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Supplement of

The potential of open-access data for flood estimations: uncovering inundation hotspots in Ho Chi Minh City, Vietnam, through a normalized flood severity index

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Supplementary Material S1: List of freely available DEMs

Table S1: A list of freely available DEMs along with their different versions, their issuers and their date of issuance as well as their resolution and vertical accuracy.

Freely Available Satellite DEMs					
Name	**Version**	**Issuer with Link (Reference)**	**Publication Date**	**Horizontal Resolution**	**Vertical Accuracy**
SRTM	1	NASA (EROS, 2018)	2004	3-arcsecond	16 m absolute error (Globe) (Farr et al., 2007)
	2.1		2005	3-arcsecond	
	3		2013	1-arcsecond	
ALOS	1	JAXA (OpenTopography, 2016)	2015	1-arcsecond	4.10 m RMSE (Globe) (Tadono et al., 2015)
	2		2017	1-arcsecond	
	3		2020	1-arcsecond	
ASTER	1	NASA/METI (ASTER)	2009	1-arcsecond	9.34 m RMSE (US) (Gesch et al., 2012)
	2		2011	1-arcsecond	8.68 m RMSE (US) (Gesch et al., 2012)
	3		2016	1-arcsecond	8.52 m RMSE (US) (Gesch et al., 2016)
COPERNICUS	1	ESA (Copernicus DEM, 2019)	2019	1-arcsecond	<4 m absolute error (Copernicus DEM, 2019)
CoastalDEM	1.1	Climate Central (Kulp and Strauss, 2018)	2018	3-arcsecond	4.02 m RMSE (Globe <5 m) (Kulp and Strauss, 2021)
	2.1		2022	3-arcsecond	2.63 m RMSE (Globe <5 m) (Kulp and Strauss, 2021)
FABDEM	1.0	Fathom Global (Hawker et al., 2022)	2022	1-arcsecond	<2.88 m absolute error (Hawker et al., 2022)
	1.2		2023	1-arcsecond	

