



Turkey – Syria earthquake of 6 February 2023

Damage Proxy Map from COSMO-SkyMed Imagery

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Christian Bignami, Emanuele Ferrentino, Salvatore Stramondo, Stefano Salvi, 16/02/2023, INGV Remote Sensing Unit.

This summary report describes a preliminary remote sensing analysis of damage occurred over the cities of Gaziantep and Kahramanmaras.

Four COSMO-SkyMed Second Generation (CSG) images have been used to derive a damage proxy map based on a change detection method applied to SAR intensity data.

The acquisition dates are:

- 03/02/2023 and 11/02/2023 for the pre-event and post-event acquisition, respectively, on Gaziantep;
- 04/02/2023 and 12/02/2023 for the pre-event and post-event acquisition, respectively, on Kahramanmaras.

Images are in stripmap mode, HH polarisation, at 2m x 2m resolution on the ground, and with descending and ascending orbit for Gaziantep and Kahramanmaras, respectively.

The change detector index we used as Damage Proxy, is the Intensity Correlation Difference (ICD). The ICD is based on the intensity correlation quantity, a change estimator that analyses the spatial distribution of scatterers, and their SAR intensity value, within a user-defined window (e.g. Stramondo et al. 2006, Matsuoka & Yamazaki 2005, Romaniello et al, 2017). It is defined as:

$$ICD = R_{cos} - R_{pre}$$

Where R_{cos} is the intensity correlation values obtained from a co-seismic images pair, and R_{pre} is the correlation obtained from two images acquired before the earthquake.

Where damage occurs, the R_{cos} is expected to be lower than R_{pre} , and we can have a damage proxy indicator. The correlation R is defined as:

$$R_I = \frac{E(I_1 I_2)}{\sqrt{E(I_1^2) E(I_2^2)}}$$

Where I_1 and I_2 refer to the pixels of the two SAR images, and $E(...)$ is the expected value operator. Finally, a threshold is applied to the ICD to highlight the stronger changes, most likely related to collapsed or heavily damaged buildings.

