Preliminary building damage mapping following the 2016 Kumamoto Mw7.1 Earthquakes using PALSAR-2 image

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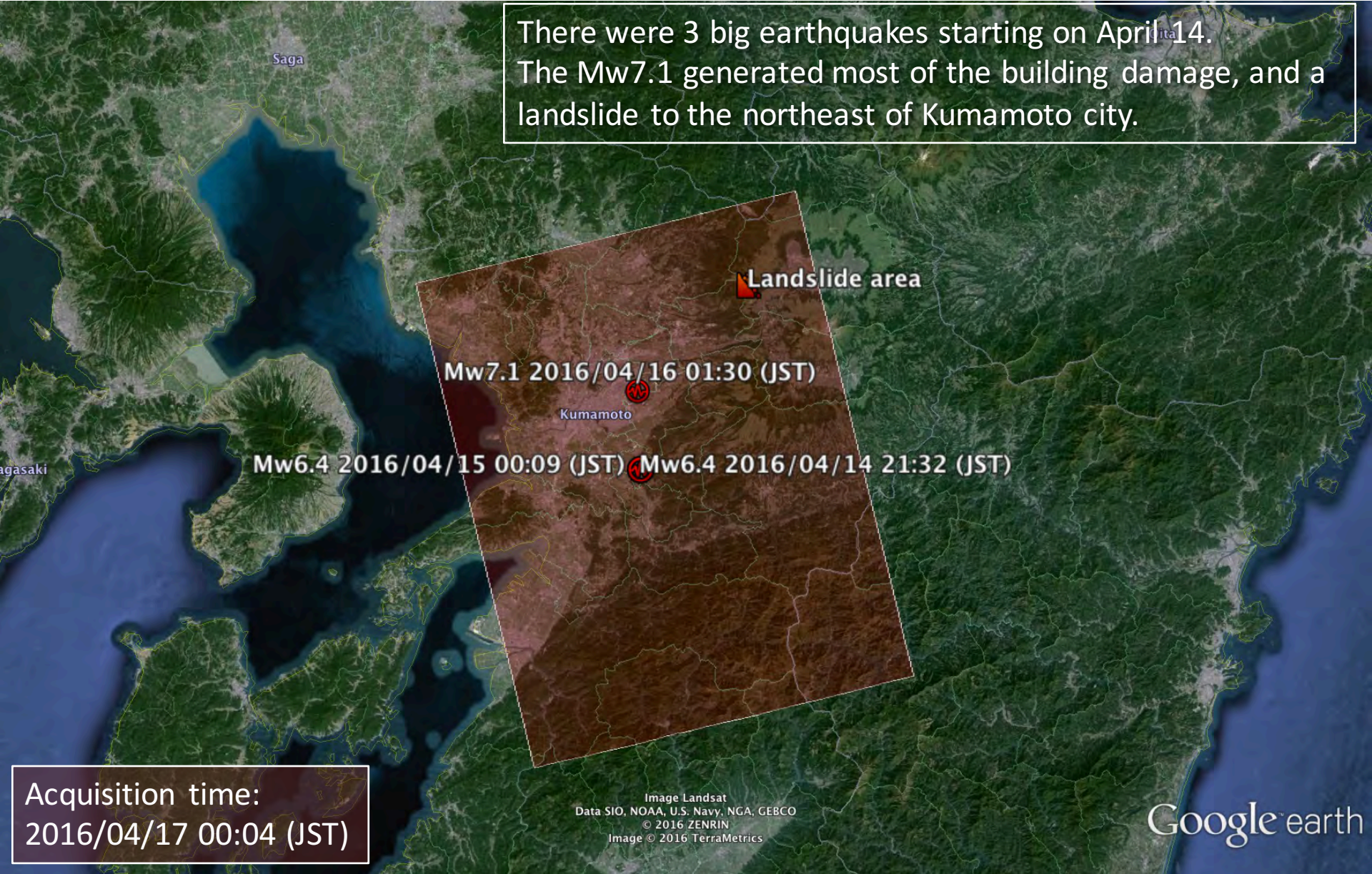Shunichi Koshimura

