

# Seismic Hazard under Cities Pleiades Stereo Data

John Elliott, Ruth Amey & Scott Watson



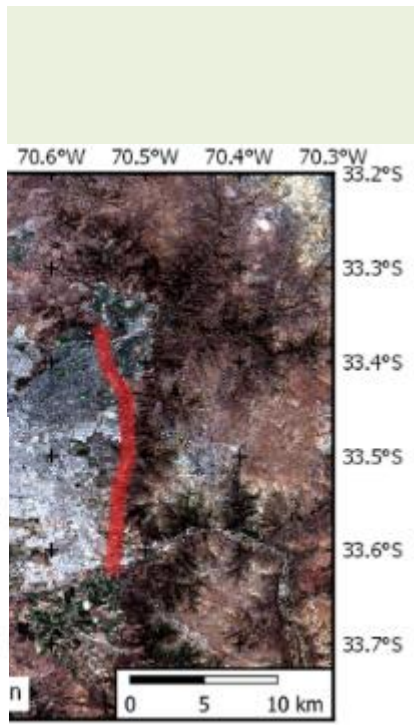
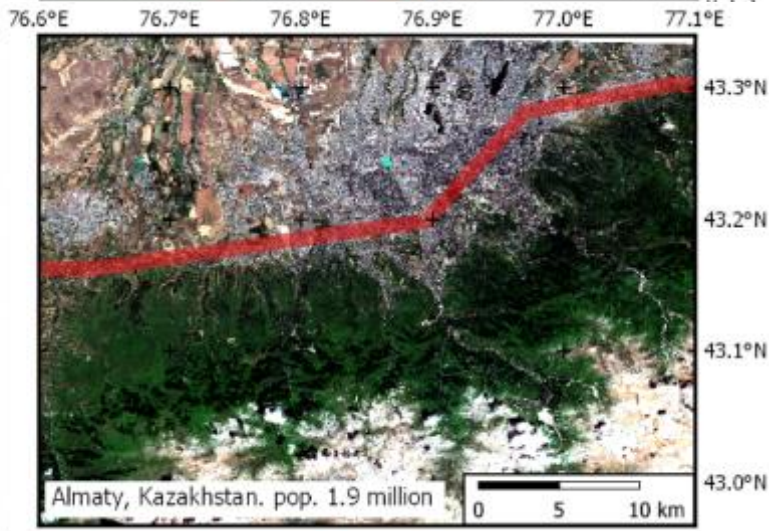
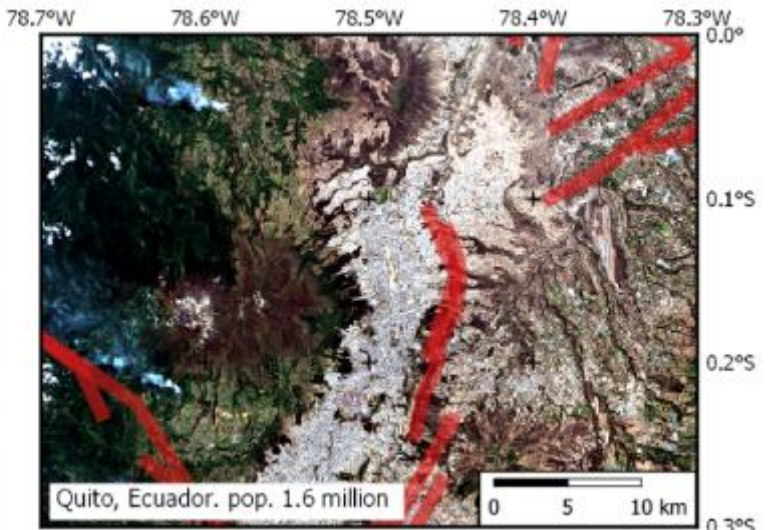
Natural Environment Research Council



COMET

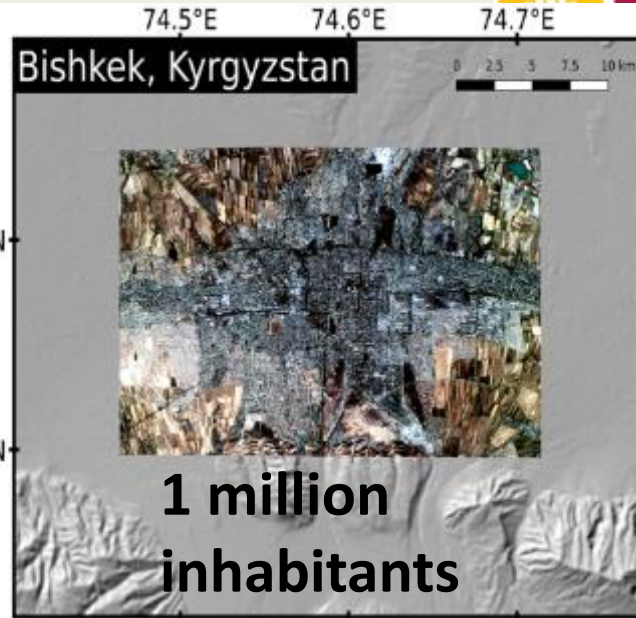
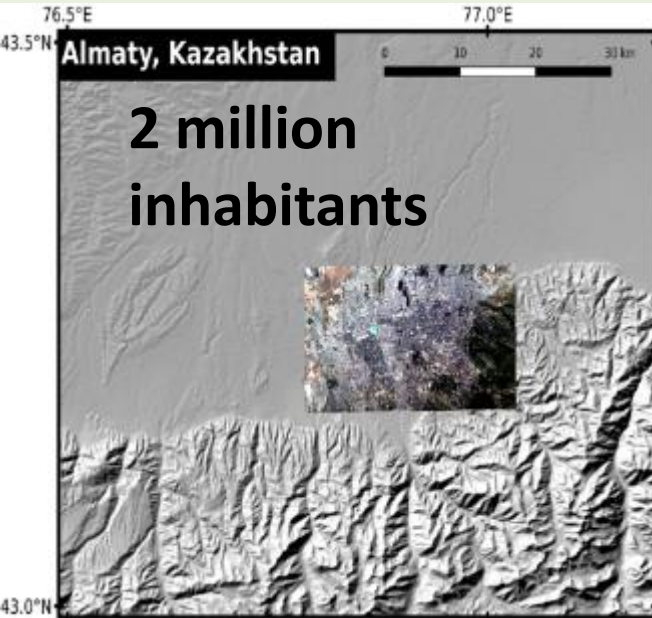


# neath Cities



# Seismic Cities

- Santiago, Chile (reported Sept 2019)
- Almaty, Kazakhstan (reported Sept 2020)
- Bishkek, Kyrgyzstan



# Almaty, Kazakhstan

- Submitted to Earth, Space Sciences Feb 2021

Significant Seismic Risk Potential from Buried Faults Beneath Almaty City, Kazakhstan, revealed from high-resolution satellite DEMs

Ruth M.J. Amey<sup>1</sup>, John R. Elliott<sup>1</sup>, Ekbal Hussain<sup>2</sup>, Richard Walker<sup>3</sup>, Marco Pagani<sup>4</sup>, Vitor Silva<sup>4</sup>, Kanatbek E. Abdrakhmatov<sup>5</sup>, C. Scott Watson<sup>1</sup>

