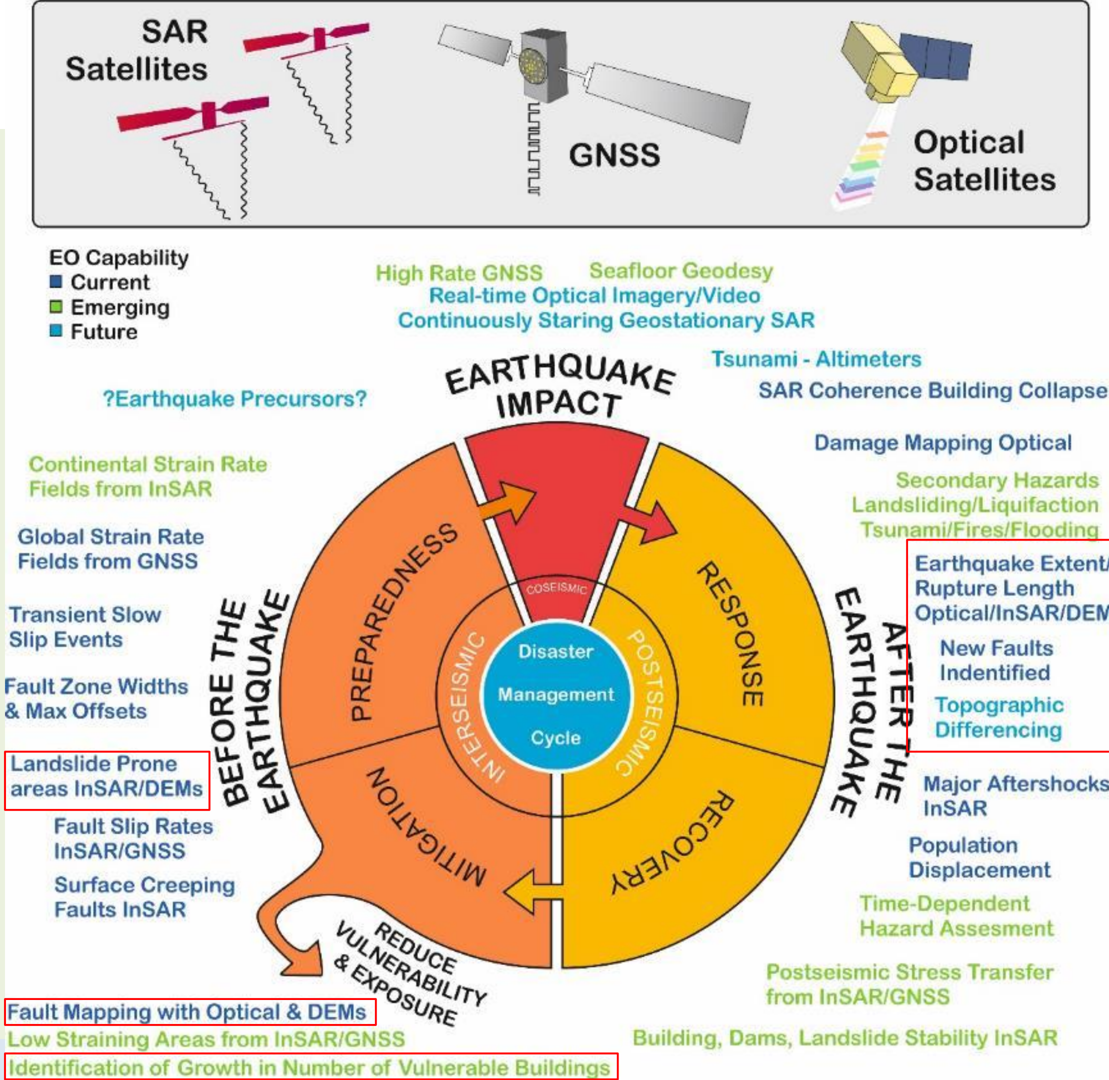
# Seismic Hazard under Cities
# Pleiades Stereo Data

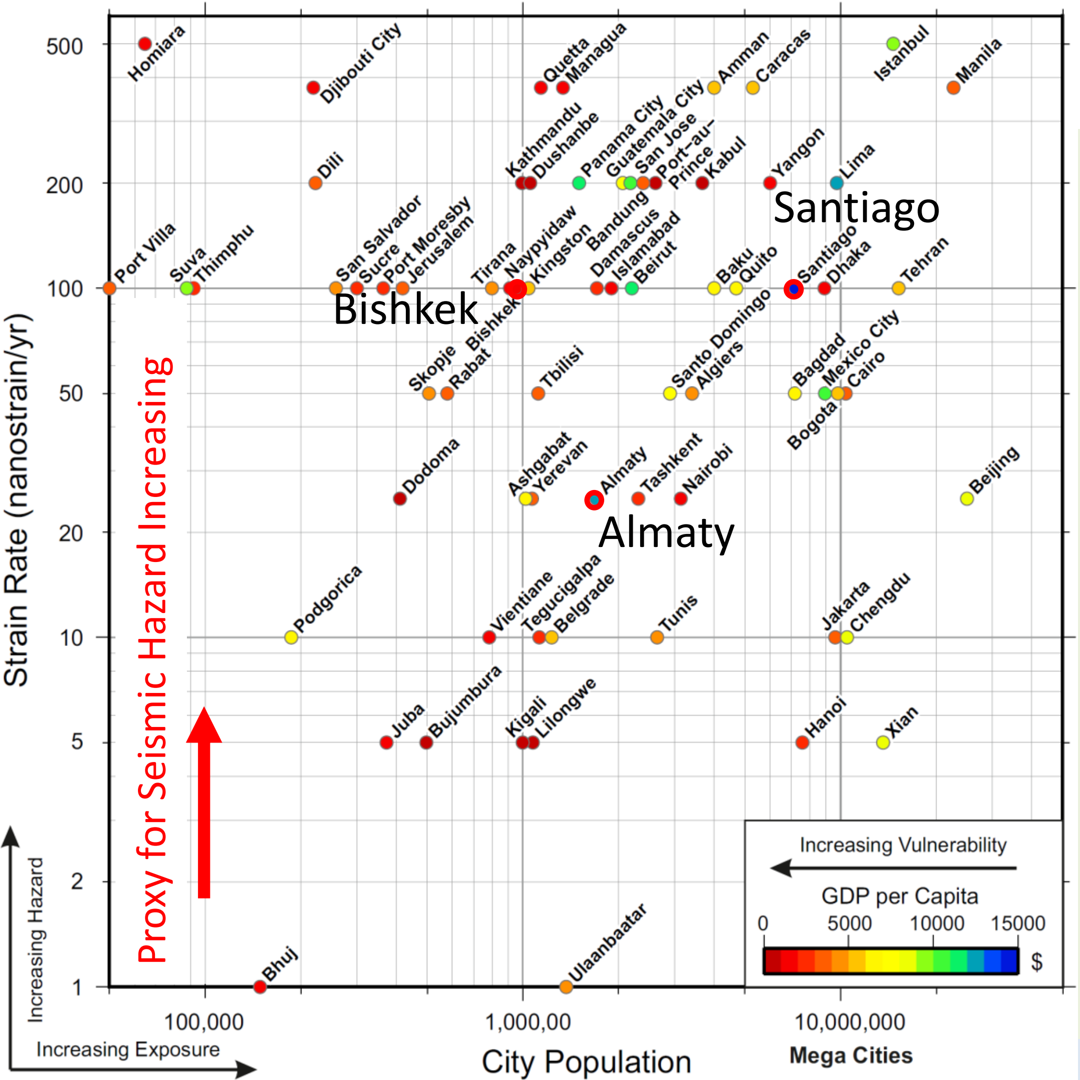
John Elliott, Ruth Amey & Scott Watson

Tomorrow's CITIES Urban Risk in Transition
Seismic Cities
UNIVERSITY OF LEEDS
GCRF Global Challenges Research Fund
GEM GLOBAL EARTHQUAKE MODEL working together to assess risk
cnes CENTRE NATIONAL D'ÉTUDES SPATIALES
THE ROYAL SOCIETY
UKRI Natural Environment Research Council
CEOS The Committee on Earth Observation Satellites
COMET CENTRE FOR OBSERVATION & MODELLING OF EARTHQUAKES, VOLCANOES & TECTONICS

- EO in Disaster Risk Management for earthquakes
- Potential for assessing seismic hazard and improving identification of earthquake risk.




Elliott (2020)



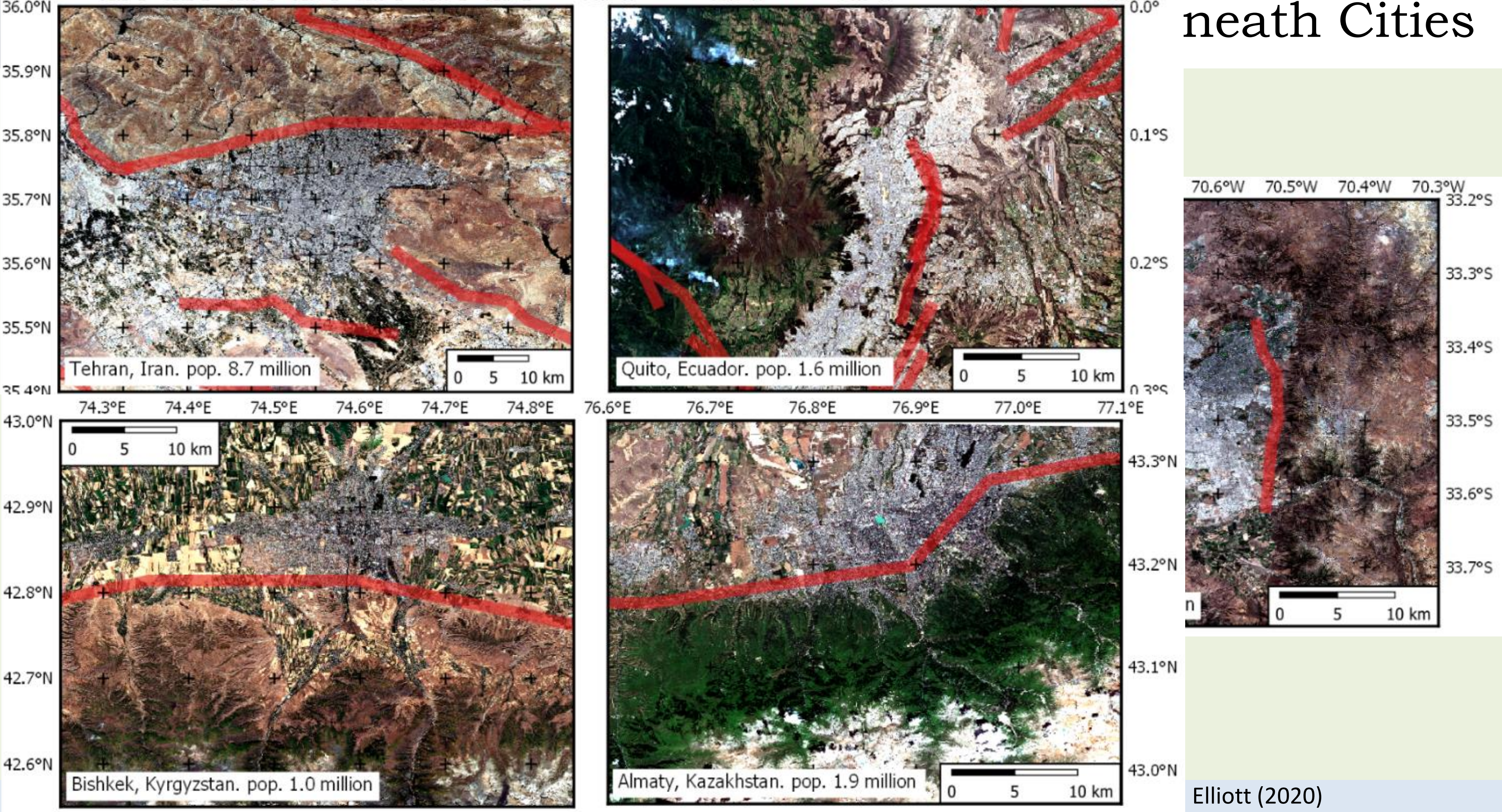

# Exposed Major Cities

- Over 50 capitals of the least developed countries are located on or near a major fault and are at increasing risk from earthquakes.