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BACKGROUND

❖ A M_w6.4 earthquake occurred on April 14, 2016 21:32 (JST) in Kumamoto City, Kyushu Island, Japan. This event was followed by two big aftershocks of M_w6.4 on April 15, 2016 00:09 (JST) and Mw7.1 on April 16, 2016 01:30 (JST). It was reported that the latest event generated most of the damage in Kumamoto city and surroundings[1].

❖ The ReGiD Lab. From IRIDeS, Tohoku University in collaboration with JAXA and the University of Tokyo conducted a preliminary building damage estimation using a model that is being developed using only post-event Synthetic Aperture Radar (SAR) images from Katmandu city taken after the 2015 Nepal Earthquake (Bai et al., 2016).

❖ In this preliminary damage assessment, we employed a post-event SAR image captured after the main shock of Mw 7.1 (third significant earthquake) on April 17, 2016. The image from Kumamoto city was acquired by the Advanced Land Observing Satellite 2 (ALOS-2) / L-band Synthetic Aperture Radar (PALSAR-2)

❖ **The training data used in the damage estimation model is from Nepal earthquake and they are probably different.**

[1]http://irides.tohoku.ac.jp/topics_disaster/2016kumamoto-eq.html

ALOS-2/PALSAR-2 coverage

There were 3 big earthquakes starting on April 14.
The Mw7.1 generated most of the building damage, and a landslide to the northeast of Kumamoto city.

Landslide area

Mw7.1 2016/04/16 01:30 (JST)

Kumamoto

Mw6.4 2016/04/15 00:09 (JST) Mw6.4 2016/04/14 21:32 (JST)

Acquisition time:
2016/04/17 00:04 (JST)

Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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Image © 2016 TerraMetrics

