Toward an estimation of damage caused by a natural disaster using remote sensing technology

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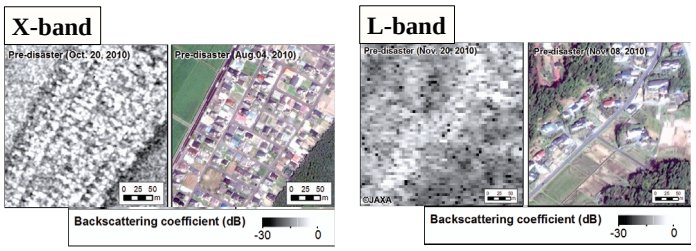
L-band SAR data (ALOS/PALSAR)



- **X-band SAR data (TerraSAR-X)**
  - Higher spatial resolution (1 m～3 m)
  - Swath width 30 km
- **L-band SAR data (ALOS/PALSAR)**
  - Lower spatial resolution than that of X-band（3 m～10 m）
  - Swath width 70 km

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Background

Tsunami disaster (ex : 2010 Chile, 2011 Tohoku)

- Extensive areas were devastated
- Areas affected by the tsunami might be isolated

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It might take a long time for comprehending the damage

Remote sensing technology

- Can observe extensive areas affected by the tsumai
- Can be used to identify the changes caused by a disaster

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Useful for comprehending extensive damage caused by a tsunami disaster

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Objective

To develop a method to estimate building damage in a tsunami-affected areas using L-band SAR data.

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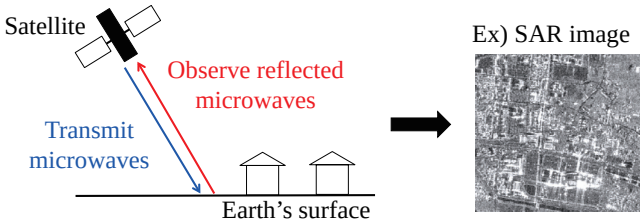
What is Synthetic Aperture Radar (SAR)?

Synthetic Aperture Radar (SAR)



- Nearly unaffected by weather conditions
- Possible to acquire images regardless of day and night

Possible to comprehend the extensive damage soon after a tsunami disaster

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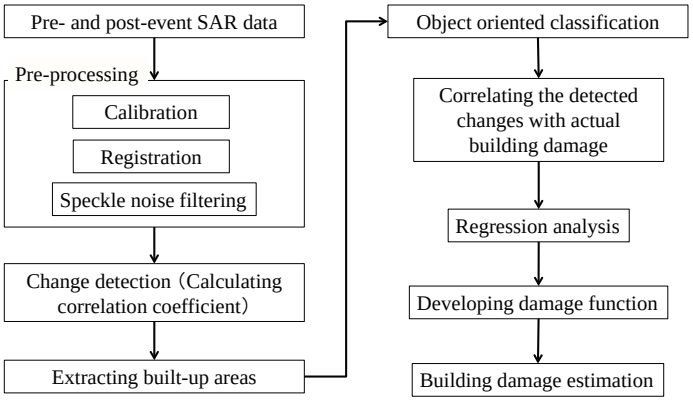
Framework



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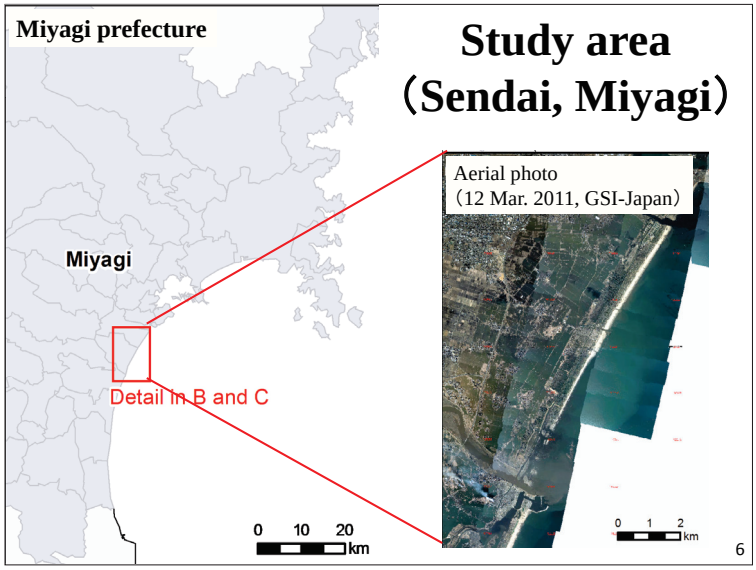
Study area (Sendai, Miyagi)



