# Mapeo de áreas afectadas por el terremoto-tsunami del 2018 en Sulawesi, Indonesia mediante imágenes satelitales Sentinel-2

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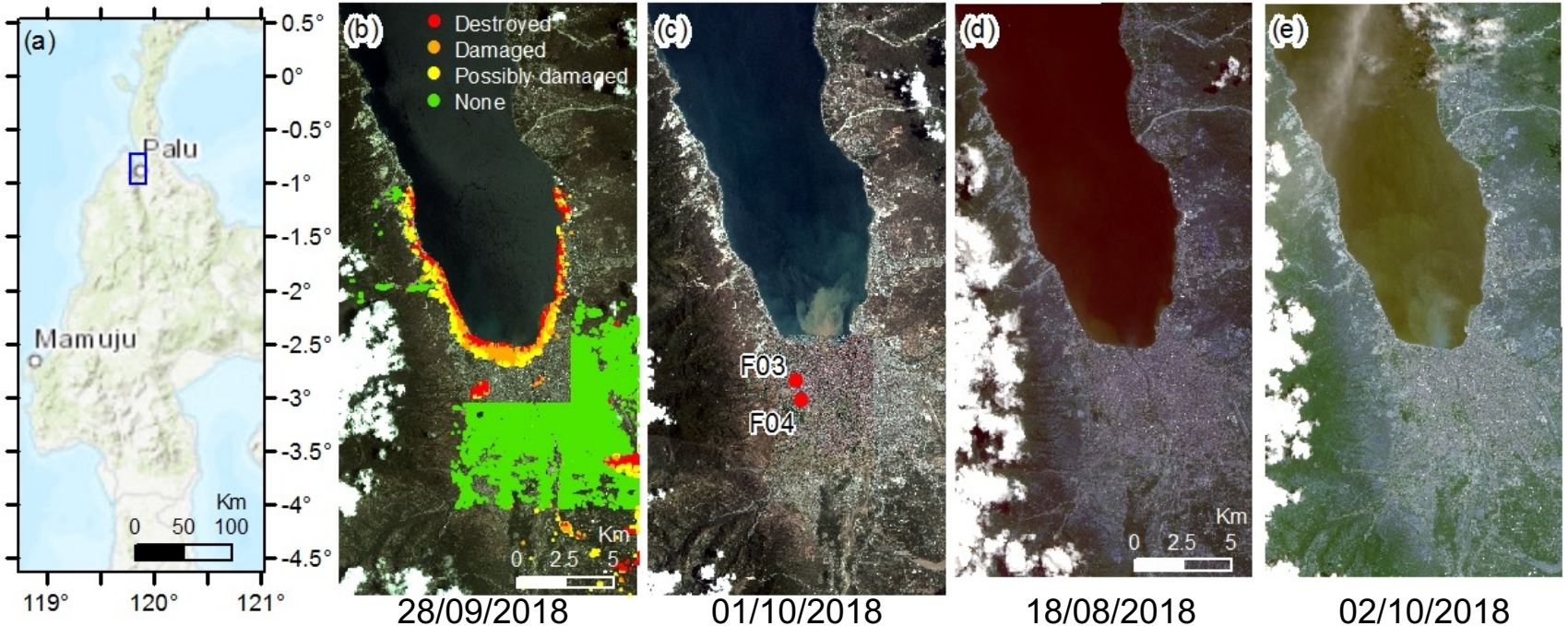
1 de Diciembre 2021

# MAIN TARGET: IDENTIFICATION OF THE AFFECTED AREAS FROM SATELLITE IMAGERY

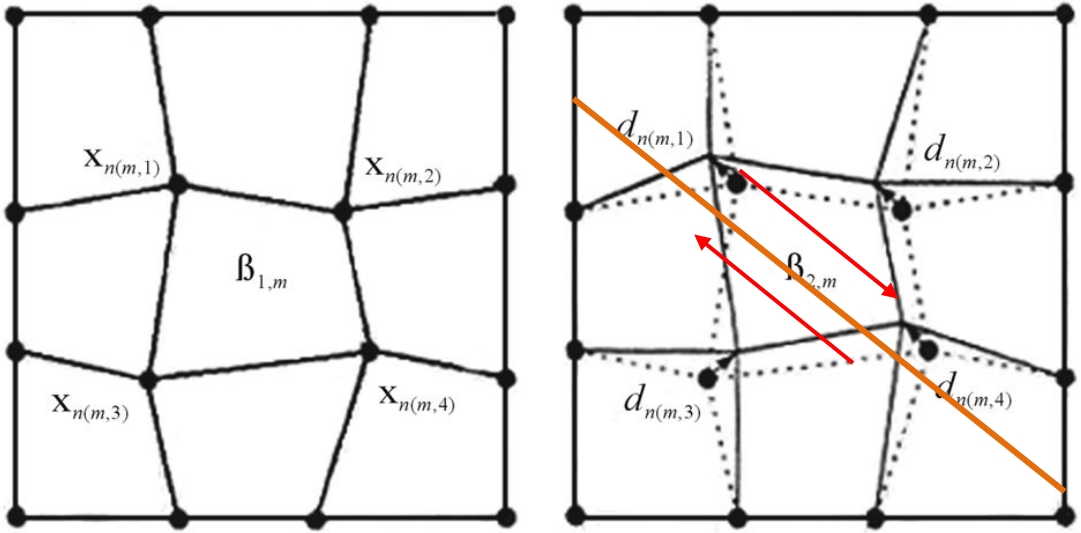
Input data: VNIR images recorded before (pre-event) and after (post-event) the 2018 Sulawesi Indonesia earthquake-tsunami

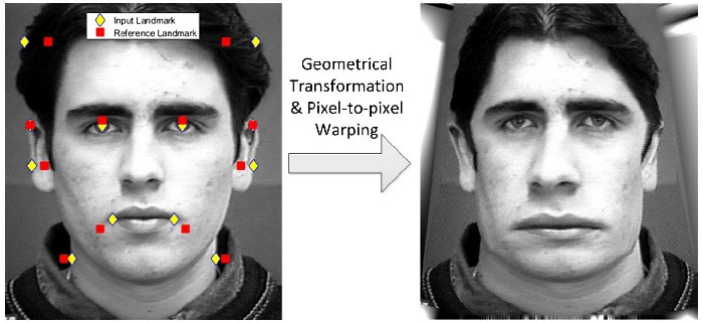
Planet (3-m resolution) | Sentinel-2 (10-m resolution)

