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Automatic Extraction of Urban Building Area and Height using High Resolution Satellite Imagery

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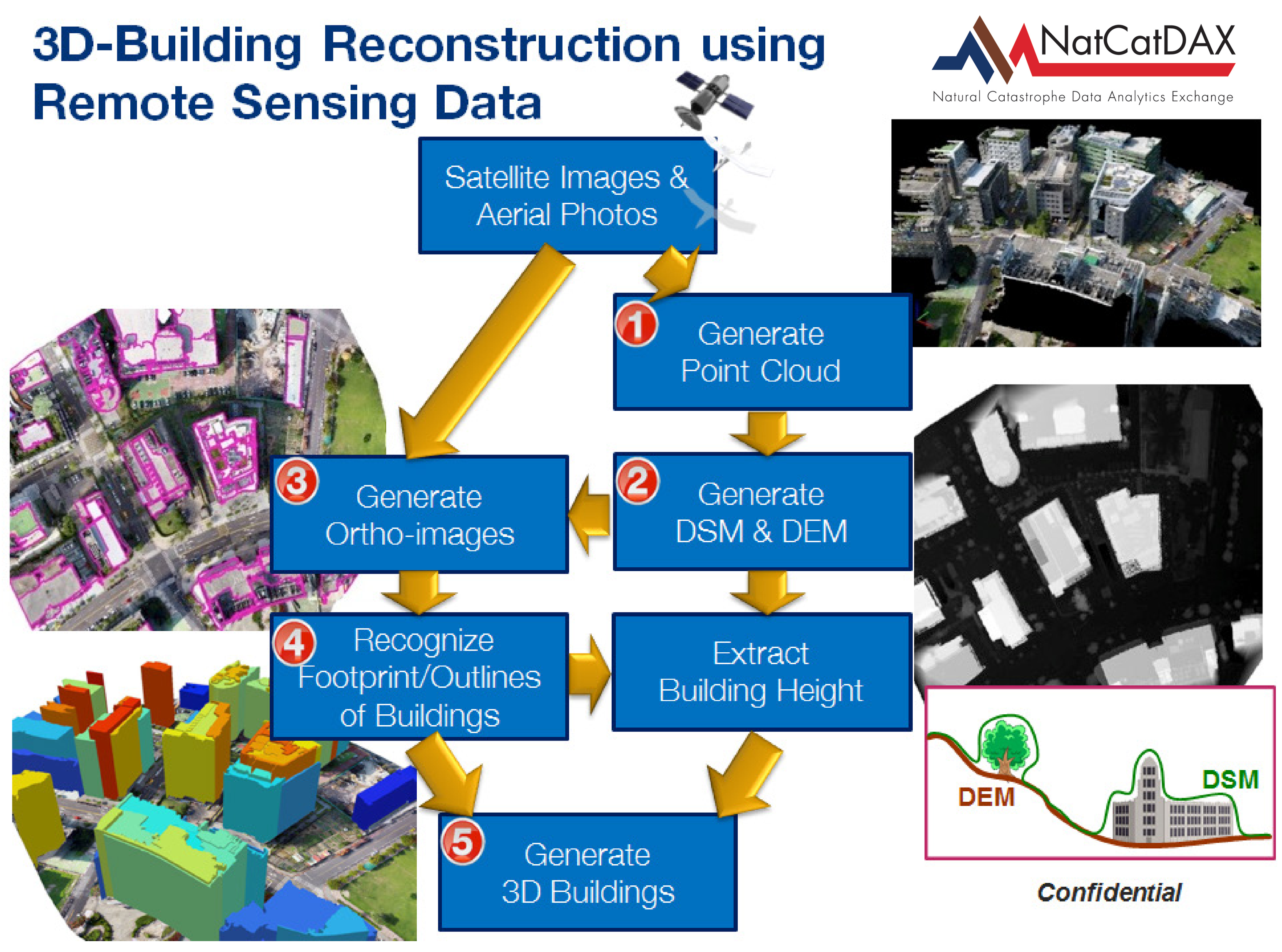
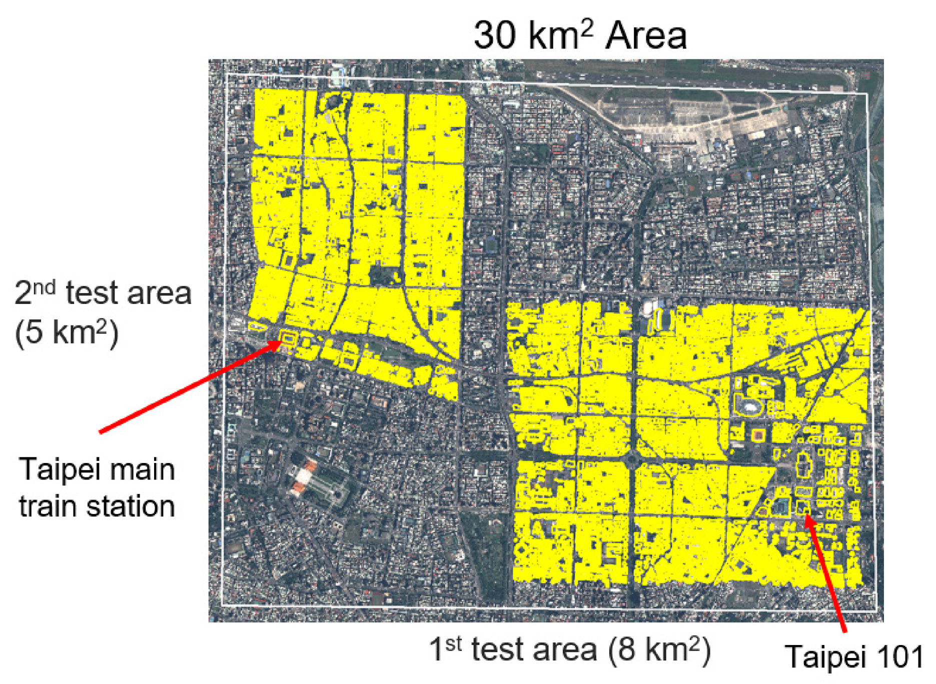