Google earth

Methodology for Damage Estimation

Pre-processing
❖ The PALSAR-2 data was converted from digital number to backscattering coefficient (sigma-naught [dB]) using the equation provided by JAXA website[1]. Then, the PALSAR-2 data was filtered using a Lee filter (Lee 1980) using a 3 x 3 pixel window.
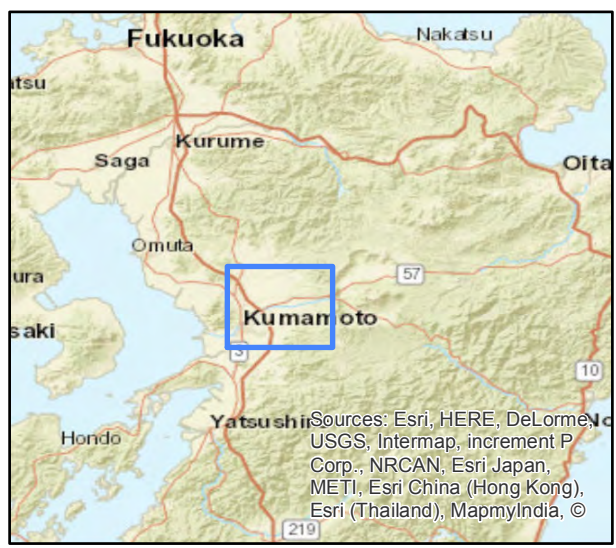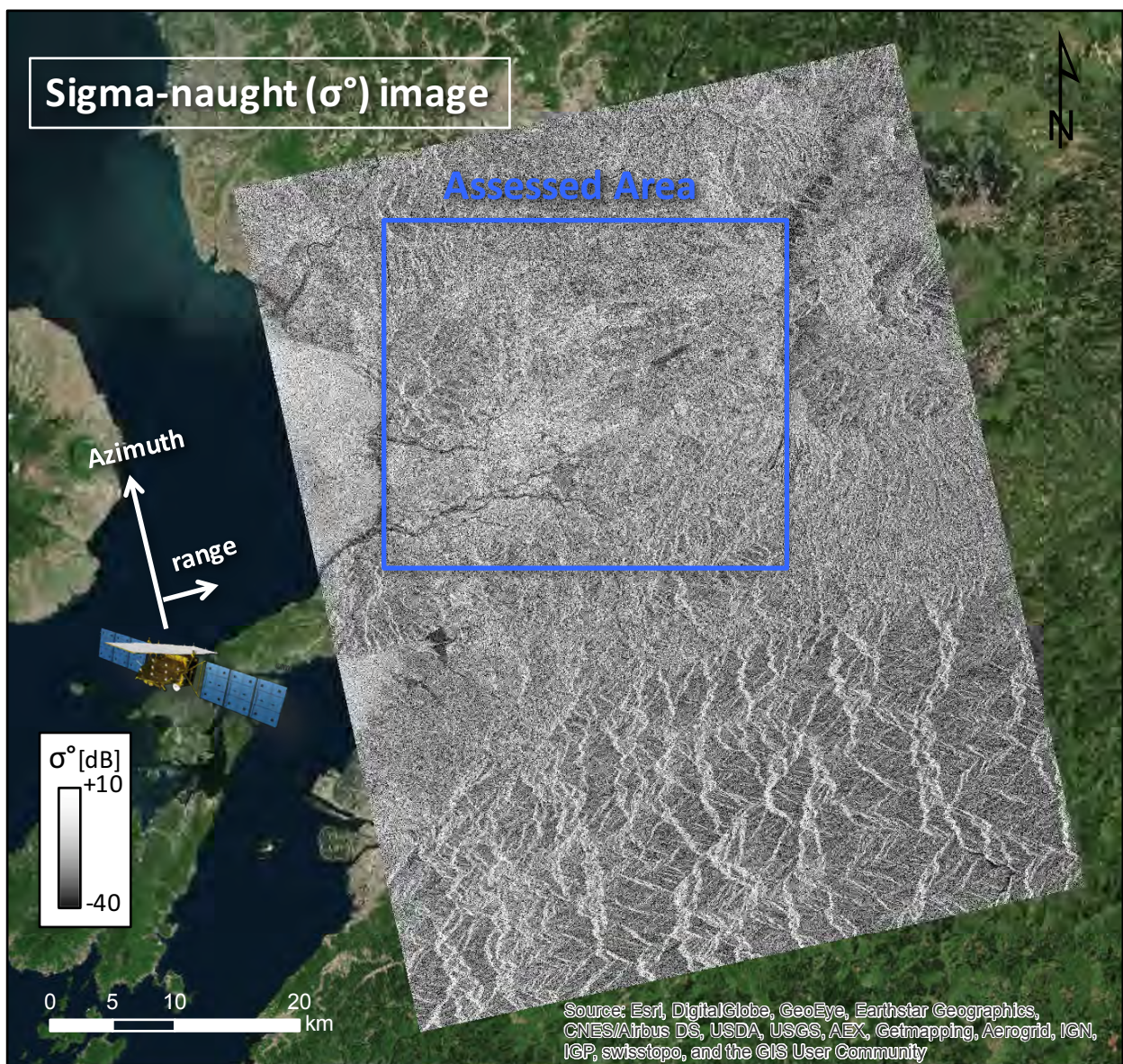
Damage estimation
① We calculated 16 texture parameter based on the Grey-Level Co-occurrence Matrix (Haralick et al., 1973), Gray histogram properties (Anys et al., 1994), and the HH-polarization information.
② Using the building footprint downloaded from the Geospatial Information Authority of Japan website[2], the average value of each texture parameter is calculated for each building.
③ Finally, using as training sample the damage observed after the 2015 Nepal earthquake, a random forest algorithm (Breiman et al., 2001) was used to classify the building damage into two categories in Kumamoto city.

