United Nations
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UNESCO Chair on the Prevention and
Sustainable Management of Geo-Hydrological Hazards,
University of Florence, Italy

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Characterization and monitoring of a riverbank failure in a UNESCO World Heritage Site: the 2016 Florence (Italy) case study

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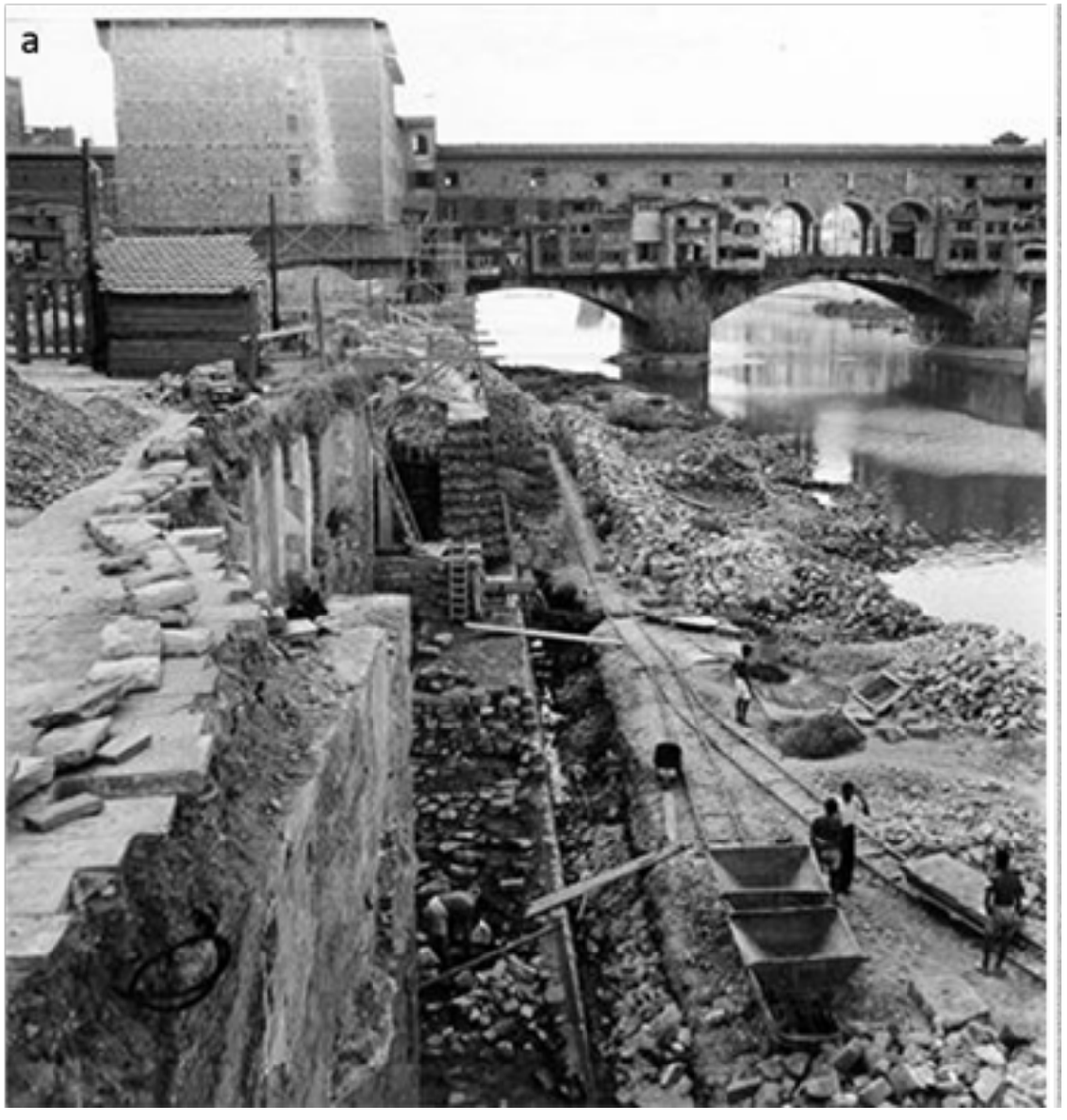
Riverbank instabilities in Florence

