



Research article

An assessment framework for evaluating urban flood vulnerabilities using Night-Time Light data

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Supplementary

Table S1. Summary of data and sources.

Data	Data source	Reason
River gauge data from 2000-2021	Irrigation Department, Sri Lanka.	To determine the exact flood occurrences for the past 20 years.
Sentinel-1 SAR GRD: C-band Synthetic Aperture Radar	Retrieved from Google Earth Engine (Image Collection-COPERNICUS/S1_GRD)	To determine the extent of flooding in the identified past flood events. To calculate the indices NDVI as a conditioning factor, NDWI & EVI to calculate NUACI
Conditioning factors	Meteorological Department, Sri Lanka Survey Department, Sri Lanka National Building Research Organization USGS Earth Explorer	To determine the flood susceptibility in the Kelani River basin
Night-time Light data	Retrieved from Google Earth Engine (NOAA/VIIRS/DNB/MONTHLY_V1/CMCFG)	To utilize in measuring the levels of human exposure to urban flooding.

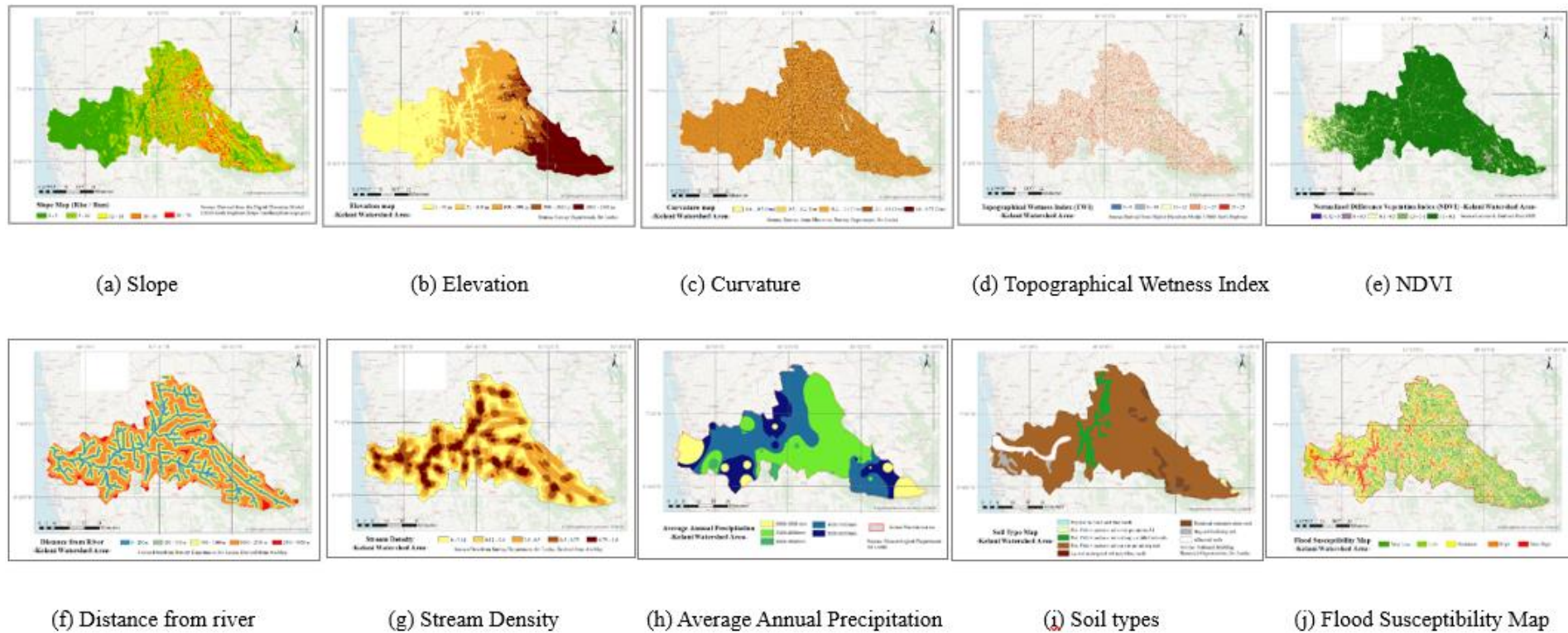


Figure S1. Conditioning factors for flood susceptibility.

