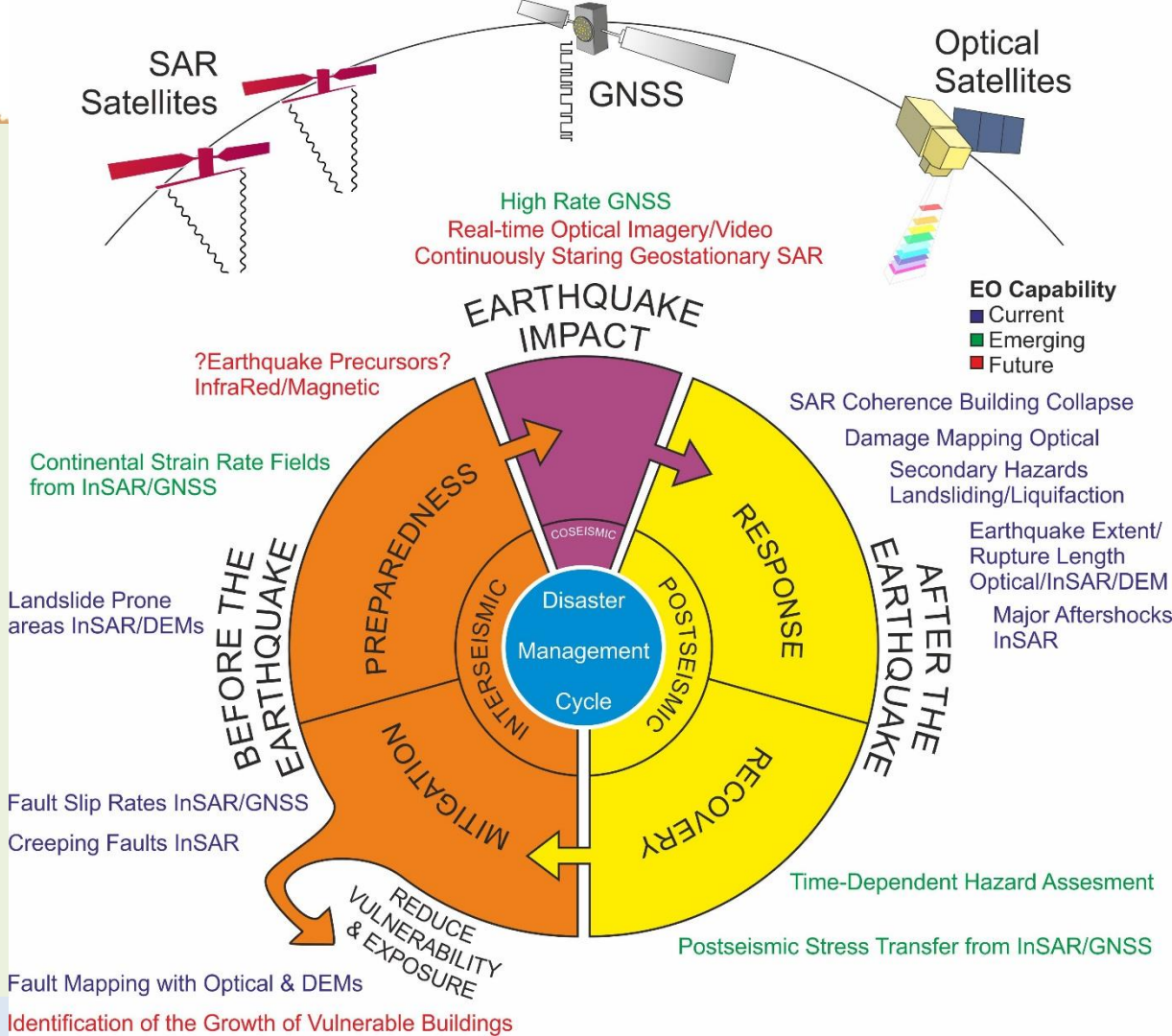
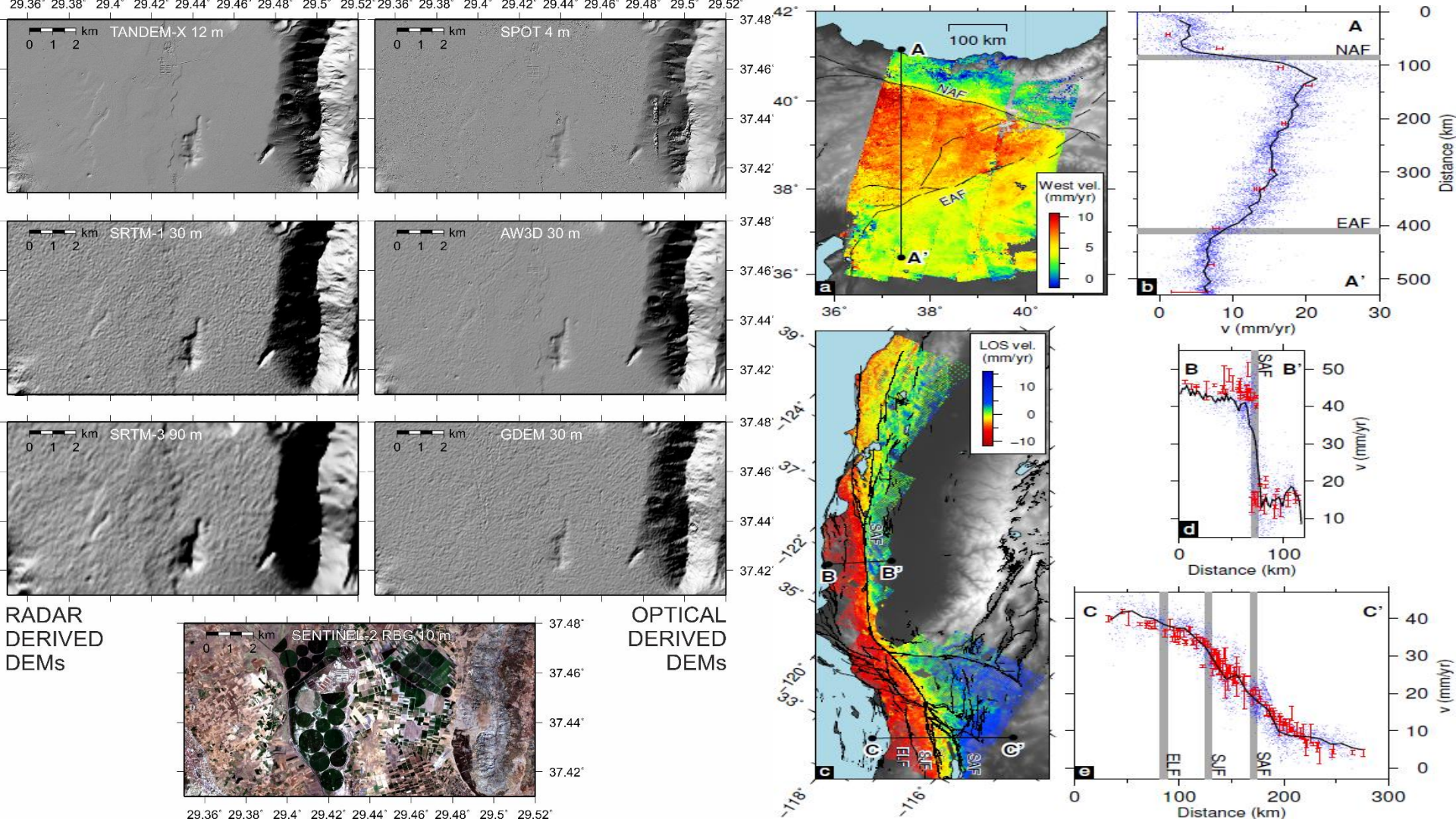
# Seismic Risk from Near-field Active Faults around Expanding Cities in Economically Developing Countries

John Elliott, Ruth Amey, Ekbal Hussain

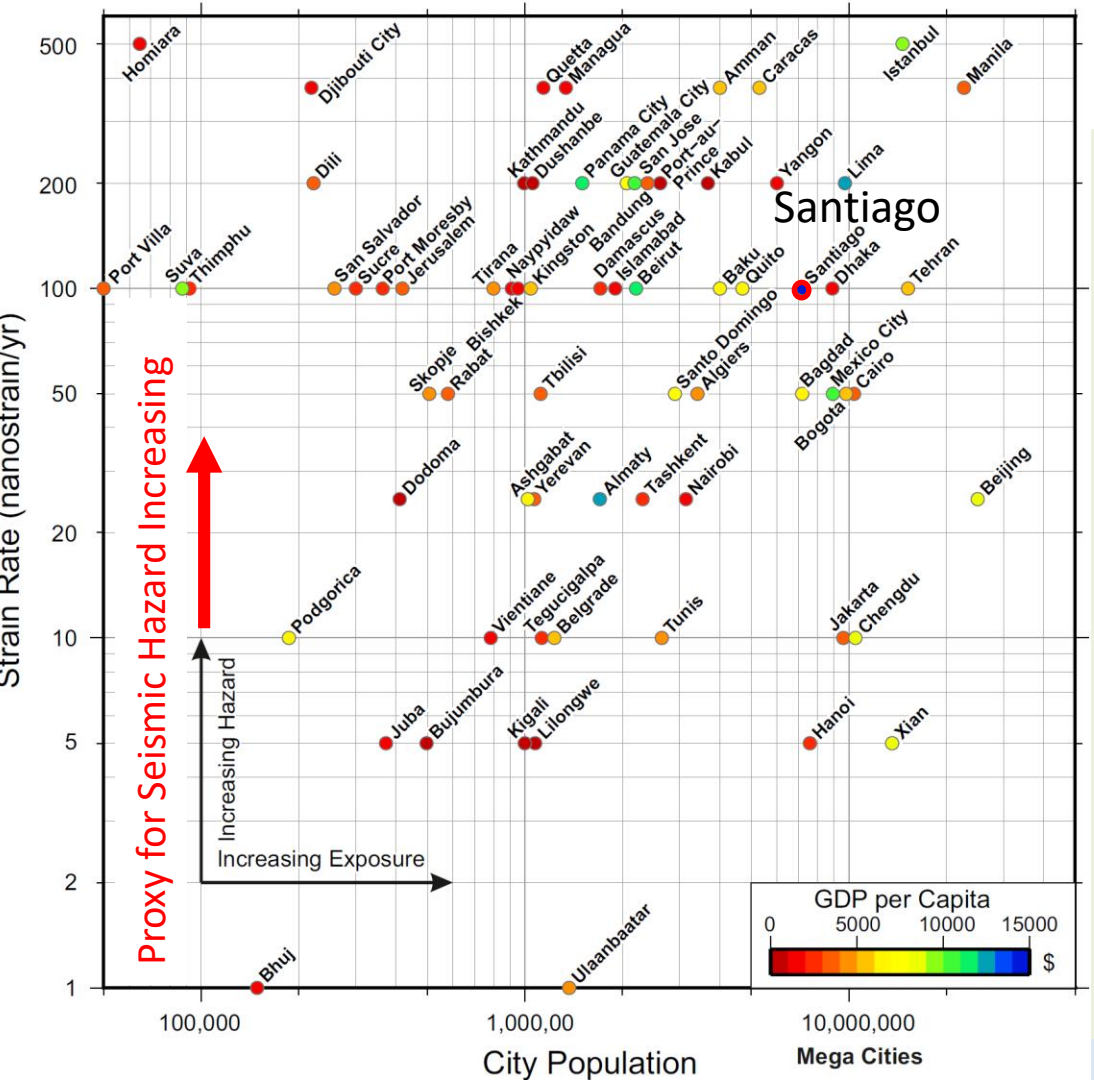
https://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2019-30/