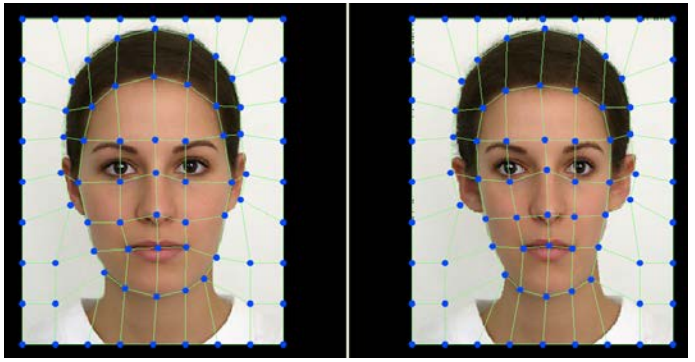



28/09/2018 | 01/10/2018 | 18/08/2018 | 02/10/2018

# MOTIVATION: IMAGE REGISTRATION



*…Typically, having at least one **link** near each corner of the raster dataset and a few throughout the interior produces the best results.*

# Real case: The 2018 Sulawesi Indonesia earthquake-tsunami



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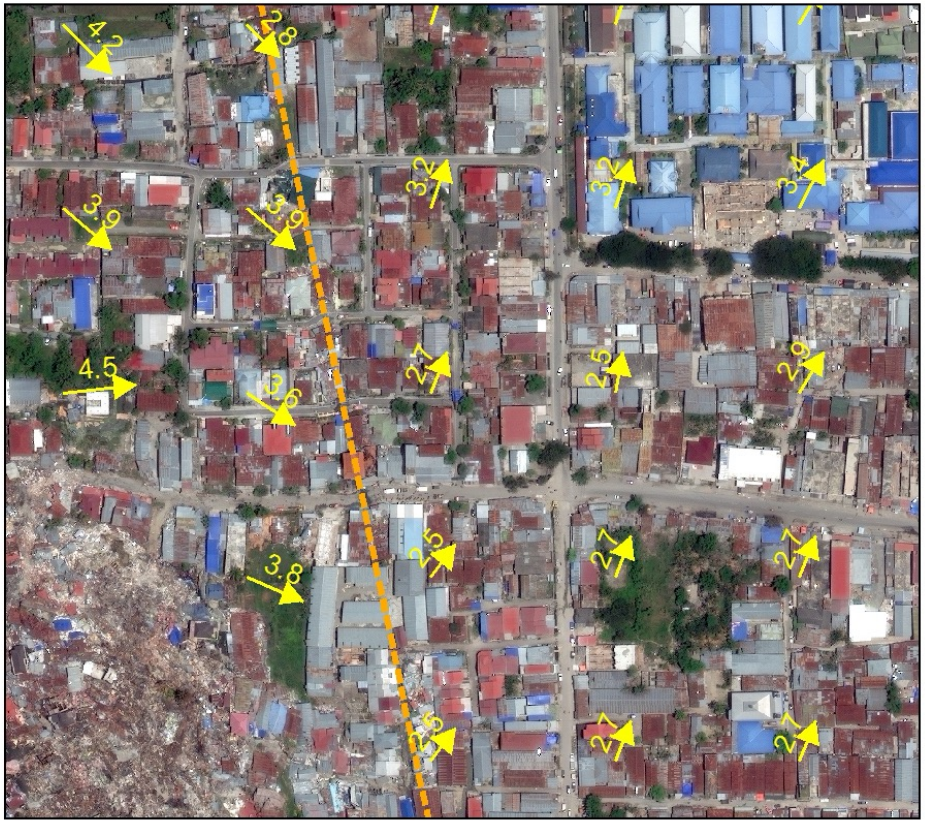
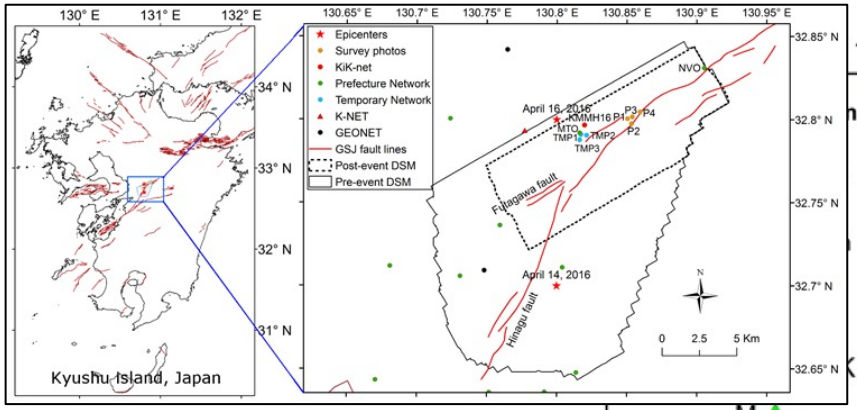
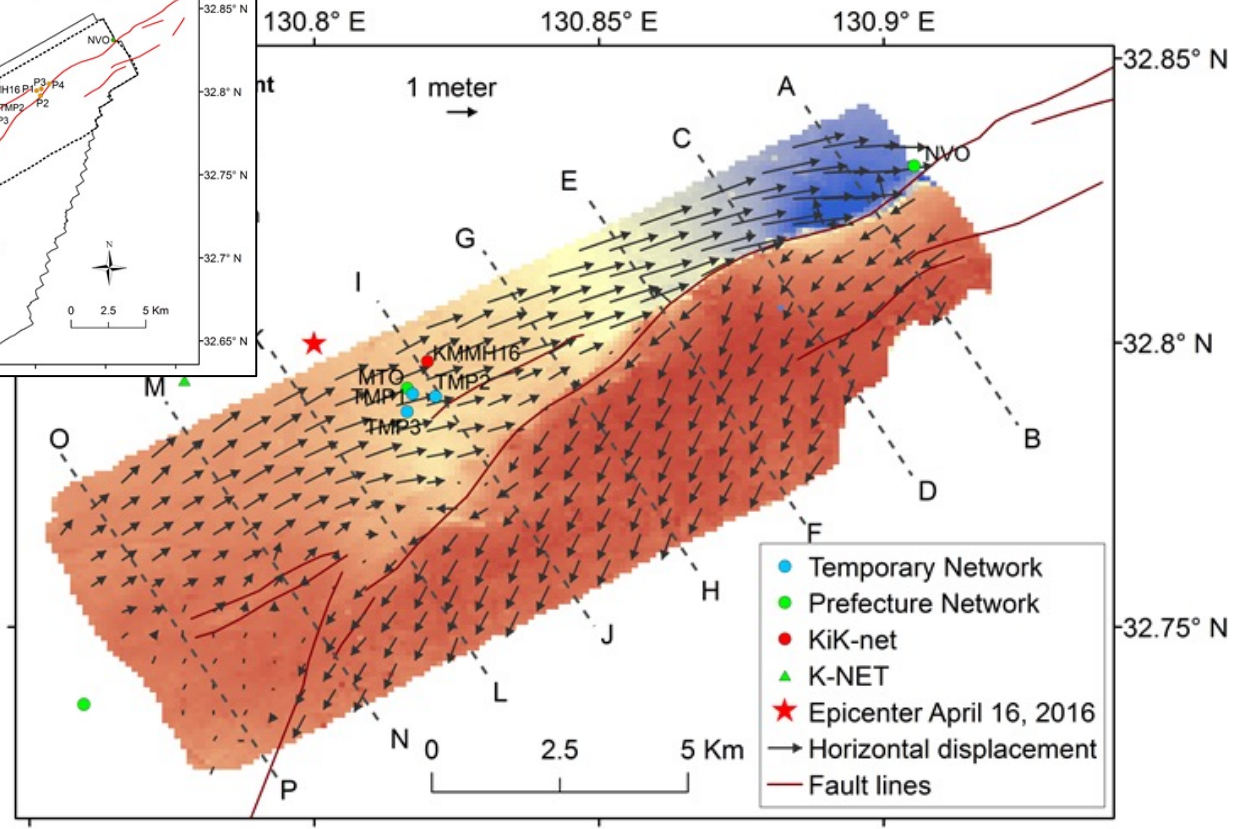