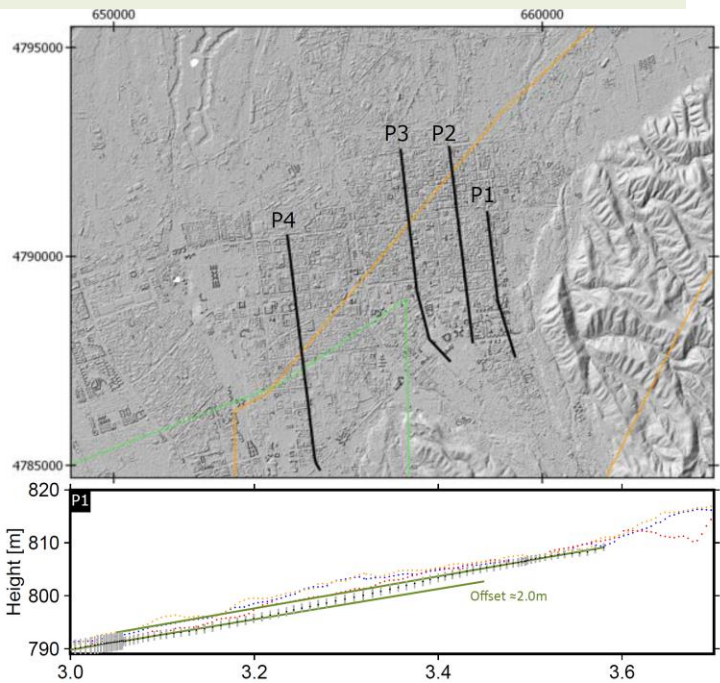
<sup>1</sup>COMET, School of Earth and Environment, University of Leeds, LS2 9JT, UK

<sup>2</sup>British Geological Survey, Natural Environment Research Council, Environmental Science Centre, Keyworth, Nottingham, NG12 5GG, UK

<sup>3</sup>COMET, Department of Earth Sciences, University of Oxford, Oxford, OX1 3AN

<sup>4</sup>GEM Foundation, Via Ferrata 1, 27100 Pavia, Italy

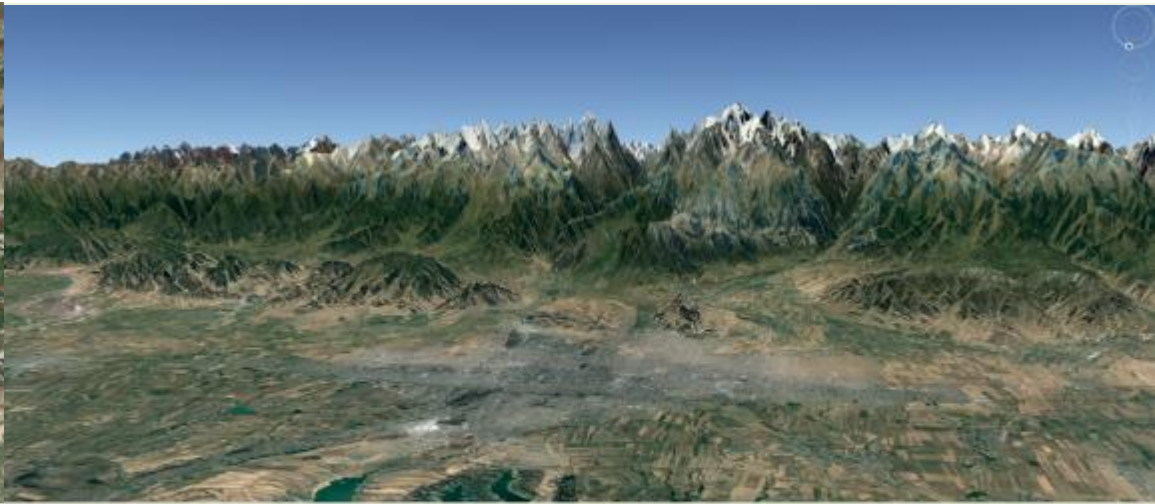
<sup>5</sup>Institute of Seismology, National Academy of Sciences, Bishkek, Kyrgyzstan



## Key Points:

- Digital elevation models derived from high-resolution satellite imagery can map active faulting near cities and determine building heights
- Scenario risk calculations show a moderate earthquake on a fault in north Almaty would cause considerable damage and loss due to proximity
- Properly characterising fault location and geometry close to cities is key to quantifying the relative level of seismic hazard and risk