Supplementary Material S2: Processing of terrain data

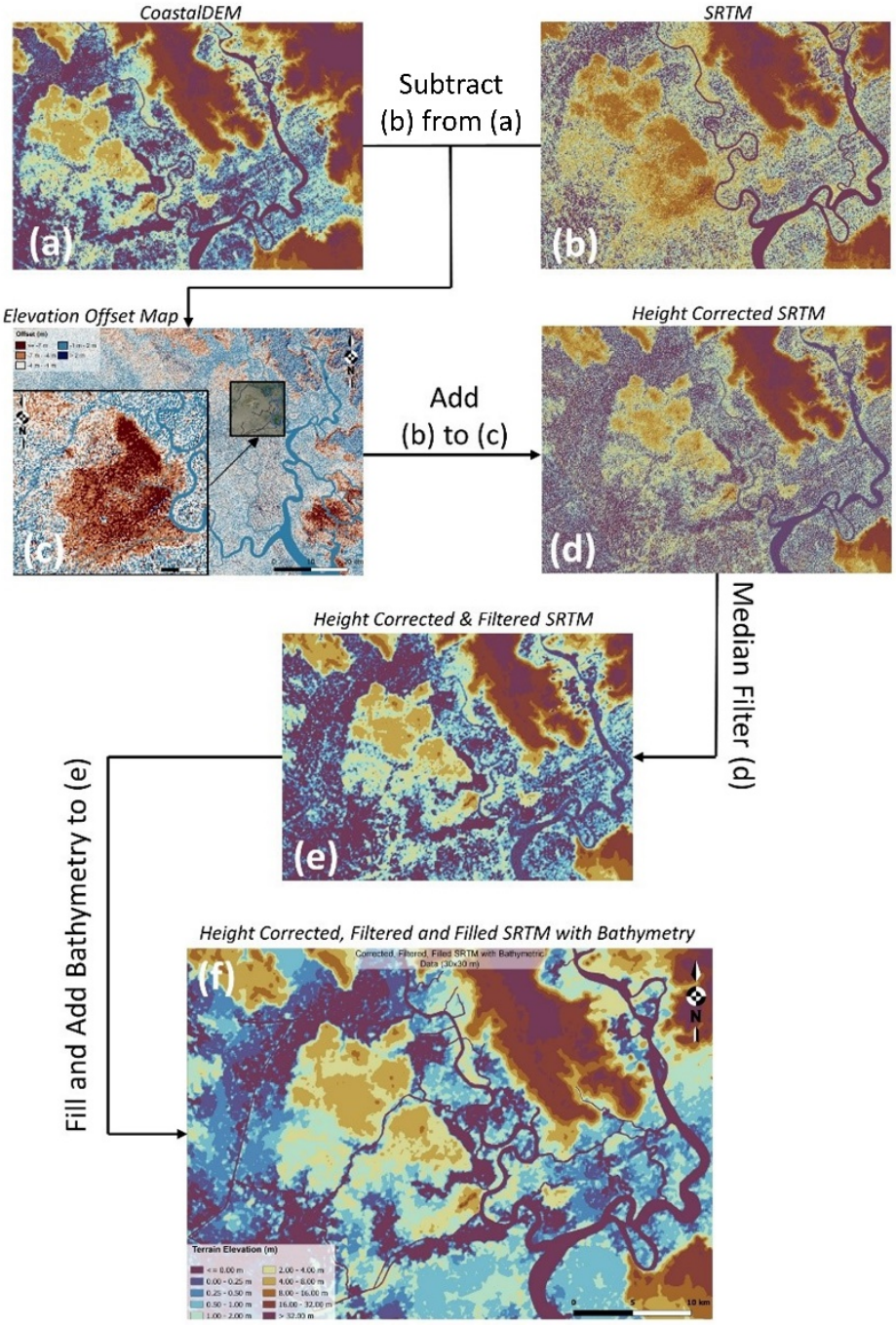

Figure S2. TERRAIN DATA: (a) represents the CoastalDEM, which is subtracted from the SRTM shown in (b) to produce the elevation offset map presented in (c). (d) is the result of adding (b) to (c). (e) depicts the result of the 3×3 2D median filter, which was then filled and enriched with bathymetric data, leading to the final elevation model shown in (f). Topographic data visualized using scientific color maps created by Crameri (2021).

Supplementary Material S3: Characteristics of the LiDAR data

Generating Software:	'TerraScan'		
Number of Point Records:	51401717		
Scale Factor X Y Z:	0.00100000	0.001000000	0.001
Offset X Y Z:	672194.312	1183851.815	0.000
Min X Y Z:	672194.314	1183851.817	-28.630
Max X Y Z:	674199.100	1185856.582	62.480
ProjectedCSType:	PCS_WGS84_UTM_zone_48N		
Bounding Box:	672194.314, 1183851.817, 674199.100, 1185856.582		