Santiago: https://nhess.copernicus.org/articles/20/1533/2020/

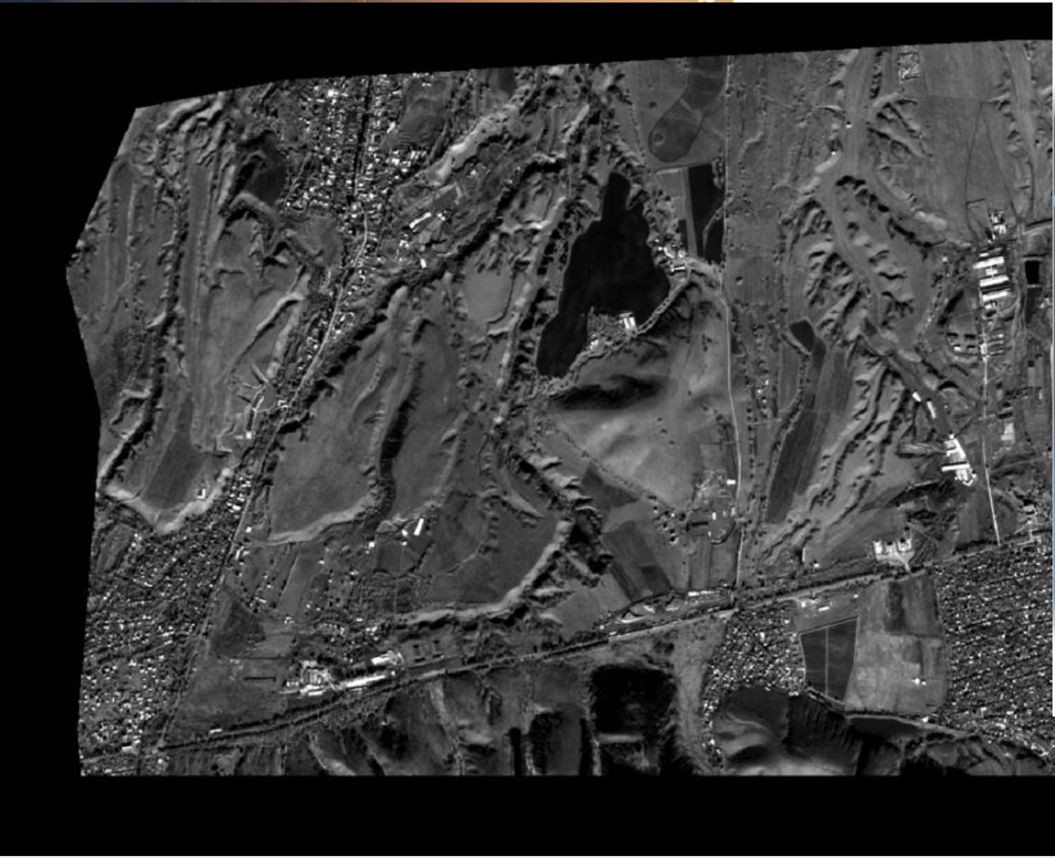
Elliott (2020)

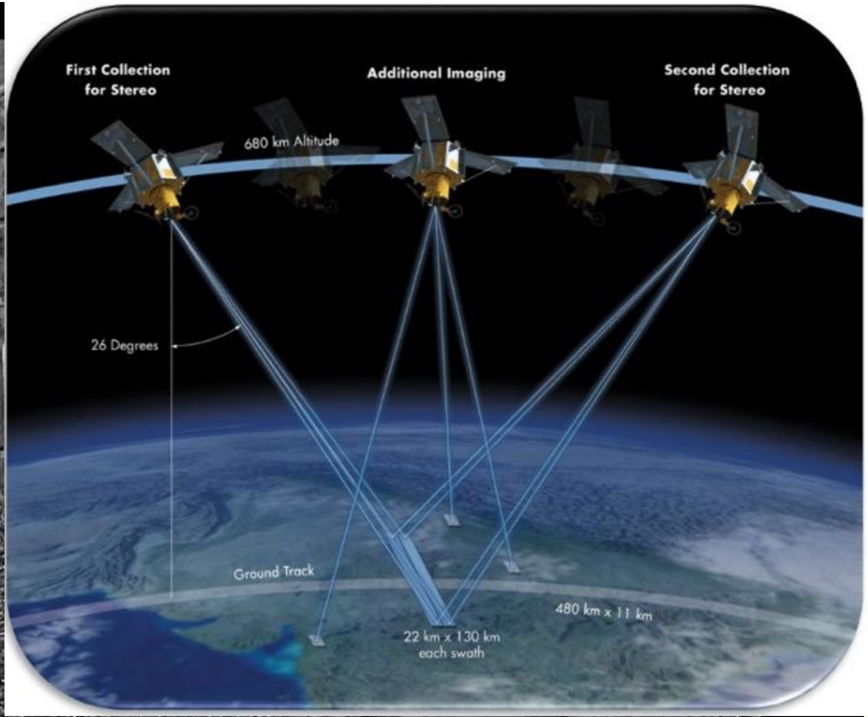
neath Cities




Elliott (2020)

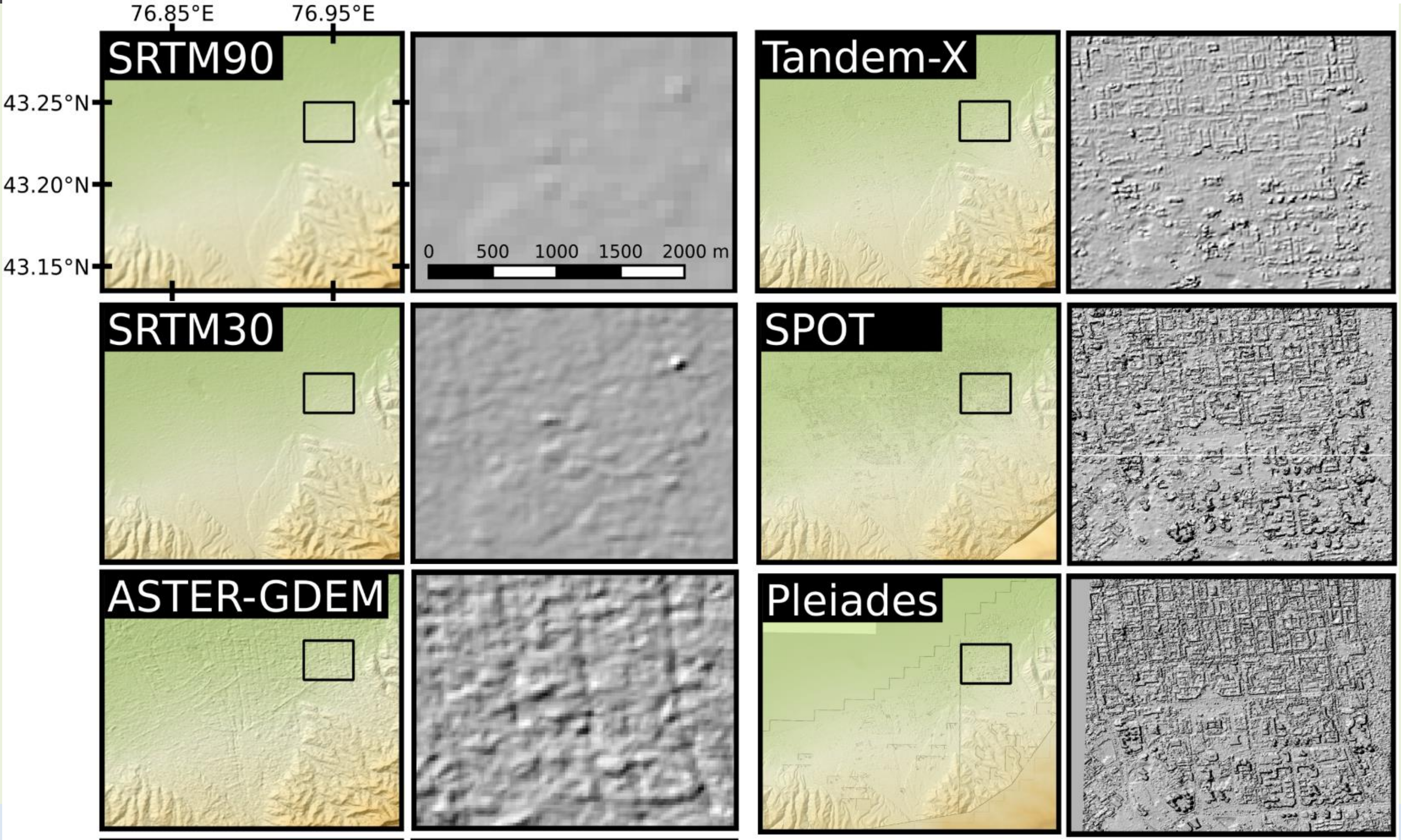
# Pleiades Stereo






10 km

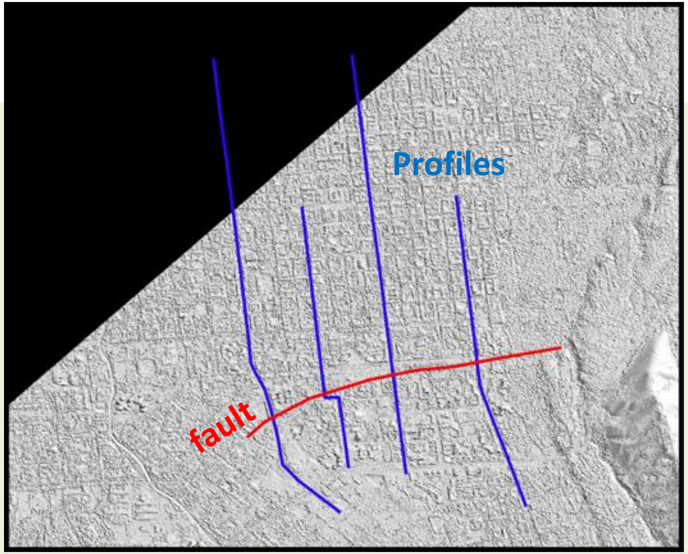
# DEM Comparison

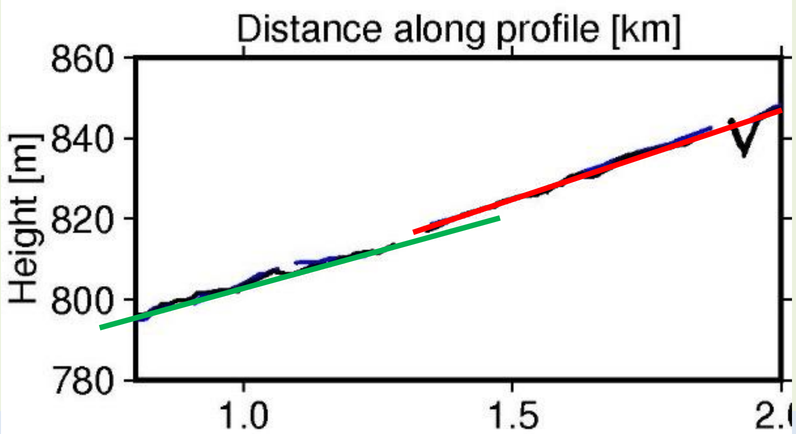



Amey et al. (in prep)

