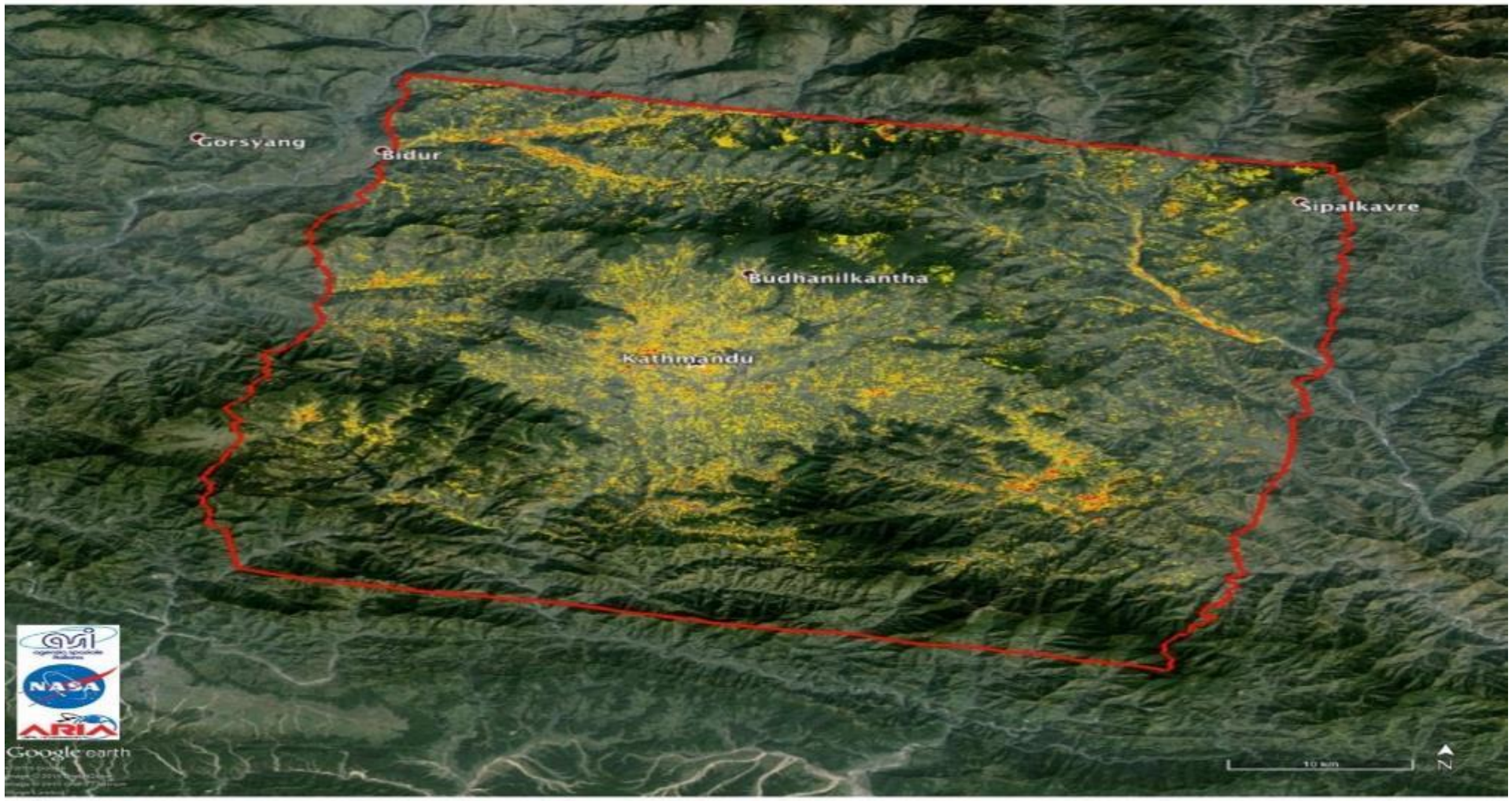
Rapid Disaster Response with the GEE

Jeroen van Heyningen – TU Delft



DPM of the Kathmandu area after the 2015 Earthquake – Yun, S., et al. (2015)

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Time is a crucial factor

Better infrastructures and quick response are equally important

USAR Team assisted during the 2015 Nepal Earthquake

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So, automation is crucial

Various options for Rapid Disaster Response:

- Ground teams
- Drones
- Aerial footage
- Satellite imagery (optical)

However, none is available for automation as manual labour is required and data supply is irregular.

Radar could be the solution

Sentinel-1 Mission (ESA) systematically acquires imagery every 3-days (in any orientation) from the Earth's surface using SAR.

Both the **phase** and the amplitude signal can be used in building damage detection.