# Real precedent: The 2016 Kumamoto earthquake




Is registration really necessary to obtain a fast estimation of the affected area?

# Detection of Collapsed Buildings

## Phase Correlation

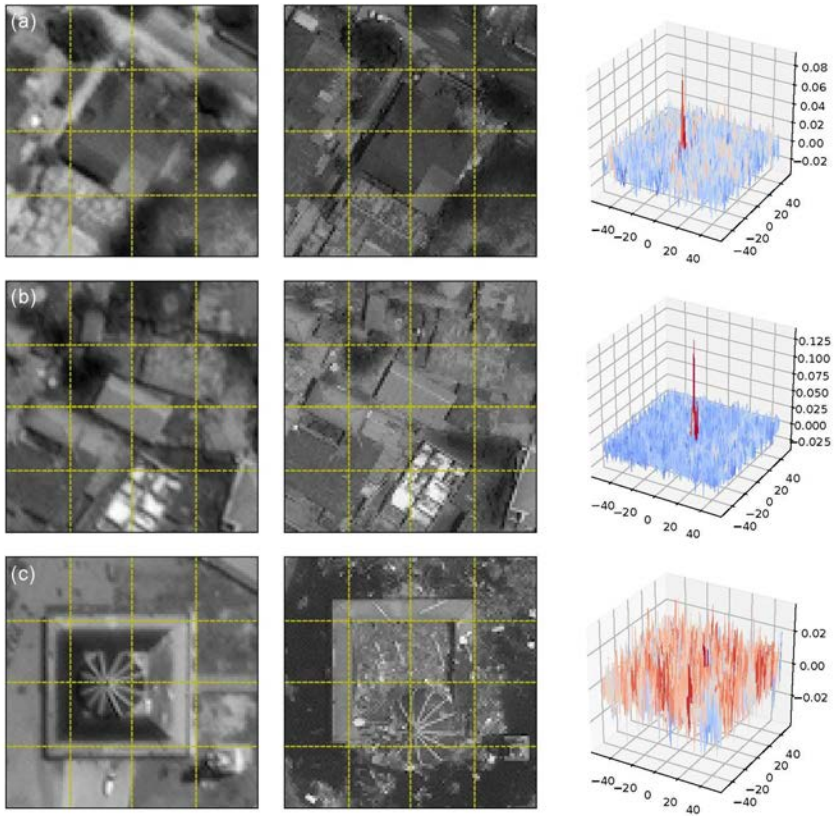



*Image representation*

$$f(n_1, n_2) = f(x, y)|_{x=n_1 T_1, y=n_2 T_2}$$

$$g(n_1, n_2) = f(x - x_0, y - y_0)|_{x=n_1 T_1, y=n_2 T_2}$$

*Relation between images in frequency domain*

$$\hat{G}(k_1, k_2) \cong \hat{F}(k_1, k_2) \cdot \exp(-2j\pi(\frac{k_1 x_0}{N_1} + \frac{k_2 y_0}{N_2}))$$

*Normalized cross power spectrum*

$$\hat{R}(u, v) = \frac{\hat{G}(u, v)\overline{\hat{F}(u, v)}}{|\hat{G}(u, v)\overline{\hat{F}(u, v)}|}$$

*Phase correlation*

$$\hat{r}(n_1, n_2) \cong \frac{\alpha}{N_1 N_2} \frac{\sin \pi(n_1 + x_0)}{\sin \frac{\pi}{N_1}(n_1 + y_0)} \frac{\sin \pi(n_2 + x_0)}{\sin \frac{\pi}{N_2}(n_2 + y_0)}$$