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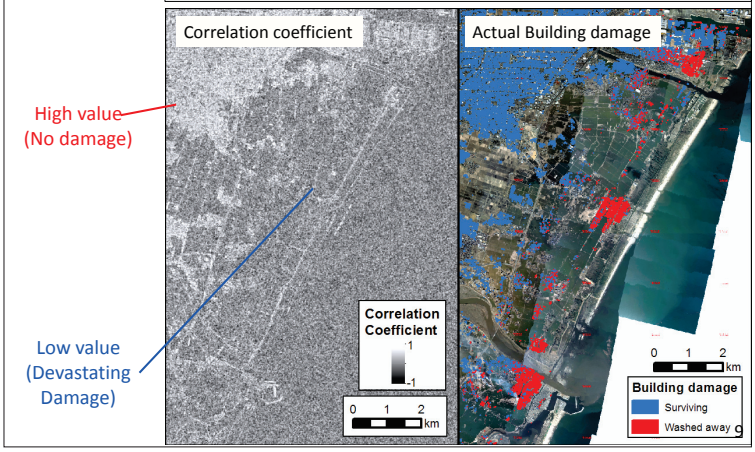
$$r = \frac{N\sum_{i=1}^{N} Ia_i Ib_i - \sum_{i=1}^{N} Ia_i \sum_{i=1}^{N} Ib_i}{\sqrt{(N\sum_{i=1}^{N} Ia_i^2 - (\sum_{i=1}^{N} Ia_i)^2)}\sqrt{(N\sum_{i=1}^{N} Ib_i^2 - (\sum_{i=1}^{N} Ib_i)^2)}}$$



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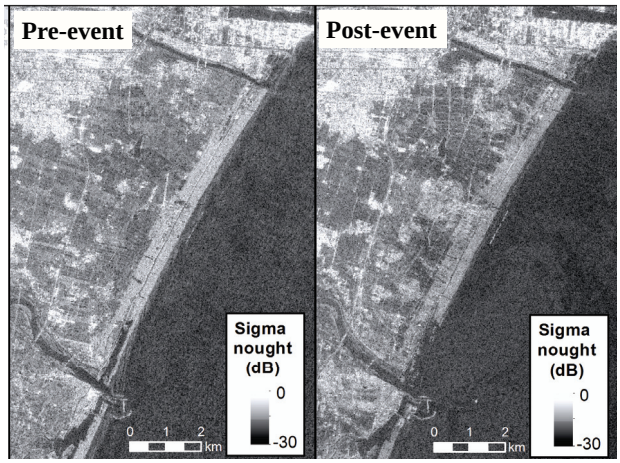
ALOS/PALSAR data (Sendai, Miyagi)



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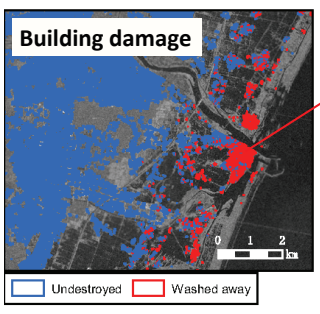
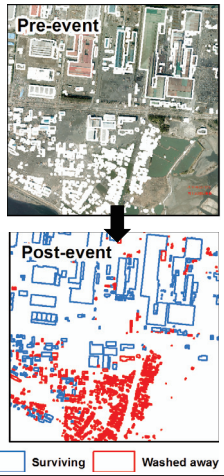
Truth data for validation

Building damage map (Gokon et al., 2012)

- Visually inspected using aerial photo
- Spatial distribution of washed away and undestroyed buildings
- Red : washed away, Blue : Surviving