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




TANDEM-X 12 m
SPOT 4 m
SRTM-1 30 m
AW3D 30 m
SRTM-3 90 m
GDEM 30 m
SENTINEL-2 RBG 10 m
km
0 1 2
RADAR DERIVED DEMs
OPTICAL DERIVED DEMs
29.36° 29.38° 29.4° 29.42° 29.44° 29.46° 29.48° 29.5° 29.52°
37.48° 37.46° 37.44° 37.42°
100 km
A
A'
NAF
EAF
West vel. (mm/yr)
10
5
0
a
b
Distance (km)
v (mm/yr)
36° 38° 40°
42° 40° 38° 36°
LOS vel. (mm/yr)
10
0
−10
B
B'
SAF
c
d
C
C'
ELF
SJF
e
Distance (km)
v (mm/yr)
39° 37° 35° 33°
−124° −122° −120° −118° −116°

# 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.

# Seismic Cities

- Increase resilience of cities to seismic shocks to address the *global sustainable cities & communities challenge* in regions prone to earthquake hazard

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DISASTER RISK REDUCTION

Experiences and perceptions of natural hazards among international migrants living in Valparaiso, Chile

M. Bernales[a,b,*], P. Repetto[b,c], A. McIntyre[a], A. Vasquez[d], J. Drury[e], G.B. Sullivan[f], J. Castañeda[b]

Check for updates

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co-working and

il, the Singapore
Development Fund).

chological analysis of
ngs and the 2010

upport among other

cities. She utilises
istory of earthquake
quake prone regions.

arch.

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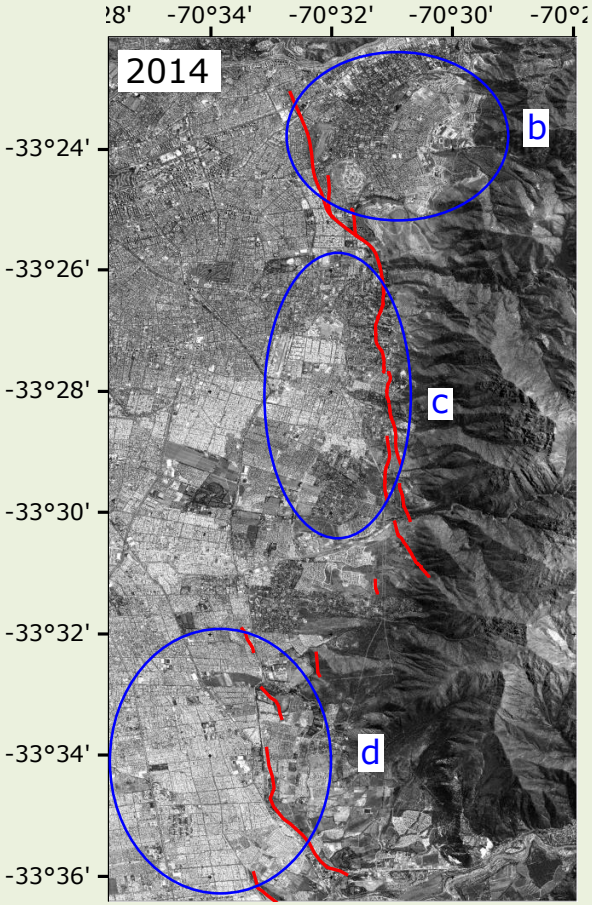
e being evaluated in
he creation of a

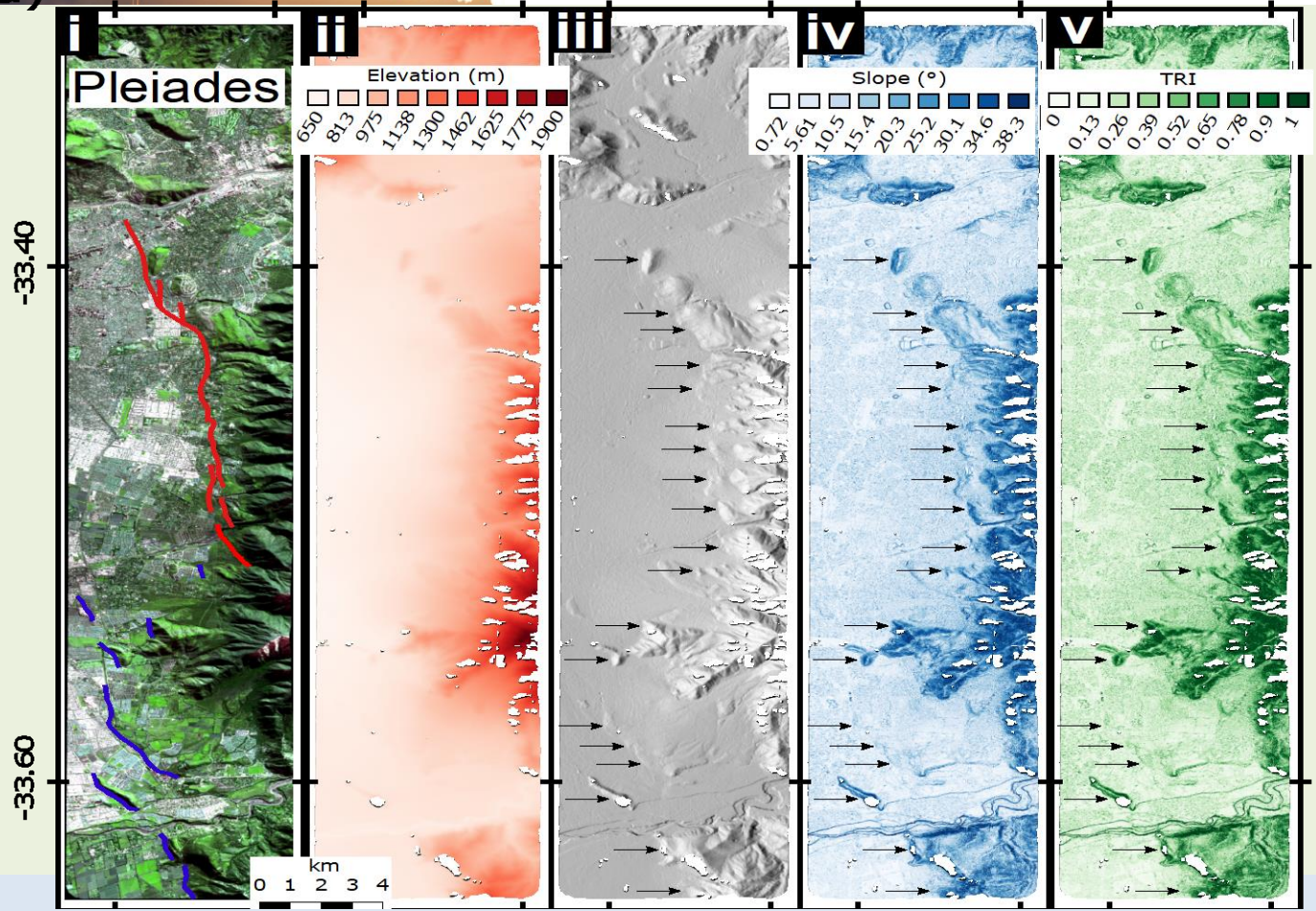
# Santiago Introduction

- Increasing population in cities on top of faults
- Examine relative effect of known distant hazard relative to lesser known nearby faults
- Seismic risk calculations taking a scenario approach applied to Santiago, Chile
- Identify particularly vulnerable districts

