000,000). OA represents the overall accuracy.

City level	OA (%)	Kappa	F1-score of ISA (%)	F1-score of NISA (%)
Level 1	85.35	0.2205	91.92	30.41
Level 2	87.43	0.2189	93.11	29.41
Level 3	85.42	0.4005	91.86	47.06

Table S7. Results of quantitative accuracy assessment for China (CHN) and Saudi Arabia (SA) based on local and transferred samples. OA denotes the overall accuracy.

	Saudi Arabia				China			
	OA (%)	Kappa	F1-score of ISA (%)	F1-score of NISA (%)	OA (%)	Kappa	F1-score of ISA (%)	F1-score of NISA (%)
ISA_SA & NISA_SA	**93.00**	**0.8599**	**92.39**	**93.95**	79.50	0.5915	77.60	81.86
ISA_SA & NISA_CN	53.00	0.7253	65.44	26.77	55.00	0.5233	4.35	70.59
ISA_CN & NISA_SA	70.50	0.8396	53.23	78.55	48.00	0.6251	63.38	10.53
ISA_CN & NISA_CN	50.50	0.0846	64.77	16.95	**89.00**	**0.7778**	**86.90**	**91.30**

Table S8. Results of the global accuracy assessment for the ISA$_{RS}$ and ISA$_{OSM}$ samples. OA denotes the overall accuracy, while PA and UA indicate the user's accuracy and the producer's accuracy, respectively.

Source of training samples	OA (%)	Kappa	F1-score of ISA (%)	F1-score of NISA (%)	UA of ISA (%)	PA of ISA (%)	UA of NISA (%)	PA of NISA (%)
NISA+ISA$_{RS}$+ISA$_{OSM}$	**86.06**	**0.7165**	**83.65**	**88.55**	86.13	**81.30**	**86.01**	91.25
NISA+ISA$_{RS}$	80.24	0.5871	73.85	84.63	**88.16**	63.54	76.73	**94.35**
NISA+ISA$_{OSM}$	82.99	0.6500	78.96	86.34	86.24	72.81	81.17	92.23

Table S9. Results of the quantitative accuracy assessment for the test grid cells with the number of ISA$_{OSM}$ training samples less than or more than the recommended size. OA represents the overall accuracy.

Type of test grid cell	OA (%)	Kappa	F1-score of ISA (%)	F1-score of NISA (%)
#ISA$_{OSM}$ < 2500	85.61	0.7021	81.79	89.01
#ISA$_{OSM}$ > 2500	86.23	0.7218	84.32	88.35
Both of the above	86.06	0.7165	83.65	88.55