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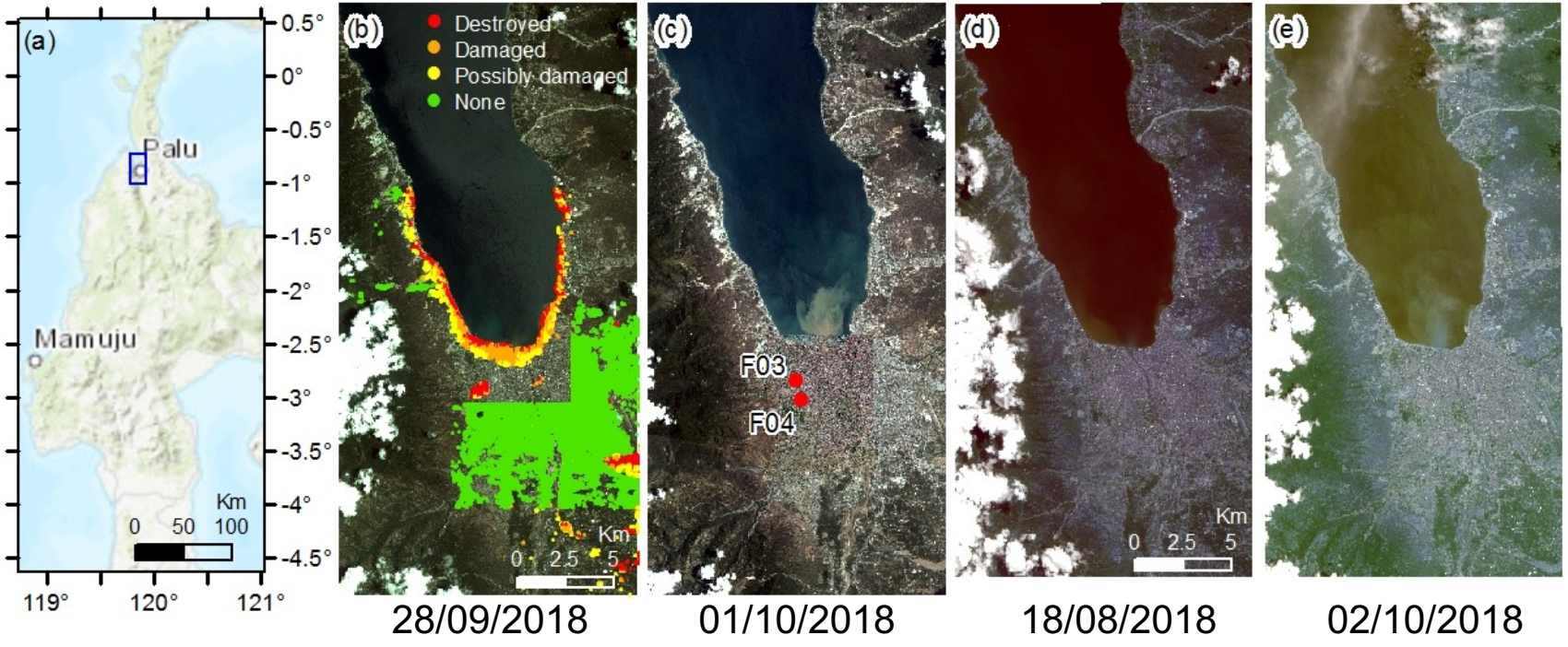


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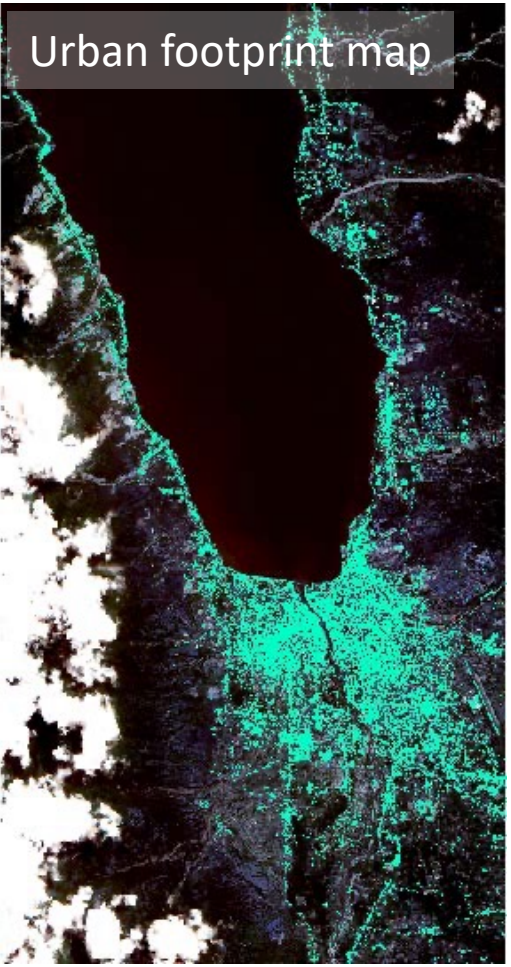
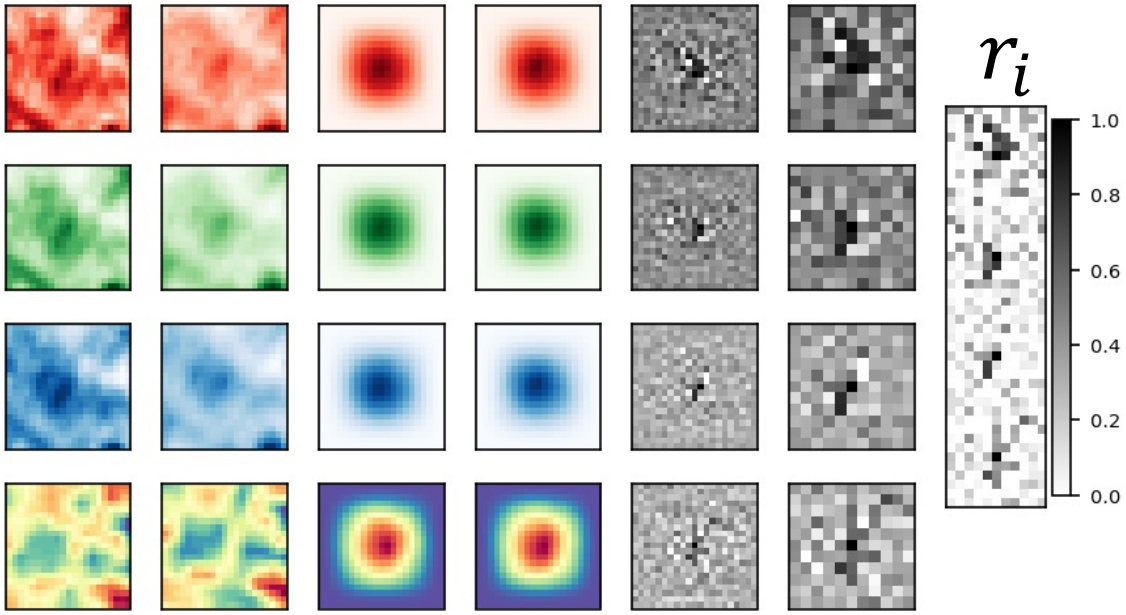