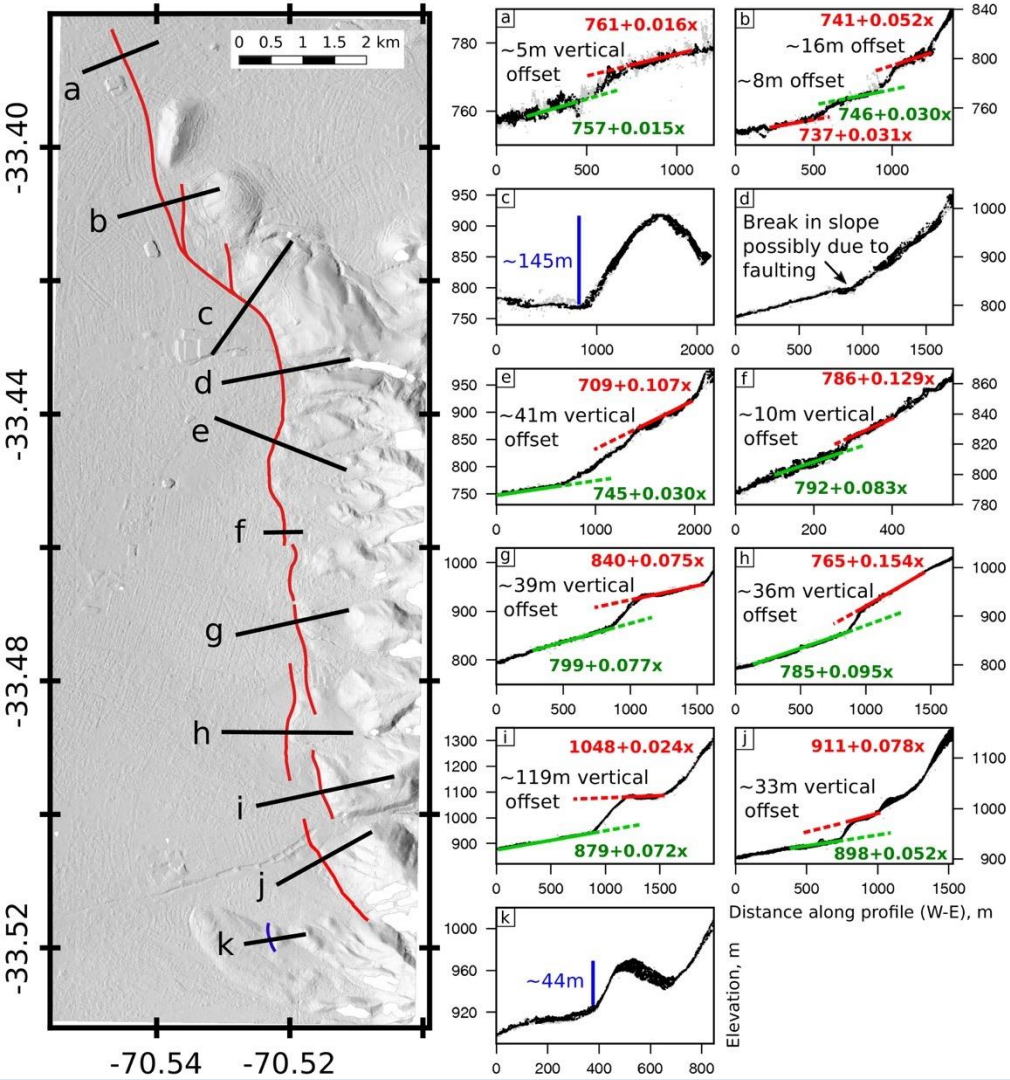
# City Expansion

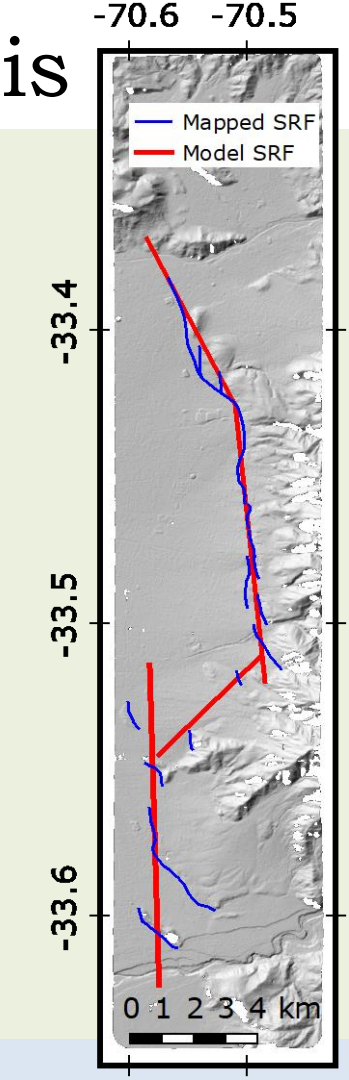


# DEM Analysis

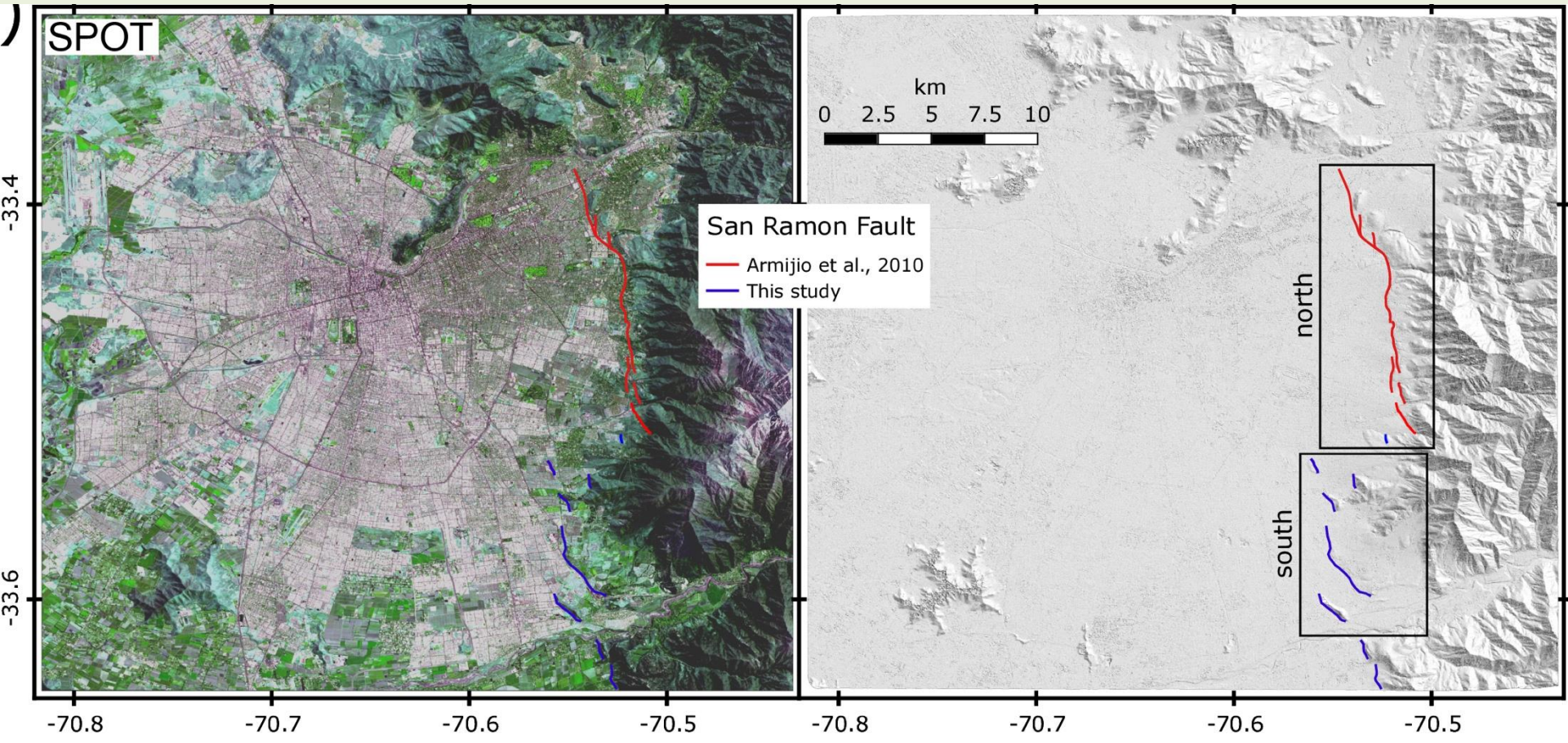


# DEM Analysis



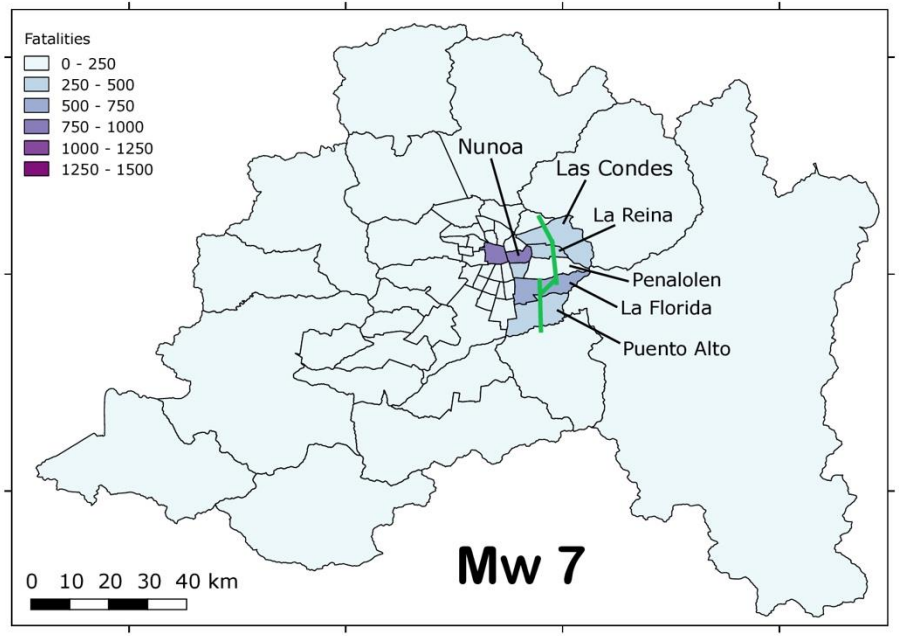



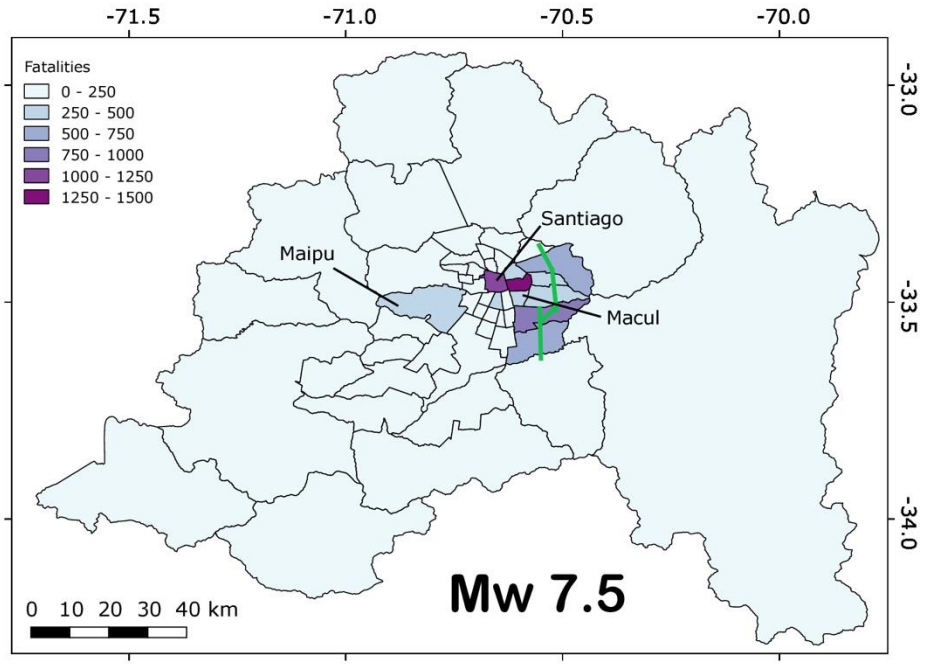
# SPOT DEM


SPOT
km
0 2.5 5 7.5 10
San Ramon Fault
Armijio et al., 2010
This study
north
south
-33.4
-33.6
-70.8
-70.7
-70.6
-70.5
-70.8
-70.7
-70.6
-70.5