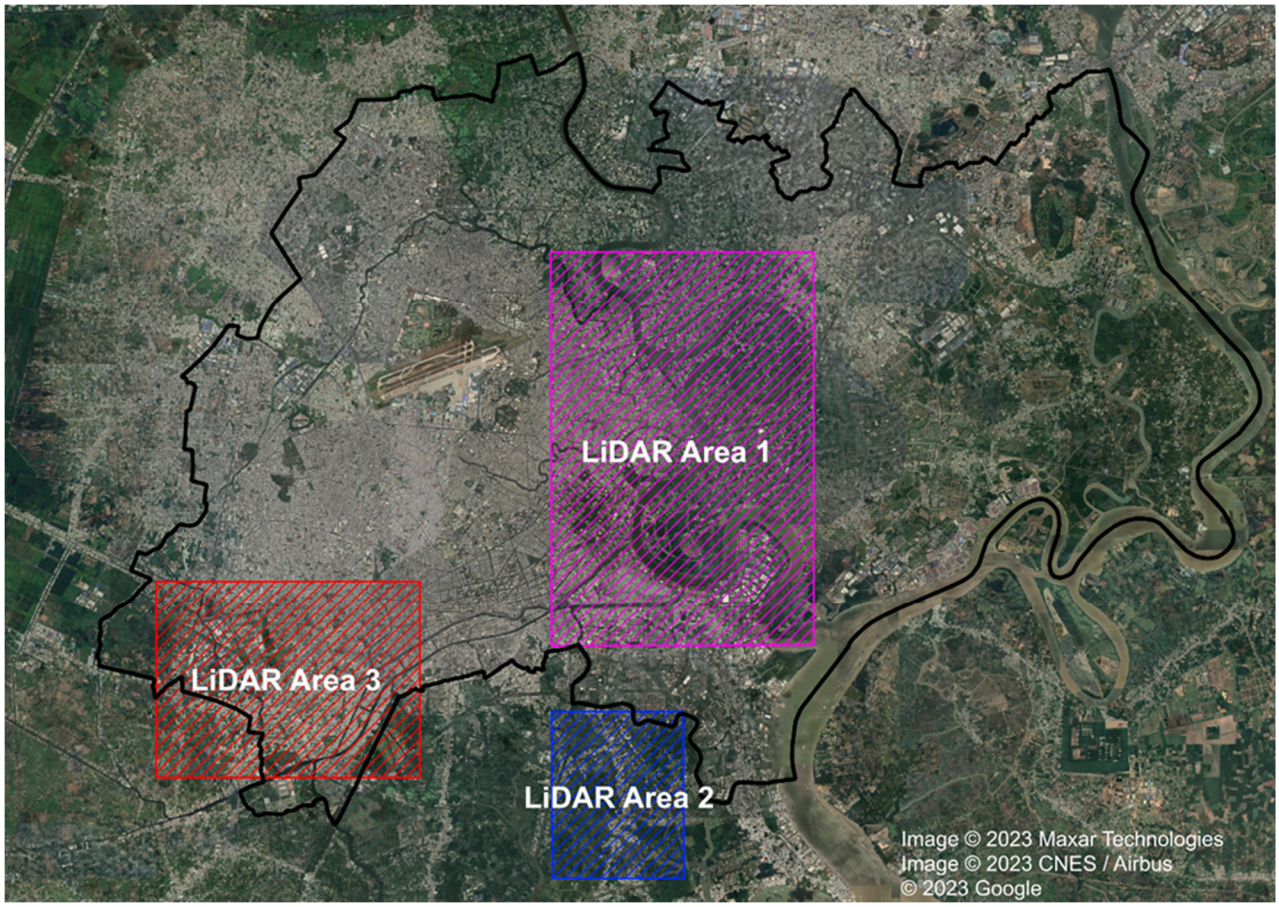

Figure S3. LIDAR DATA: Locations of the acquired LiDAR samples.

Supplementary Material S4: Comparison for globale DEMs and LiDAR

Table S4: Comparison of LiDAR height data with global digital elevation models.

Generated DEM					
LiDAR Area	**Area (m^2)**	**Absolute Mean Error (m)**	**Mean Error (m)**	**Root Mean Square Error (m)**	**Standard Deviation (m)**
1	96	0.80	-0.52	0.96	0.81
2	21	0.62	-0.39	0.75	0.64
3	48	0.80	-0.38	0.95	0.86
Total	165	0.77	-0.45	0.93	0.81

CoastalDEMv1					
LiDAR Area	**Area (m^2)**	**Absolute Mean Error (m)**	**Mean Error (m)**	**Root Mean Square Error (m)**	**Standard Deviation (m)**
1	96	1.34	-1.00	1.80	1.50
2	21	4.58	-1.10	1.70	1.40
3	48	1.22	-0.73	1.60	1.40
Total	165	1.28	-0.91	1.71	1.45