# Fault Splays

- Hidden faults in cities present seismic hazard
- High resolution Pleiades-derived DEMs can identify them

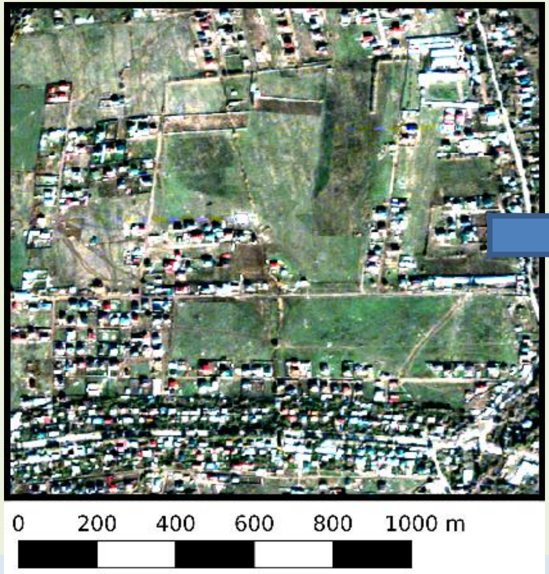


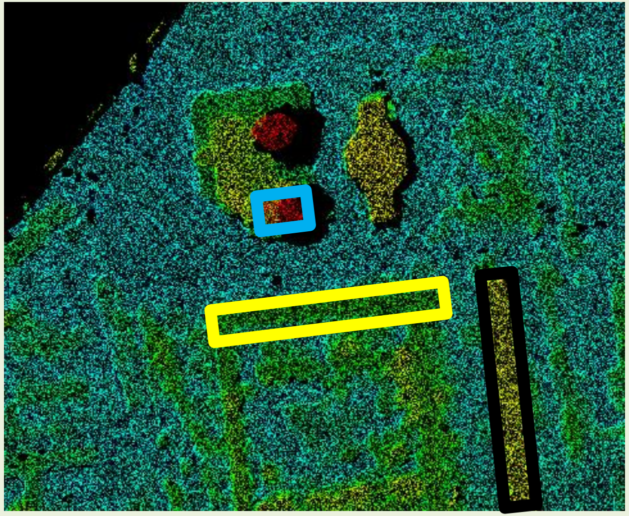
Building information must be recorded and updated

- Calculating building heights
  - Potential to calculate on city-wide basis with satellite data
  - Potential to update as the city expands
  - Better exposure model to use in earthquake modelling

Stereo Optical Images

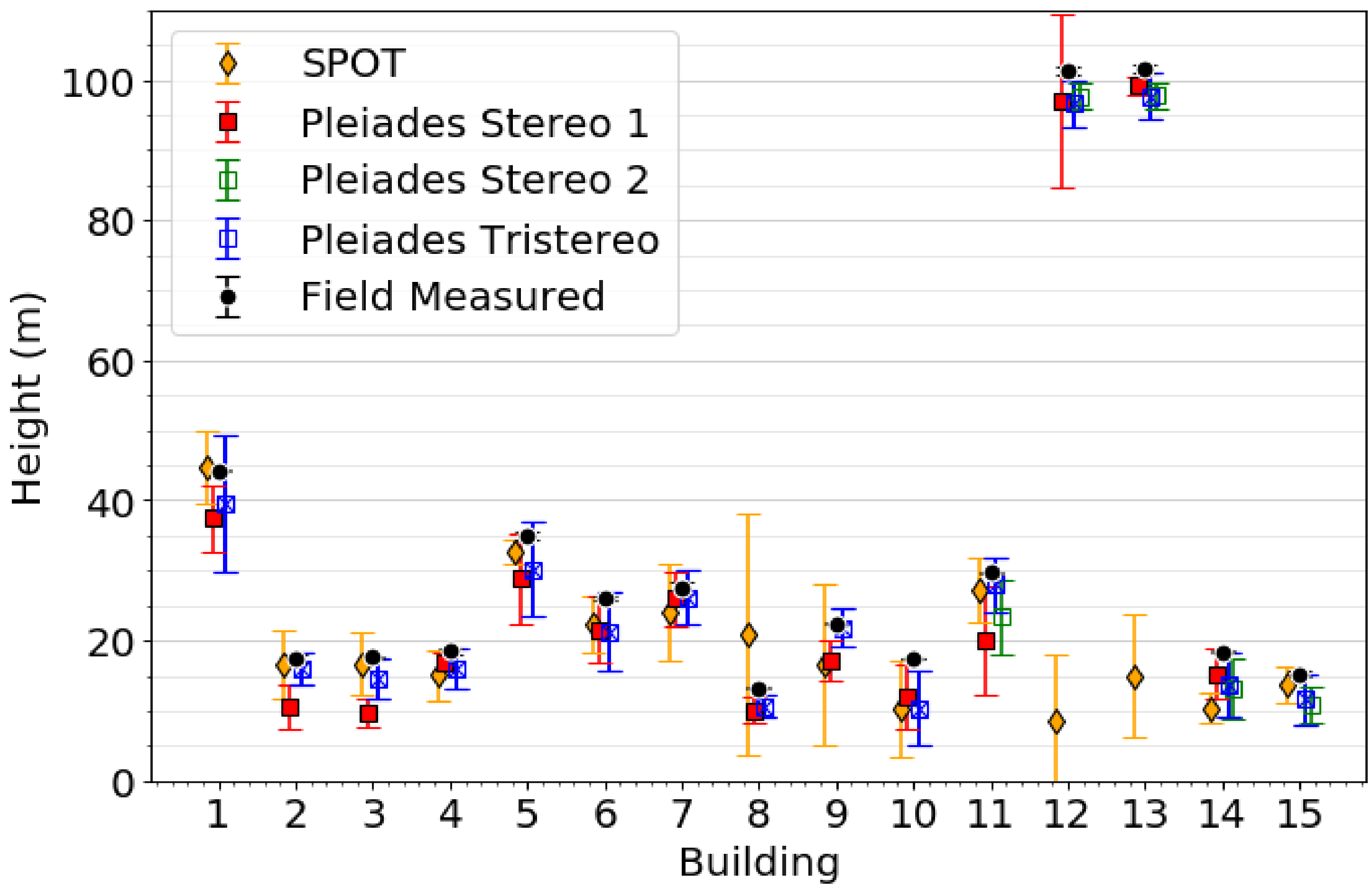



Digital elevation model (DEM)

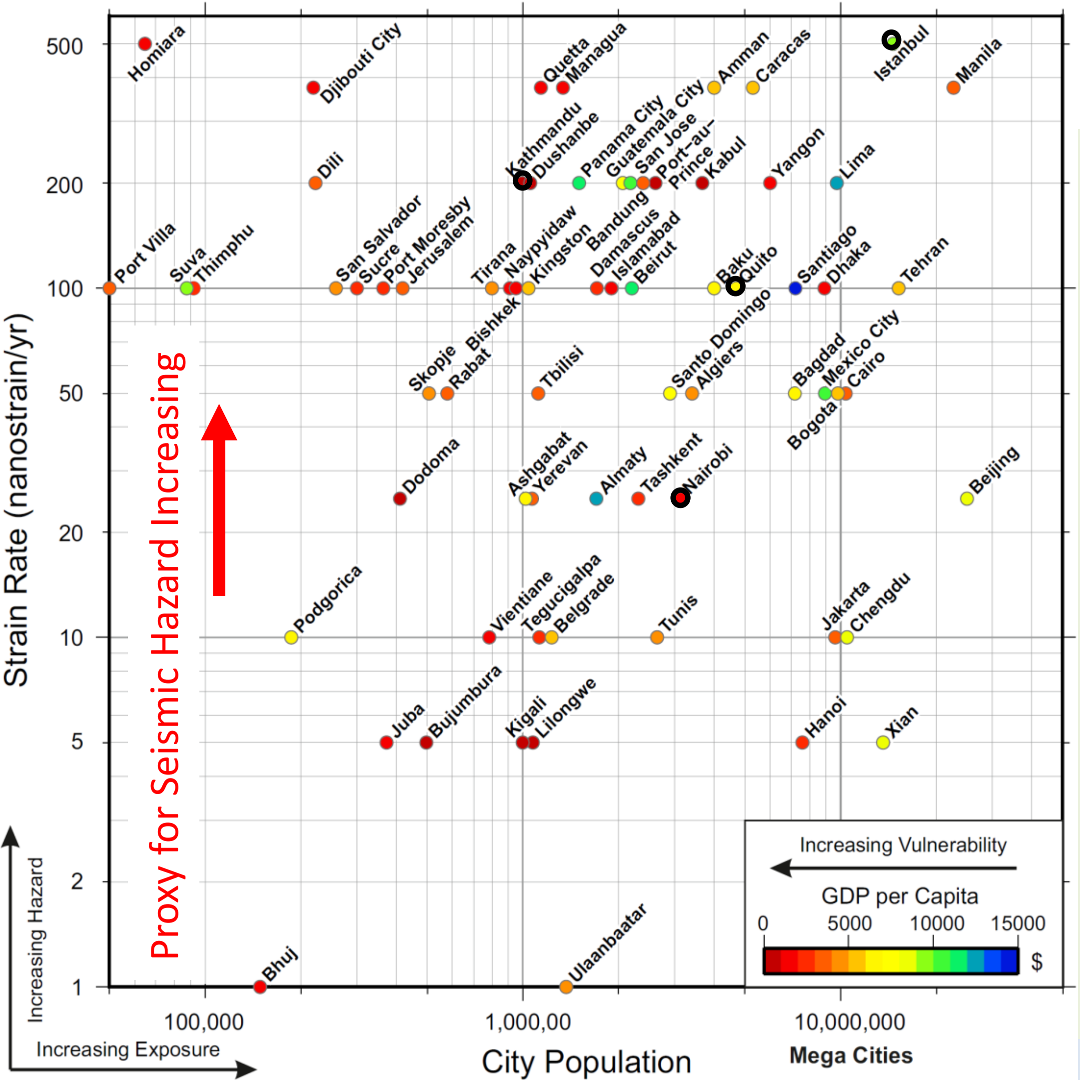


Amey et al. (in prep)