Visual inspection



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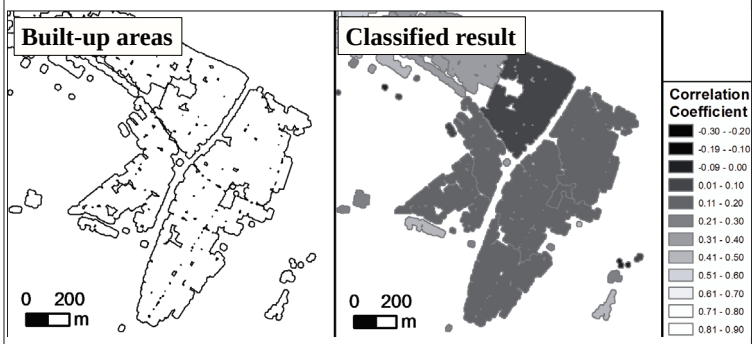
Object-based classification

Similar damage → Similar feature in the image



Correlation coefficient image inside the built-up areas was classified into objects with same features in shape and color.

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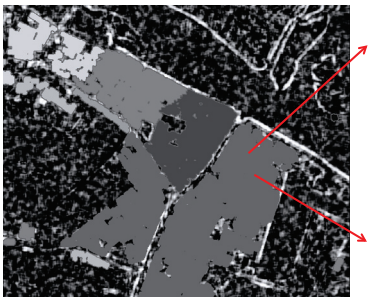
Feature calculation

Homogeneous objects



Mean value of correlation coefficient

Damage proportion of washed-way buildings

Regression analysis

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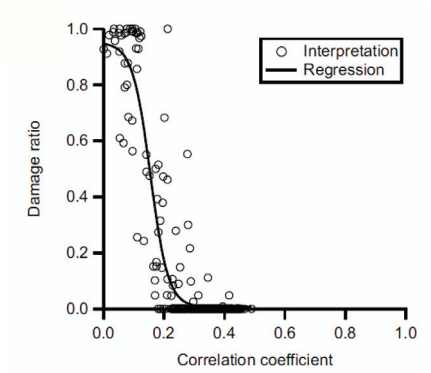
Damage function



$$F_L = 0.95 - \frac{0.95}{\left(1 + \exp\left(-\frac{R_{mL} - 0.16}{0.03}\right)\right)}$$

F_L : Damage ratio
R_{ML} : Mean value of correlation coefficient at each object

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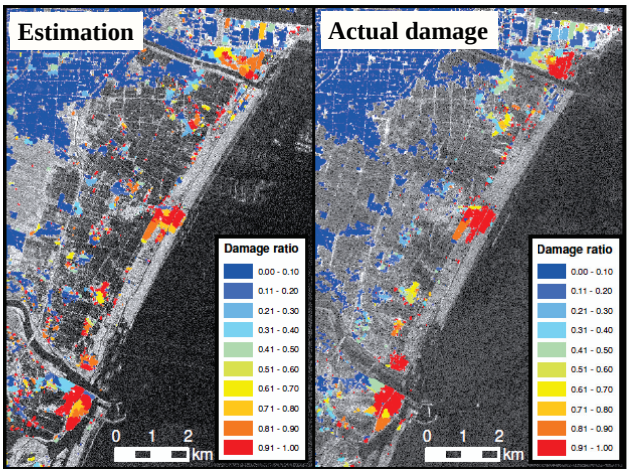
Result of damage estimation



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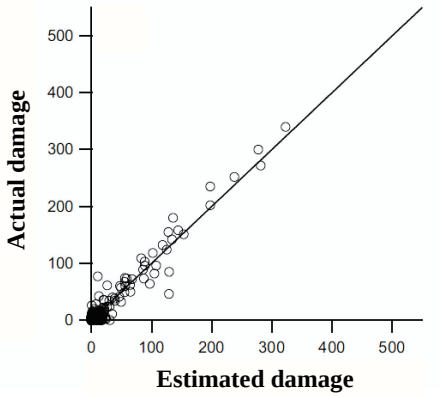
Validation of the result

(Number of washed-away buildings＝Damage ratio × Number of buildings in each object)



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Conclusion

- We developed a method to estimate building damage using ALOS/PALSAR data
- Could confirm the good agreement between the estimated building damage and the ground truth data

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