SRTM					
LiDAR Area	**Area (m^2)**	**Absolute Mean Error (m)**	**Mean Error (m)**	**Root Mean Square Error (m)**	**Standard Deviation (m)**
1	96	2.47	1.28	3.30	3.07
2	21	8.40	0.98	3.50	3.33
3	48	2.50	1.20	3.20	3.03
Total	165	2.50	1.20	3.30	3.10

ALOS					
LiDAR Area	**Area (m^2)**	**Absolute Mean Error (m)**	**Mean Error (m)**	**Root Mean Square Error (m)**	**Standard Deviation (m)**
1	96	4.14	4.01	5.30	3.47
2	21	14.10	1.98	2.90	2.16
3	48	3.10	2.70	4.31	3.30
Total	165	2.50	3.20	4.60	3.30

ASTER					
LiDAR Area	**Area (m^2)**	**Absolute Mean Error (m)**	**Mean Error (m)**	**Root Mean Square Error (m)**	**Standard Deviation (m)**
1	96	7.06	7.03	7.65	2.99
2	21	24.12	7.33	8.06	2.54
3	48	7.41	7.65	8.15	2.92
Total	165	7.35	7.34	7.89	2.92

Copernicus					
LiDAR Area	**Area (m^2)**	**Absolute Mean Error (m)**	**Mean Error (m)**	**Root Mean Square Error (m)**	**Standard Deviation (m)**
1	96	4.02	4.00	4.65	2.37
2	21	13.75	2.42	2.86	1.52
3	48	3.17	3.14	3.77	2.09
Total	165	3.48	3.46	4.12	2.24

CoastalDEMv2					
LiDAR Area	**Area (m^2)**	**Absolute Mean Error (m)**	**Mean Error (m)**	**Root Mean Square Error (m)**	**Standard Deviation (m)**
1	96	2.22	2.17	2.46	1.18
2	21	7.59	1.47	1.75	0.96
3	48	2.12	2.12	2.28	0.85
Total	165	2.08	2.05	2.31	1.07

FABDEM					
LiDAR Area	**Area (m^2)**	**Absolute Mean Error (m)**	**Mean Error (m)**	**Root Mean Square Error (m)**	**Standard Deviation (m)**
1	96	1.68	1.67	2.04	1.18
2	21	2.16	0.95	1.29	0.88
3	48	1.51	1.49	1.69	0.78
Total	165	1.41	1.37	1.75	1.08