Instabilities can occur for:

1) **increase of destabilizing factors typical of slope landslides** (rainfall infiltration, anthropic pressure on soil strain, etc.)
   - ➢ *from the foundation in 56 BC to nowadays*

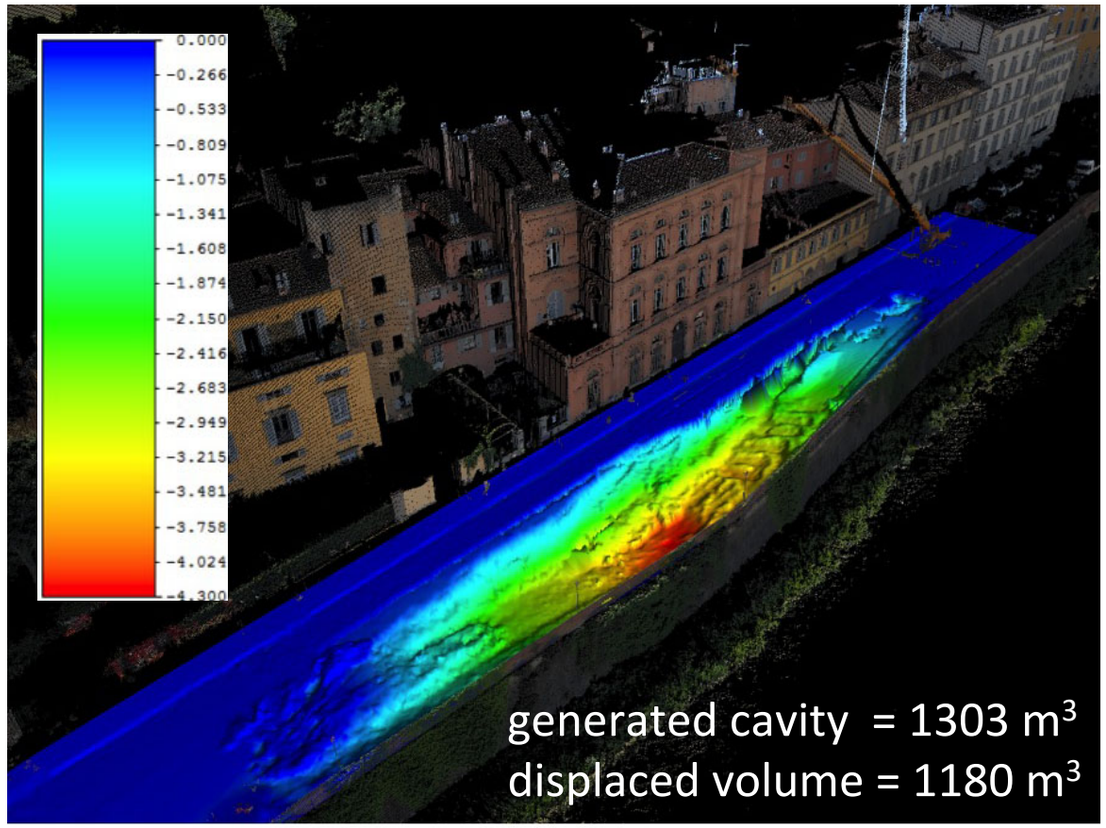
2) **exceptional river dynamics (floods)**
   - ➢ *low impact from the foundation in 56 BC to 1175 (urban enlargement up to the river)*
   - ➢ *high impact from 1175 to nowadays with the riverbed narrowings*

3) **high loss of water from subterranean pipes of the modern aqueduct**
   - ➢ *last 70 years (after the second world war)*



Firenze capital of Italy
Modern riverbank construction
(1865-1871)