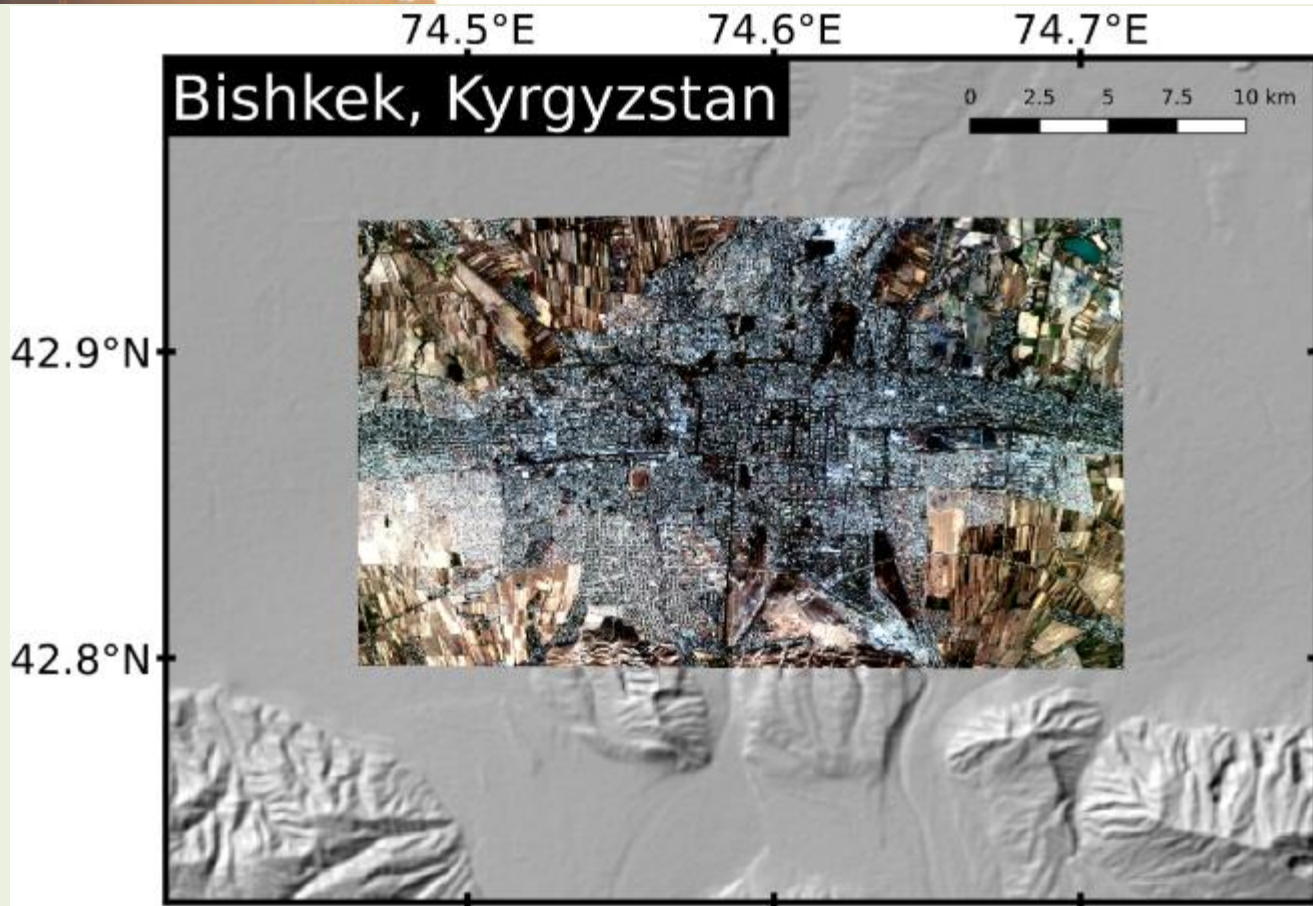
# Bishkek, Kyrgyzstan



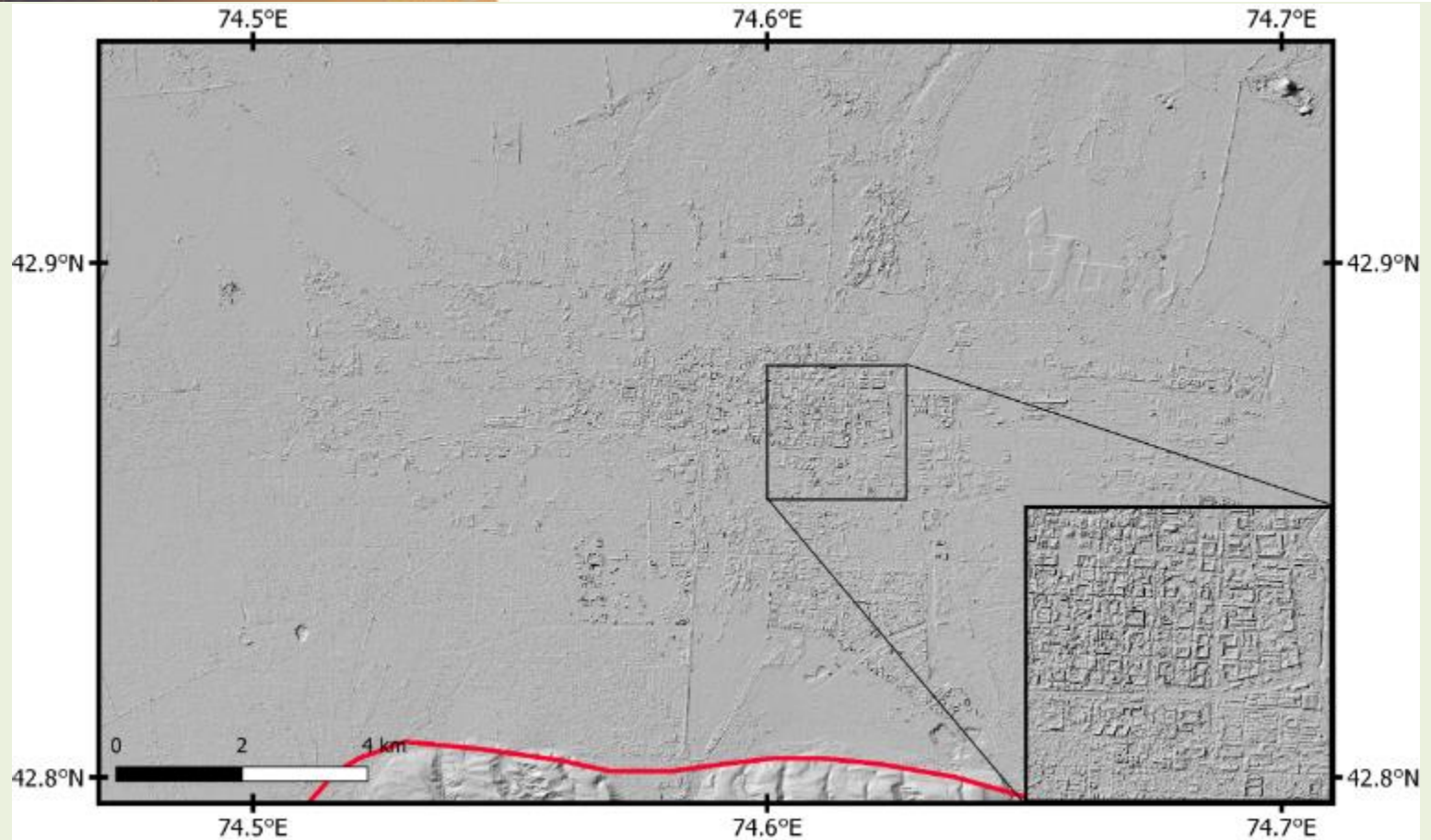
Pleiades Tri Stereo Archive from 2013

Bishkek, Capital of Kyrgyzstan, 1.1 million inhabitants

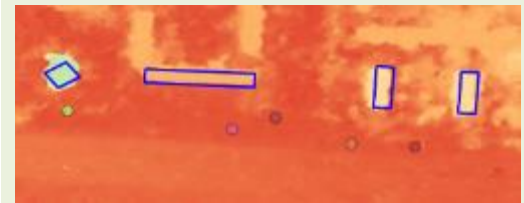
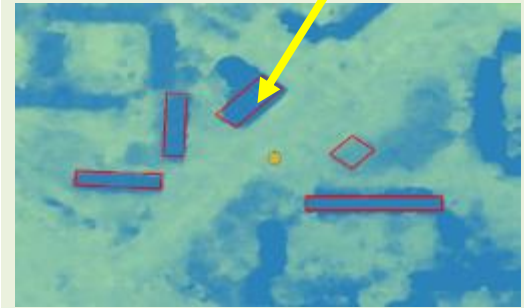