0.5m Pleiades tri-stereo imagery

- Asia has the largest growth of real assets and urban centers
- Of the world's 35 megacities in 2017, 21 are in the Asia
- Asia has historically suffered the most from catastrophic (Cat) events, but has the least amount of safety net or risk transfer mechanisms
- While insurance industry could significantly contribute in mitigating the impact of natural catastrophes, effective Cat risk financing solutions need robust models and data, including exposure data models, to quantify the Cat risk
- This effort aims to develop a high resolution exposure model (geometric characteristics) of building structures in cities via high resolution satellite imagery
- The image processing incorporating a high degree of automation is demonstrated for two test areas in Taipei covering 13 km^2 and being extended to 30 km^2
- Next step: develop exposure models for full cities of Jakarta, Manila and Bangkok

Building Footprint & Height Extraction



Input	Purpose	Output
DSM(Digital Surface Model) DEM(Digital Elevation Model)	Generate OHM(Object Height Model) from DSM-DEM	Building footprint via segmentation on Object Height Model (OHM) or ortho-image (for low buildings).
Multispectral satellite image	Generate NDVI (Normalized Difference Vegetation Index) to filter out vegetation area	
Open Street Map road data	Generate road buffer to filter out road area	Building height via OHM values over extracted building footprint
Ortho-rectified Image	Building footprint for low bldgs	


Extracted (V6C, yellow) and Taipei Vector Data (ground truth, red)

Classification Results: Extracted Polygons vs Ground Truth

- Larger polygons with Total Floor Area (TFA) >8,000m^2 well extracted with Case 2 (one-to-one) classification at 70% and Mean Absolute Error in TFA at <20%
- Case 3 (1 extracted to multiple) further corresponds to closely spaced buildings which are very similar in height and structurally, and thus in vulnerability
- Combined probability of being Case 2 or 3 for buildings with TFA >8,000m^2 rises to 90%