[1] http://www.eorc.jaxa.jp
[2] http://www.gsi.go.jp

PALSAR-2 Post-event Image (2016/04/17)

Sigma-naught (σ°) image

Assessed Area

Azimuth

range

σ° [dB]
+10
-40

0 5 10 20
km

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Fukuoka
Nakatsu
Kurume
Saga
Oita
Omuta
57
Kumamoto
Yatsushiro
Hondo
10
219

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, ©

- Acquisition mode: StripMap (SM1)
- Ascending Orbit direction (azimuth)
- Right side observation (range)
- HH-polarization
- Data format Level 1.5
- Pixel Spacing: 2.5 m

The PALSAR-2 image was provided by JAXA

Preliminary Building Damage Mapping

The training data used in the damage estimation model is from Nepal earthquake and they are probably different.
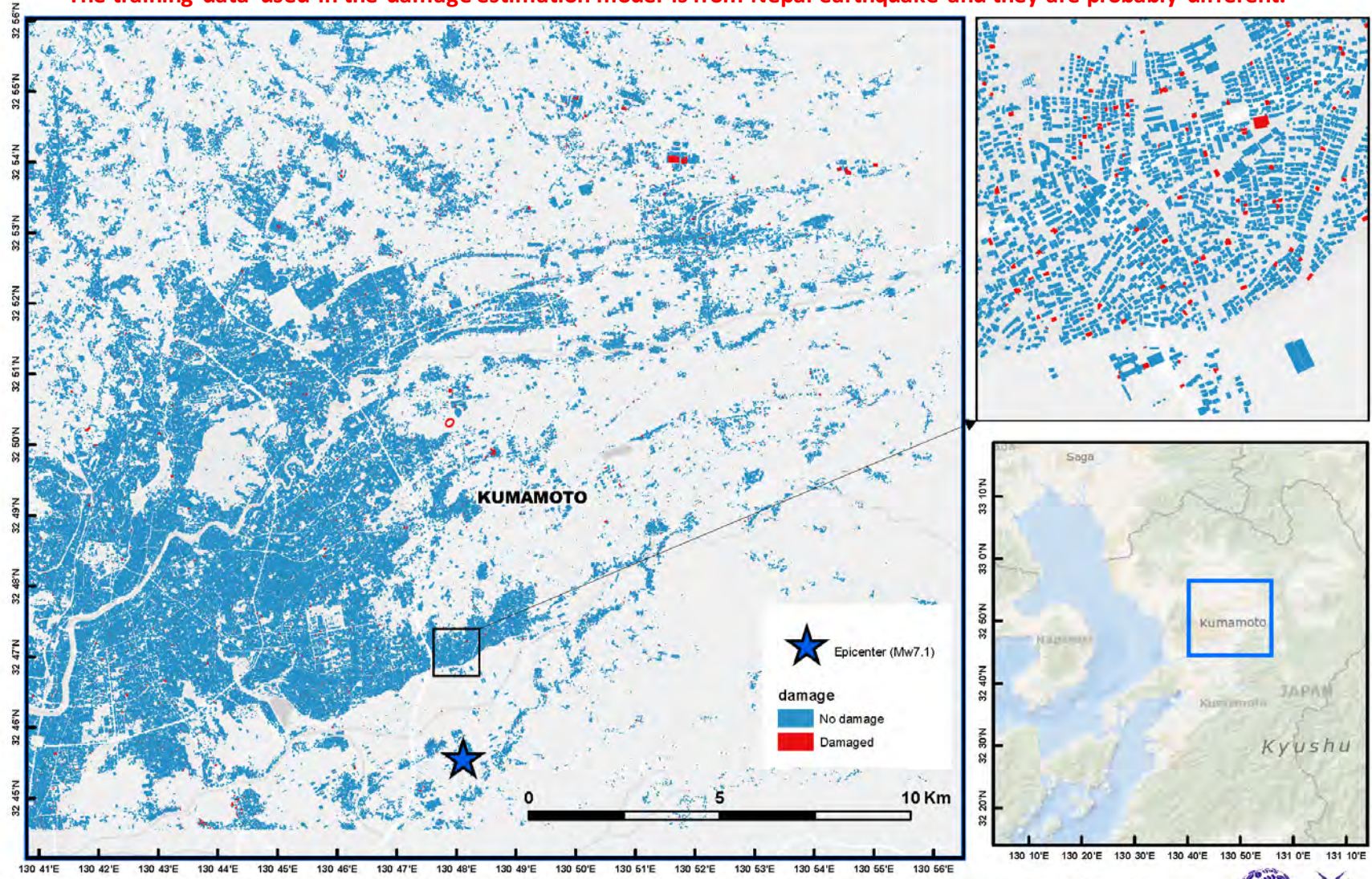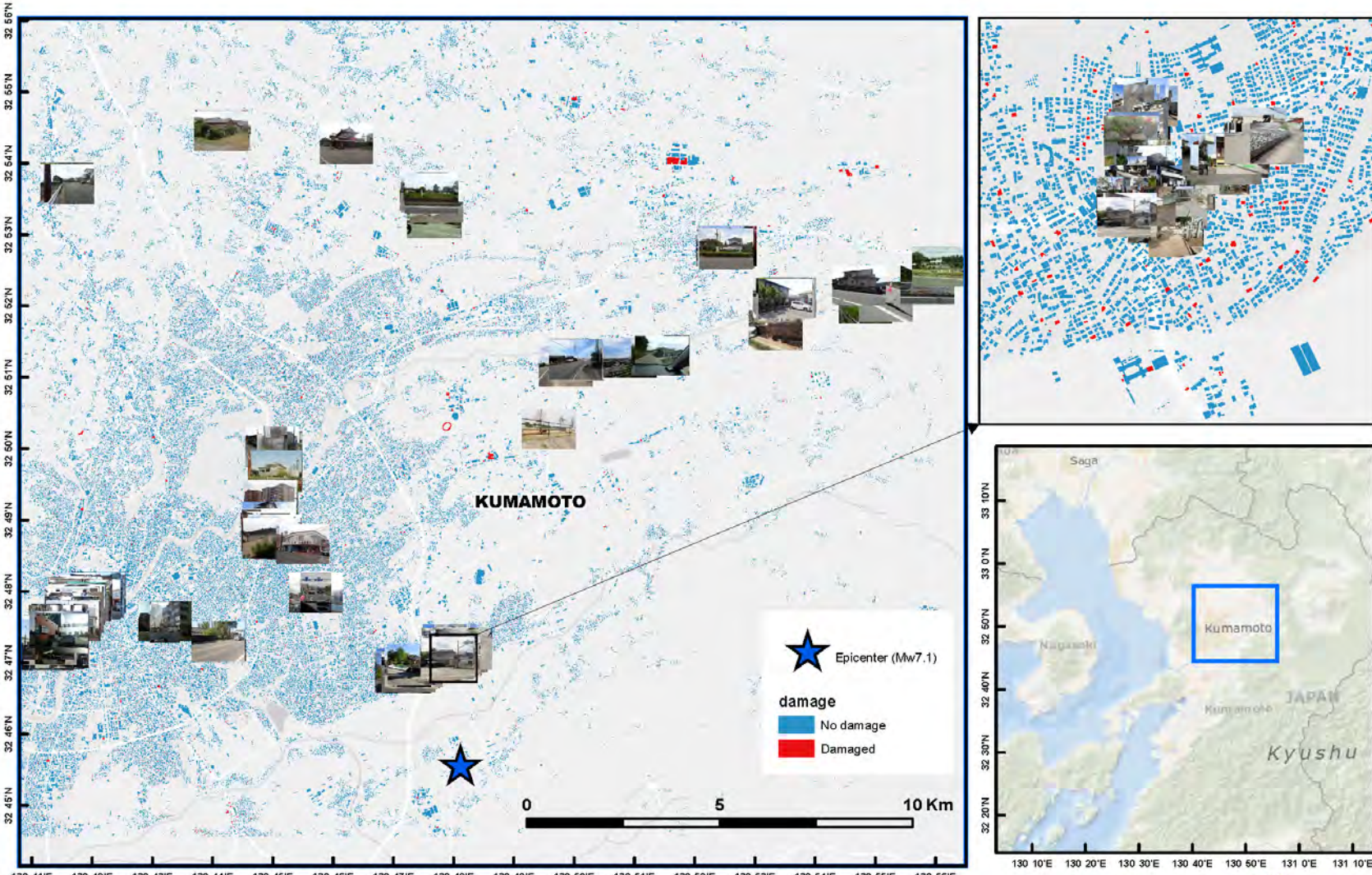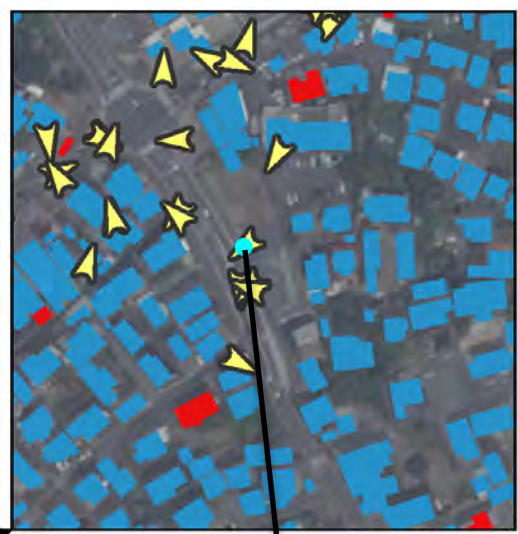