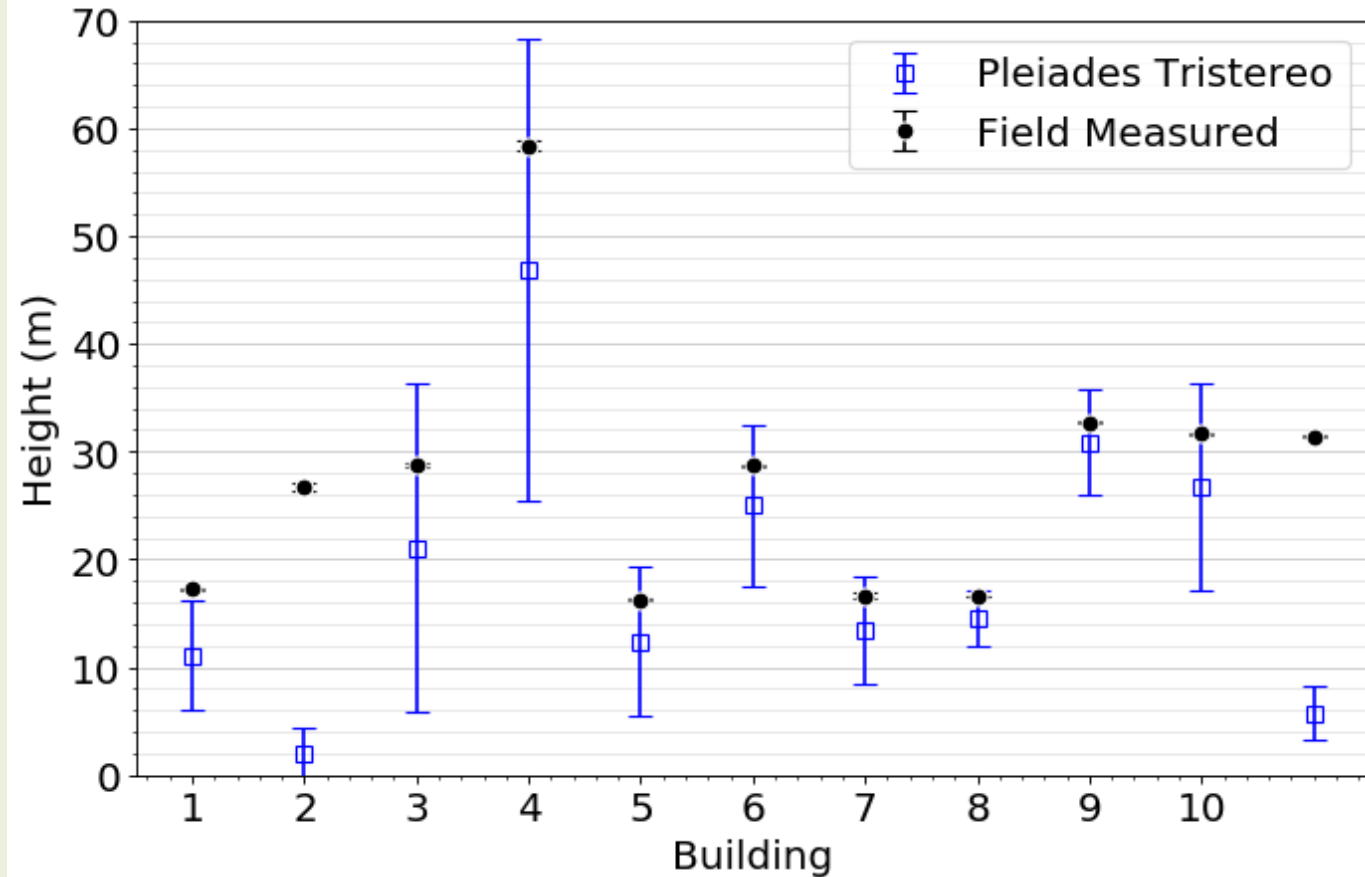
# Bishkek - Pleiades



# Bishkek - DEM



# Bishkek – Building Heights





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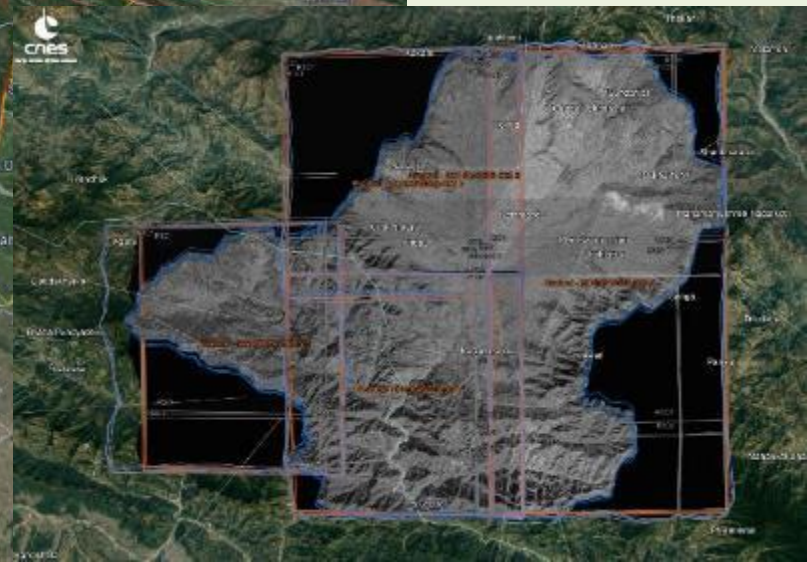
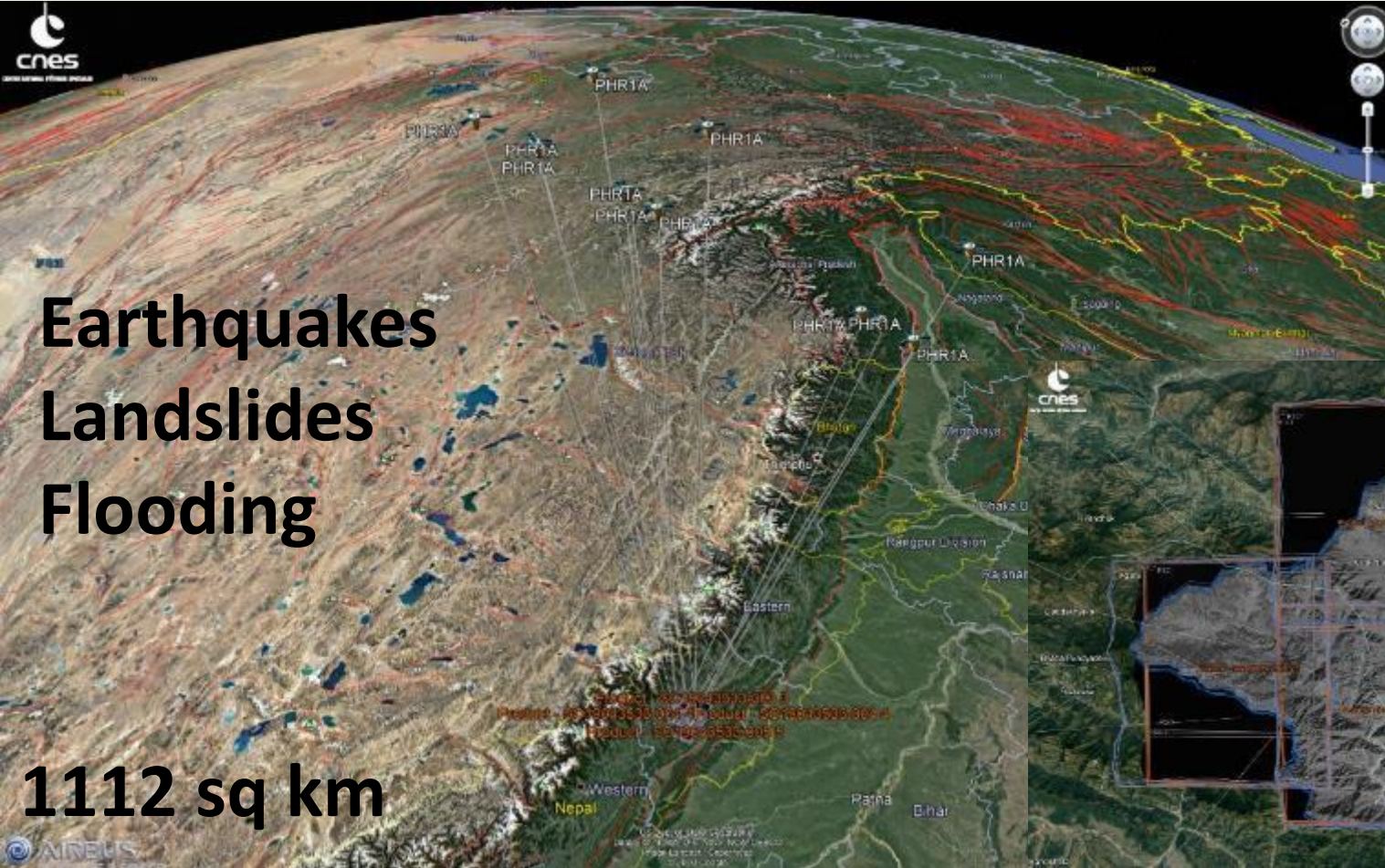
भोलिको काठमाडौं (Tomorrow's Kathmandu)