# Building Heights




Amey et al.
(in prep)



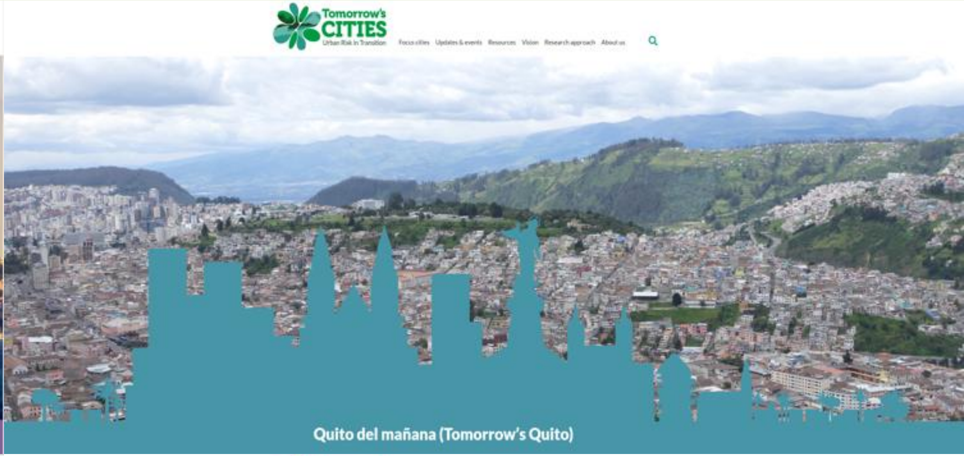

Tomorrow's CITIES
Urban Risk in Transition

- GCRF Hub - Urban Multi-hazards
  - Kathmandu (Nepal)
  - Quito (Ecuador)
  - Istanbul (Turkey)
  - Nairobi (Kenya)

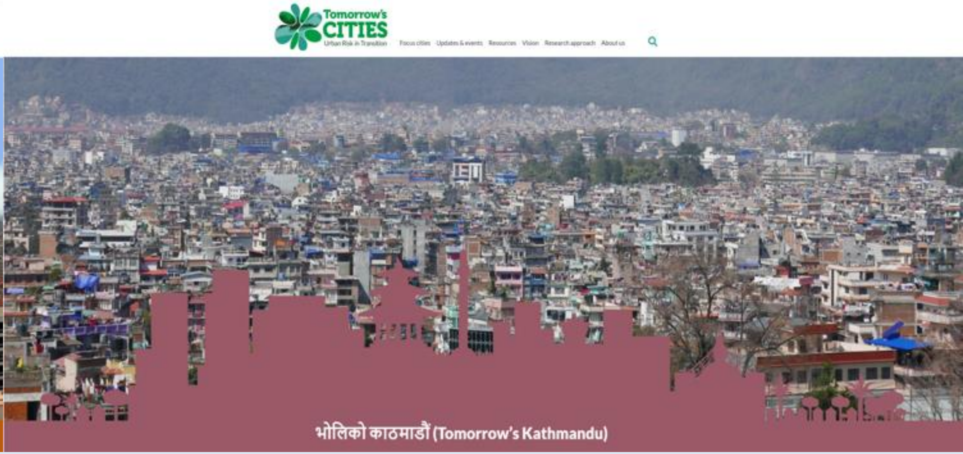
https://www.tomorrowscities.org/

Elliott (2020)