# San Ramon Fatalities

San Ramon



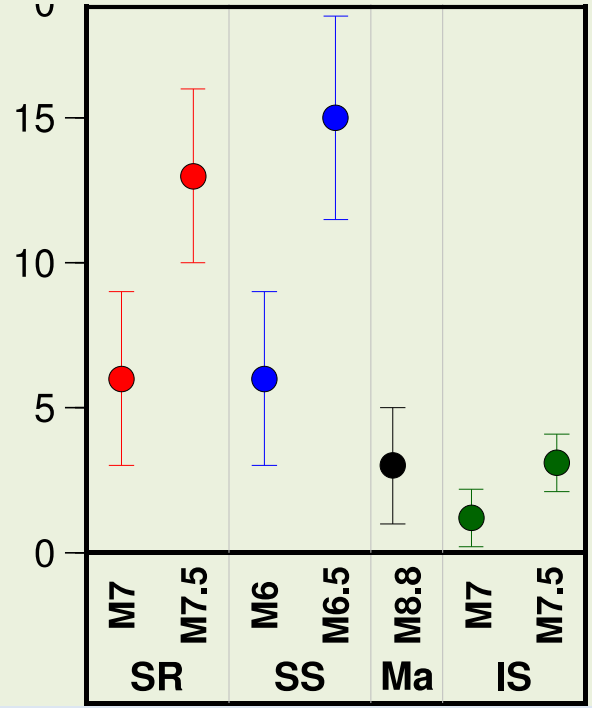




Total: 6,820 Fatalities (0.1%)

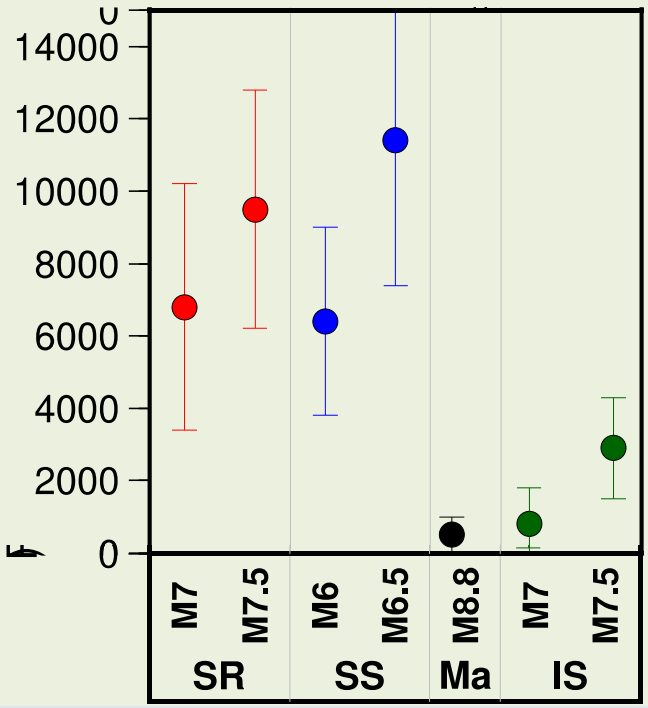
Total: 9,550 Fatalities (0.14%)

# Summary Statistics

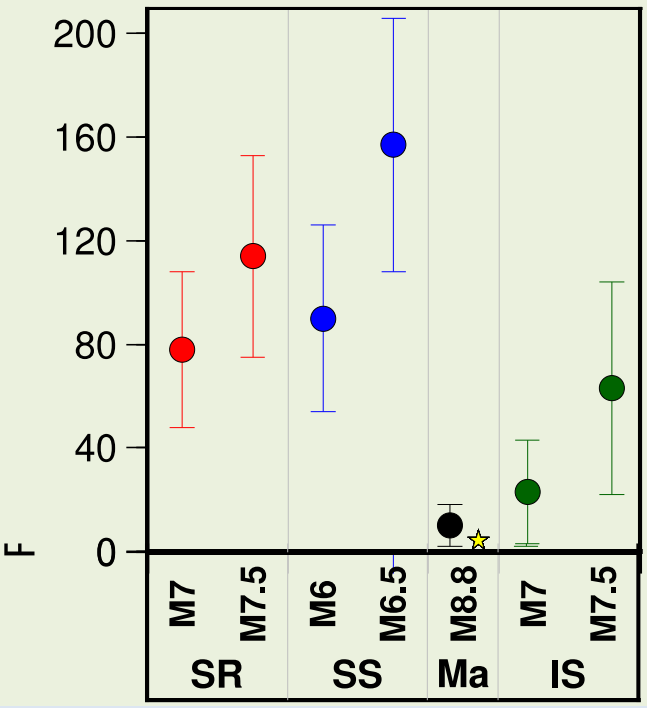
**Replacement Cost (billions USD)**




**Fatalities**



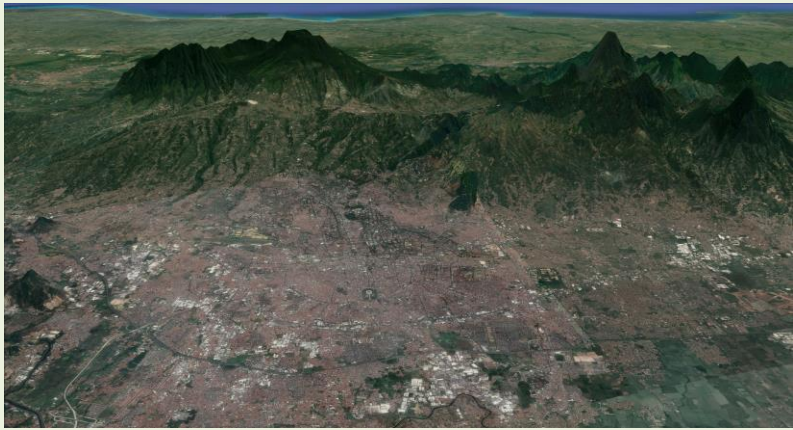

**Building Collapses (1000s)**

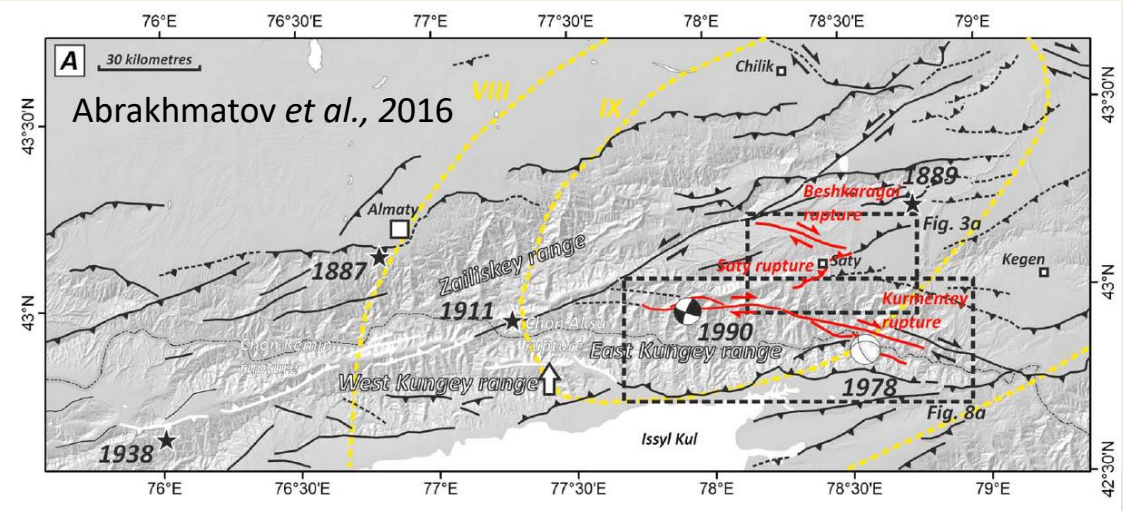


# Next Steps

- Examine the sensitivity of assumptions made in the Santiago Scenarios (e.g. top depth of faulting) – new PhD student.