DPM 20071023 20080109

DPM from coherence (phase) data in Pasadena, CA – Yun, S., et al. (2011)

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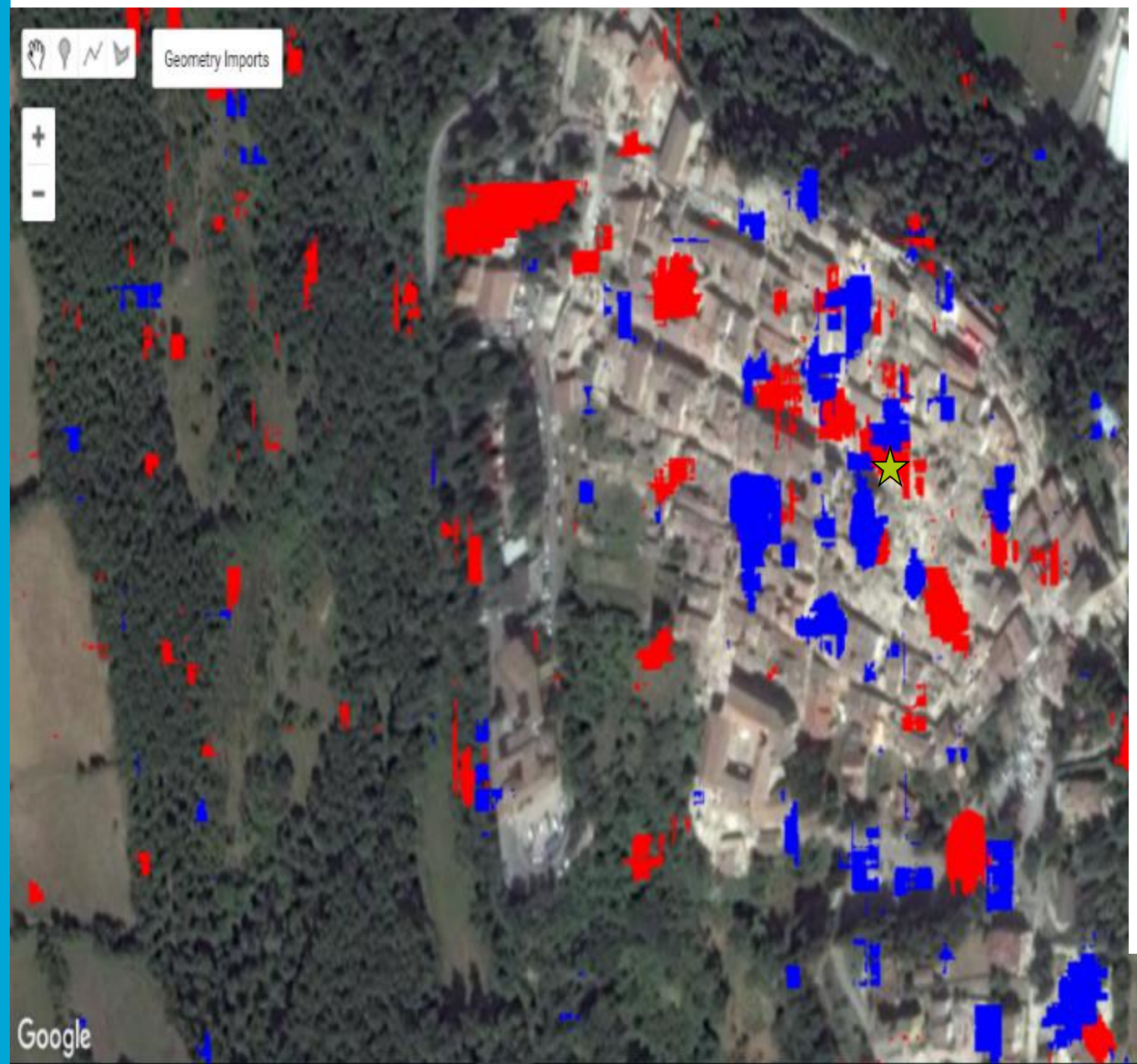
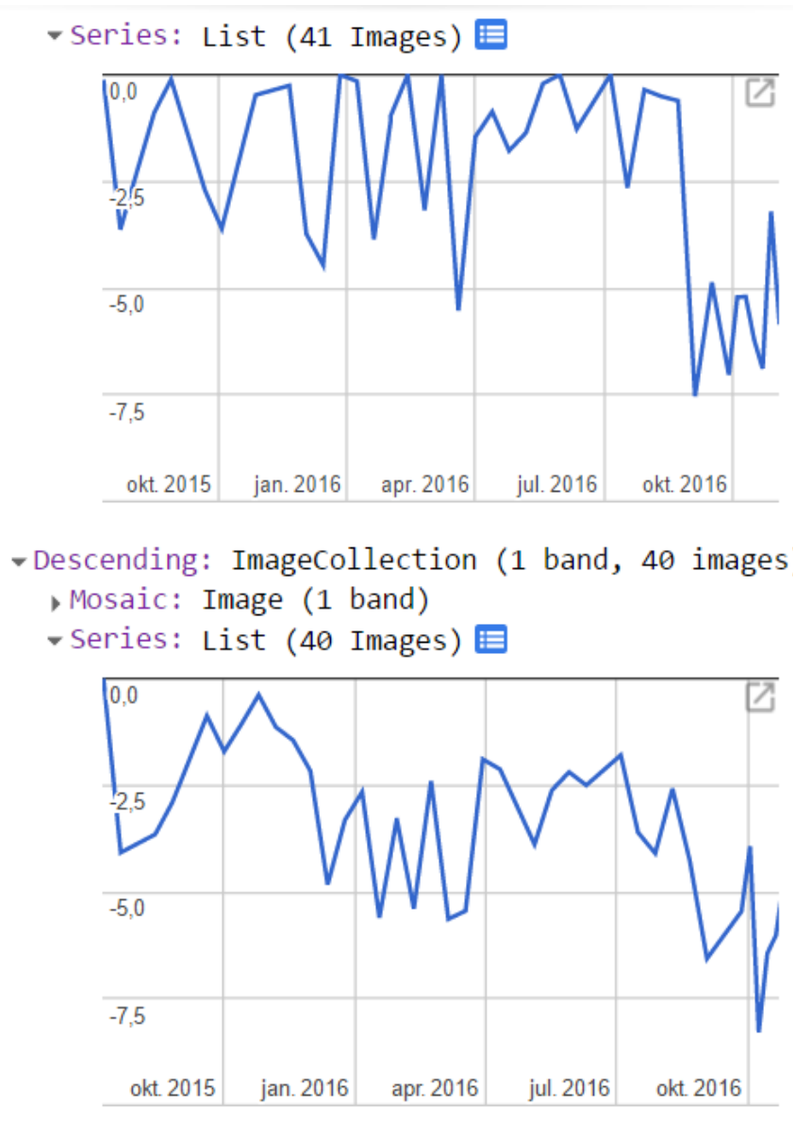
Radar could be the solution