# Kathmandu, Nepal

- Acquired: Oct 2019, Dec 2019 & January 2020

Earthquakes  
Landslides  
Flooding

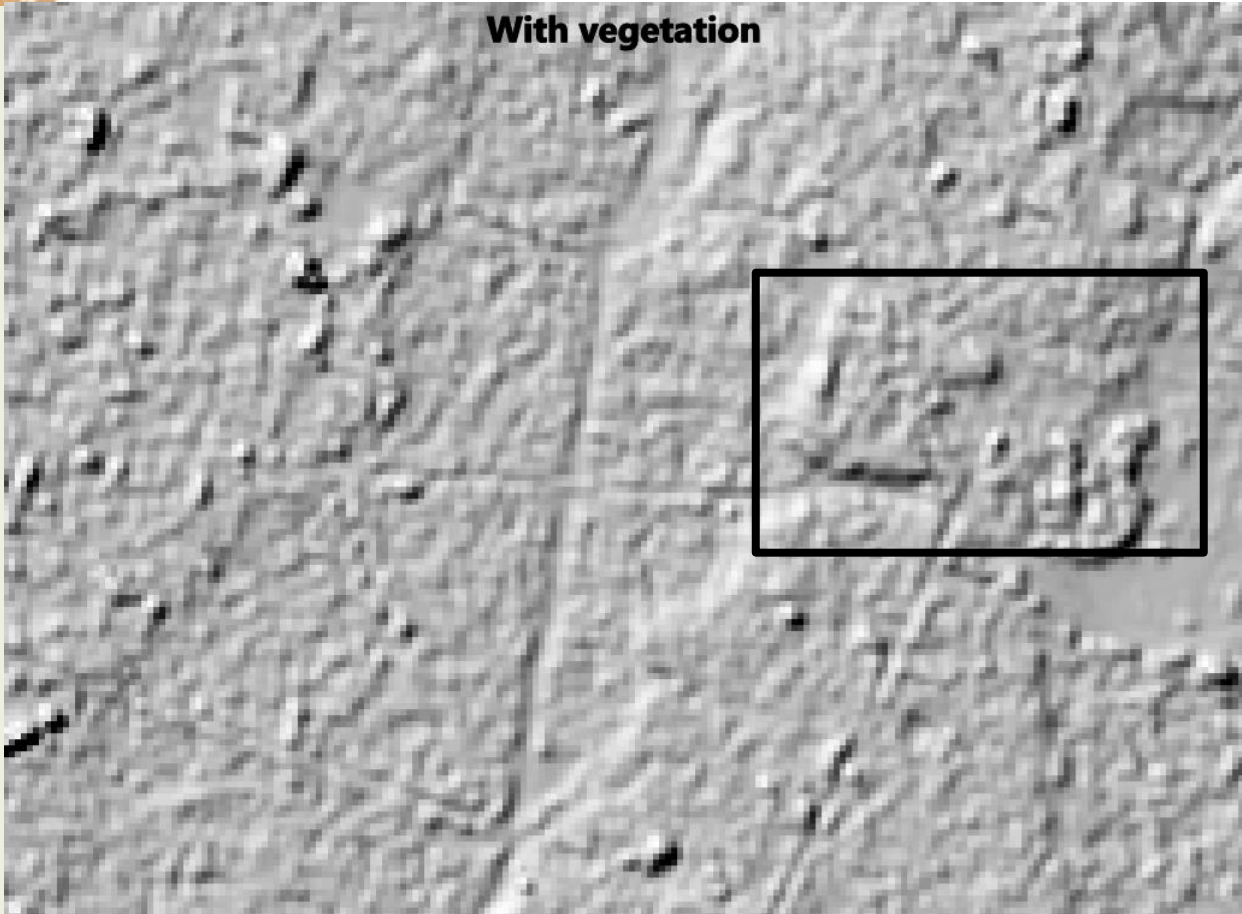
1112 sq km



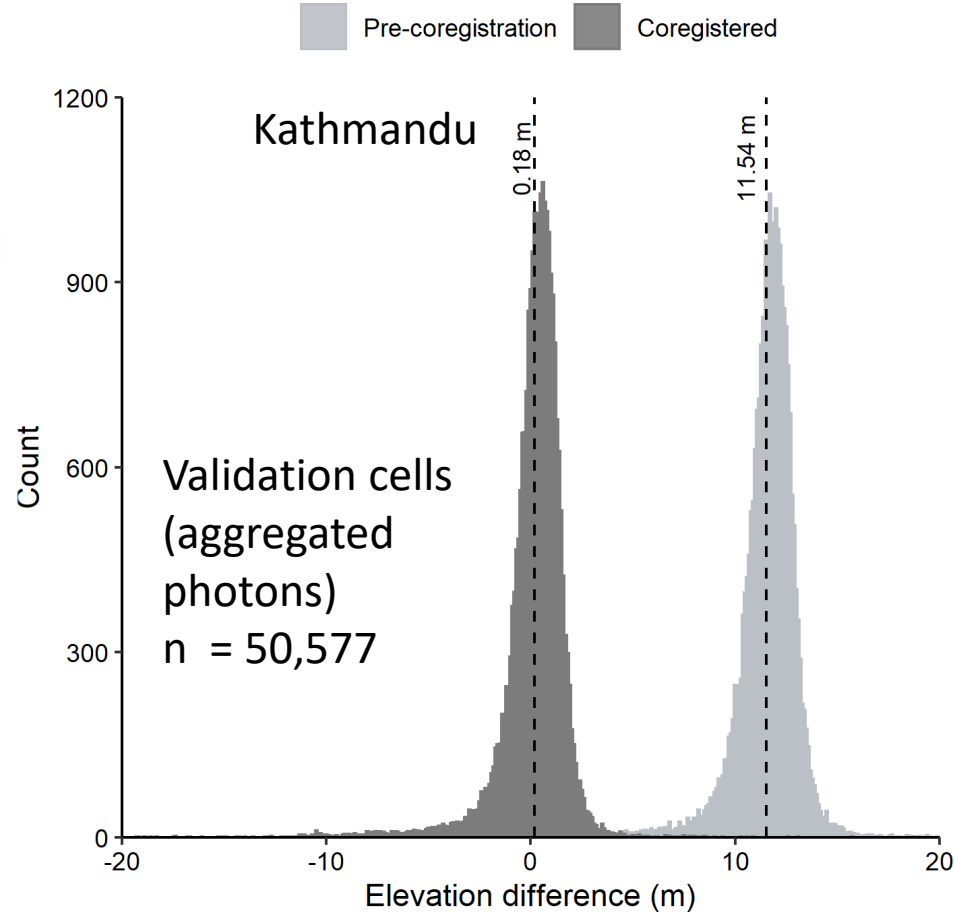
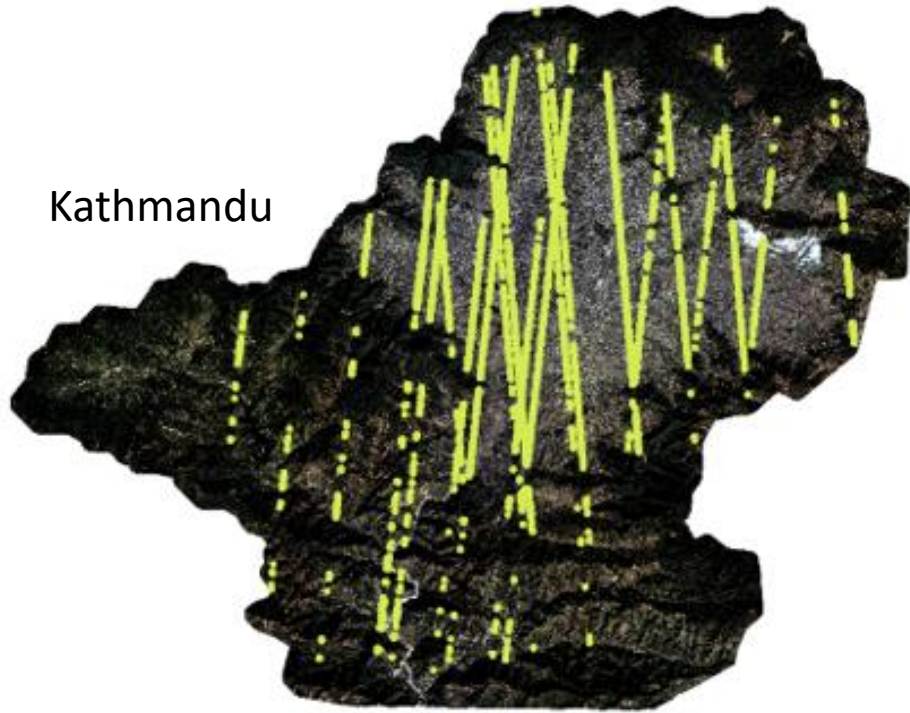
# Kathmandu

**With vegetation**

- Vegetation removal for flood modelling