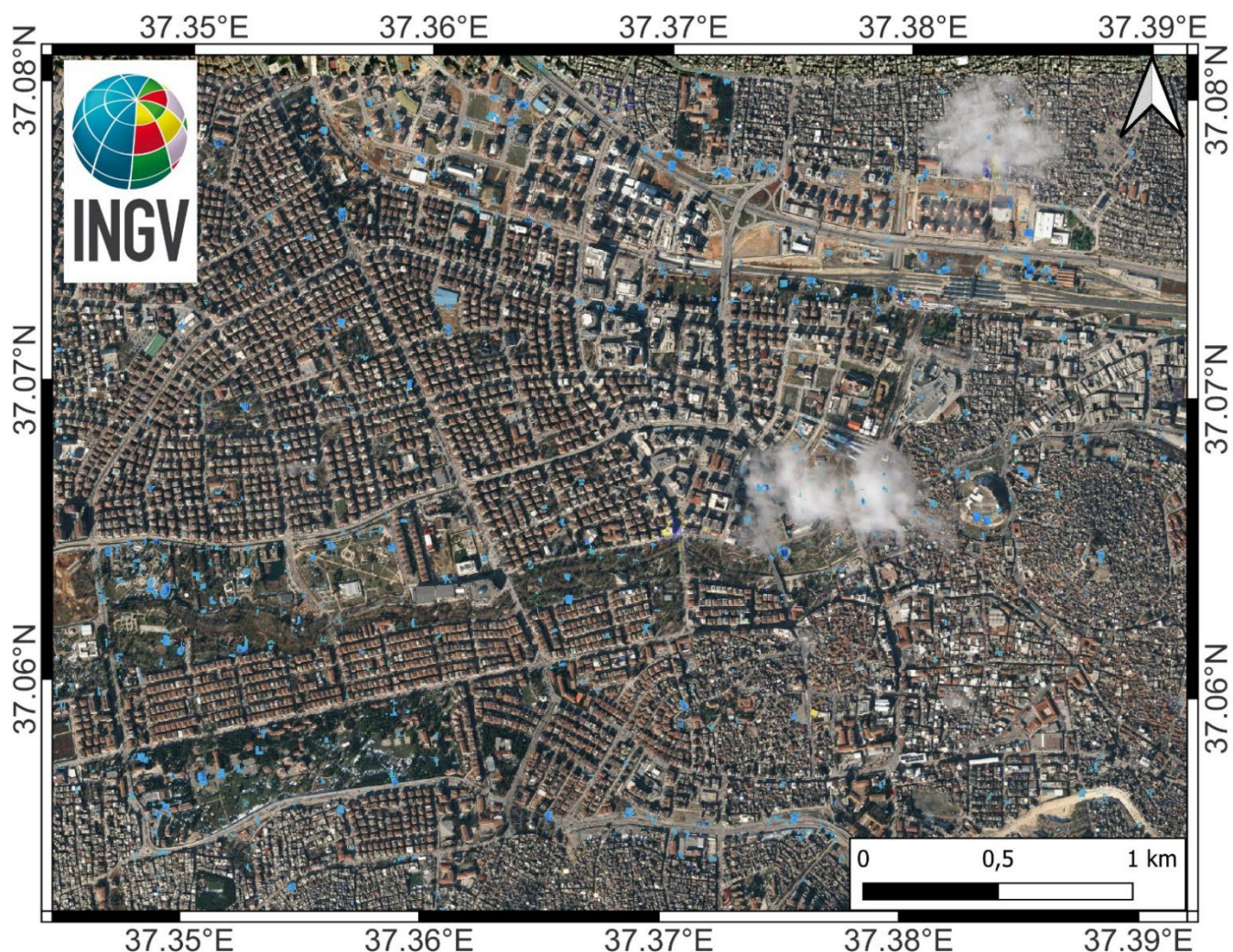


Figure 1. Overview damage map of Gaziantep city centre based on ICD.



Figure 1 shows an overview of the Gaziantep city centre, where the superimposed blue pixels identify the changes detected by CSG. The background image is a post-seismic very high-resolution (VHR) optical data acquired by PLANET satellite and freely available from <https://map.openaerialmap.org/>

Figures 2 reports a zoom on two areas where damage are visible from the VHR image. Note that the ICD seems to clearly identify the actual damage (e.g. the famous Gaziantep Castle, Fig.2) even though some false alarms are present mainly in non-built areas, and where changes non related to damage may have occurred.