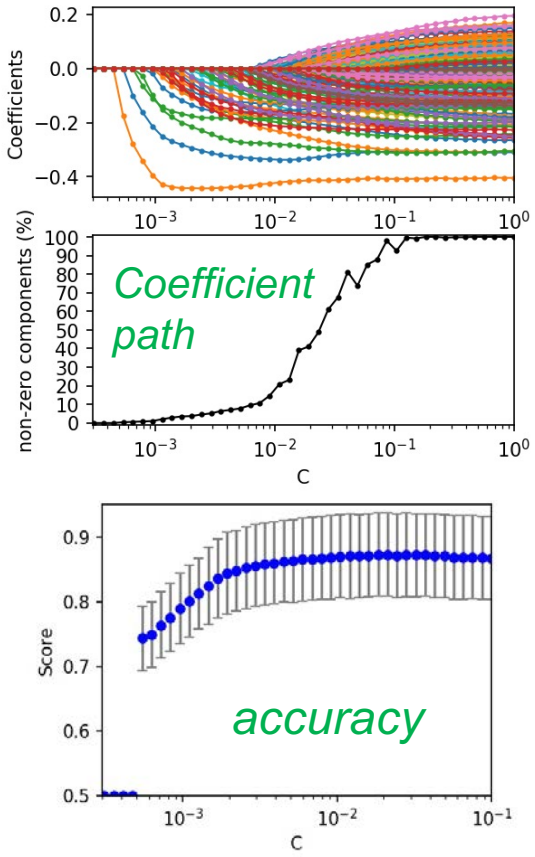

# Feature Space Definition

- Four phase-correlation array were merged as shown below
- A sample consists of 484 features



# SPARSE LOGISTIC REGRESSION MODEL

*Effect of the regularization*

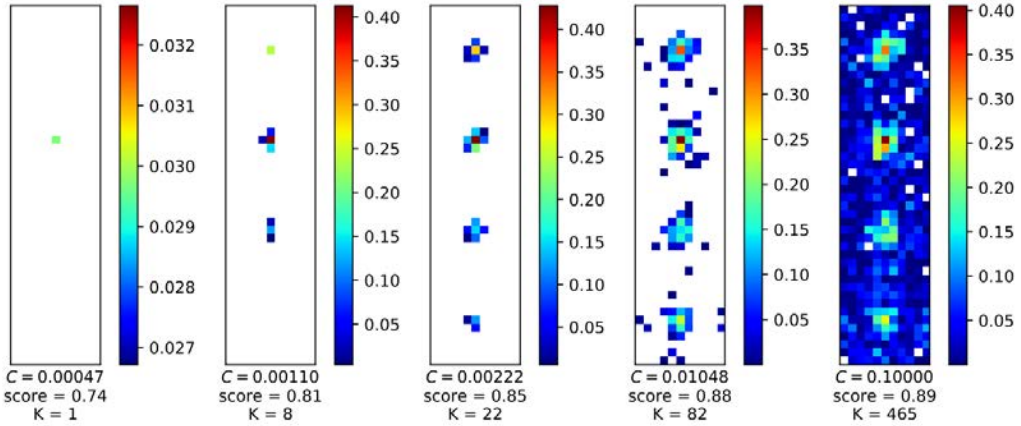



*Discriminant function*

$$Pr(z_i = 1|\mathbf{r}_i) = \frac{\exp(\beta_0 + \beta^T \mathbf{r})}{1 + \exp(\beta_0 + \beta^T \mathbf{r})}$$

*Optimization problem*

$$\underset{\beta_0,\beta}{\text{minimize}} \left\{ C \sum_{i=1}^{N} \log\left(1 + \exp(-z_i(\beta_0 + \beta^T \mathbf{r}_i))\right) + \|\beta\|_1 \right\}$$



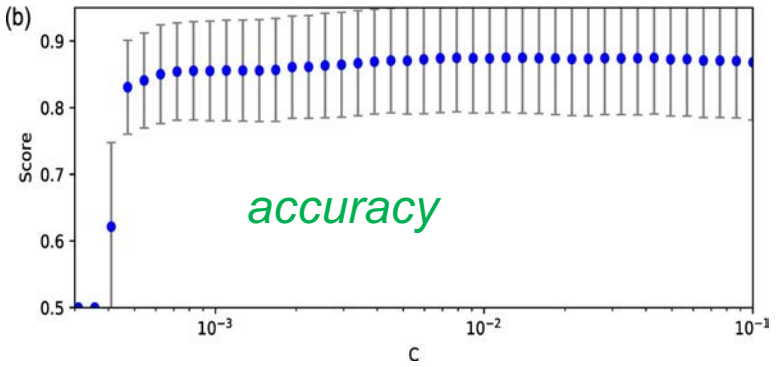
# Sparse Logistic Regression Model

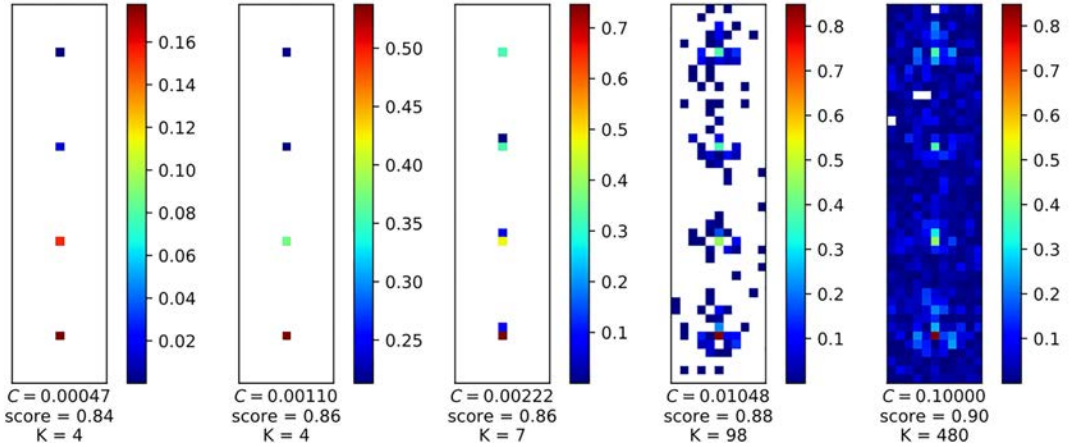
*Discriminant function*

$$Pr(z_i = 1|\mathbf{r}_i) = \frac{\exp(\beta_0 + \beta^T \mathbf{r})}{1 + \exp(\beta_0 + \beta^T \mathbf{r})}$$