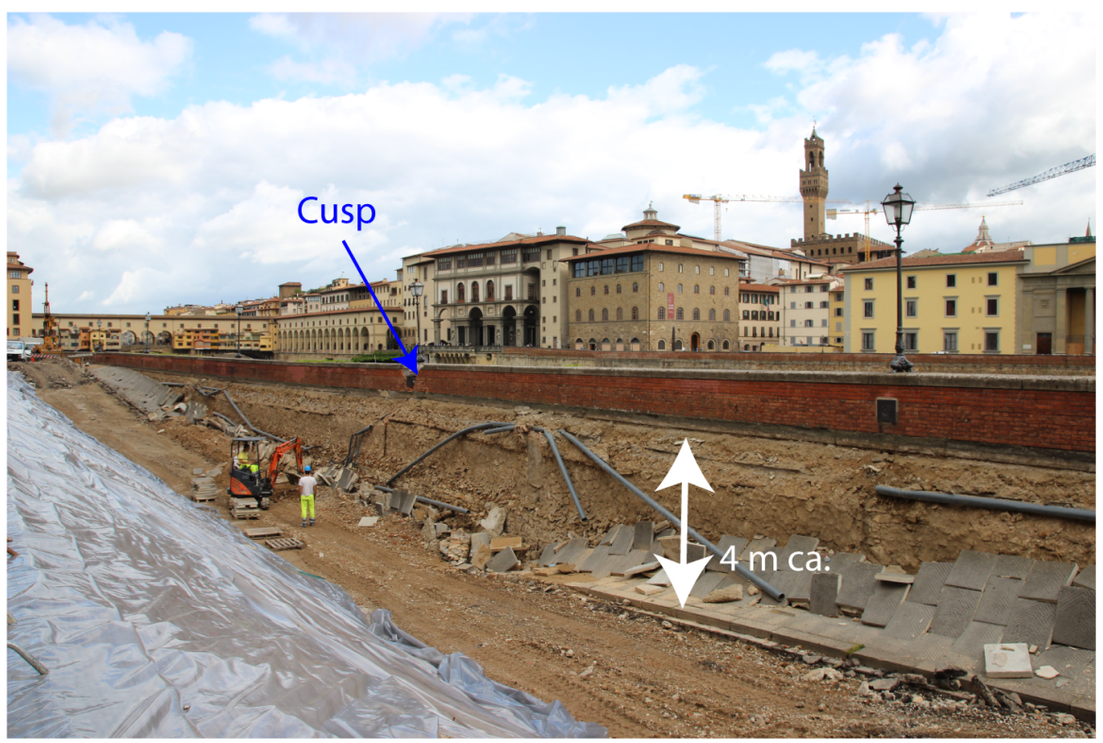
The 2016 collapse



(a)

(b)

(c)