Table S2. Hourly water levels on the flood identified dates (Hanwell).

Hanwella			Hourly water Level in meters																							
Year	Month	Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
2012	11	1	5.08	5.32	5.61	5.89	6.15	6.39	6.64	6.82	7.00	7.18	7.36	7.47	7.60	7.68	7.76	7.86	7.94	8.02	8.09	8.17	8.21	8.25	8.29	8.32
		2	8.34	8.35	8.36	8.36	8.36	8.36	8.34	8.31	8.29	8.25	8.19	8.15	8.09	8.04	7.96	7.88	7.79	7.70	7.61	7.51	7.40	7.29	7.20	7.06
2014	12	26	4.51	5.03	5.59	6.01	6.43	6.65	6.84	7.00	7.15	7.28	7.36	7.47	7.52	7.57	7.62	7.66	7.68	7.68	7.68	7.66	7.65	7.63	7.58	7.50
		27	7.40	7.31	7.20	7.06	6.93	6.81	6.70	6.55	6.40	6.26	6.11	5.97	5.82	5.69	5.57	5.45	5.33	5.21	5.11	5.03	4.93	4.88	4.78	4.70
2016	05	16	7.35	7.60	7.90	8.08	8.33	8.50	8.63	8.73	8.83	8.89	8.96	9.05	9.13	9.19	9.24	9.32	9.36	9.40	9.45	9.48	9.52	9.55	9.56	9.60
		17	9.64	9.66	9.66	9.68	9.72	9.75	9.77	9.78	9.80	9.81	9.83	9.84	9.85	9.87	9.88	9.89	9.91	9.93	9.94	9.94	9.96	9.98	9.98	9.98
		18	9.98	10.00	10.00	10.01	10.02	10.02	10.02	10.02	10.02	10.03	10.03	10.03	10.03	10.03	10.03	10.02	10.01	9.96	9.94	9.90	9.89	9.84	9.82	9.78
		19	9.75	9.71	9.66	9.60	9.52	9.46	9.40	9.32	9.25	9.16	9.10	9.02	8.96	8.90	8.86	8.80	8.76	8.74	8.72	8.77	8.79	8.81	8.86	8.90
		20	8.96	9.00	9.01	9.01	9.04	9.10	9.13	9.15	9.16	9.16	9.17	9.17	9.17	9.17	9.16	9.14	9.09	9.07	9.04	9.01	8.97	8.91	8.87	8.82
		21	8.76	8.72	8.64	8.54	8.49	8.43	8.36	8.29	8.20	8.14	8.06	8.00	7.96	7.90	7.86	7.80	7.79	7.78	7.75	7.73	7.70	7.65	7.60	7.55
		22	8.76	8.72	8.64	8.54	8.49	8.43	8.36	8.29	8.20	8.14	8.06	8.00	7.96	7.90	7.86	7.80	7.79	7.78	7.75	7.73	7.70	7.65	7.60	7.55
2017	05	26	4.40	4.62	4.86	5.28	5.88	6.60	7.29	7.90	8.40	8.63	8.79	8.93	9.08	9.16	9.26	9.32	9.36	9.40	9.42	9.43	9.43	9.43	9.43	9.42
		27	9.42	9.40	9.38	9.36	9.33	9.30	9.26	9.20	9.15	9.10	9.03	8.90	8.83	8.74	8.64	8.53	8.42	8.31	8.20	8.10	7.99	7.88	7.78	7.68
		28	7.58	7.48	7.38	7.30	7.22	7.14	7.06	6.96	6.89	6.79	6.69	6.59	6.49	6.39	6.28	6.18	6.09	5.98	5.90	5.82	5.72	5.66	5.60	5.55
2018	05	21	6.20	6.54	6.79	7.06	7.26	7.38	7.52	7.61	7.70	7.77	7.81	7.85	7.88	7.91	7.95	7.99	8.01	8.06	8.10	8.17	8.23	8.30	8.35	8.40
		22	8.45	8.49	8.51	8.54	8.57	8.60	8.62	8.63	8.64	8.64	8.63	8.61	8.58	8.57	8.52	8.48	8.48	8.38	8.30	8.25	8.18	8.12	8.01	7.96
		23	7.86	7.74	7.67	7.56	7.46	7.32	7.21	7.10	7.03	6.97	6.91	6.86	6.84	6.87	6.92	7.00	7.08	7.15	7.22	7.28	7.30	7.32	7.33	7.32
2021	05	25	4.44	4.72	4.99	5.24	5.49	5.72	5.95	6.15	6.33	6.52	6.66	6.80	6.89	6.98	7.02	7.06	7.10	7.12	7.15	7.12	7.13	7.13	7.12	7.12
		26	7.11	7.10	7.08	7.07	7.04	7.03	7.01	6.97	6.93	6.90	6.84	6.78	6.70	6.64	6.55	6.48	6.40	6.34	6.30	6.27	6.26	6.28	6.30	6.34
	06	4	5.71	5.90	6.09	6.38	6.69	7.08	7.24	7.48	7.66	7.80	7.90	7.96	8.01	8.03	8.06	8.08	8.08	8.05	8.03	8.00	8.00	7.99	7.98	7.95
		5	7.91	7.89	7.87	7.81	7.85	7.87	7.94	8.00	8.08	8.16	8.22	8.28	8.32	8.36	8.42	8.45	8.46	8.49	8.51	8.53	8.54	8.55	8.55	8.54
		6	8.54	8.50	8.50	8.48	8.46	8.42	8.37	8.32	8.27	8.20	8.14	8.07	8.00	7.92	7.85	7.76	7.68	7.60	7.52	7.44	7.36	7.30	7.20	7.10