Sources: Geospatial Information Authority of Japan, LandScan 2011, Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
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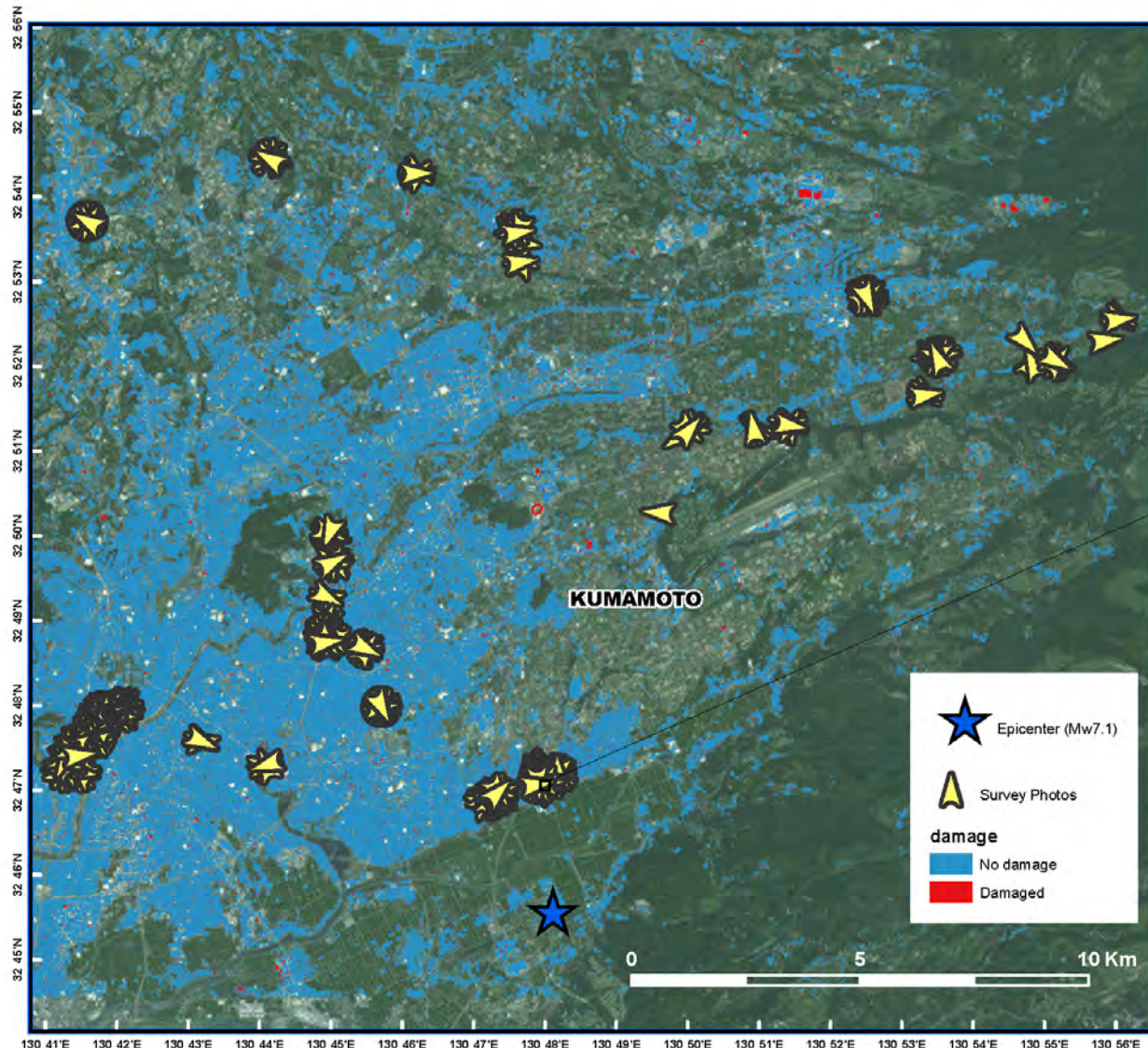# Preliminary Building Damage Mapping