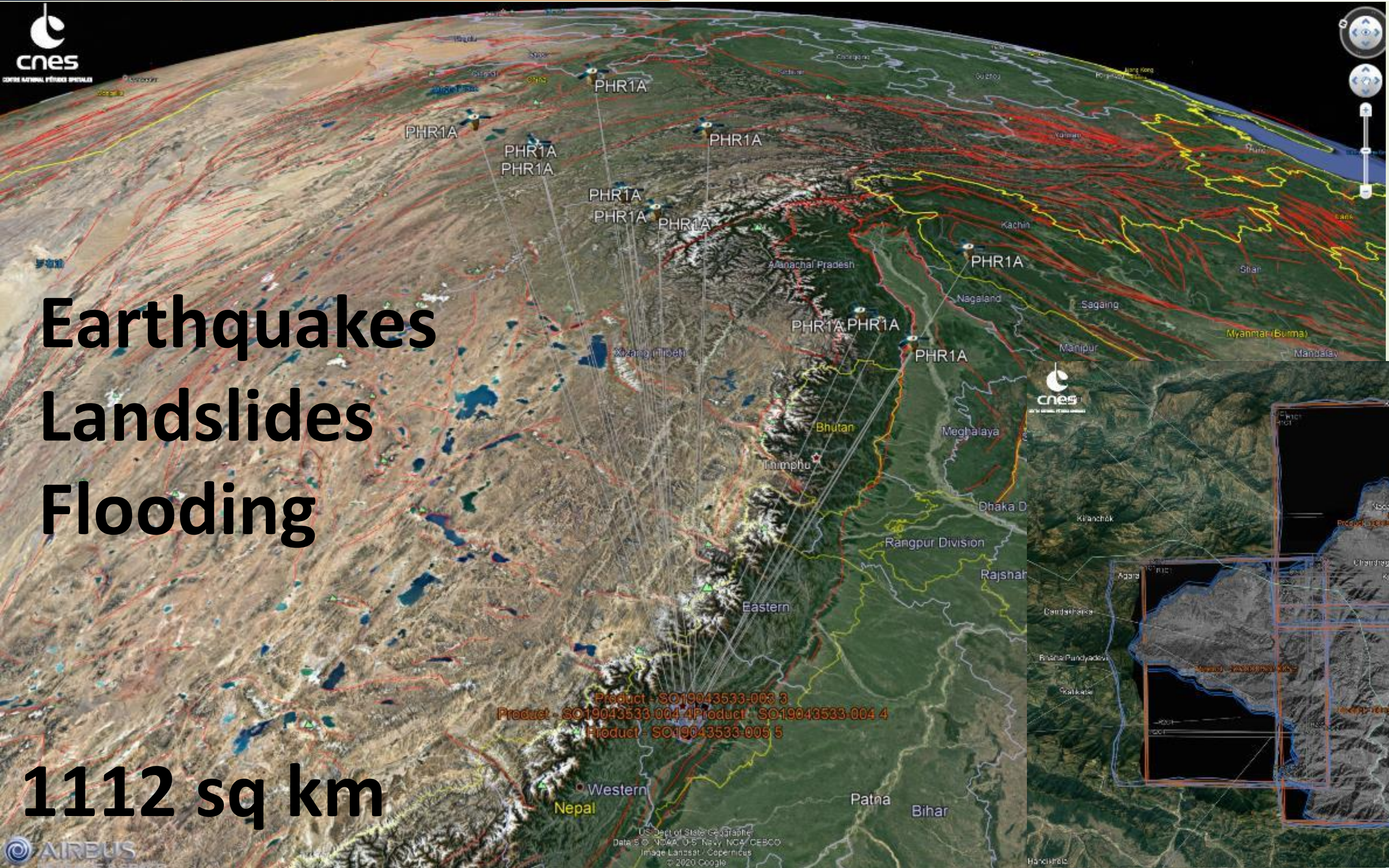

# Tomorrow’s Cities





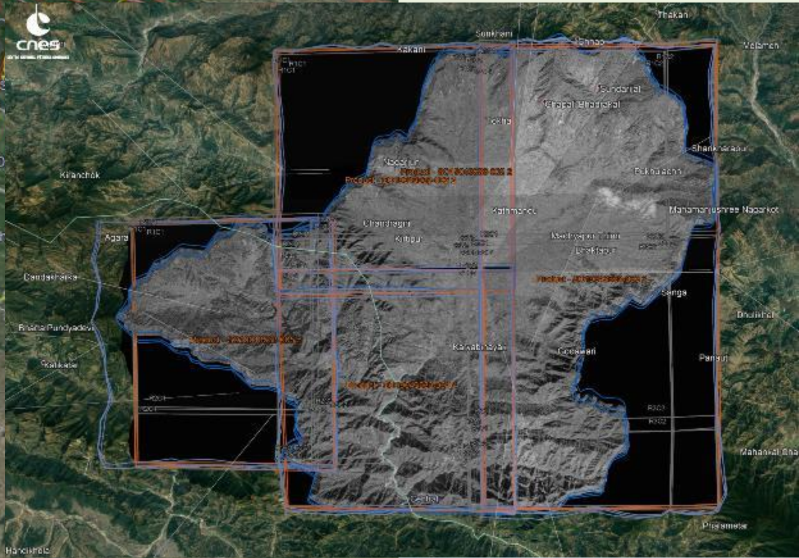

# Kathmandu, Nepal

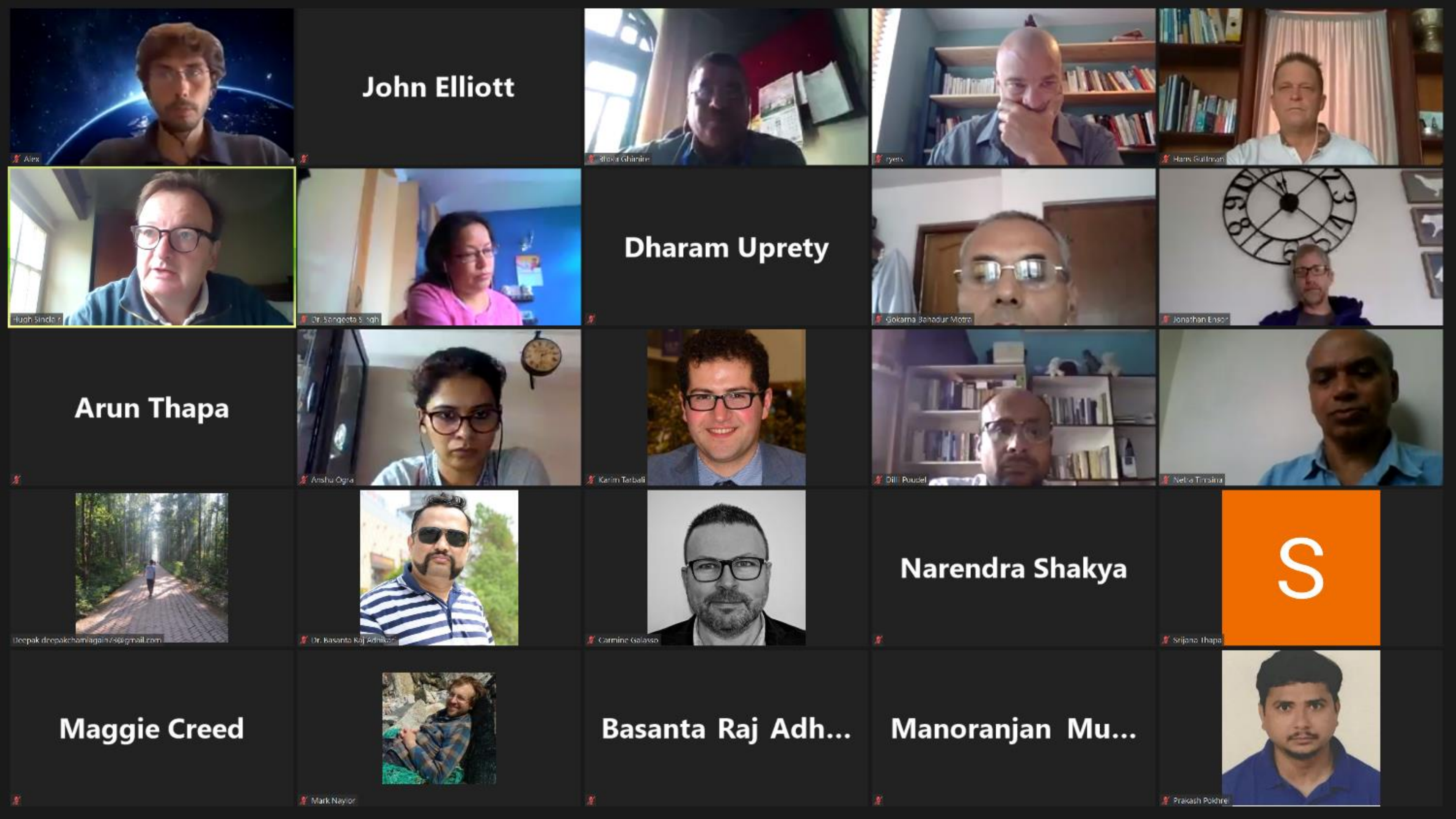


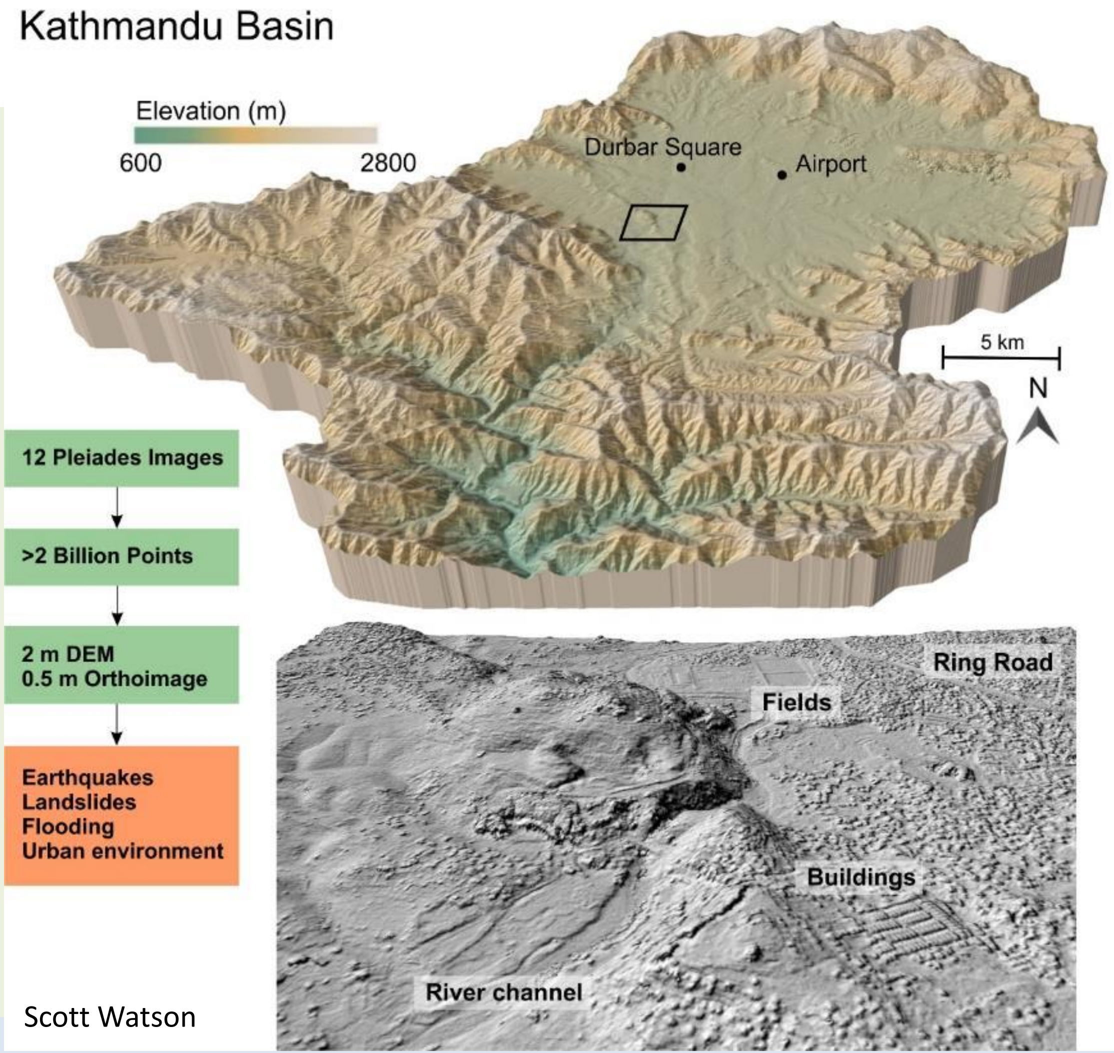

**Earthquakes**
**Landslides**
**Flooding**

**1112 sq km**

- Acquired: Oct 2019, Dec 2019 & January 2020

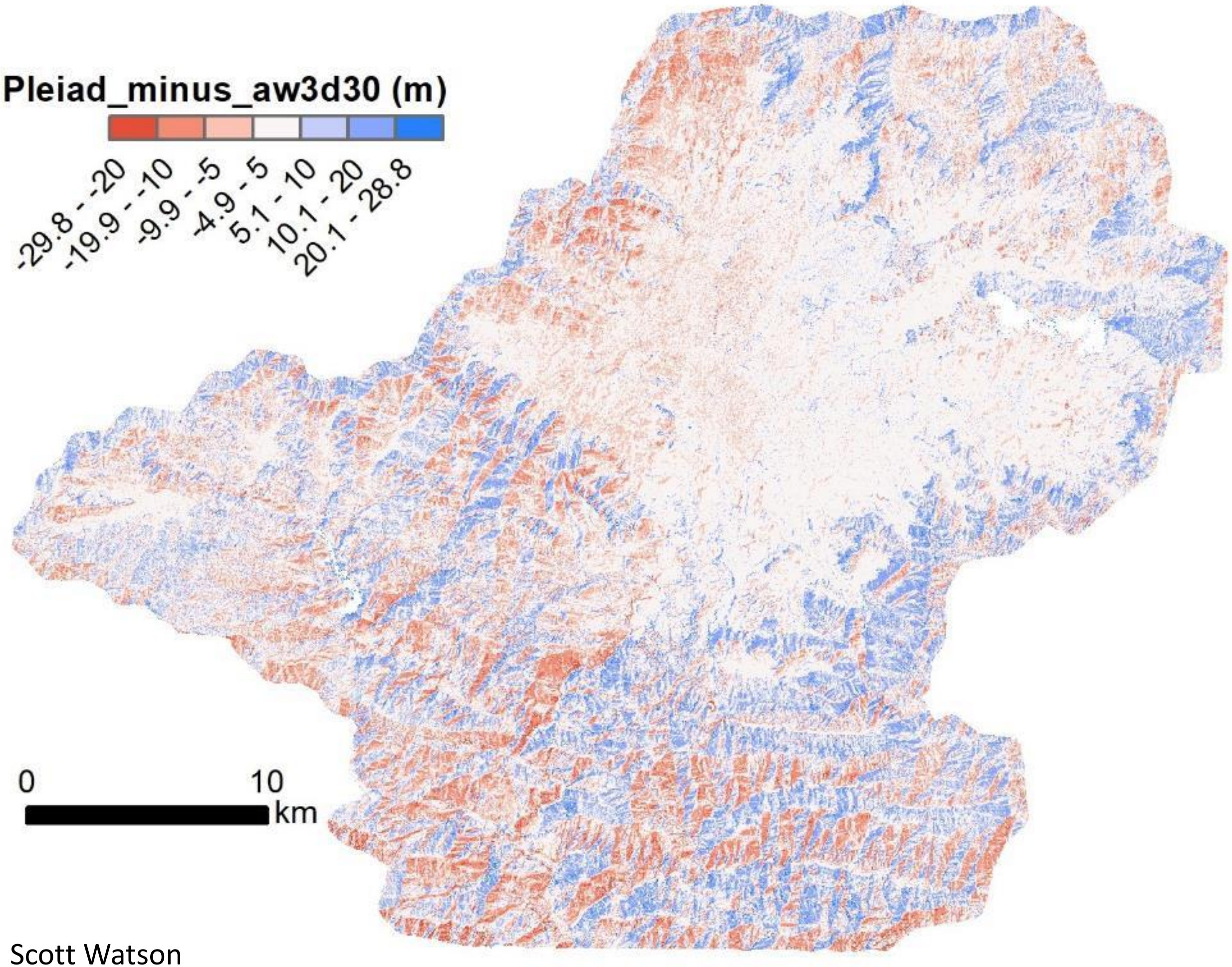



Alex
John Elliott
Dharam Uprety
Arun Thapa
Anshu Ogra
Karim Tarbali
Dilli Poudel
Netra Timsina
Carmine Galasso
Narendra Shakya
S
Srijana Thapa
Maggie Creed
Mark Naylor
Basanta Raj Adh...
Manoranjan Mu...

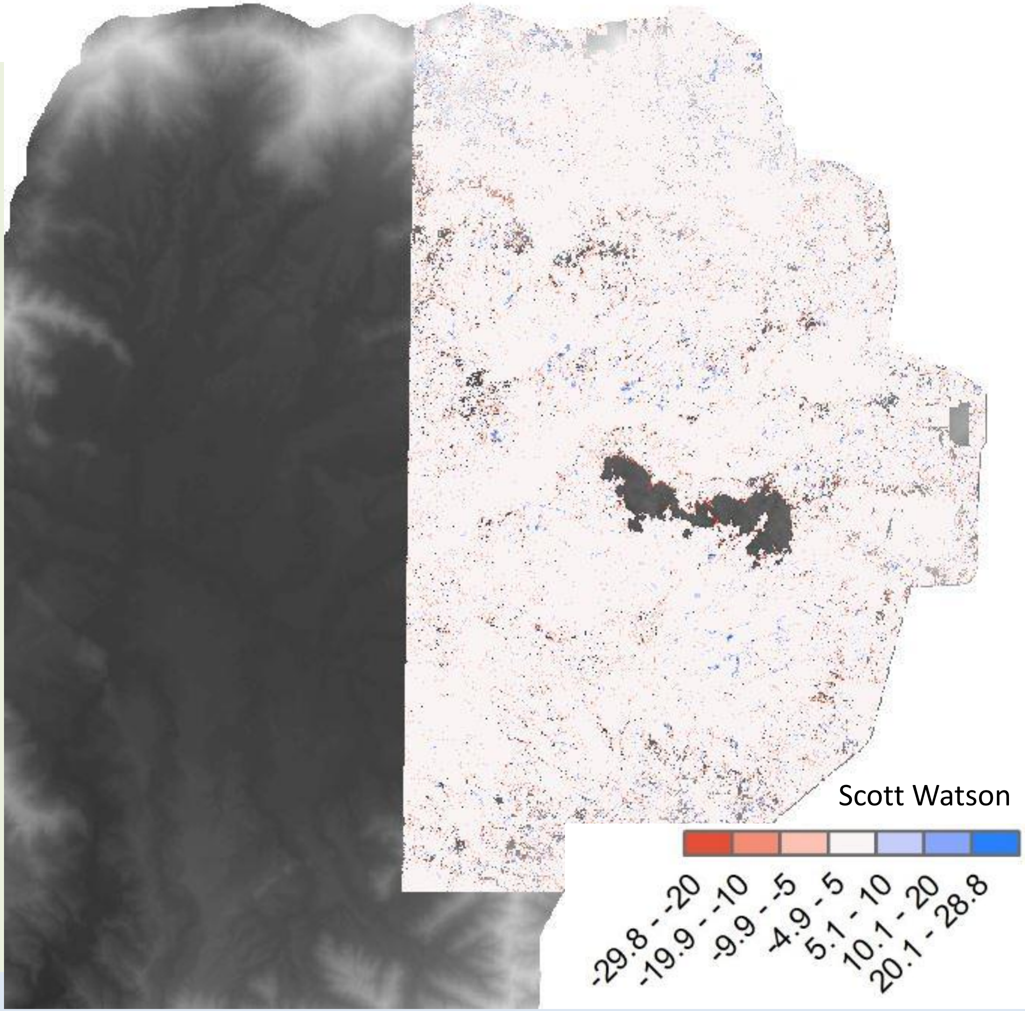

Scott Watson

Pleiades minus AW3D30 after coregistration. Standard deviation of difference ~8 m but looks to be an apparent offset, due to earthquake topography change?