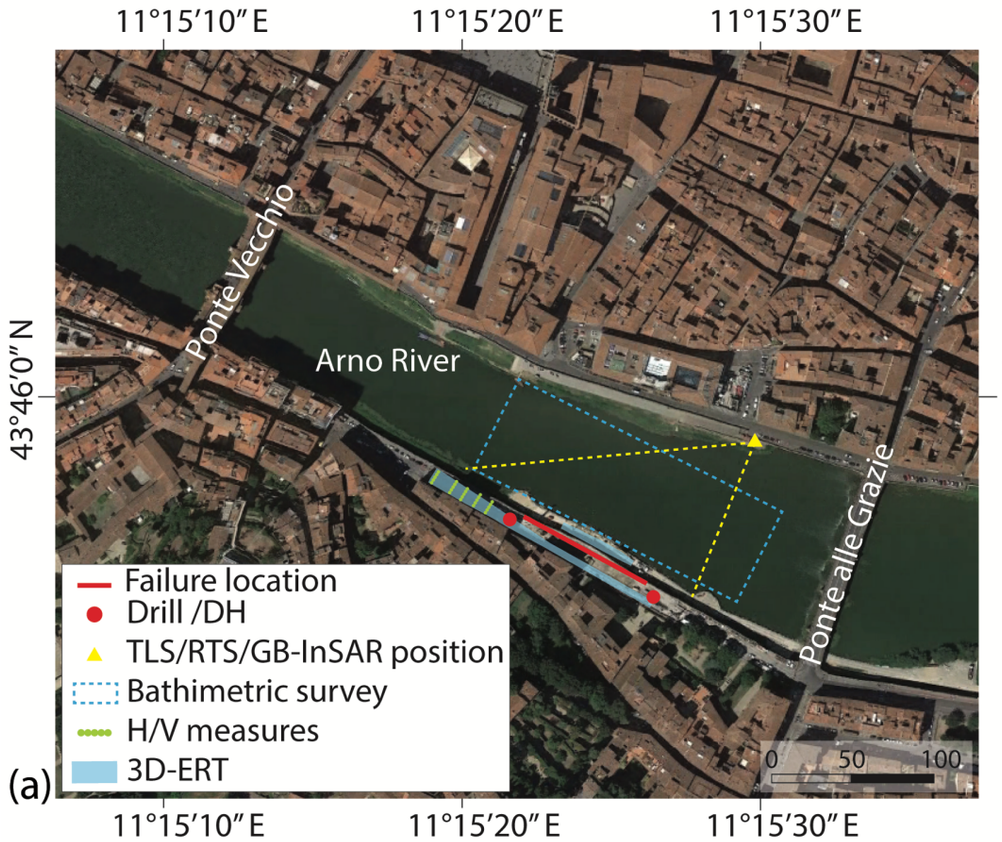


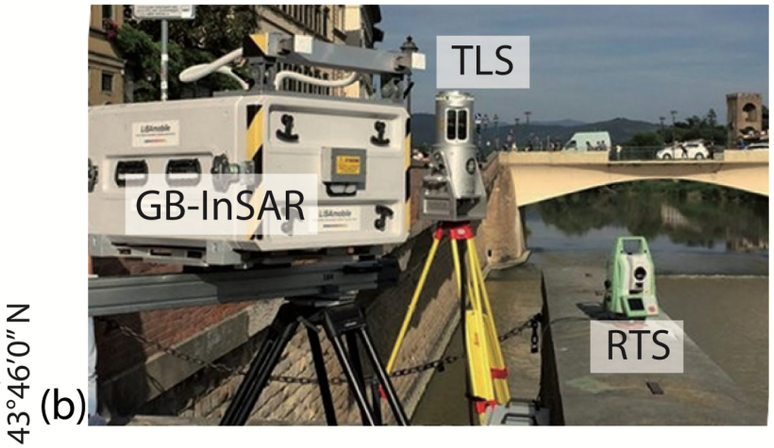
(d)