- Bandung – Indonesia, Lembang Fault

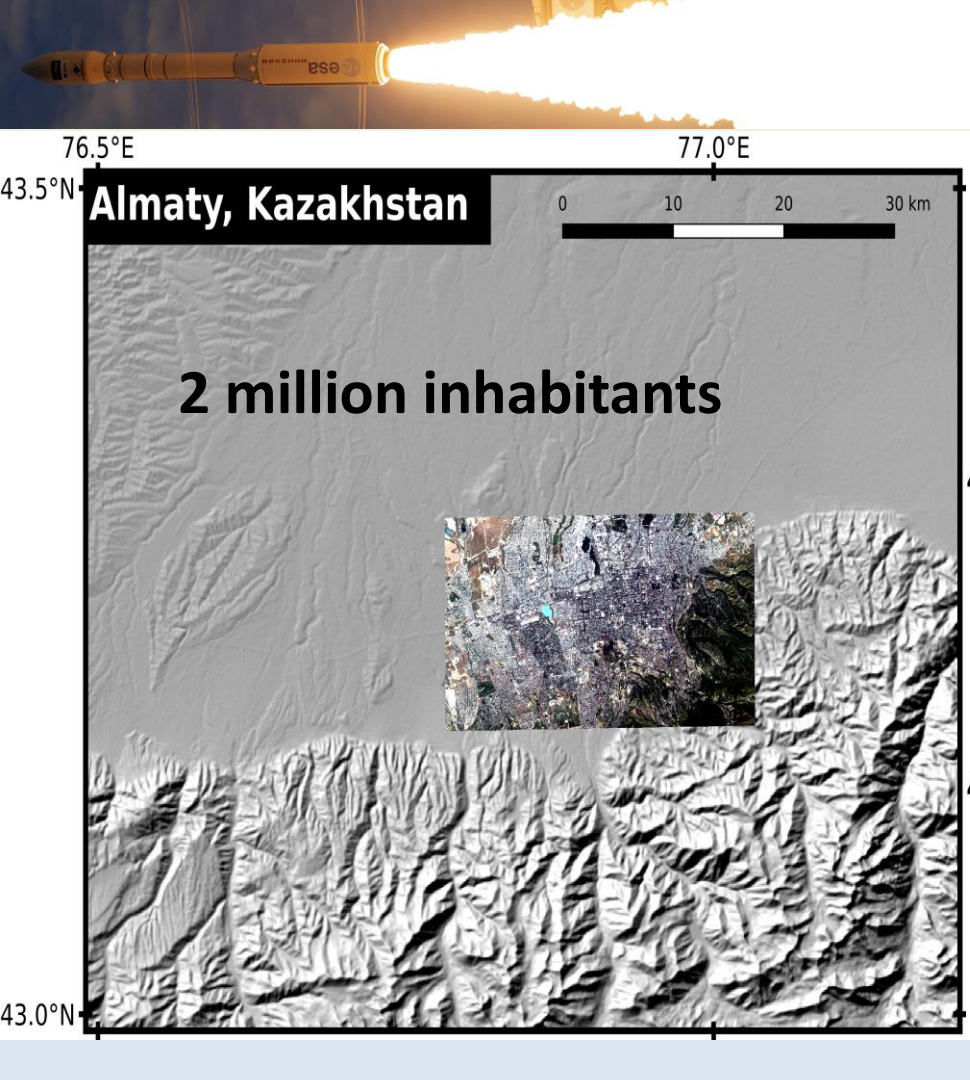





- Tien Shan

Bishkek, Kyrgyzstan &
Almaty, Kazakhstan

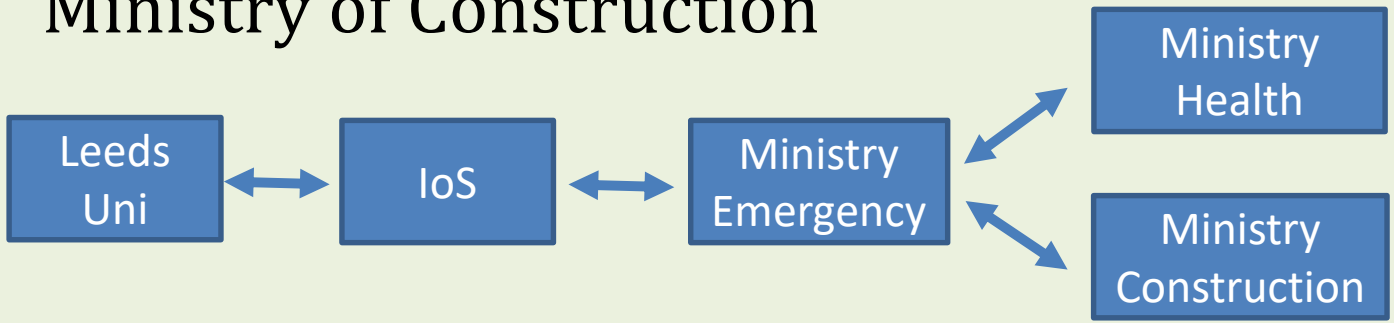
# Tien Shan


76.5°E
77.0°E
43.5°N
43.0°N
Almaty, Kazakhstan
0 10 20 30 km
2 million inhabitants

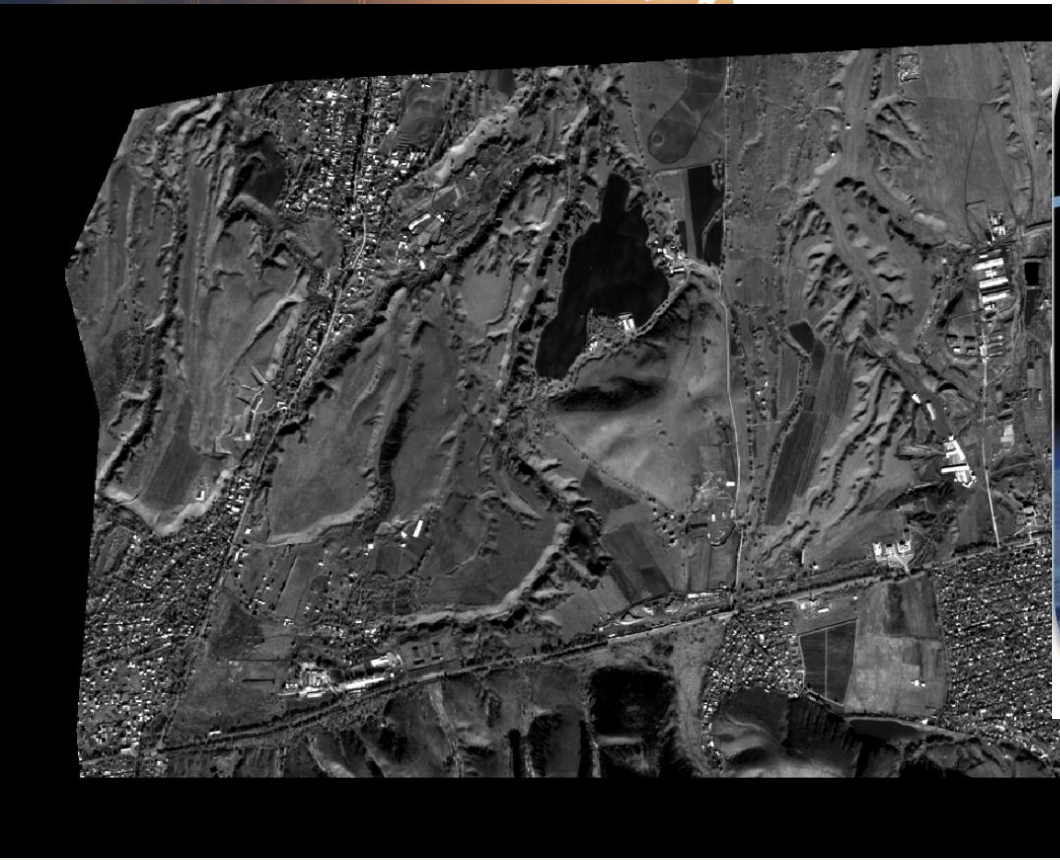

74.5°E
74.6°E
74.7°E
42.9°N
42.8°N
Bishkek, Kyrgyzstan
0 2.5 5 7.5 10 km
1 million inhabitants

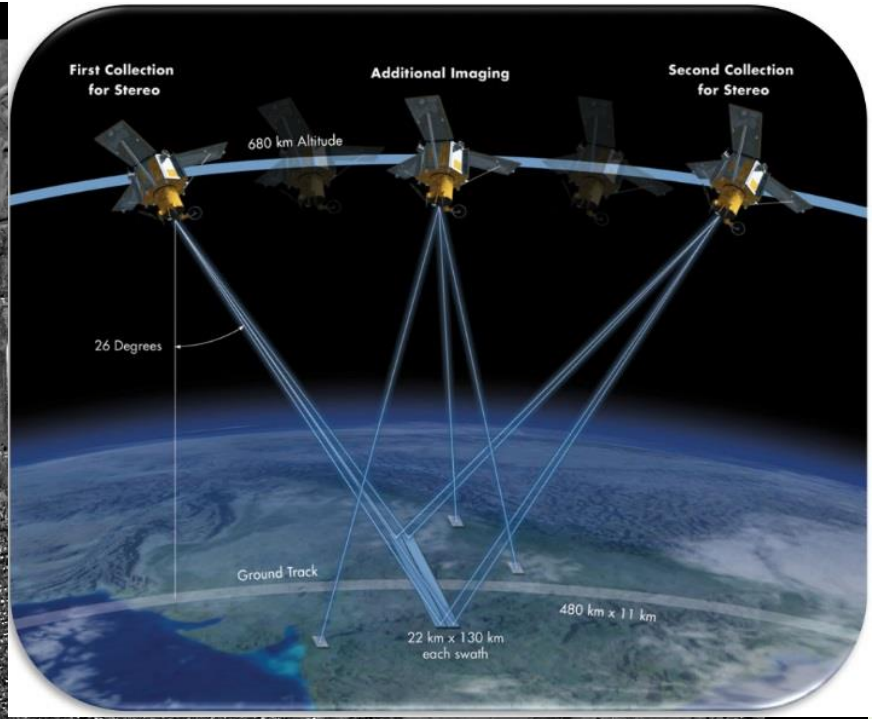
# Bishkek

- Motivation: World Bank Report
- Collaborator: Institute of Seismology embedding local capacity
- End Users: Ministry of Emergency Situations, Ministry of Health and Ministry of Construction