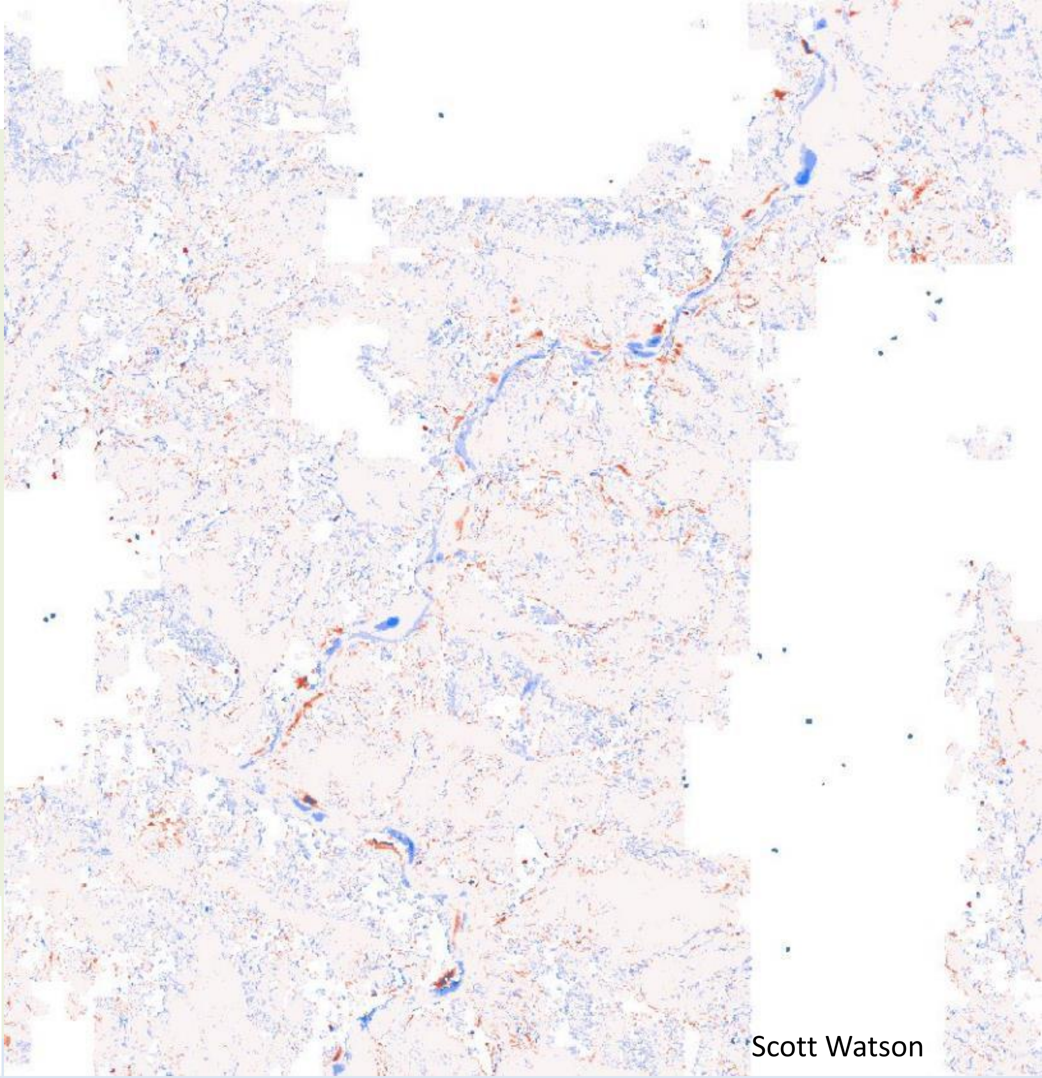


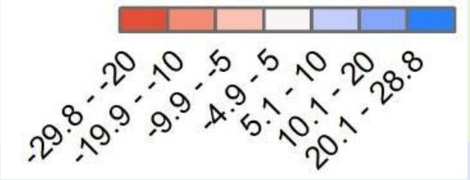

Scott Watson

Pleiades minus High Mountain Asia DEM (12/12/2015) after coregistration. Standard deviation of difference ~3 m. Much improved compared to AW3D30 comparison.



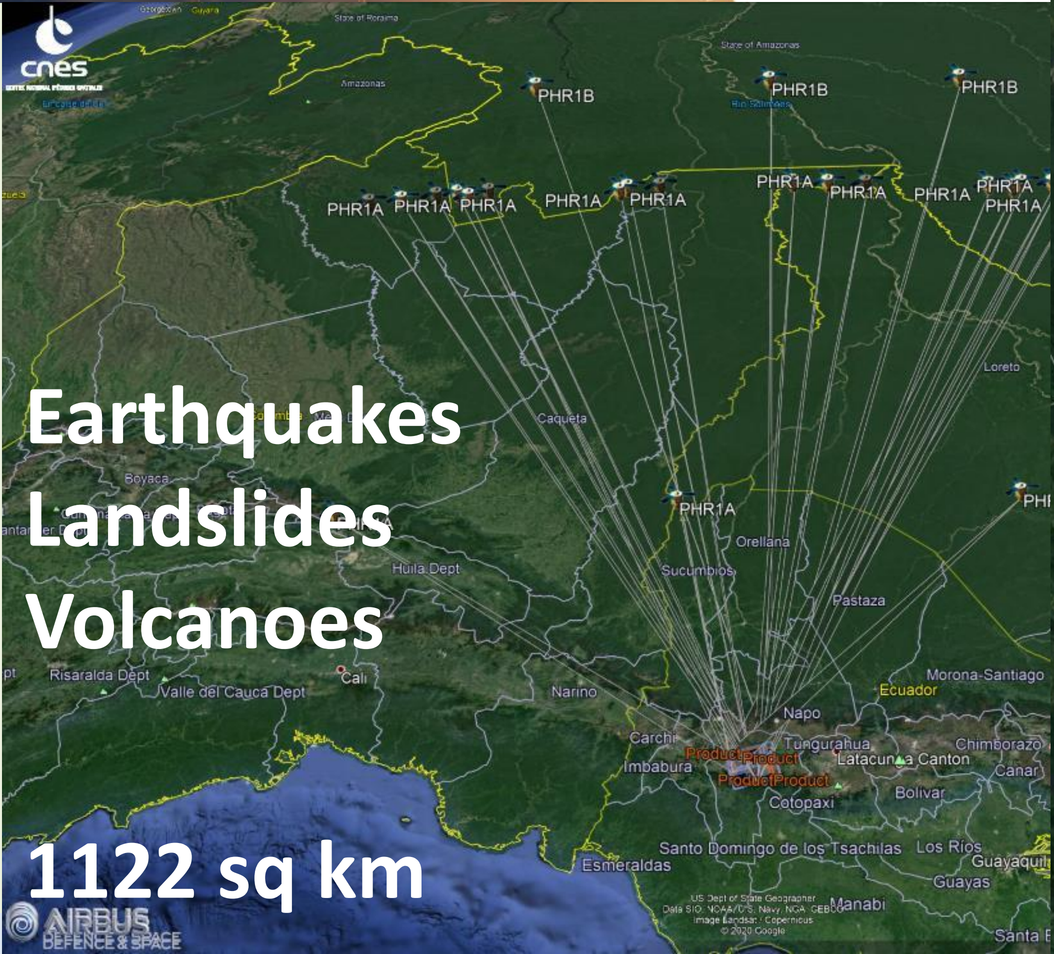
Pleiades minus **High Mountain Asia DEM** Shows elevation change associated with a river channel (2016 to 2020). Monsoon flooding is key element of KTM team analysis for Tomorrow's cities.