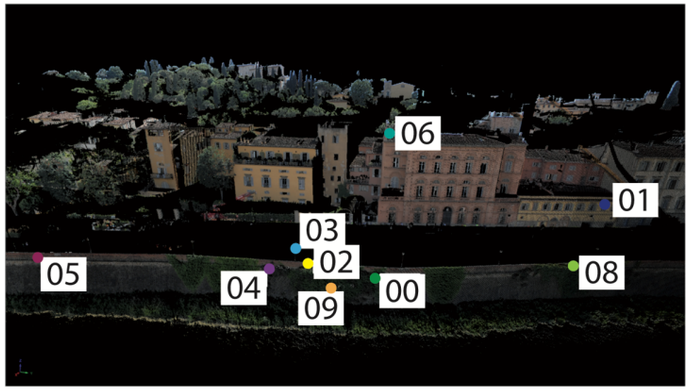
Monitoring and study

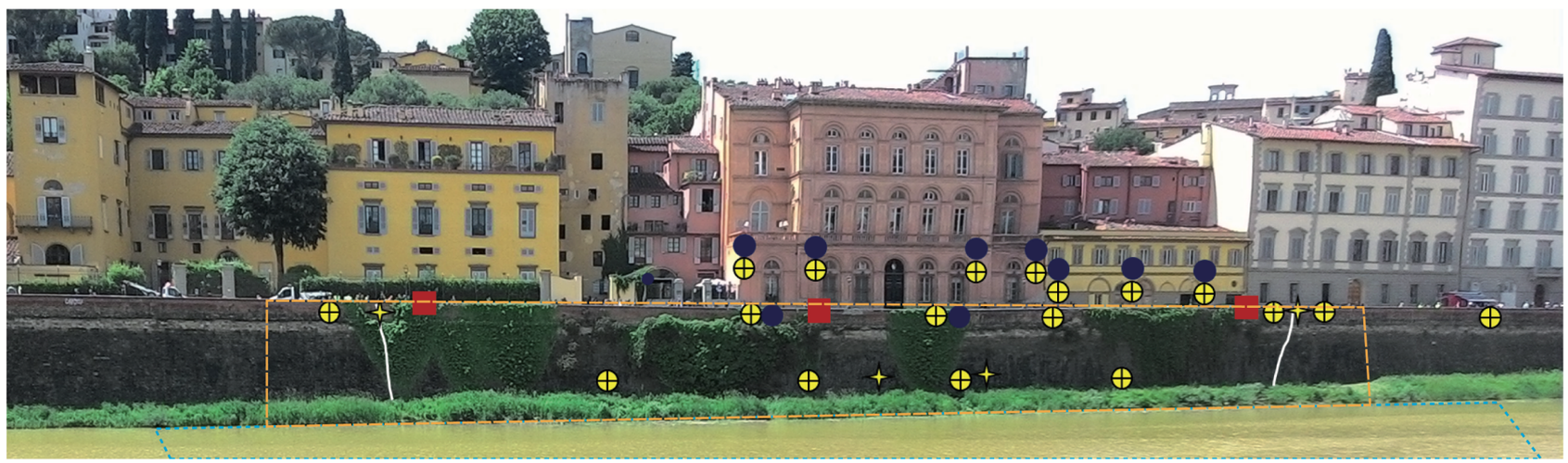
Double approach → **Emergency management (increasingly targeted observation)**