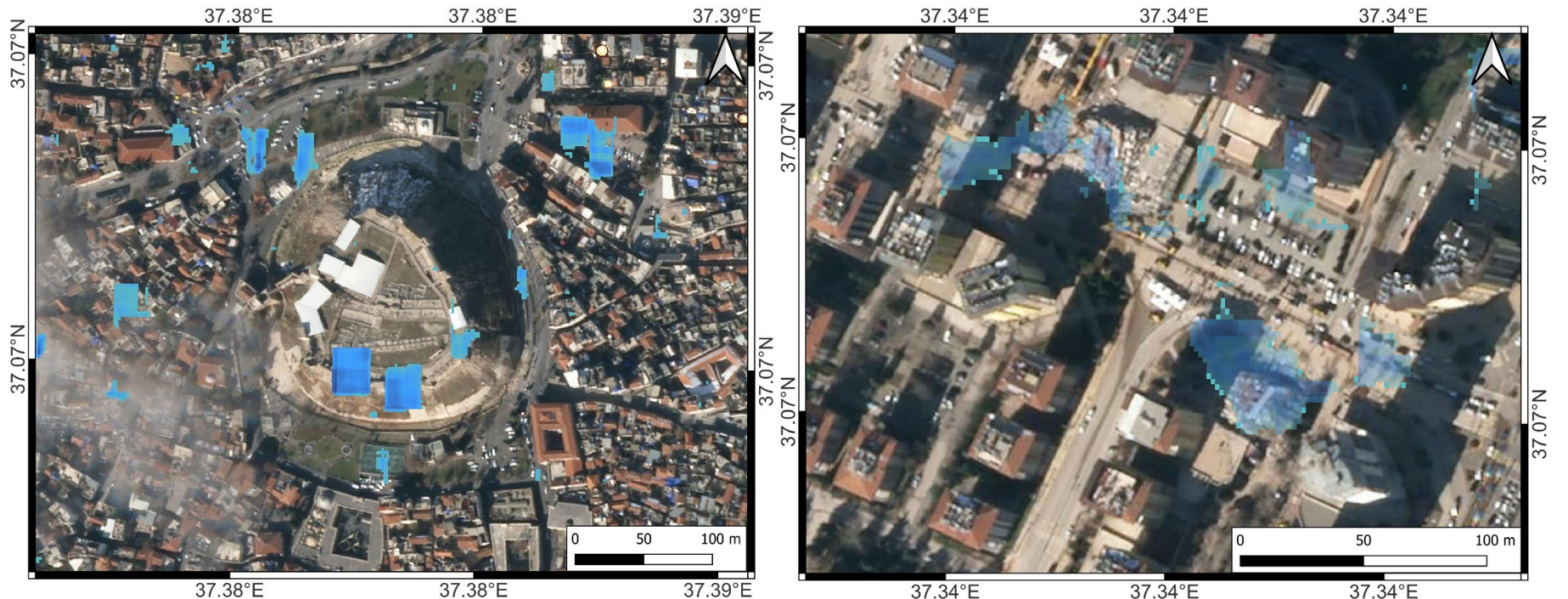


Figure 2. Zoom in of two damaged areas in Gaziantep

A second analysis has been carried out on Kahramanmaras city, probably the city where the strongest damage occurred. The overview on the city centre highlights a clear pattern of changes, well identified in the central part of Figure 3.

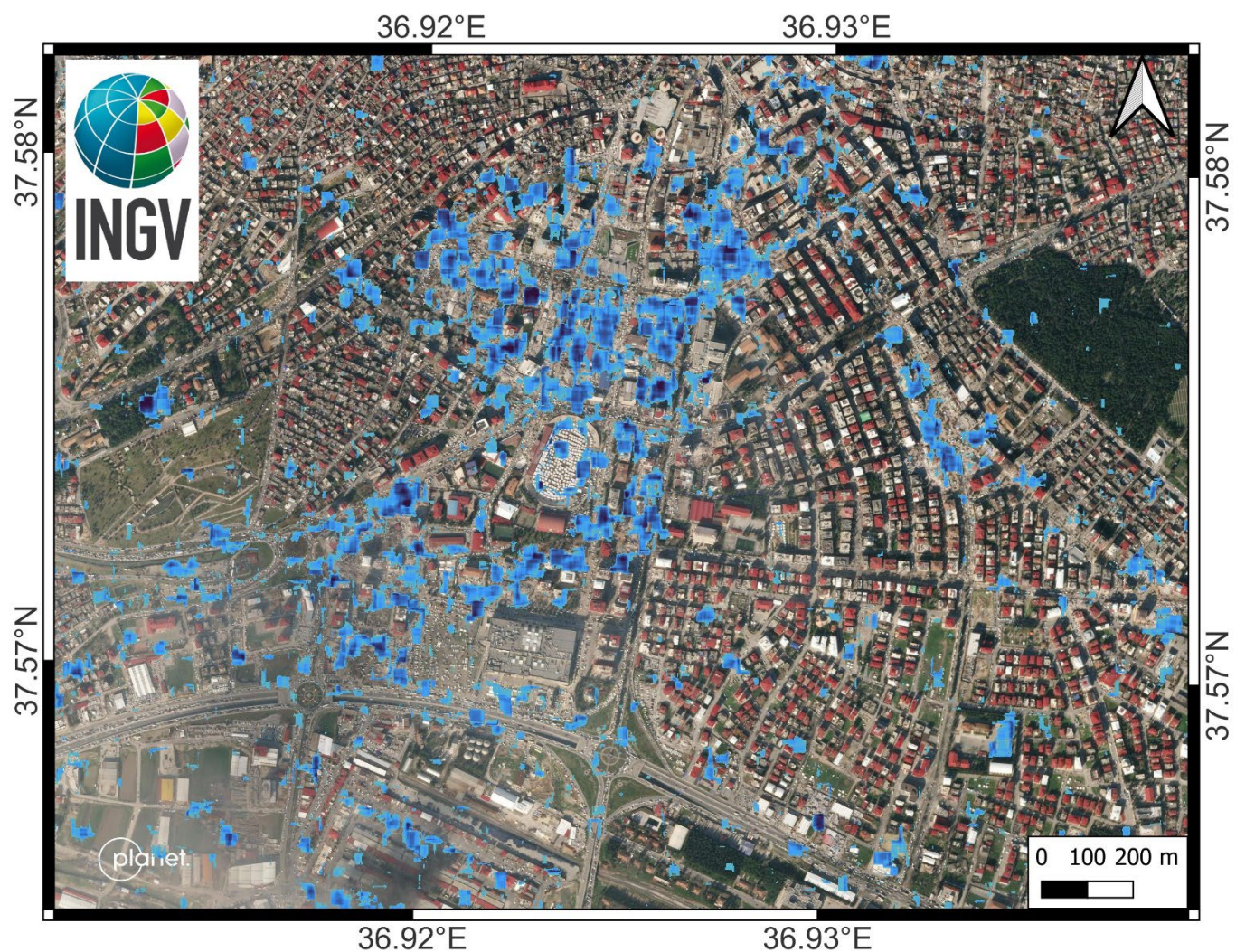


Figure 3. Overview damage map based on ICD detector of Kahramanmaras city centre.