Supplementary Material S5: Processing of bathymetric data

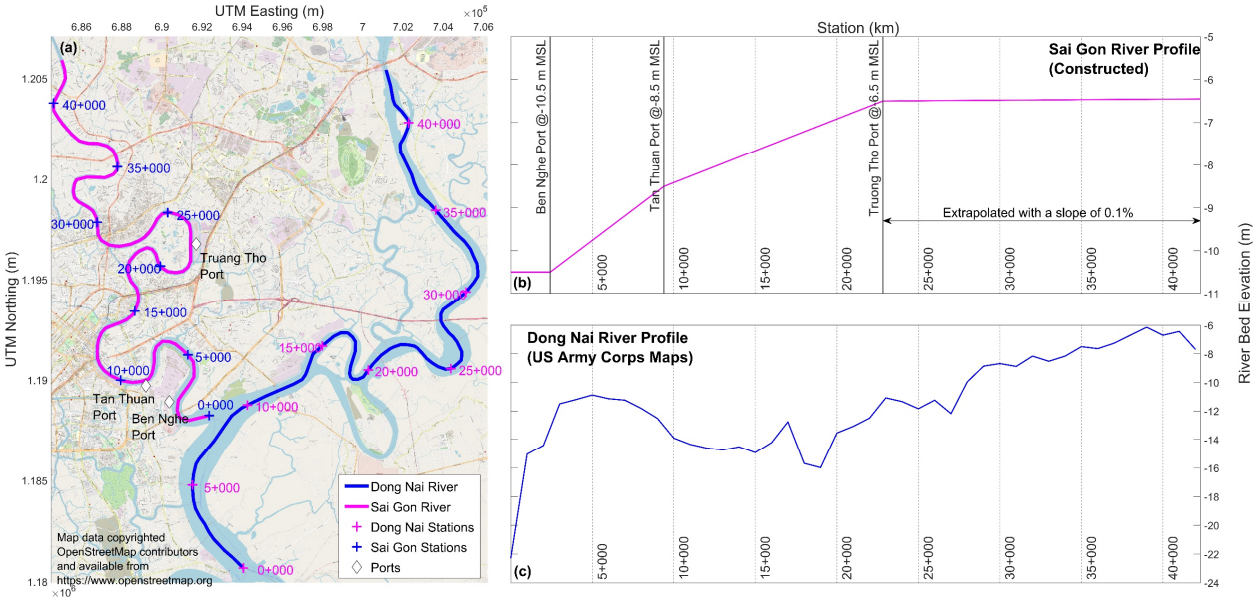

Figure S5. RIVER BATHYMETRY: (a) shows the location of the ports used to determine the depth of the Sai Gon River as well as the stationing for the river bed elevation. (b) and (c) show the constructed Sai Gon River and digitized Dong Nai River longitudinal profiles, respectively.

Supplementary Material S6: Comparison of measured and extrapolated water levels at Nha Be station

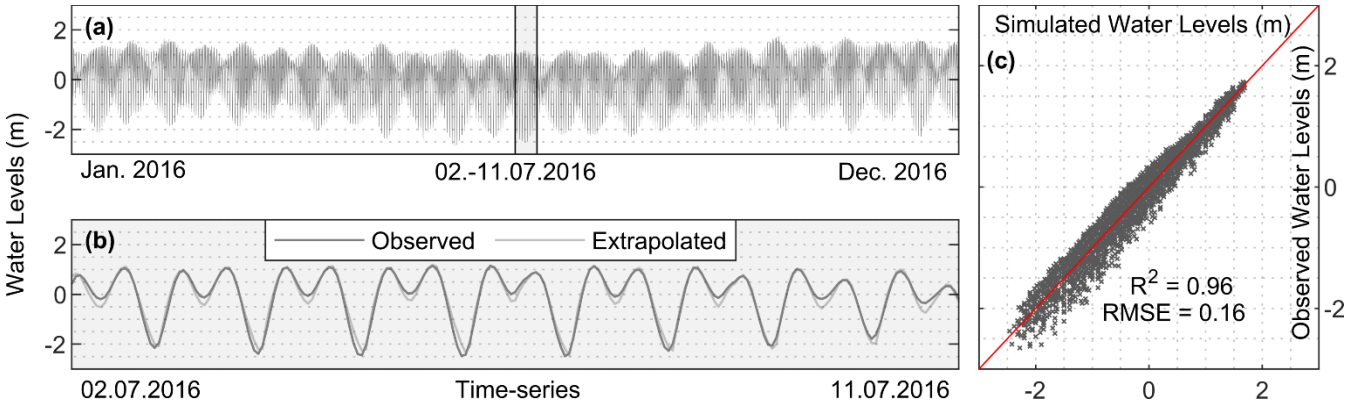

Figure S6. WATER-LEVEL COMPARISON (a) Time series of the Nha Be tidal gauge for 2016 versus data from Vung Tau after adjusting by a scaling factor of 1.05 and removing the temporal phase shift of 1.8 hrs. (b) Exemplary section of the same time series illustrating the fit of tidal high-water levels. (c) Linear regression for all hourly data points and corresponding quality estimates R^2 and RMSE.