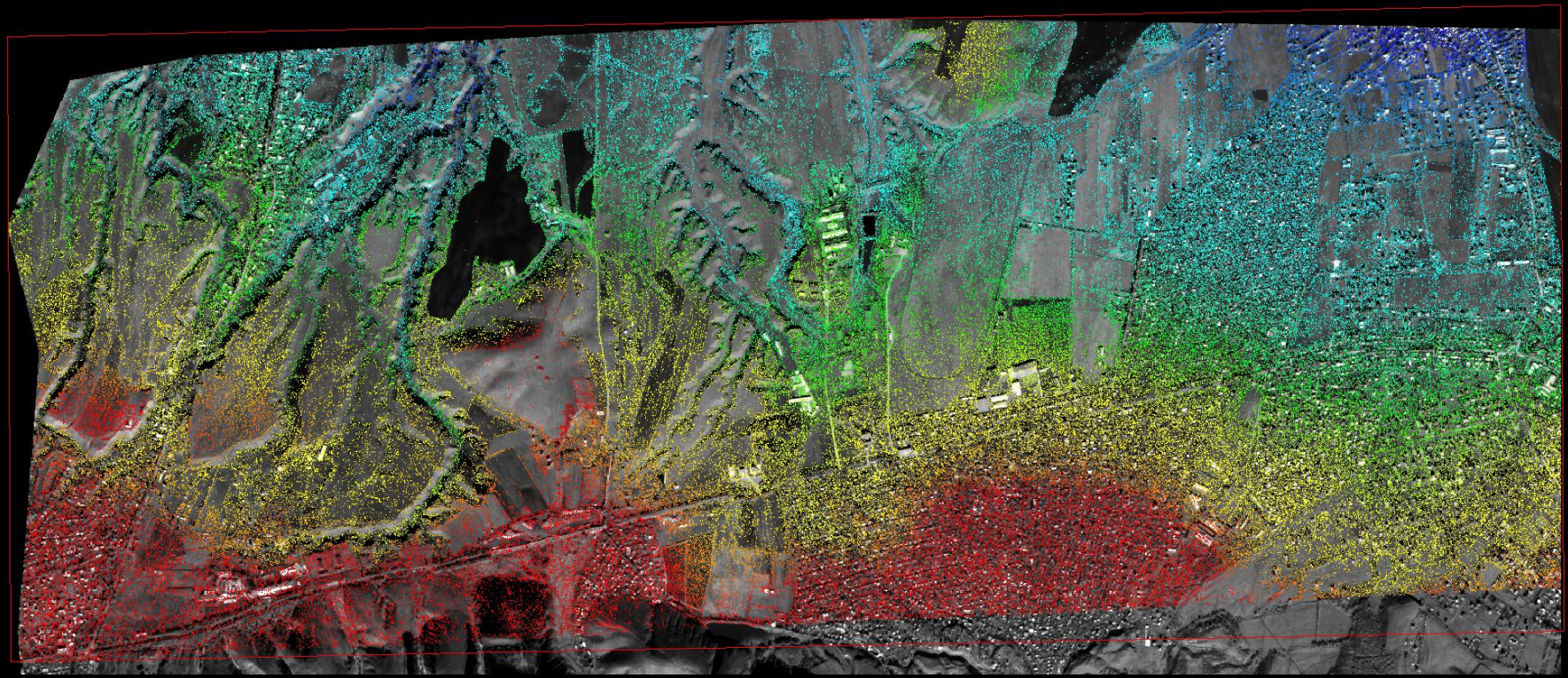
# Pleiades Stereo






10 km

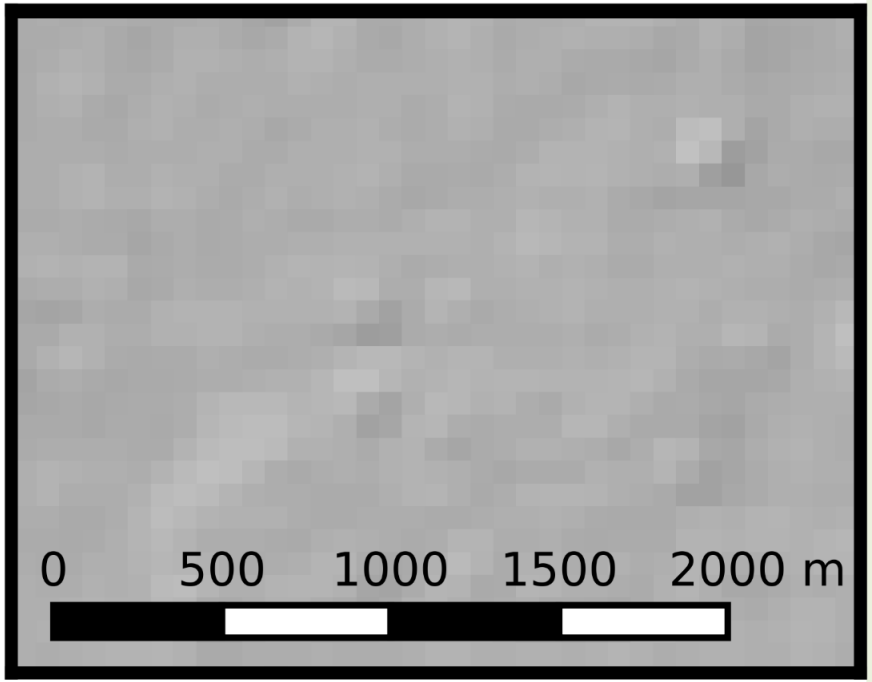
# Pleiades Stereo



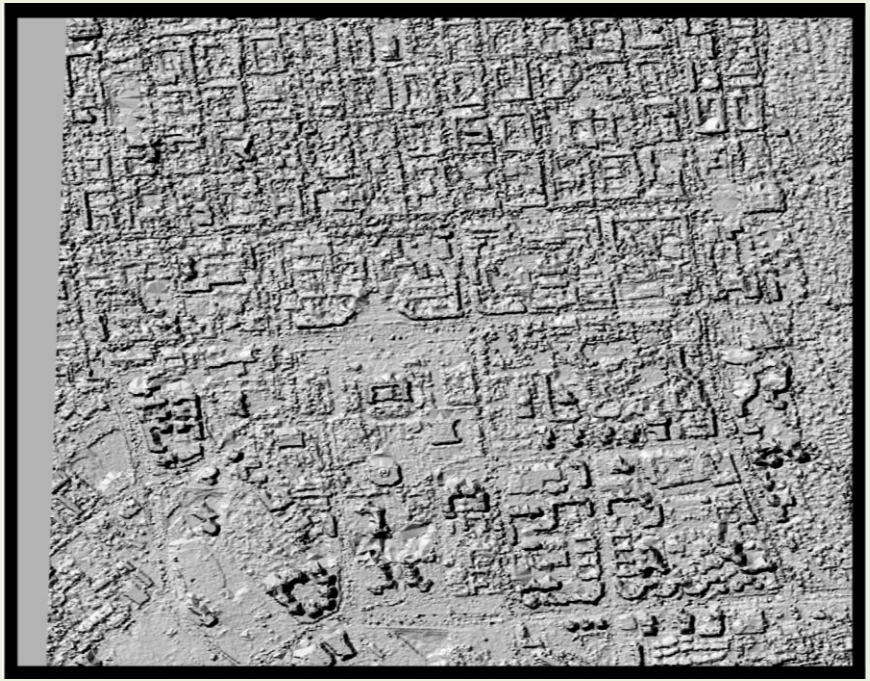
We can derive high-resolution DEMs to better map small splays in the city