Table S3. Hourly water levels on the flood identified dates (Nagalagam Weediya).

Nagalagam Weediya			Hourly water level in meters																							
Year	Month	Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
2000	09	21	4.30	4.35	4.40	4.55	4.65	4.80	4.90	4.95	4.95	5.00	4.90	4.90	4.90	4.90	4.90	4.90	4.95	5.00	5.00	5.00	5.00	4.95	4.90	4.85
		22	4.85	4.80	4.80	4.80	4.75	4.70	4.70	4.65	4.60	4.60	4.45	4.30	4.15	4.05	3.95	3.90	3.80	3.70	3.70	3.60	3.50	3.40	3.35	3.30
2006	06	21	4.70	4.65	4.65	4.65	4.65	4.70	4.80	4.85	4.90	4.95	4.95	4.85	4.75	4.70	4.55	4.45	4.40	4.35	4.40	4.35	4.35	4.30	4.30	4.20
		22	4.05	3.95	3.80	3.65	3.55	3.40	3.30	3.30	3.40	3.50	3.60	3.55	3.30	3.40	3.30	3.10	3.00	3.00	2.90	2.90	2.90	2.80	2.80	2.90
2008	04	29	5.05	5.10	5.15	5.25	5.35	5.40	5.45	5.45	5.50	5.50	5.55	5.55	5.55	5.60	5.60	5.60	5.65	5.70	5.70	5.75	5.75	5.75	5.75	5.70
		30	5.70	5.70	5.70	5.70	5.70	5.65	5.60	5.65	5.60	5.60	5.55	5.50	5.40	5.30	5.20	5.10	4.90	4.80	4.80	4.70	4.60	4.60	4.55	4.40
	06	1	5.30	2.30	5.20	5.20	5.20	5.20	5.30	5.40	5.50	5.60	5.70	5.80	5.90	5.90	5.75	5.65	5.60	5.55	5.50	5.55	5.60	5.60	5.70	5.70
		2	5.80	5.80	5.70	5.65	5.60	5.55	5.45	5.45	5.50	5.60	5.70	5.75	5.80	5.80	5.80	5.65	5.50	5.40	5.30	5.30	5.30	5.30	5.30	5.35
		3	5.40	5.40	5.40	5.30	5.10	4.95	4.85	4.80	4.80	4.90	5.00	5.10	5.20	5.25	5.20	5.10	5.00	4.80	4.65	4.50	4.40	4.50	4.50	4.50
	02	17	4.10	4.10	4.20	4.20	4.25	4.40	4.45	4.45	4.40	4.20	4.10	4.10	4.20	4.25	4.30	4.40	4.50	4.60	4.60	4.60	4.50	4.50	4.40	4.30
		18	4.20	4.10	4.00	4.00	4.10	4.30	4.50	4.50	4.55	4.55	4.50	4.40	4.40	4.45	4.50	4.50	4.55	4.55	4.60	4.60	4.60	4.55	4.45	4.35
2012	02	24	1.20	1.40	1.55	1.60	1.75	1.80	1.90	2.40	2.65	3.30	3.50	3.70	4.00	4.25	4.25	4.30	4.40	4.50	4.60	4.75	4.85	4.95	4.95	4.95