Supplementary Material S7: Determination of flooding threshold (media examples, all accessed in Feb. 2023)

https://openjicareport.jica.go.jp/618/618_123.html

https://www.c40.org/case-studies/mitigate-urban-flooding-in-ho-chi-minh-city-phase-1/

https://global.royalhaskoningdhv.com/projects/flood-management-in-ho-chi-minh-city-vietnam

https://borneobulletin.com.bn/poor-urban-development-cause-of-flooding-congestion-in-ho-chi-minh-say-experts/

https://e.vnexpress.net/news/news/major-anti-flooding-project-in-hcmc-misses-deadline-for-four-years-4444006.html

https://www.channelnewsasia.com/cnainsider/siege-climate-man-made-problems-sinking-ho-chi-minh-city-floods-2052231

Supplementary Material S8: Model validation data

Table S8.1: Reported vs. simulated flood depths

ID	Reported Flood Depth (m)	Simulated Flood Depth (m)	ID	Reported Flood Depth (m)	Simulated Flood Depth (m)	ID	Reported Flood Depth (m)	Simulated Flood Depth (m)
1	0.10	0.15	10	0.20	0.20	19	0.25	0.25
2	0.10	0.10	11	0.20	0.25	20	0.25	0.15
3	0.15	0.20	12	0.20	0.15	21	0.30	0.25
4	0.15	0.20	13	0.20	0.20	22	0.30	0.30
5	0.15	0.15	14	0.20	0.20	23	0.30	0.25
6	0.20	0.20	15	0.20	0.20	24	0.35	0.30
7	0.20	0.20	16	0.20	0.20	25	0.40	0.40
8	0.20	0.15	17	0.20	0.20			
9	0.20	0.20	18	0.25	0.20			
NSE		0.70	RMSE (m)		0.03	PBIAS (%)		4

Table S8.2: Street names for model validation locations

ID	Street Name	ID	Street Name	ID	Street Name
1	Hem 42/51 Tran Dai Nghia	10	Hem 2/3 Lo Siue	19	Duong Hong Ha
2	Duong An Duong Vuong	11	Duong Luong Minh Nguyet	20	Binh Quai
3	Ben Lo Gom	12	Hem 174 Thai Phien	21	Song Hanh QL22
4	Hem 851/935 Duong Huynh Tan Phat	13	Duong Hoa Binh	22	Duong Duong Van Cam
5	Duong Thap Muoi	14	Duong Trinh Dinh Trong	23	Duong Le Loi
6	Duong Pham Huu Chi	15	Hem 710 Duong Luy Ban Bich	24	Duong So 1
7	Hem 336 Nguyen Van Luong	16	Bau Cat	25	Duong D
8	Hem 63 Luu Trong Lu	17	Duong Hoa Bang		
9	Duong Dang Nguyen Can	18	Tran Quoc Toan		

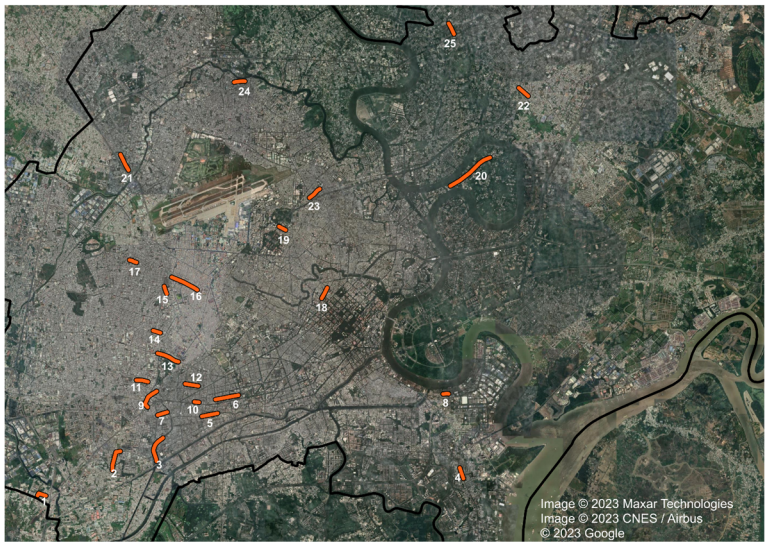

Figure S8. REPORTED INUNDATIONS: Location of flooded streets used for model validation.