- Ongoing analysis by Maggie Creed (Edinburgh - Tomorrow's Cities)



# DEM validation using ICESat-2



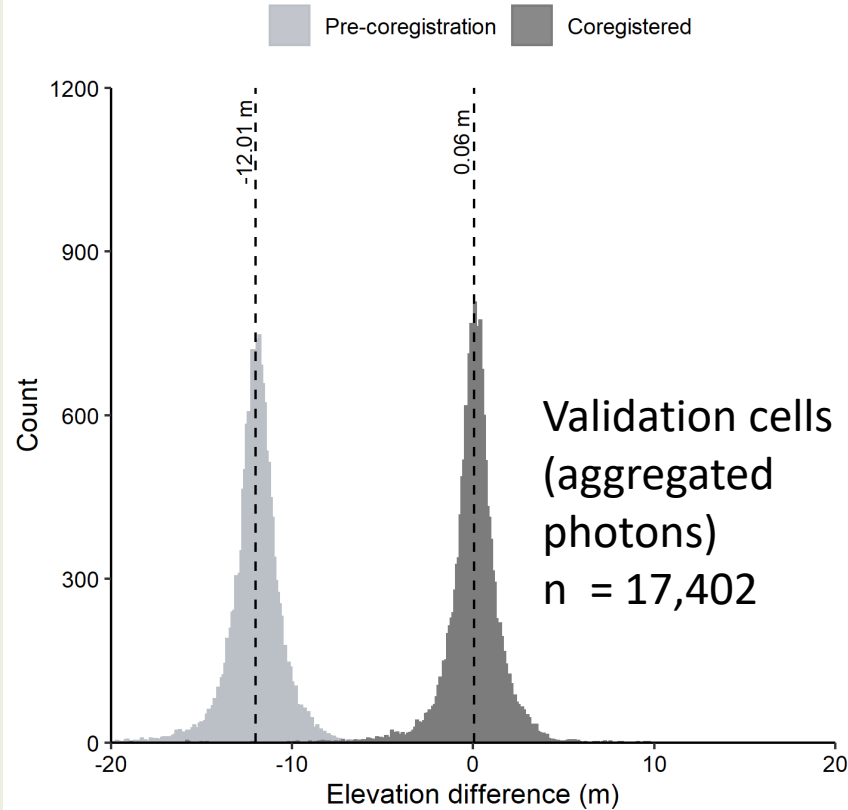
Elevation model mean difference of 0.18 m and standard deviation of 1.67 m relative to ICESat-2 data