		25	4.90	4.85	4.80	4.80	4.85	4.95	5.00	5.05	5.15	5.30	5.35	5.40	5.40	5.35	5.30	5.20	5.10	5.10	5.05	5.05	5.15	5.15	5.15	5.10
		26	5.10	5.10	5.05	4.95	4.90	4.85	4.85	4.85	4.90	5.00	5.05	5.05	5.05	5.00	4.85	4.60	4.45	4.30	4.15	4.00	4.00	4.00	4.00	4.00
	08	2	4.95	5.15	5.30	5.40	5.35	5.25	5.10	5.00	4.85	4.85	4.85	4.90	5.00	5.15	5.20	5.20	5.20	5.10	4.90	4.80	4.70	4.60	4.60	4.65
		3	4.70	4.80	4.85	4.85	4.75	4.60	4.30	4.15	3.90	3.75	3.70	3.70	3.70	3.80	3.90	3.90	3.85	3.70	3.50	3.35	3.10	3.00	3.00	3.00
	02	15	6.40	6.45	6.45	6.40	6.40	6.40	6.40	6.45	6.55	6.70	6.80	6.90	7.00	7.00	7.00	7.00	7.00	6.95	7.00	7.00	7.05	7.10	7.20	7.30
		16	7.35	7.40	7.45	7.45	7.30	7.25	7.25	7.25	7.35	7.40	7.50	7.60	7.65	7.65	7.65	7.65	7.60	7.50	7.40	7.35	7.35	7.35	7.35	7.40
		17	7.45	7.50	7.45	7.40	7.30	7.25	7.20	7.20	7.20	7.20	7.30	7.35	7.45	7.50	7.50	7.40	7.30	7.20	7.15	7.10	7.05	7.05	7.10	7.15
		18	7.20	7.20	7.20	7.15	7.05	3.95	3.90	3.80	3.80	3.80	3.90	7.00	7.00	7.10	7.05	6.95	6.80	6.70	6.55	6.50	6.35	6.25	6.30	6.35
2018	06	8	4.30	4.50	4.70	4.70	4.60	4.45	4.20	3.90	3.70	3.65	3.65	3.65	3.80	3.90	4.10	4.10	3.90	3.60	3.25	2.95	2.70	2.70	2.70	2.90
		9	3.05	3.30	3.60	3.60	3.55	3.35	3.00	2.70	2.50	2.40	2.30	2.45	2.70	3.00	3.00	3.10	3.00	2.90	2.70	2.20	1.90	1.90	1.90	2.00

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Nagalagam Weediya			Hourly water level in meters																							
Year	Month	Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
2019	02	19	4.80	4.85	4.90	4.95	5.00	5.10	5.15	5.20	5.20	5.20	5.15	5.20	5.20	5.20	5.25	5.30	5.40	5.40	5.40	5.45	5.45	5.35	5.25	5.10
		20	5.10	5.00	5.00	5.00	5.00	5.00	5.00	4.95	4.95	4.90	4.90	4.80	4.70	4.70	4.65	4.65	4.65	4.70	4.75	4.80	4.80	4.85	4.80	4.70
		21	4.60	4.60	4.60	4.50	4.50	4.50	4.55	4.55	4.60	4.60	4.60	4.45	4.40	4.30	4.15	4.00	4.00	3.95	3.95	3.90	3.90	3.95	4.00	3.95

Table S4. Frequency ratio values.