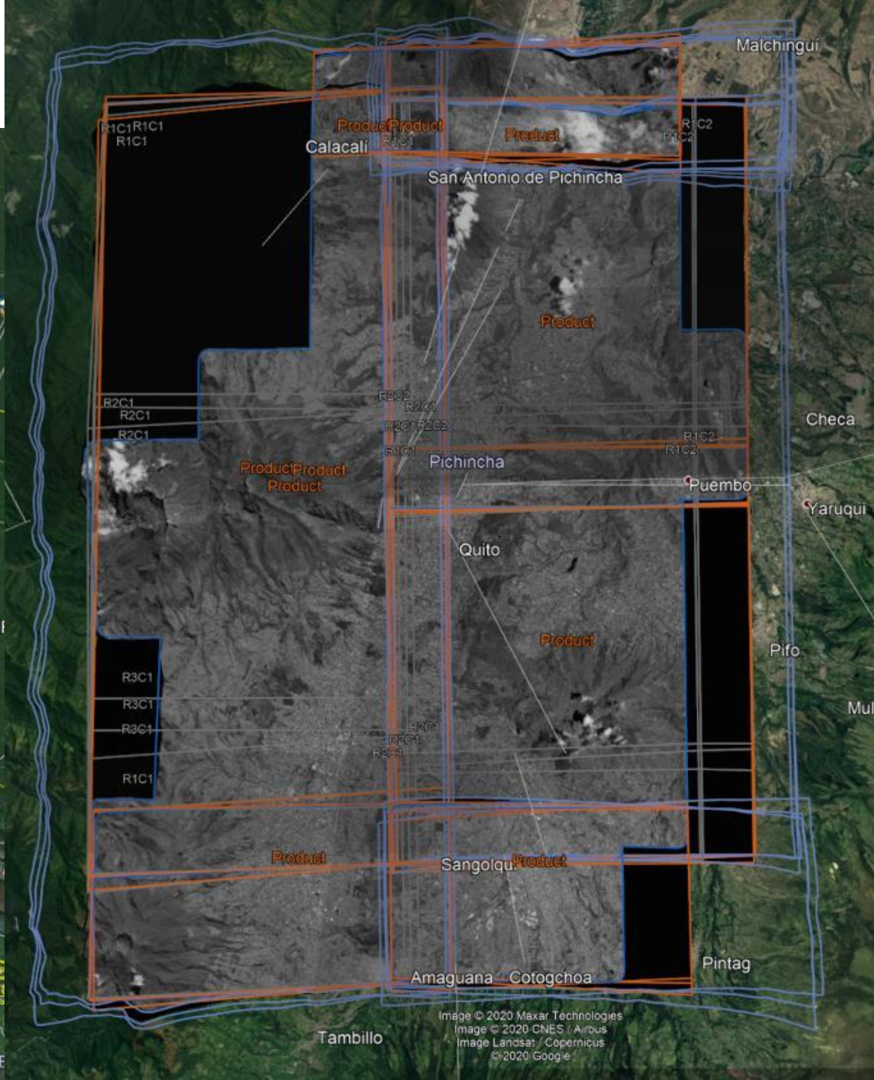

Scott Watson

# Quito, Ecuador

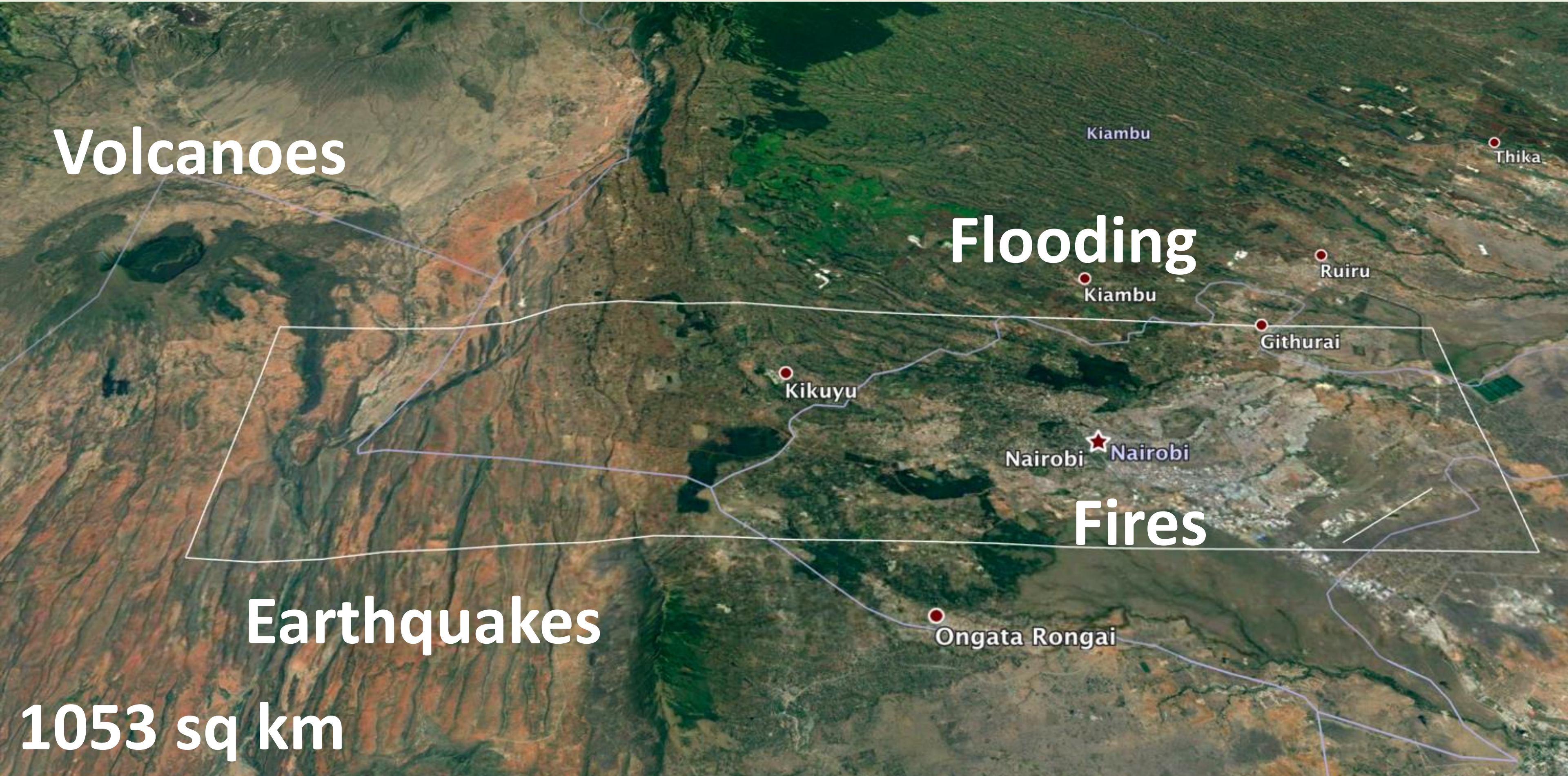



**Earthquakes**
**Landslides**
**Volcanoes**

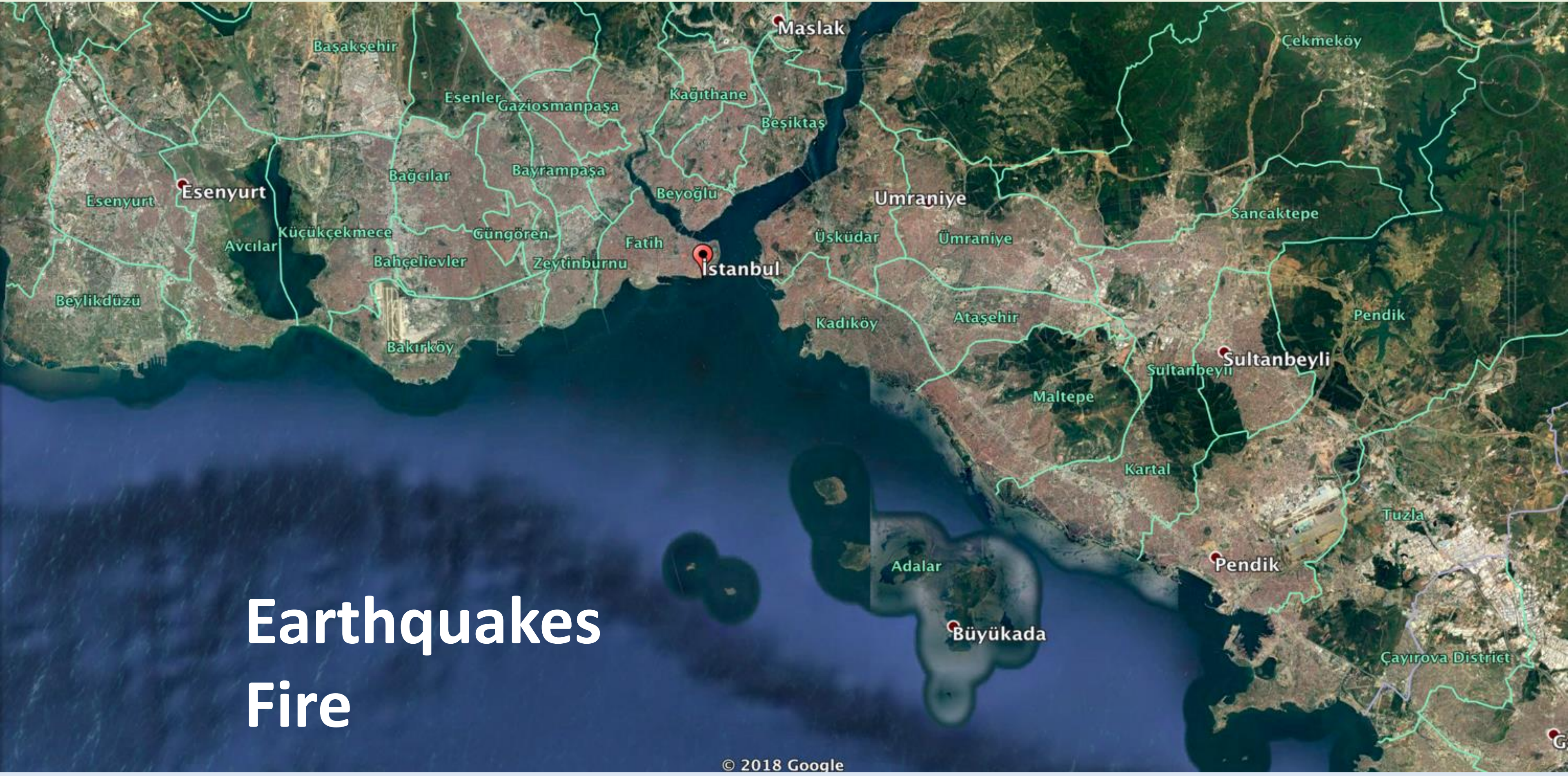
**1122 sq km**



# Nairobi, Kenya

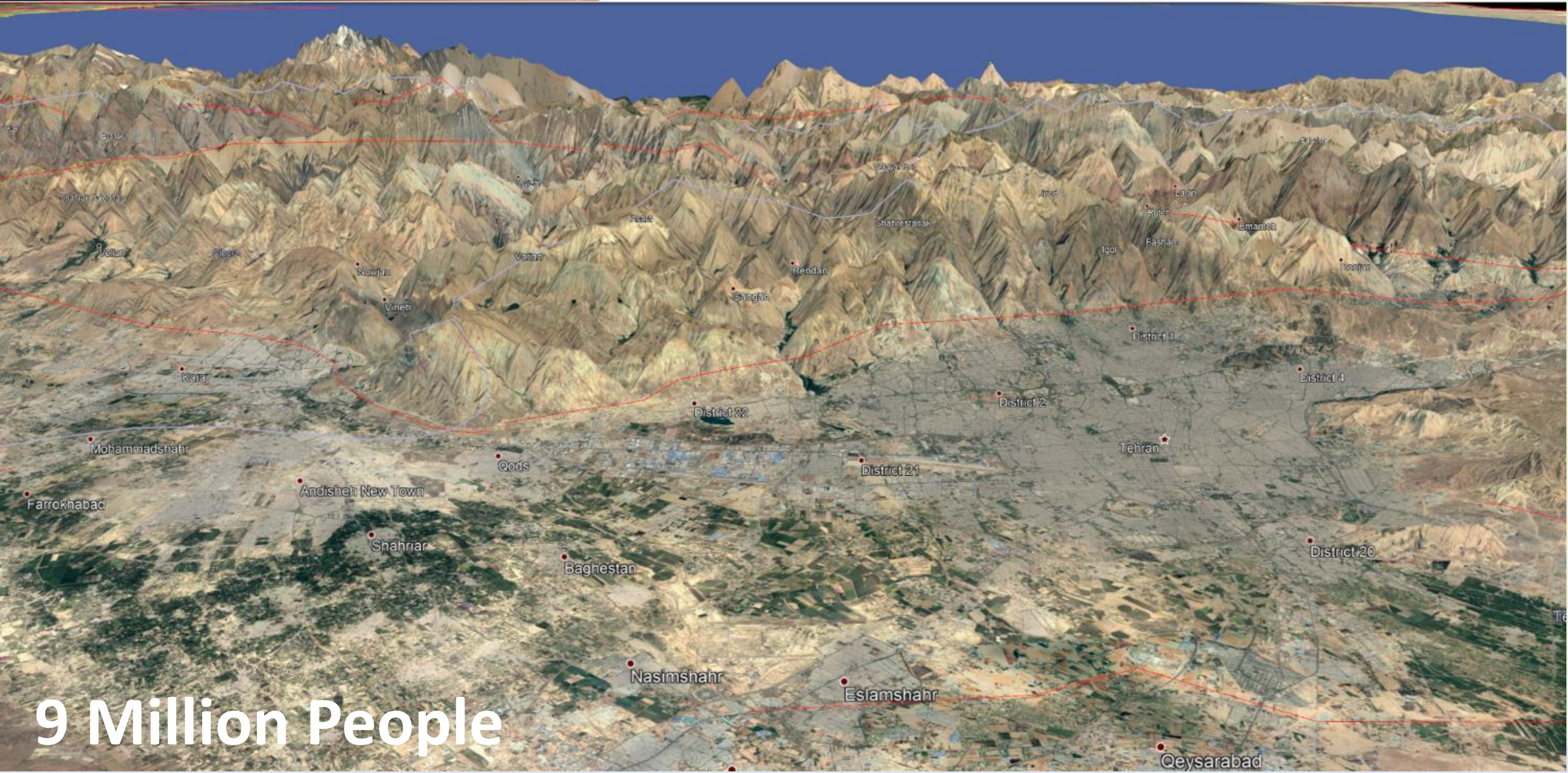



# Istanbul, Turkey



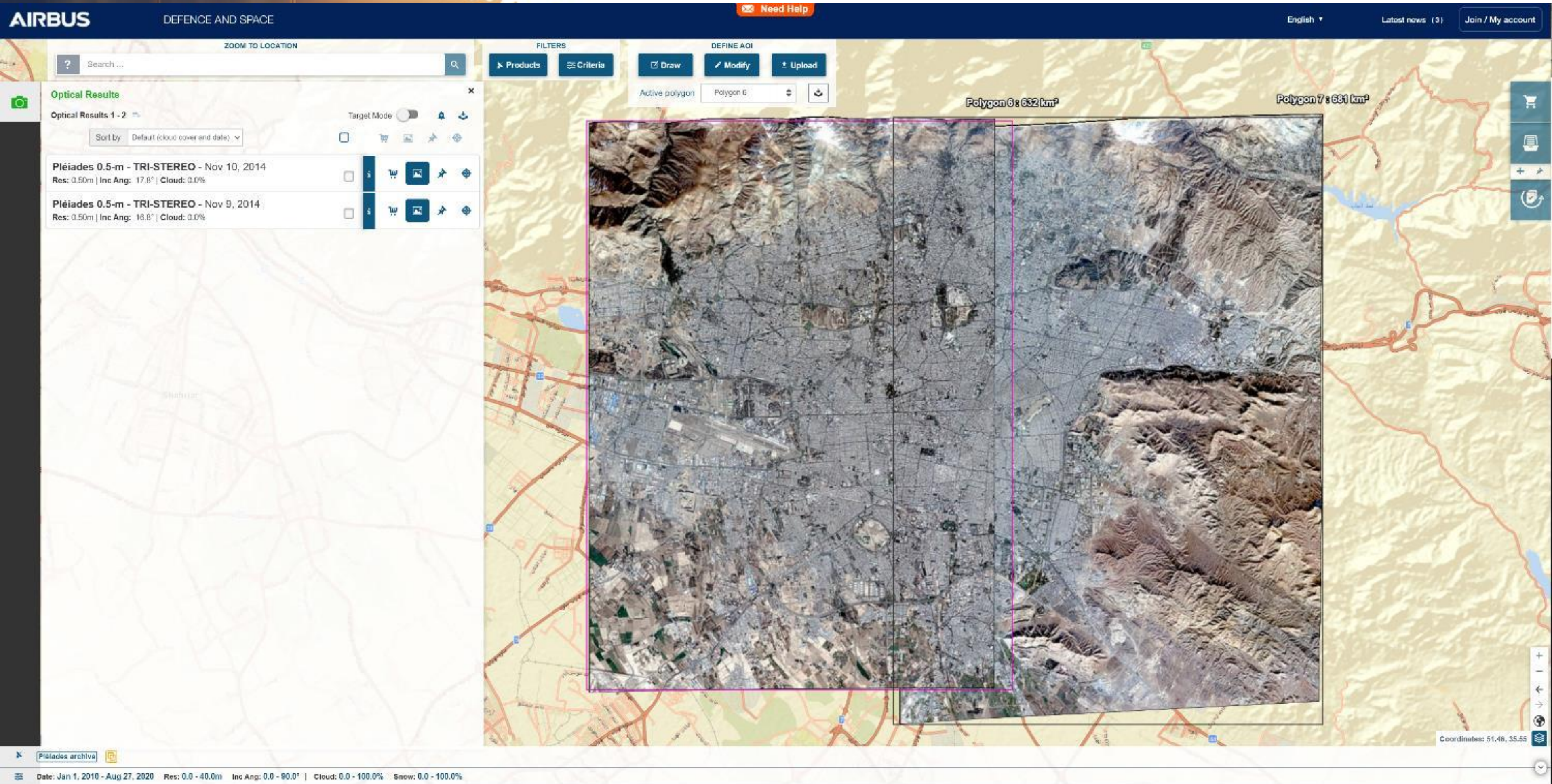

**Earthquakes**
**Fire**

# Next City - Tehran




**9 Million People**


# Archive Data



# Turkey Earthquake

24th January 2020
Magnitude 6.7 earthquake
Eastern Turkey

Request for Pleiades taking over Fault Rupture Zone and also over city of Elazig

No acquisitions have yet been made in the intervening 7 months.

Surveys in Geophysics
https://doi.org/10.1007/s10712-020-09606-4

# Earth Observation for the Assessment of Earthquake Hazard, Risk and Disaster Management

J. R. Elliott[1]

Received: 6 December 2019 / Accepted: 23 July 2020


**Abstract**
Earthquakes pose a significant hazard, and due to the growth of vulnerable, exposed populations, global levels of seismic risk are increasing. In the past three decades, a dramatic improvement in the volume, quality and consistency of satellite observations of solid earth processes has occurred. I review the current Earth Observing (EO) systems commonly used for measuring earthquake and crustal deformation that can help constrain the potential sources of seismic hazard. I examine the various current contributions and future potential for EO data to feed into aspects of the earthquake