# Urban expansion and intersection with hazards - Quito

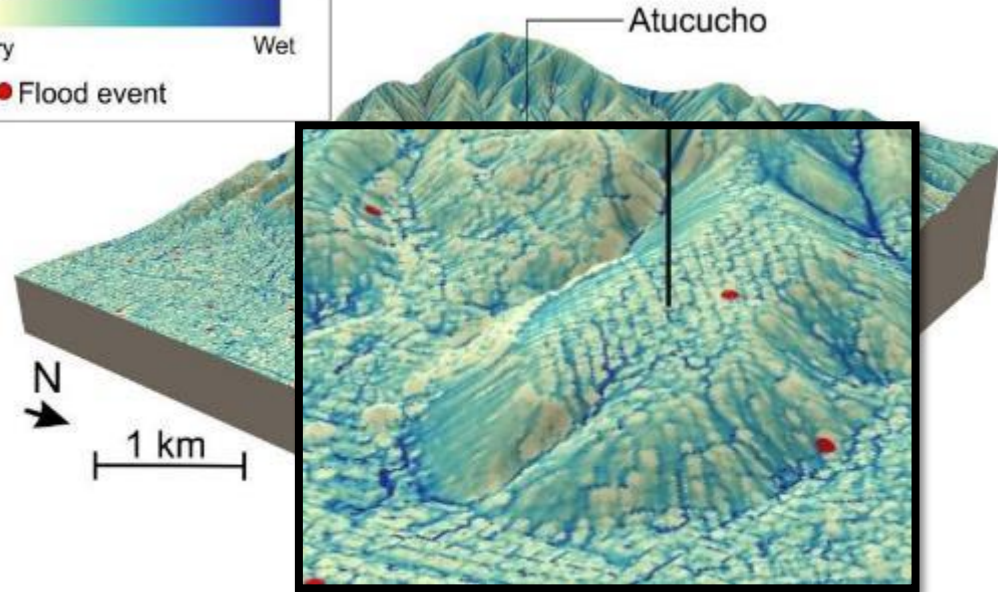
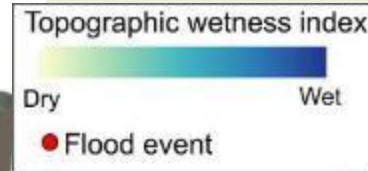
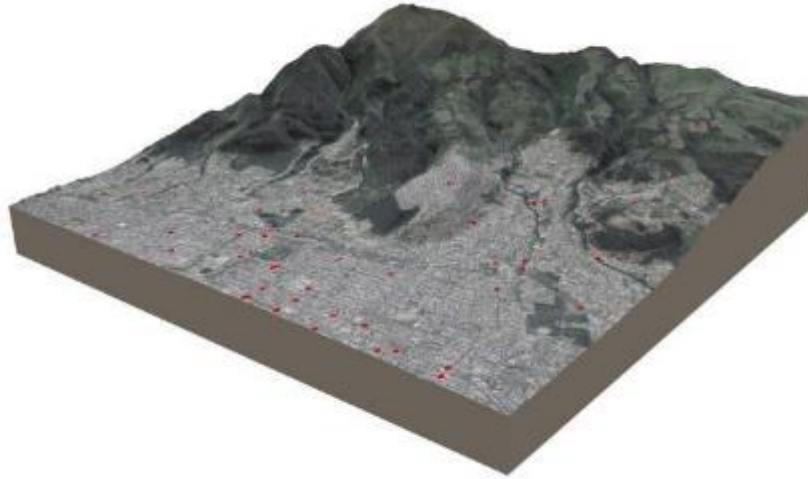
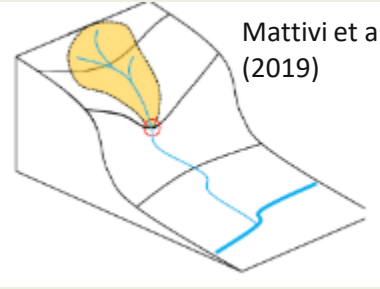


Elevation model mean difference of 0.06 m and standard deviation of 1.42 m relative to ICESat-2 data



# Pleiades elevation data - TWI

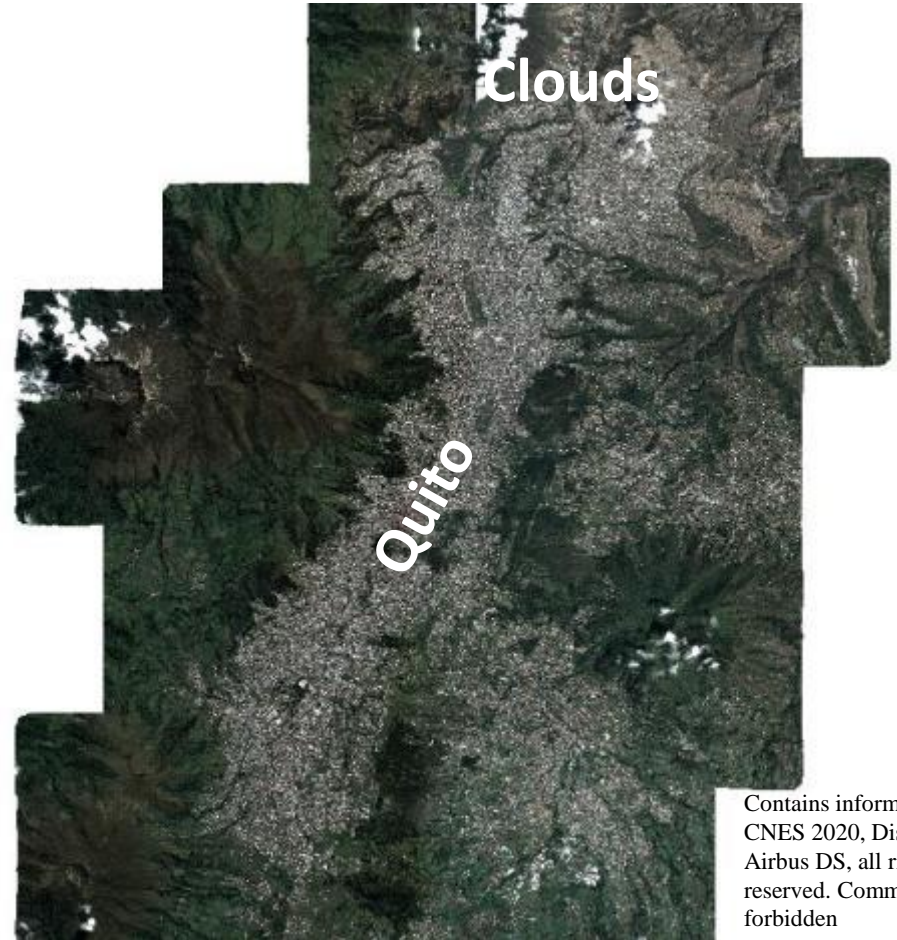
- Topographic wetness index association with recorded flood events



- Flow routing in areas with natural drainage (few sewers)

# Pleiades - orthoimagery

- Greenspace analysis for disaster risk resilience
- College of Architects of Ecuador (CAE) partnership with Tomorrow's Cities to investigate the distribution and accessibility of greenspace around Quito



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# Greenspace and risk mitigation is recognised by the municipality

*Biocorredores...They are a tool for conservation of **biological diversity** and also serve as elements for **risk mitigation**.*

***Strengthening the district's resilience** to threats natural and anthropic, as well as pressures and risks for **climate change**.*