Conditioning factors	Classes	Total number of pixels		Number of floods occurred pixel in each class		Frequency ratio
		Number	Percentage	Number	Percentage	
Slope	0–5	63800	35.20%	1142	51.21%	1.45
	5–12	49925	27.55%	269	12.06%	0.44
	12–18	34752	19.18%	240	10.76%	0.56
	18–30	29021	16.01%	429	19.24%	1.20
	30–70	3737	2.06%	150	6.73%	3.26
Elevation	0–200	101675	56.10%	1486	66.64%	1.19
	200–500	32261	17.80%	345	15.47%	0.87
	500–1000	14693	8.11%	166	7.44%	0.92
	1000–1500	22120	12.21%	132	5.92%	0.48
	1500–2500	10486	5.79%	101	4.53%	0.78
Curvature	–4.6––0.5	11986	6.61%	198	8.88%	1.34
	–0.5––0.1	53786	29.68%	678	30.40%	1.02
	–0.1––0.2	74760	41.25%	911	40.85%	0.99
	–0.2–0.6	31845	17.57%	237	10.63%	0.60
	0.6–7.5	8858	4.89%	206	9.24%	1.89
TWI	–0.8–8	23834	13.15%	218	9.78%	0.74
	8–10	72363	39.93%	622	27.89%	0.70
	10–12	52593	29.02%	658	29.51%	1.02
	12–15	24923	13.75%	501	22.47%	1.63
	15–25	7522	4.15%	231	10.36%	2.50
Rainfall	2000–3500	17574	9.70%	58	2.60%	0.27
	3500–4000	28285	15.61%	425	19.06%	1.22
	4000–4500	63304	34.93%	864	38.74%	1.11
	4500–5500	68948	38.04%	843	37.80%	0.99
	5500–8500	3124	1.72%	40	1.79%	1.04
NDVI	–0.32–0	742	0.41%	2	0.09%	0.22
	0–0.3	3155	1.74%	42	1.88%	1.08
	0.3–0.5	10022	5.53%	176	7.89%	1.43
	0.5–0.6	19027	10.50%	312	13.99%	1.33
	0.6–0.8	148289	81.82%	1698	76.14%	0.93
Distance from river	0–200	23164	12.78%	621	27.85%	2.18
	200–500	32698	18.04%	478	21.43%	1.19
	500–1000	47365	26.13%	490	21.97%	0.84
	1000–2500	72145	39.81%	593	26.59%	0.67
	2500–5000	5863	3.24%	48	2.15%	0.67

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Conditioning factors	Classes	Total number of pixels		Number of floods occurred pixel in each class		Frequency ratio
		Number	Percentage	Number	Percentage	
Slope	0–5	63800	35.20%	1142	51.21%	1.45
Stream density	0–0.12	48274	26.64%	394	17.67%	0.66
	0.12–0.3	37525	20.71%	361	16.19%	0.78
	0.3–0.5	48504	26.76%	497	22.29%	0.83
	0.5–0.75	32370	17.86%	664	29.78%	1.67
	0.75–1.3	14562	8.03%	314	14.08%	1.75
Soil type	Regosol on the recent beach and dune sands	204	0.11%	4	0.18%	1.59
	Red, Yellow podzolic soils with prominent A1 or semi-prominent A1	1014	0.56%	0	0.00%	0.00
	Red, Yellow podzolic soils strongly mottled sub-soils	12427	6.86%	72	3.23%	0.47
	Red, Yellow podzolic soils and mountain regosol	152253	84.01%	1812	81.26%	0.97
	Latosols and regosol red and yellow sands	111	0.06%	0	0.00%	0.00
	Erosional remnants steep rock	6133	3.38%	137	6.14%	1.82
	Bog and half-dog soil	2998	1.65%	74	3.32%	2.01
	Alluvial soils	6095	3.36%	131	5.87%	1.75

Table S5. Prediction ratio values.

Conditioning factors	Prediction ratio (weight for each Parameter) PR (RFMax-RFMin)/Min (RFMax-RFMin)
Slope	2.4648
Elevation	1.0000
Curvature	1.3258
Topographic wetness index	1.6469
Average annual precipitation	1.2417
Normalized difference vegetation index	1.4612
Distance from river	1.6489
Stream density	1.1540
Soil type	1.4082



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