disaster management cycle. I discuss the implications that systematic assimilation of Earth Observation data has for the future assessment of seismic hazard and secondary hazards, and the contributions it will make to earthquake disaster risk reduction. I focus on the recent applications of Global Navigation Satellite System (GNSS) and increasingly the use of Interferometric Synthetic Aperture Radar (InSAR) for the derivation of crustal deformation and these data's contribution to estimates of hazard. I finish by examining the outlook for EO in geohazards in both science and decision-making, as well as offering some recommendations for an enhanced acquisition strategy for SAR data.

**Keywords** Earth Observation · Earthquakes · Seismic hazard · Disaster risk reduction · InSAR · Crustal strain

**Abbreviations**

| | |
|---|---|
| ASI | Agenzia Spaziale Italiana |
| ASTER | Advanced Spaceborne Thermal Emission and Reflection Radiometer |
| ALOS-PALSAR | Advanced Land Observing Satellite Phased Array type L-band Synthetic Aperture Radar |
| AW3D | Advance World 3-Dimensional |
| BIROS | Bi-spectral InfraRed Optical System |
| CNES | Centre National d'Études Spatiales |
| COMET | Centre for the Observation and Modelling of Earthquakes, Volcanoes and Tectonics |
| CONAE | Comisión Nacional de Actividades Espaciales |

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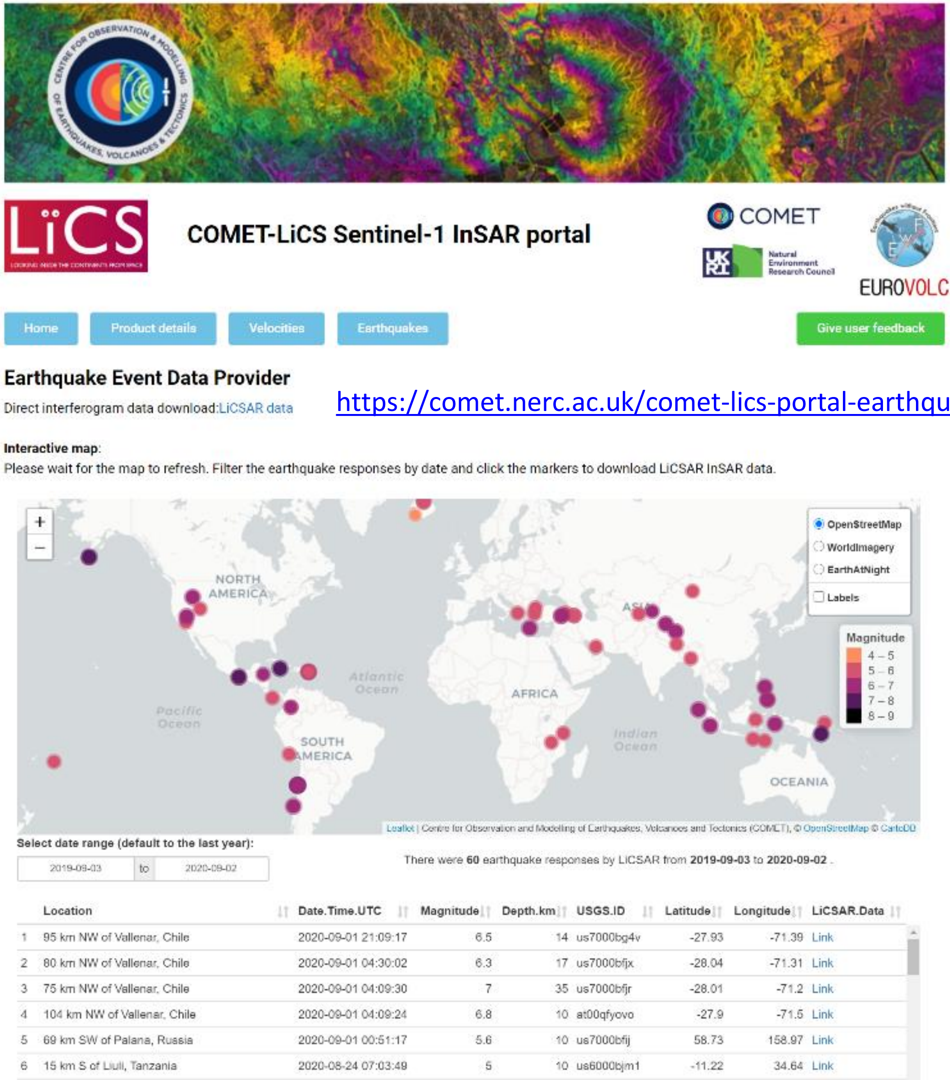


https://comet.nerc.ac.uk/comet-lics-portal-earthquake-event/