*Optimization problem*

$$\underset{\beta_0,\beta}{\text{minimize}} \left\{ C \sum_{i=1}^{N} \log\left(1 + \exp(-z_i(\beta_0 + \beta^T \mathbf{r}_i))\right) + \|\beta\|_1 \right\}$$

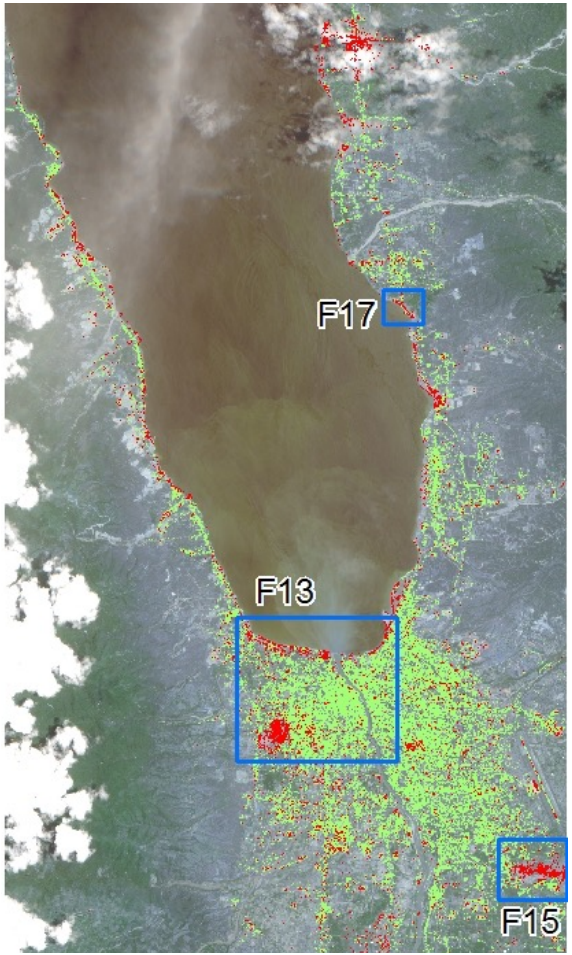


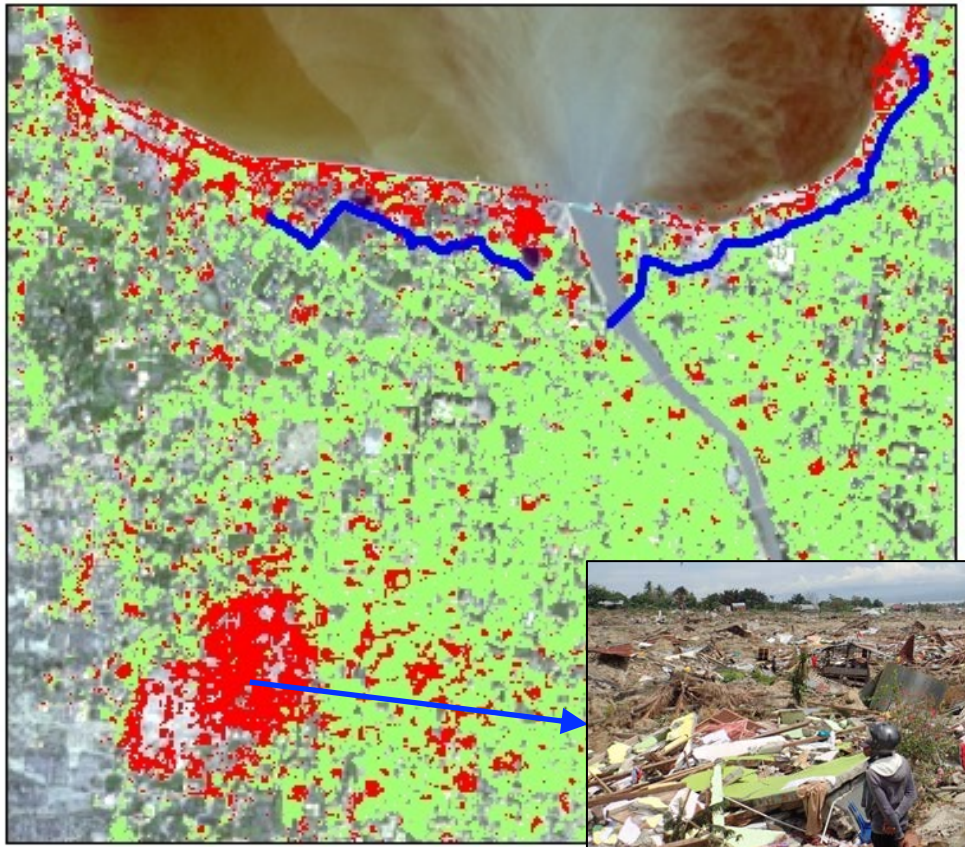
# Overall Results

- Areas in red denote detected changes.
- Areas in green denote no changes.

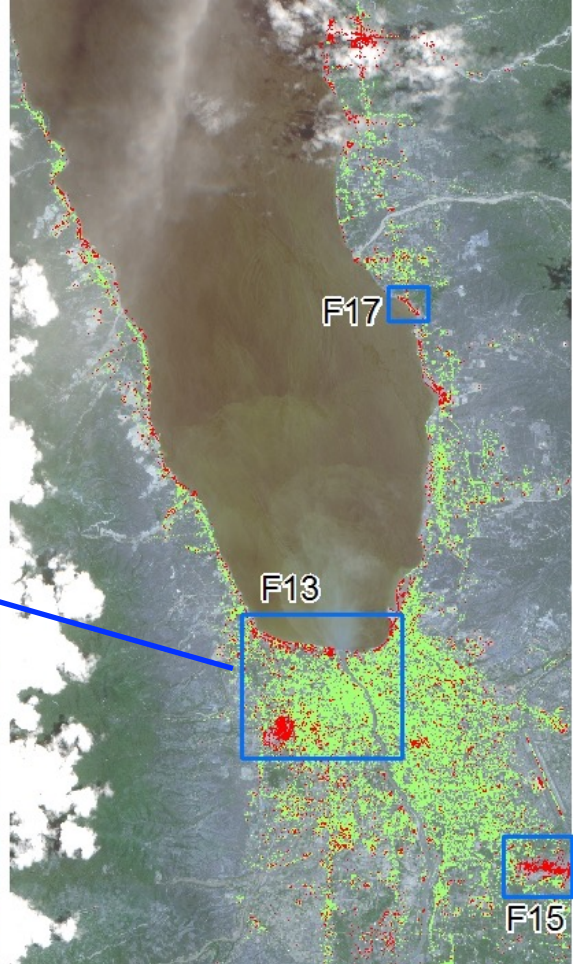
- Results are consistent with surveyed area in center Palu.
- Results from Sentinel-2 are less noisy than that from Planet.



