

Quantifying the Spatiotemporal Pattern of Urban Expansion and Hazard and Risk Area Identification in the Kaski District of Nepal

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Supplementary information

Table S1: Summary of LULC mapping accuracy (%) for 1988 to 2016 images. OA= overall accuracy; PA=Producer's accuracy; UA=user's accuracy.

Year	1988		1989		1990		1991		1992		1993		1994		1995		1996		1999		2000	
LULC	PA.	UA.	PA.	UA.	PA.	UA.	PA.	UA.	PA.	UA.	PA.	UA.	PA.	UA.	PA.	UA.	PA.	UA.	PA.	UA.	PA.	UA.
UB	90.57	80.00	89.83	88.33	91.67	91.67	89.29	83.33	89.83	88.33	90.91	83.33	91.23	86.67	92.98	88.33	93.22	91.67	88.52	90.00	88.89	93.33
CL	80.00	93.33	80.00	86.67	90.32	93.33	85.94	91.67	86.67	86.67	86.89	88.33	90.91	83.33	85.94	91.67	83.87	86.67	87.30	91.67	87.50	93.33
FC	79.66	78.33	84.75	83.33	83.33	91.67	82.26	85.00	82.09	91.67	80.30	88.33	81.25	86.67	82.35	93.33	83.33	91.67	77.94	88.33	82.09	91.67
SL	74.24	81.67	80.00	86.67	84.38	90.00	82.09	91.67	82.26	85.00	84.13	88.33	80.88	91.67	80.30	88.33	81.82	90.00	80.95	85.00	84.62	91.67
BL	88.71	91.67	85.19	76.67	88.52	90.00	91.67	91.67	92.73	85.00	88.14	86.67	93.22	91.67	94.34	83.33	94.34	83.33	94.82	91.67	89.66	86.67
SA	88.52	90.00	87.93	85.00	87.30	91.67	89.83	88.33	90.16	91.67	86.67	86.67	91.38	88.33	93.22	91.67	94.64	88.33	92.723	85.00	89.47	85.00
WB	85.71	90.00	88.14	86.67	91.23	86.67	92.98	88.33	94.64	88.33	88.52	90.00	90.16	91.67	92.86	86.67	96.43	90.00	94.55	86.67	92.86	86.67
SC	96.36	88.33	91.23	86.67	96.30	86.67	98.21	91.67	98.18	90.00	96.36	88.33	98.15	88.33	96.55	93.33	96.49	91.67	96.36	88.33	96.36	88.33
GL	79.37	83.33	78.79	86.67	91.38	88.33	84.62	91.67	75.76	83.33	82.09	91.67	80.60	90.00	79.69	85.00	83.08	90.00	82.09	91.67	82.09	91.67
OF	94.44	85.00	89.66	86.67	98.15	88.33	94.83	91.67	94.64	88.33	94.55	86.67	94.74	90.00	94.55	86.67	93.22	91.67	93.22	91.67	92.59	83.33
I&SC	89.47	85.00	88.33	88.33	90.16	91.67	91.07	85.00	85.71	90.00	91.38	88.33	91.67	91.67	83.33	83.33	88.33	88.33	96.43	90.00	96.30	86.67
OA	86.06 %		85.61%		90%		89.09%		88.03%		87.88%		89.09%		88.33%		89.39%		98.09%		88.94%	