***access to spaces green and natural resources**, and that favors **natural life and animal**.*

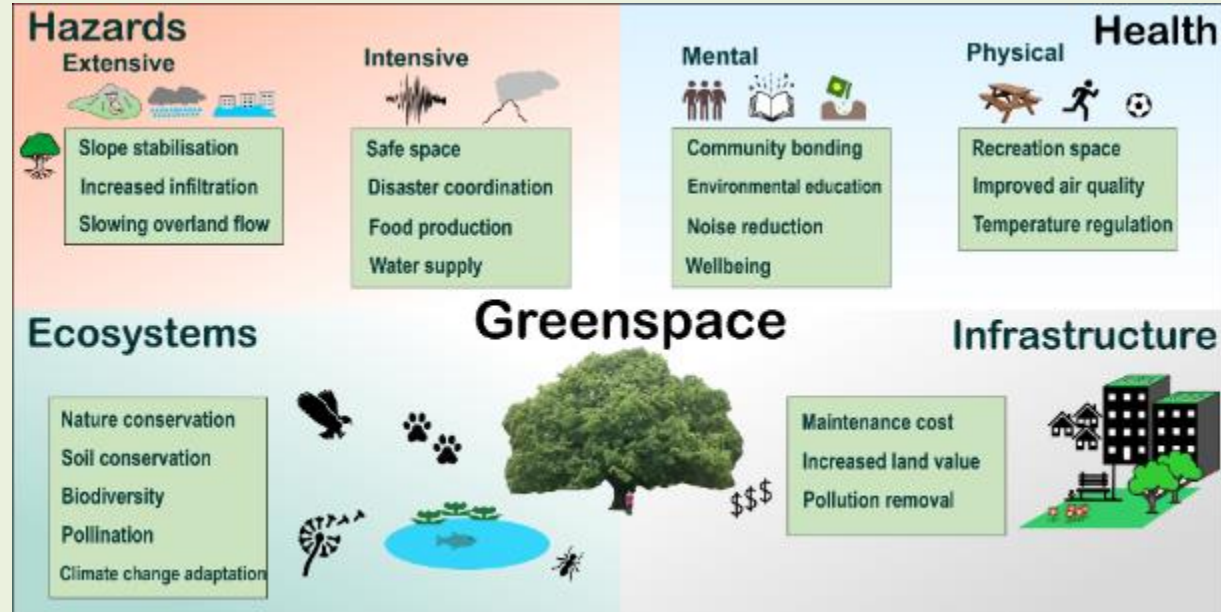


Multiple benefits

# Greenspace Interactions

## City to local scale

- Emergency refuge (safe space)
- Reducing hazard exposure
  - Slope stability
  - Flood risk
- Build community resilience to deliver health and ecological benefits



# Measuring greenspace (or open space) using Pleiades imagery

$$\text{NDVI} = (\text{Nir} - \text{Red}) / (\text{Nir} + \text{red})$$

- Vegetation has high reflectance in near infrared wavelengths and low reflectance in red wave lengths.
- Masked by 'blueness' to remove blue roofs

Less vegetated

Densely vegetated



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# Nairobi, Kenya

**Volcanoes**

**Flooding**

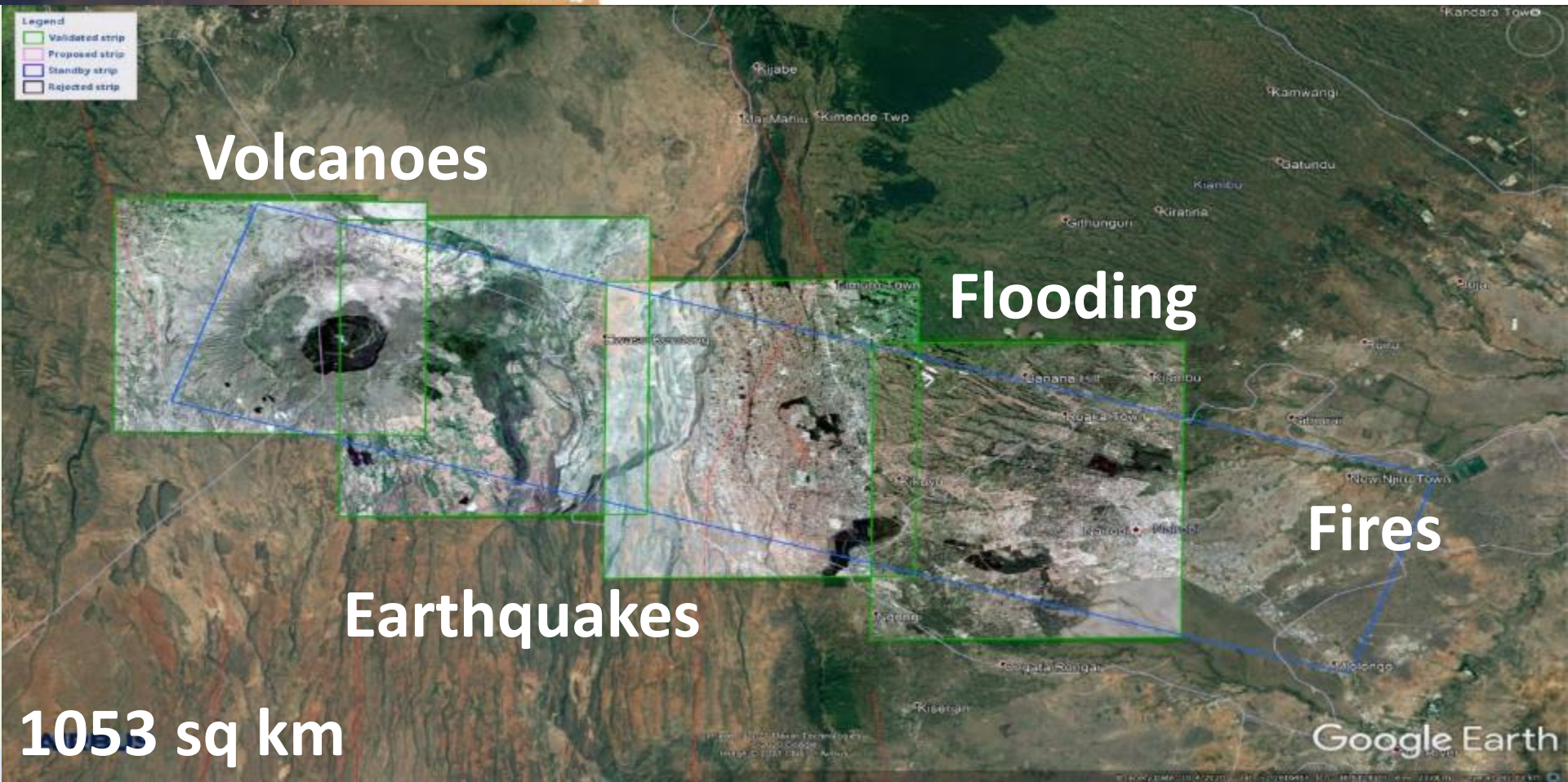
**Fires**

**Earthquakes**

**1053 sq km**

Legend

- Validated strip
- Proposed strip
- Standby strip
- Rejected strip





# Archive Data

The screenshot displays the Airbus Defence and Space archive data interface. At the top, the Airbus logo and "DEFENCE AND SPACE" are visible on the left, and "Need Help?", "English", "Latest news (3)", and "Join / My account" are on the right. Below the header, there is a search bar and a "Zoom to location" field. The main interface is divided into several sections:

- Filters:** Includes "Pinback", "Criteria", "Draw", "Modify", and "Upload" buttons.
- Default:** Includes "Active polygons" and "Polygons" dropdown menus.
- Optical Results:** A list of search results for "Optical Results 1-2". The results are:
  - Pinholes 0.5-m - TRI-STEREO - Nov 10, 2014  
Res: 0.5m | Inc: Ang: 17.8° | Cloud: 0.0%
  - Pinholes 0.5-m - TRI-STEREO - Nov 9, 2014  
Res: 0.5m | Inc: Ang: 13.8° | Cloud: 0.0%
- Map:** A 3D terrain map showing a city area with a large, semi-transparent stereo image overlay. The overlay is labeled "Polygon 0: 0.5m" and "Polygon 0: 0.5m".
- Target/Mode:** A control panel with a "Target/Mode" dropdown set to "Satellite" and various navigation icons.
- Bottom:** A status bar showing "Pinholes archive" and a date range "Date: Jun 1, 2018 - Aug 27, 2023".