Both the phase and the **amplitude** signal can be used in building damage detection.





Google Earth Engine (GEE)

Allows combination of multiple remote sensing datasets:

- S1 Ground Range Detected
- S2 Top Of Atmosphere
- LANDSAT Surface Reflectance
- MODIS
- Weather data

Two APIs for processing in Javascript and Python

Fast processing on their servers

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Google Earth Engine

Search places and datasets...

Help | jeroenvheyningen

Scripts | Docs | Assets

Filter scripts... NEW

- Owner (1)
  - users/jeroenvheyningen/def...
    - AD_NDVI_RADAR
    - Correction
    - Damage_AD
    - Damage_Amat...
    - Damage_Kumamoto
    - EQ_Amatrice
    - FireDetection

Damage_Amatrice | Get Link | Save | Run | Reset

```
Imports (6 entries)
  var Polygon: Polygon, 4 vertices
  var Landsatnew: ImageCollection "USGS Landsat 8 Surface Reflectance (pre-Collection)"
  var Sentinel1: ImageCollection "Sentinel-1: C-band Synthetic Aperture Radar (SAR) Ground R…
  var srtm: Image "SRTM Digital Elevation Data 30m" (1 band)
  var Sentinel2new: ImageCollection "Sentinel-2: MultiSpectral Instrument (MSI), Level-1C"
  var Point: Point (13.29, 42.63)
//// SET OF PARAMETERS AND FUNCTIONS ////
// Set start and end date of collection
var start = ee.Date('2015-07-01');
```

Inspector | Console | Tasks | Profiler

Geometry Imports

Layers | Kaart | Satelliet

Google

Afbeeldingen ©2017 , CNES / Airbus, DigitalGlobe, Landsat / Copernicus | 500 m | Gebruiksvoorwaarden | Een kaartfout rapporteren

Google Earth Engine (GEE)

1. Apply orbit file (using restituted orbits)
2. Thermal noise removal
3. Radiometric calibration
4. Terrain correction (orthorectification)
5. Convert to dB and cut off 1st and 99th percentile
6. Compute Gain and Bias to scale to 1-65535 and round to uint16

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Preliminary Results

http://emergency.copernicus.eu/mapping/ems-product-component/EMSR177_20AMATRICEAERIAL_GRADING_OVERVIEW/3

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Preliminary Results

https://www.jpl.nasa.gov/spaceimages/details.php?id=pia20897

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Processing

Correct the natural effects in the pre-seismic signal: rain, geometry and dielectric constant

Use a combination of:

- NDVI
- Backscatter (VV/VH, Asc/Dsc)
- Amplitude Dispersion (VV/VH, Asc/Dsc)

For Urban area selection and apply correction

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Processing

Hypothesis testing of the post seismic:

1. Assume signal follows a Rayleigh distribution in time.

2. New acquisition is expected to fall within the same distribution so that the building did not collapse (H_0).

3. If it is significantly different, the H_A is that the building collapsed.

Important to favour the Type I error over the Type II error.

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Final automated approach

USGS Data and Location

↓

Perform Damage Detection Algorithm

↓

Mask Urban areas

↓

Convert to KML/GEOTIFF

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Thank you!

Questions?

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