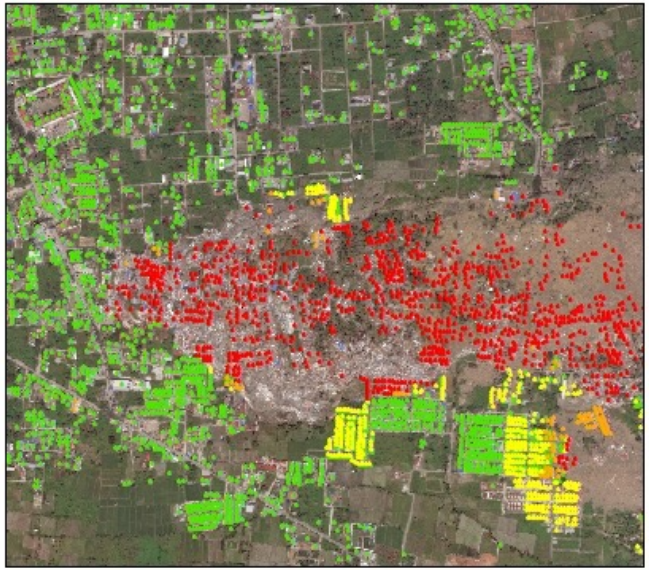
# Results: F13 Area



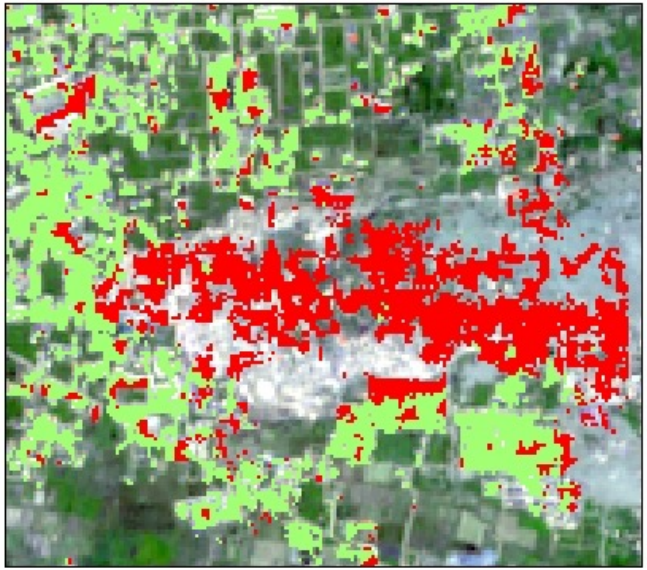




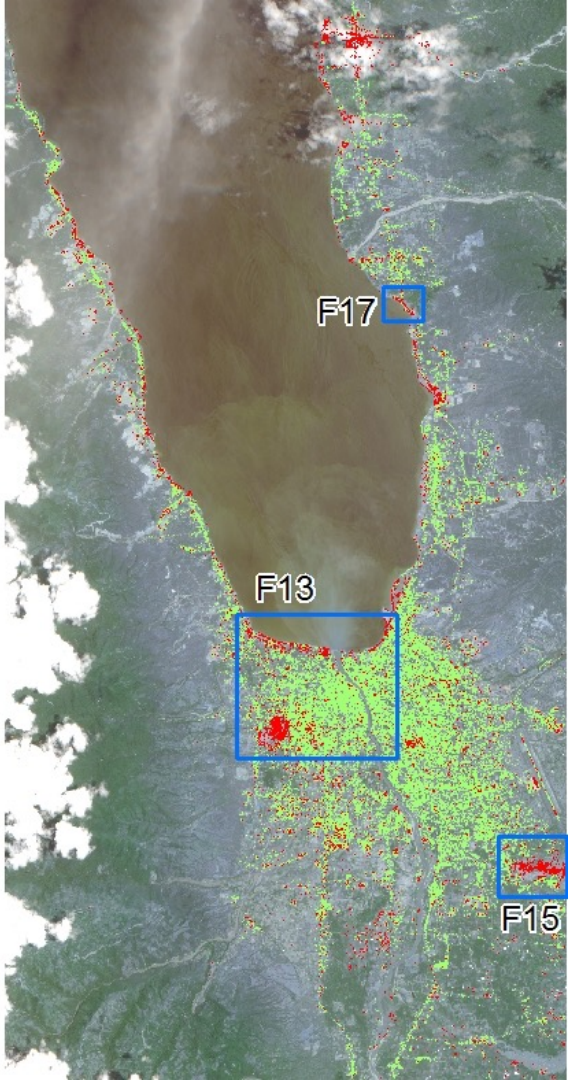
# Results: F15 Area



Visual interpretation

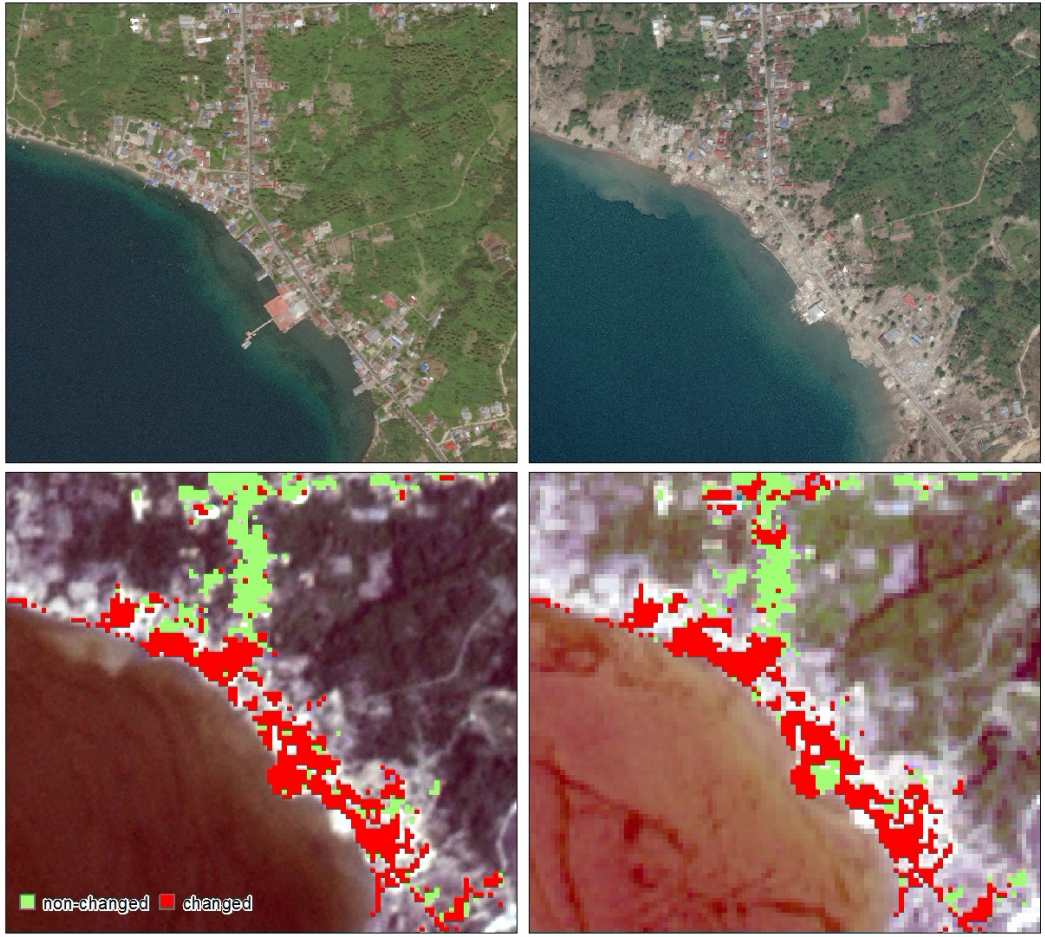


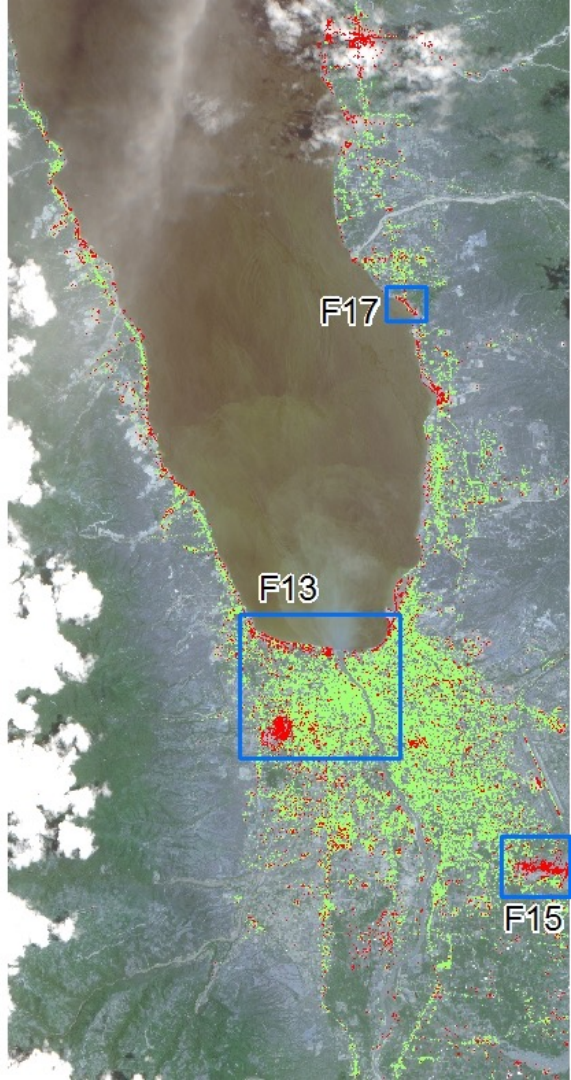
Results from Sentinel-2

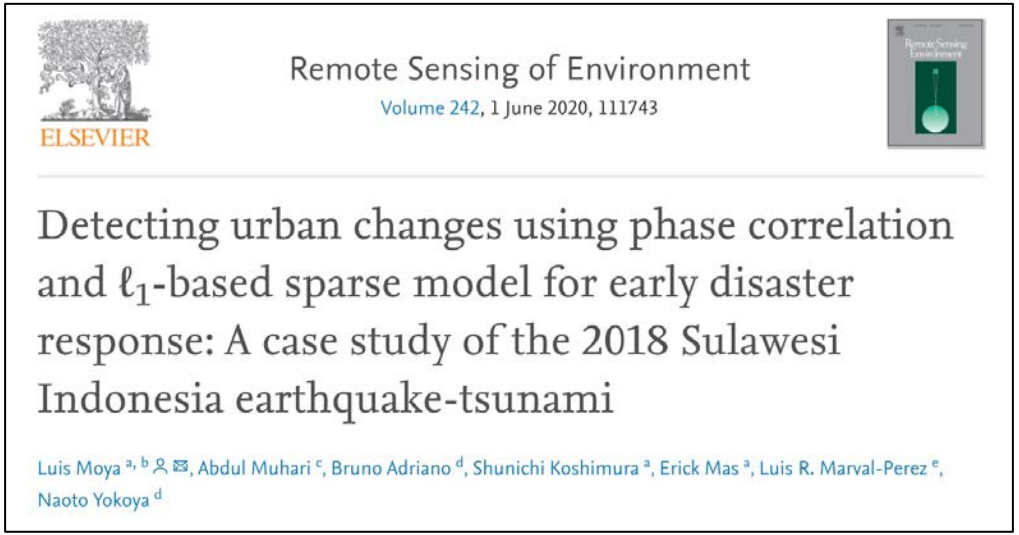


# Results: F17 Area

*Area not identified from visual interpretation*





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Detecting urban changes using phase correlation and $\ell_1$-based sparse model for early disaster response: A case study of the 2018 Sulawesi Indonesia earthquake-tsunami

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