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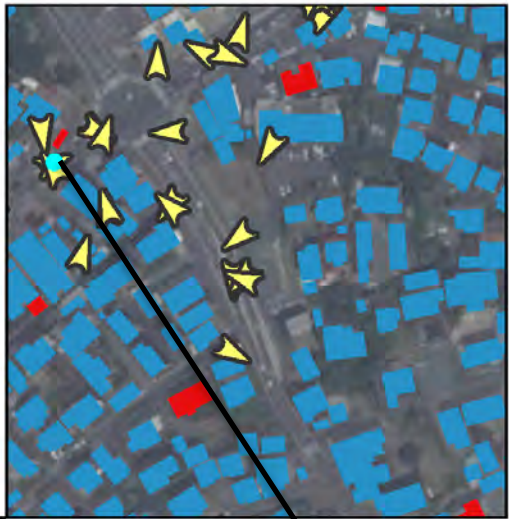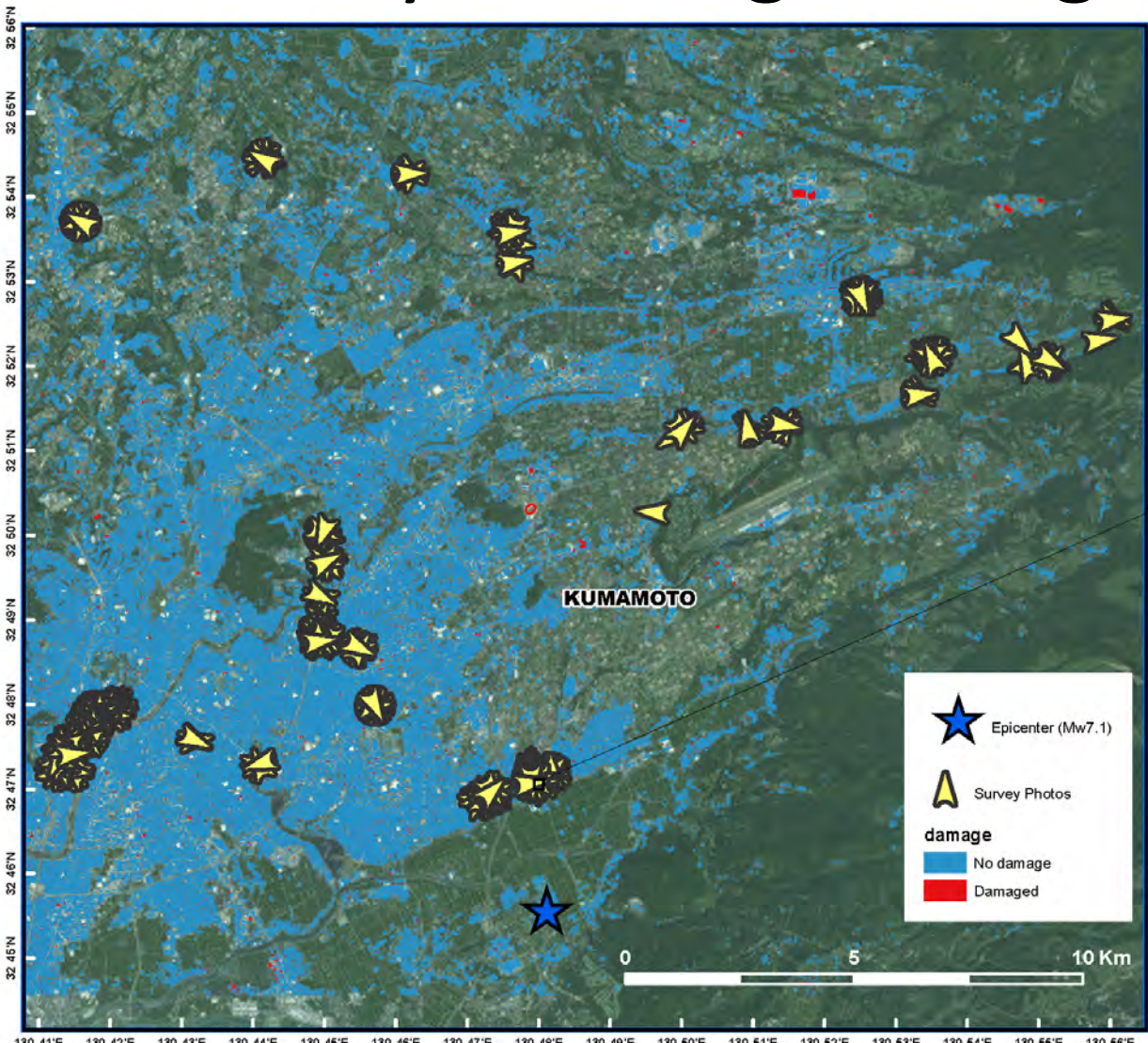# Preliminary Building Damage Mapping

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Legend:
- ★ Epicenter (Mw7.1)
- Survey Photos

damage
- No damage
- Damaged

KUMAMOTO

Preliminary Building Damage Mapping

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Final Comments

❖ According to the damage estimation, the damage is scattered throughout the Kumamoto city.

❖ To verify the estimation, survey photos were used as ground truth data (GTD). While some locations where the model detected damage agree with the GTD, other buildings that were actually damaged were not detected by the model.

❖ The estimation is expected to improve when local training data is used. For preliminary assessment Nepal earthquake data was used as the training data even though building characteristics may differ from the ones in Japan.

Acknowledgement