# DEM Comparison

## SRTM 90m

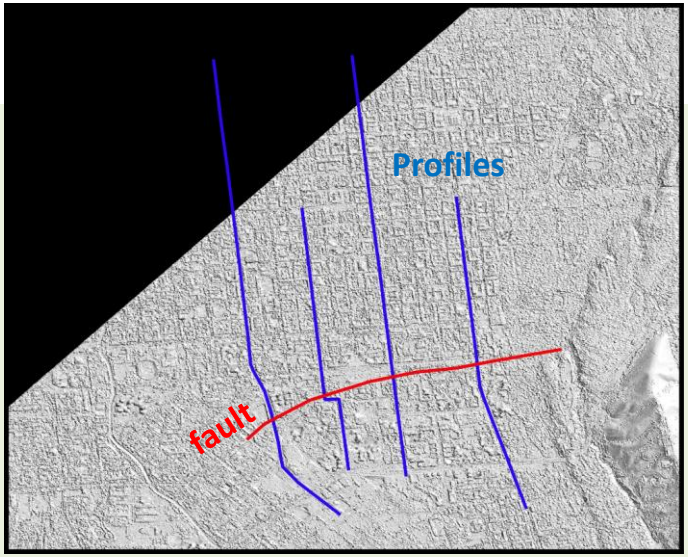


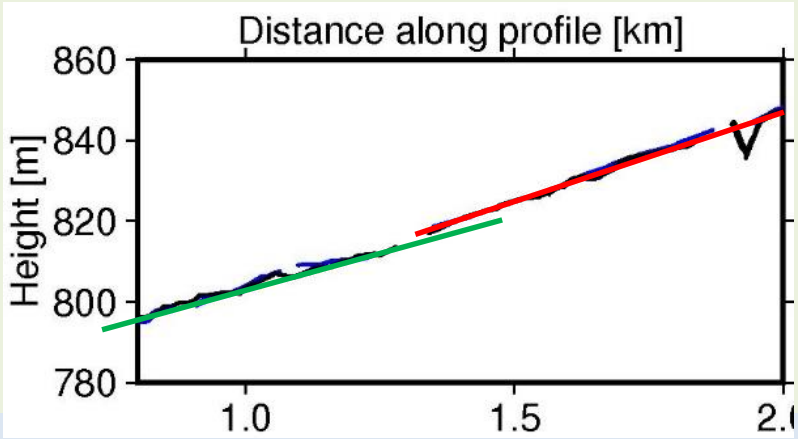

## Pleiades 2m



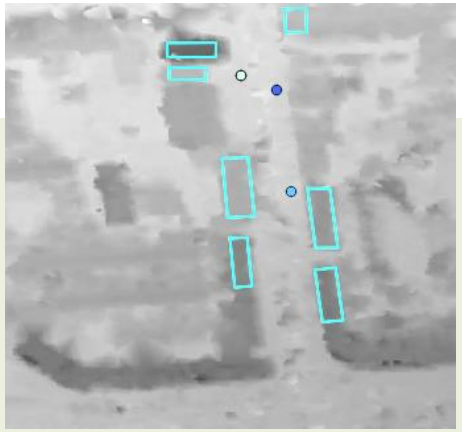
# Fault Splays

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

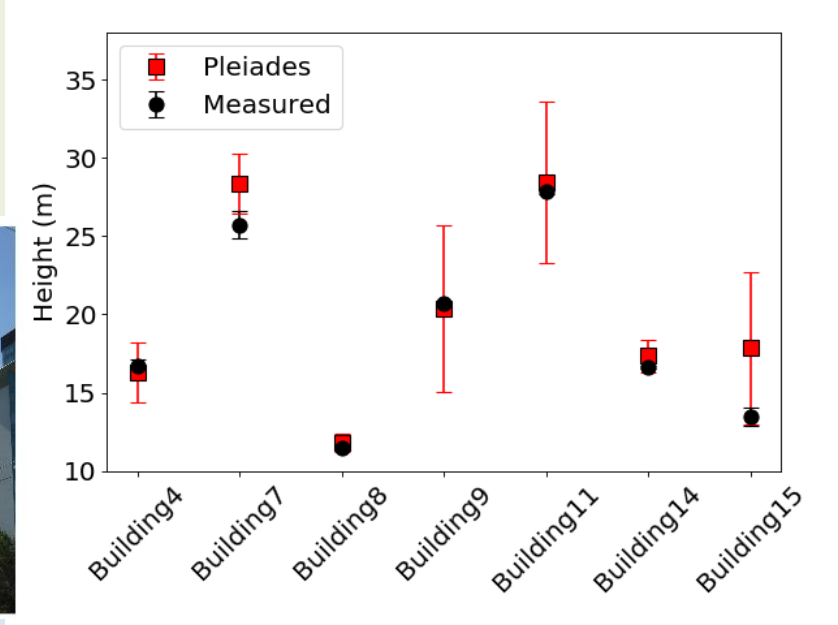


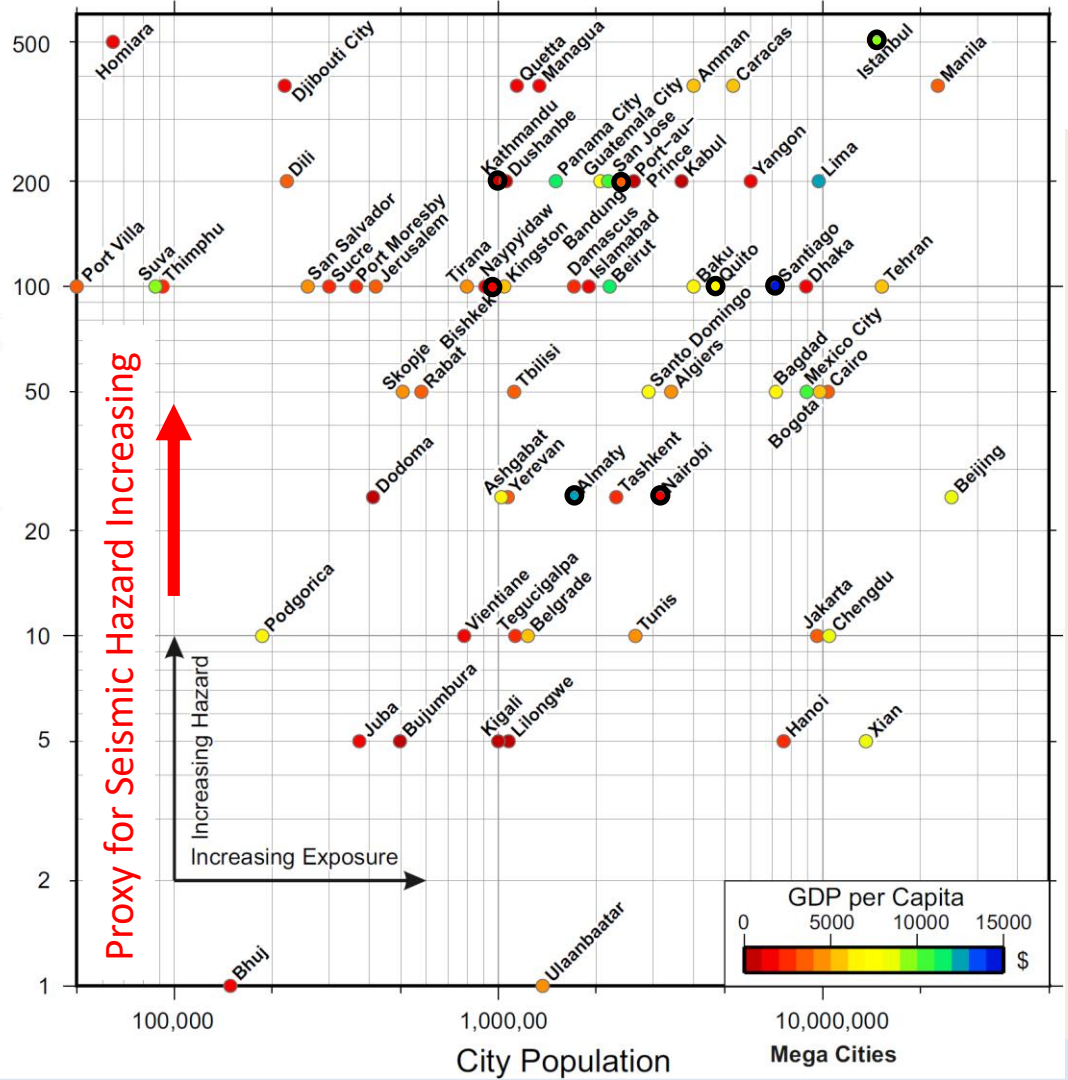



# Building Heights



- Building heights are needed over entire cities for hazard assessment
- High resolution Pleiades-derived DEMs can accurately map building heights
- Exposure models can be updated as cities expand