This can be well appreciated in the zoomed panels in Figure 4, where the post VHR data (in background) clearly show the destruction in very good agreement with the blue pixels of the ICD damage indicator.

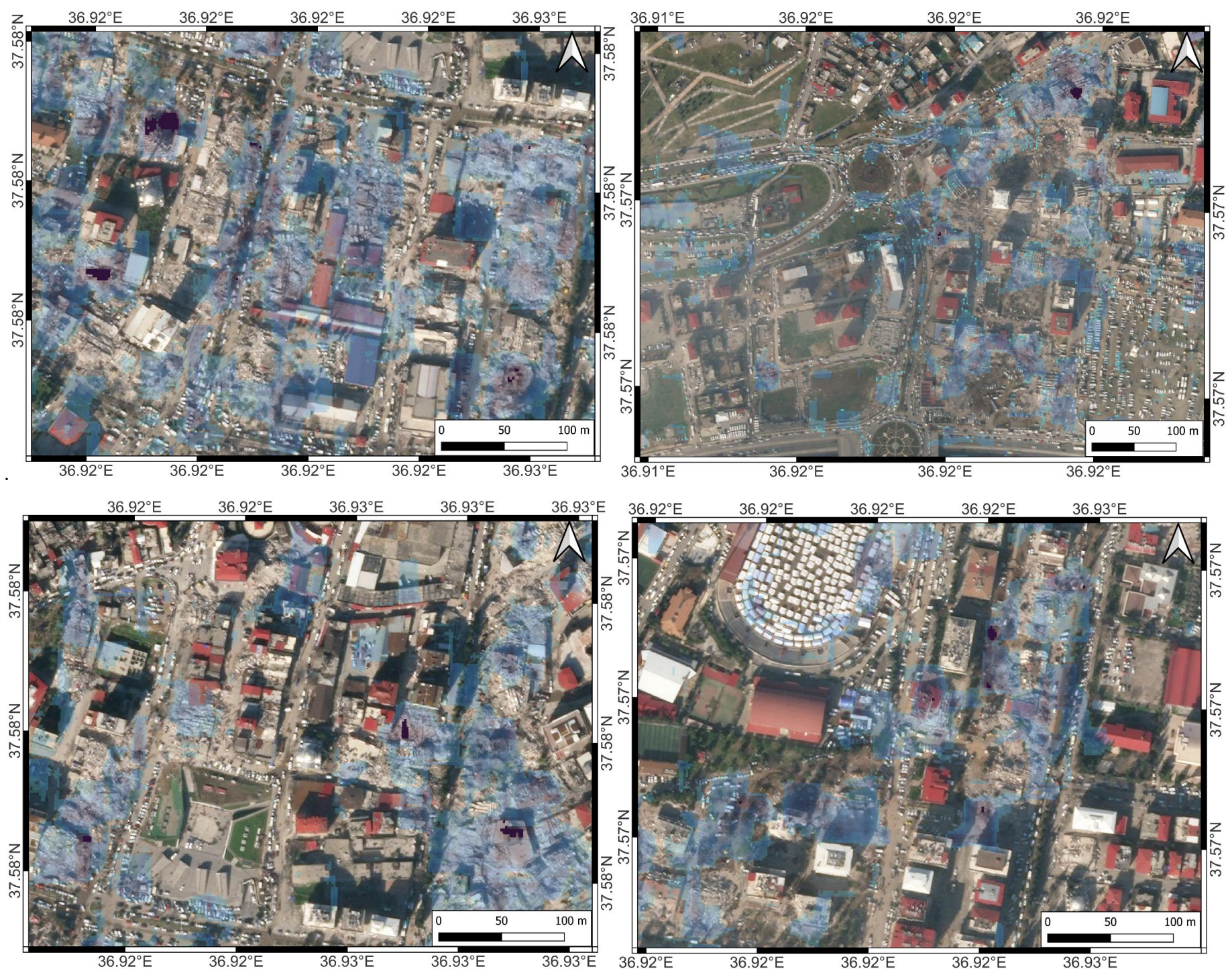


Figure 4. Zoom in of four damaged areas in Kahramanmaras.

Note that, presently, no full and quantitative ground validation has been carried out.

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