Year	2002		2003		2004		2005		2008		2009		2010		2011		2013		2014		2015		2016	
LULC	PA.	UA.	PA.	UA.	PA.	UA.	PA.	UA.	PA.	UA.	PA.	UA.	PA.	UA.	PA.	UA.	PA.	UA.	PA.	UA.	PA.	UA.	PA.	UA.
UB	88.71	91.67	91.38	88.33	94.34	83.33	94.44	85.00	94.23	81.67	92.73	85.00	94.83	91.67	92.59	83.33	95.08	96.67	95.00	95.00	87.30	91.67	94.83	91.67
CL	80.30	88.33	80.95	85.00	81.25	86.67	85.94	91.67	80.88	91.67	80.30	88.33	88.89	93.33	80.60	90.00	86.36	95.00	86.15	93.33	87.10	90.00	84.85	93.33
FC	85.25	86.67	81.54	88.33	80.33	81.67	80.95	85.00	83.33	83.33	80.00	93.33	90.00	90.00	91.80	93.33	93.33	93.33	96.61	95.00	96.55	93.33	85.94	91.67
SL	80.30	88.33	79.37	83.33	74.32	91.67	82.09	91.67	80.00	86.67	79.03	81.67	84.38	90.00	86.15	93.33	90.16	91.67	91.67	91.67	87.30	91.67	86.44	85.00
BL	89.47	85.00	90.16	91.67	86.44	85.00	94.64	88.33	87.72	83.33	92.73	85.00	88.71	91.67	85.94	91.67	95.00	95.00	93.22	91.67	89.29	83.33	88.14	86.67
SA	92.59	83.33	91.07	85.00	90.16	91.67	90.16	91.67	86.89	88.33	94.34	83.33	92.98	88.33	84.21	80.00	94.83	91.67	87.30	91.67	89.47	85.00	93.10	90.00
WB	91.67	91.67	93.22	91.67	91.07	85.00	91.53	90.00	88.33	88.33	87.50	93.33	91.53	90.00	92.98	88.33	93.44	95.00	94.74	90.00	85.94	91.67	94.64	88.33
SC	96.30	86.67	96.30	86.67	92.98	88.33	94.83	91.67	91.94	95.00	93.10	90.00	95.00	95.00	98.25	93.33	100.00	88.33	98.18	90.00	98.15	88.33	91.67	91.67
GL	81.54	88.33	82.81	88.33	79.69	85.00	85.48	88.33	80.95	85.00	84.13	88.33	85.94	91.67	84.62	91.67	87.69	95.00	80.88	91.67	84.85	93.33	85.71	90.00

OF	92.73	85.00	93.22	91.67	91.23	86.67	93.10	90.00	93.22	91.67	96.55	93.33	96.43	90.00	96.55	93.33	96.55	93.33	98.18	90.00	93.22	91.67	96.36	88.33
I&SC	90.00	90.00	91.38	88.33	88.89	80.00	94.83	91.67	94.34	83.33	96.43	90.00	96.49	91.67	96.36	88.33	96.49	91.67	96.61	95.00	96.55	93.33	87.10	90.00
OA	87.73%		88.03%		85.91%		89.55%		87.12%		88.33%		91.21%		89.70%		93.33%		92.17%		90.30%		89.70%	

Table S2. Land-use change of the Kaski district during 1988–2016 (area in km²). (Urban/built-up (UB), Cultivated land (CL), Forest cover (FC), Shrub land (SL); Barren land (BL), Sand area (SA), Water body (WB), Swamp cover (SC), Grass land (GL), Open field (OF) and Ice and snow-cover (I&SC)).

Year	UB	CL	FC	SL	BL	SA	WB	SC	GL	OF	I & SC	Total
1988	24.06	445.02	841.22	57.33	78.75	10.05	32.01	1.78	317.36	3.62	277.04	2088.25
1989	24.18	443.39	850.59	57.12	71.71	13.38	31.03	1.79	270.67	3.59	320.80	2088.25
1990	25.96	440.83	845.93	54.07	64.37	12.68	30.33	1.92	210.24	3.30	398.61	2088.25
1991	26.06	431.90	851.64	53.40	130.02	13.12	30.35	1.82	319.82	3.71	226.41	2088.25
1992	26.09	431.38	847.73	52.86	126.70	13.28	30.68	2.26	254.44	3.77	299.06	2088.25
1993	26.09	432.23	847.85	51.97	122.22	12.77	32.74	1.85	285.70	3.00	271.83	2088.25
1994	26.84	431.65	848.76	52.28	123.93	11.86	31.98	1.89	335.53	2.85	220.70	2088.25
1995	27.31	431.14	853.72	51.45	124.72	11.66	32.28	1.93	333.07	1.82	219.15	2088.25
1996	27.52	431.10	848.31	52.35	108.84	11.73	32.03	1.78	312.01	1.80	260.77	2088.25
1999	30.74	427.86	859.60	51.69	115.96	10.94	34.76	1.82	231.56	1.79	321.51	2088.25
2000	31.93	427.93	882.26	51.82	88.74	11.86	36.02	1.61	86.08	1.83	468.18	2088.25
2002	32.76	427.86	879.63	51.77	108.83	10.82	36.15	1.62	252.15	1.74	284.92	2088.25
2003	33.44	426.51	881.86	52.55	107.25	11.47	35.93	1.64	226.84	1.65	309.09	2088.25
2004	37.99	423.43	887.14	48.34	32.80	11.14	35.70	2.29	195.88	1.61	411.93	2088.25
2005	39.14	423.06	871.49	46.21	80.04	10.78	36.57	2.20	278.93	1.96	297.87	2088.25
2008	45.84	416.89	878.81	45.63	81.43	10.87	36.04	2.30	269.19	1.80	299.46	2088.25
2009	47.72	415.22	869.93	46.08	60.93	10.90	36.18	2.06	279.68	1.80	317.76	2088.25
2010	51.23	411.90	888.44	46.56	42.08	13.27	34.78	2.02	152.53	1.80	443.65	2088.25
2011	52.96	409.38	877.64	46.26	101.36	13.03	34.45	2.35	183.19	1.82	365.81	2088.25
2013	55.13	407.67	881.13	44.84	91.86	12.92	34.65	2.21	208.52	1.80	347.51	2088.25
2014	58.36	404.96	883.64	44.87	126.21	13.55	33.71	2.43	137.00	1.80	381.73	2088.25
2015	58.48	404.85	886.15	44.97	169.94	12.69	34.78	2.58	135.19	1.79	336.83	2088.25
2016	60.74	402.55	887.25	44.84	82.92	13.15	34.25	2.37	158.54	1.80	399.86	2088.25