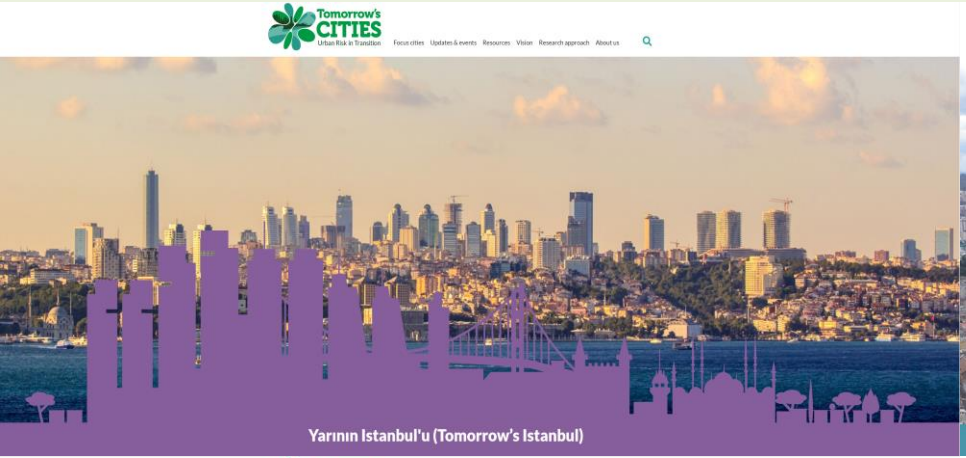



Tomorrow's CITIES
Urban Risk in Transition

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

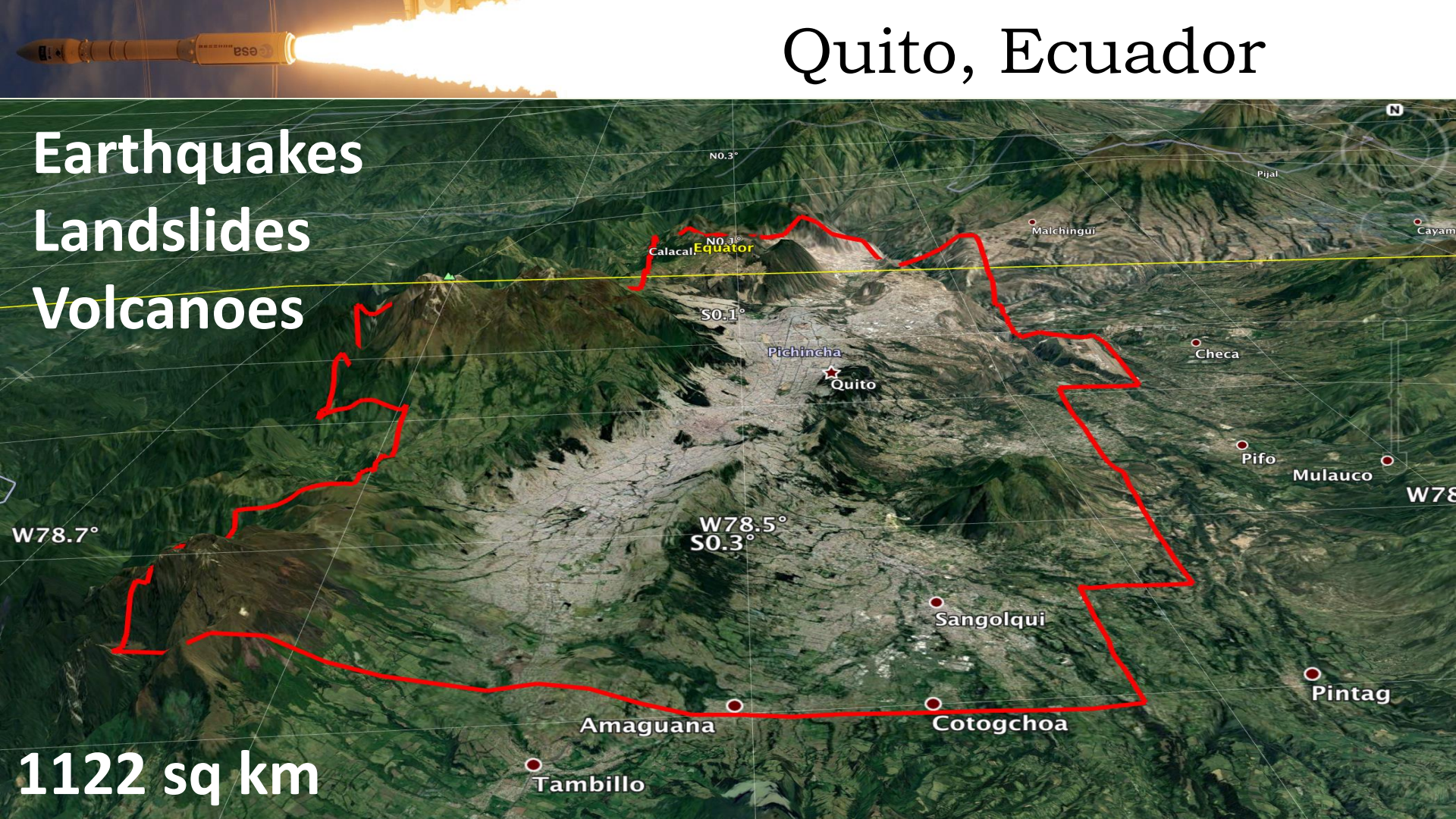
https://www.tomorrowscities.org/

# Tomorrow's Cities

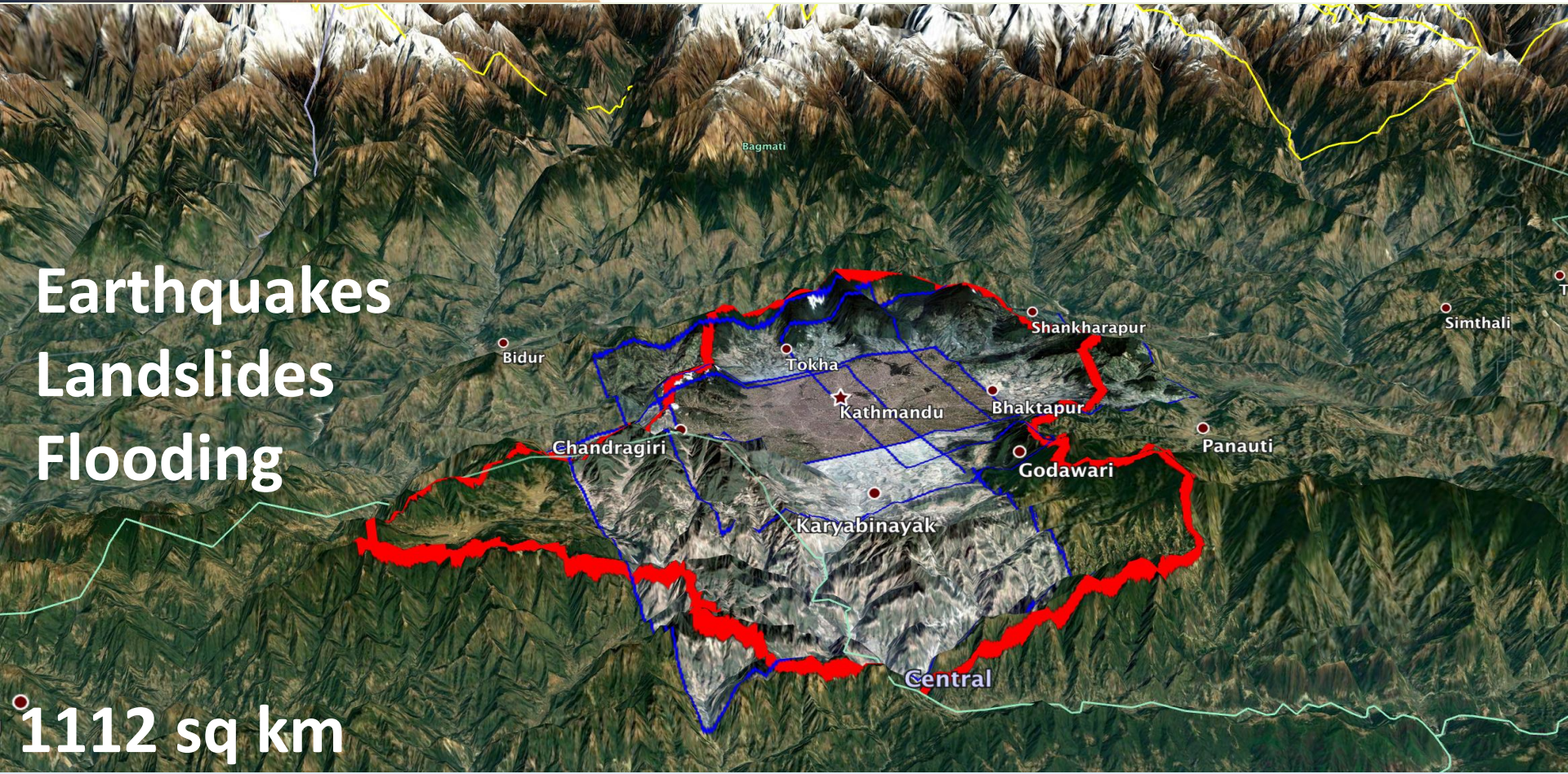


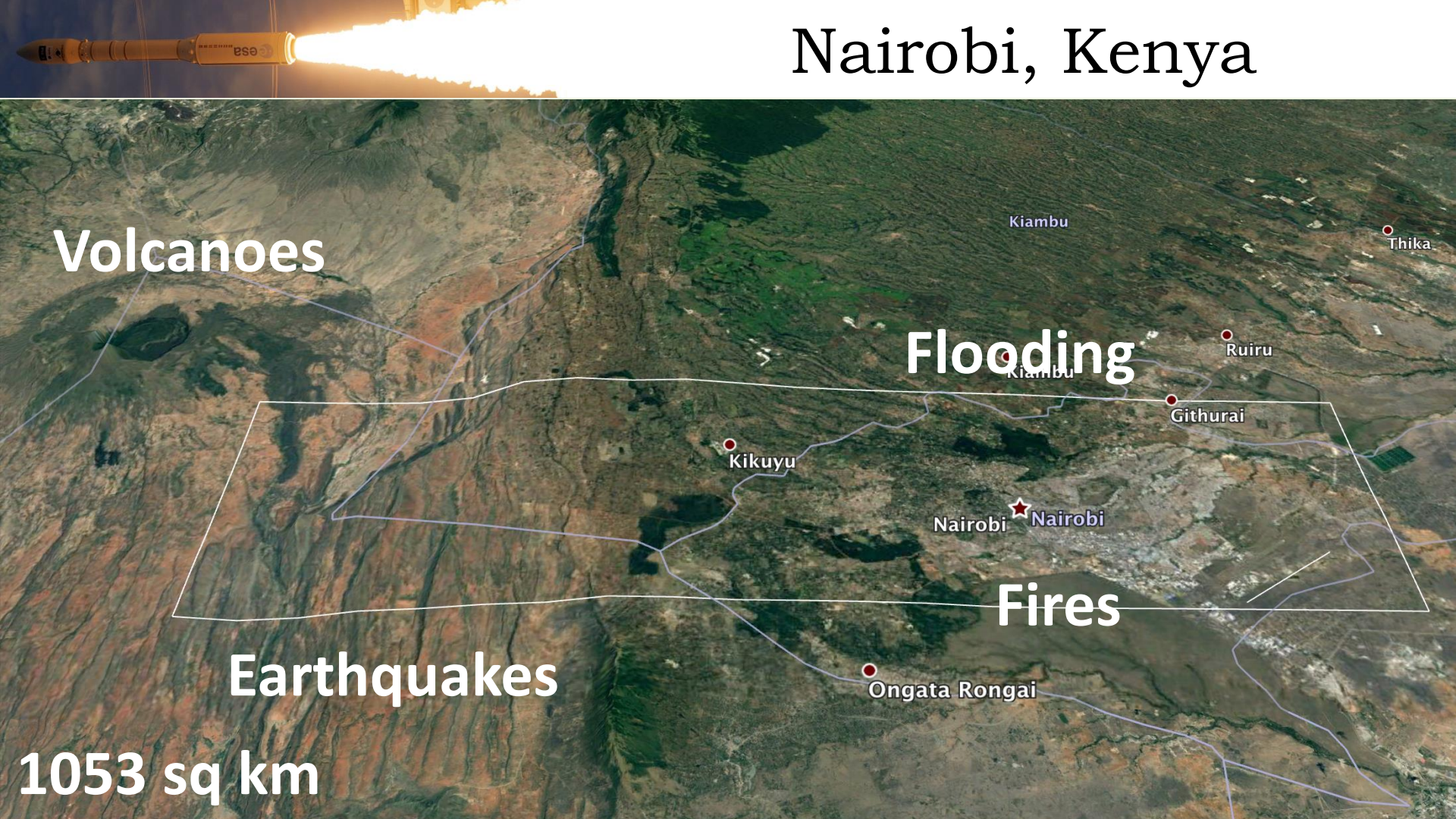



# Quito, Ecuador

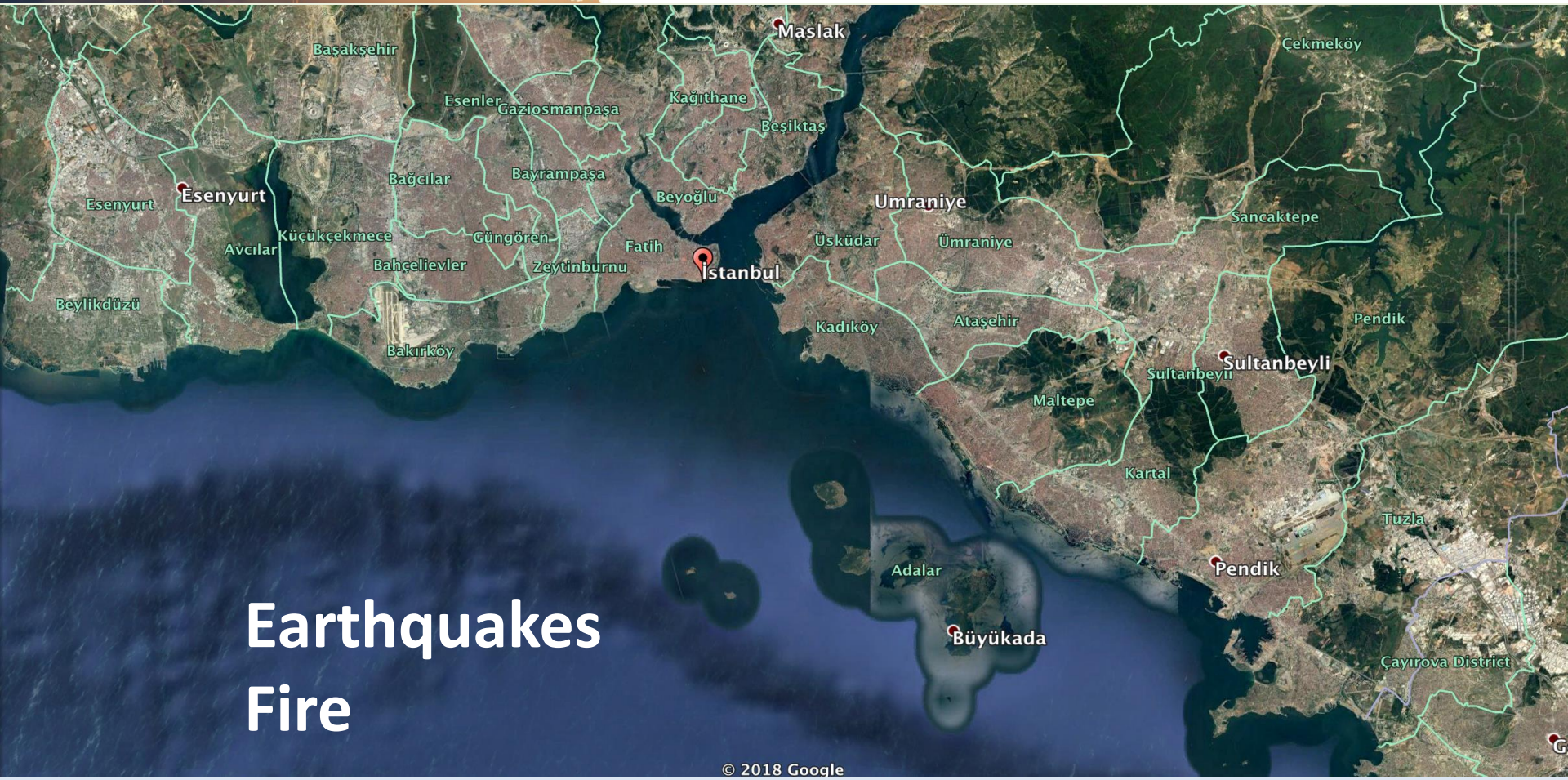


# Kathmandu, Nepal




Nairobi, Kenya
Volcanoes
Flooding
Fires
Earthquakes
1053 sq km
Kiambu
Thika
Ruiru
Githurai
Kikuyu
Nairobi
Nairobi
Ongata Rongai

# Istanbul, Turkey




**Earthquakes**
**Fire**