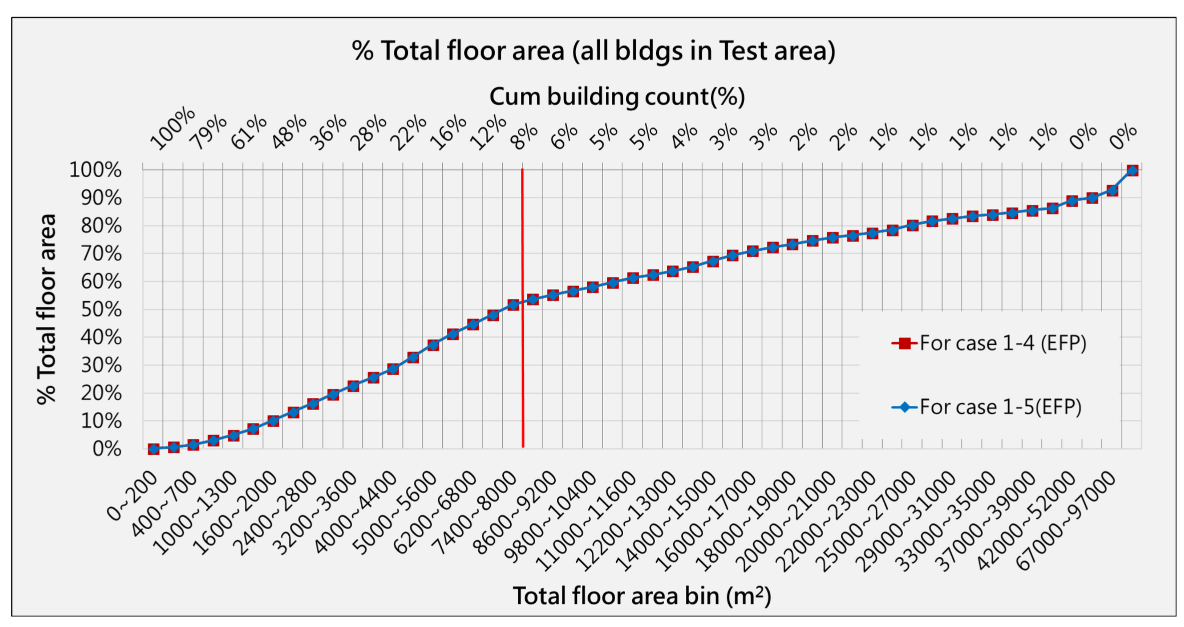
Attribute	Bldgs. TFA<8000m^2	Bldgs. TFA8000 – 16000m^2	Bldgs. TFA>=8000m^2
MAE in TFA	<50%	<20%	<20%
Coeff of variance	<1.4	<1.6%	<1.6%
Probability of Case 2	50%	70%	75
% of polygon	92.0%	4.9%	3.0%

Case	Description	V6D All Polygons	V6D TFA >8000m^2
Case 1	1 to 0 (extra)	506 (5%)	6 (0.7%)
Case 2	1 to 1	5120 (49%)	577 (72%)
Case 3	1 extracted to multiple	1993 (19%)	145 (18%)
Case 4	Multiple extracted to 1	2873 (27%)	75 (9%)
Case 5	0 to 1 (missed)	(1153)	(12)
Total No. of extracted BFT		10492	803

Average storey height of 3.45m is used to convert height to no of storeys in TFA calculation.

Summary

- Larger buildings (TFA >8,000m^2) comprise 8% of building count but 45% of the total TFA and thus value of all buildings over the two test areas. These building are well captured by the developed image processing.
- Small building (TFA <8,000m^2) comprise bulk of building count (92%) but only 55% of the TFA of all buildings and are less well captured.
- Further simulation using portfolios comprising both small and large buildings as reflecting the observed count and TFA distributions show that the portfolio mean TFA error is <4% with CV <1.
- The developed building exposure model represents building portfolio values well and supports insurance applications



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