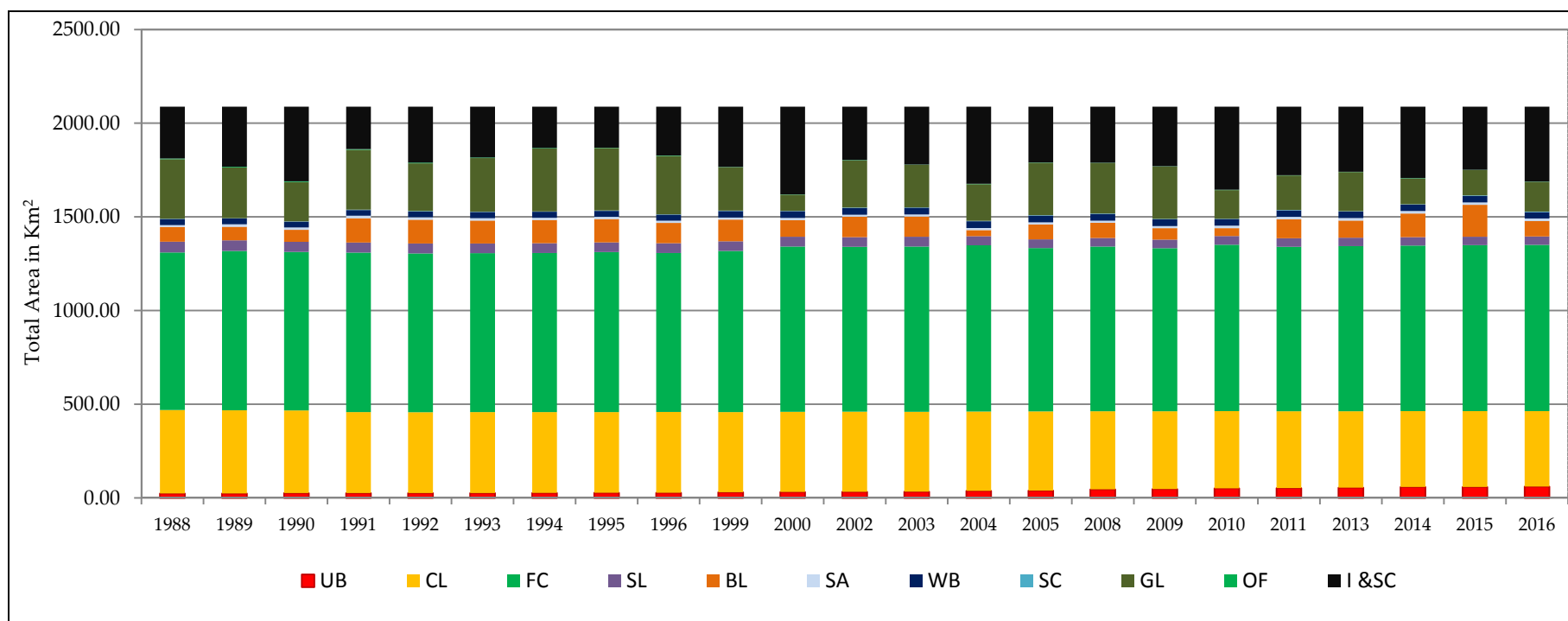


Figure S1. LULC from 1988 to 2016, (Urban/built-up (UB), Cultivated land (CL), Forest cover (FC), Shrub land (SL); Barren land (BL), Sand area (SA), Water body (WB), Swamp cover (SC), Grass land (GL), Open field (OF) and Ice and snow-cover (I&SC))