Event study and search for motivations



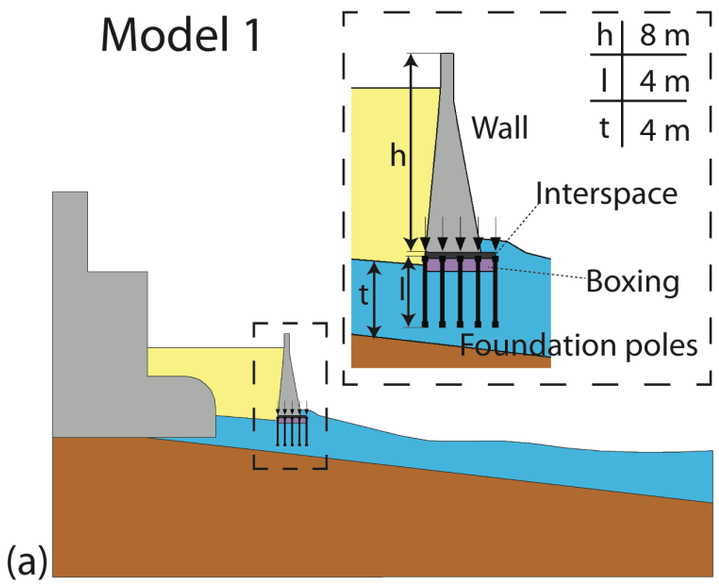


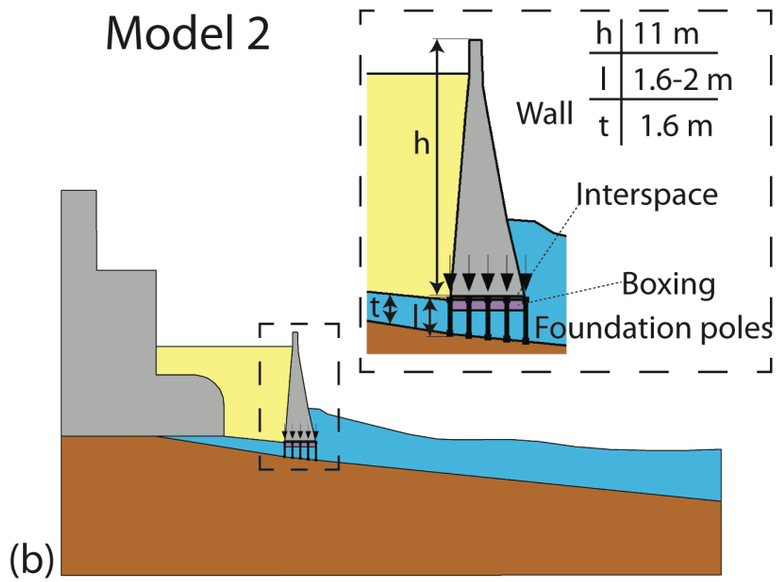




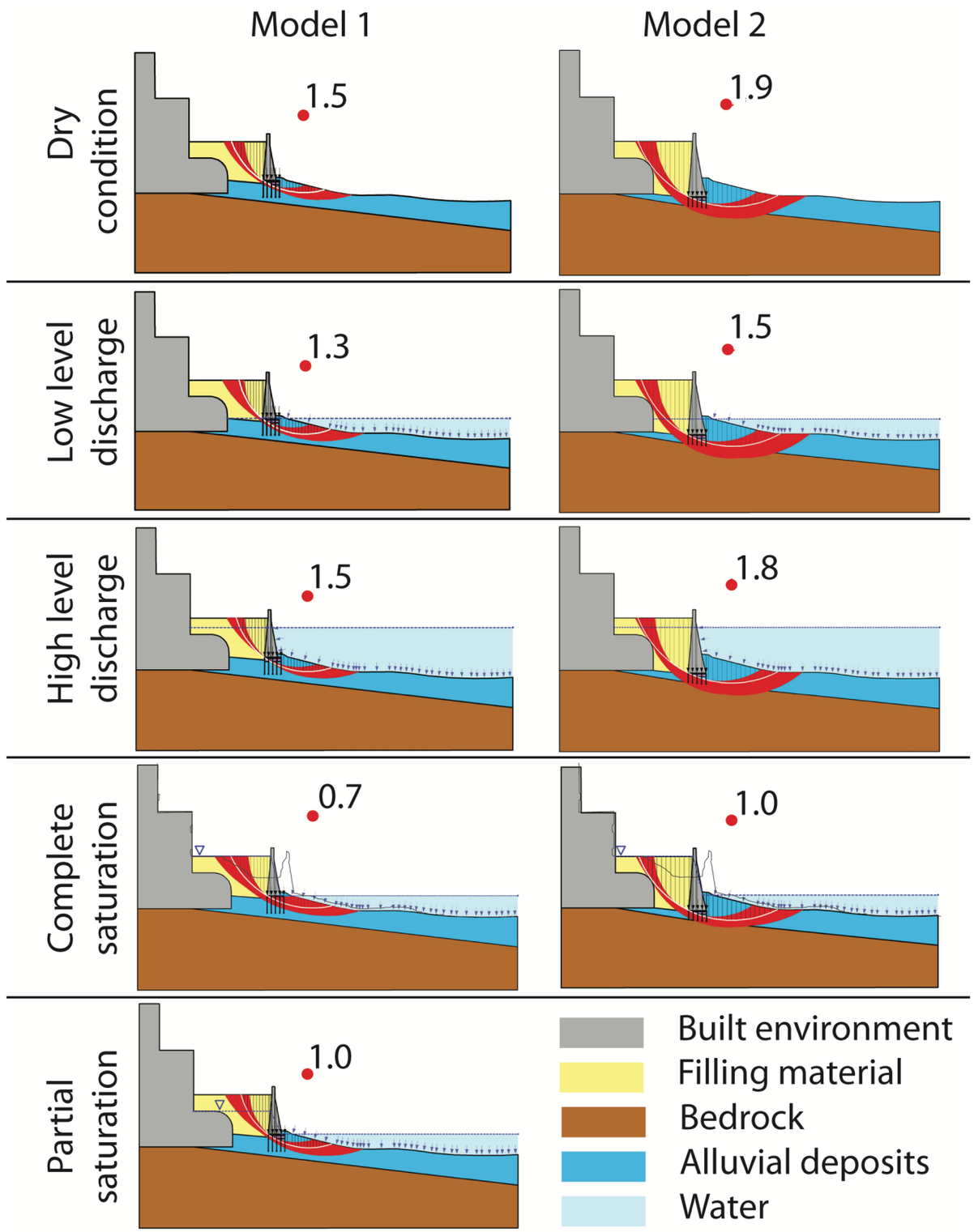
Stabilty analysis

Software: Slope/W - Geostudio 2012





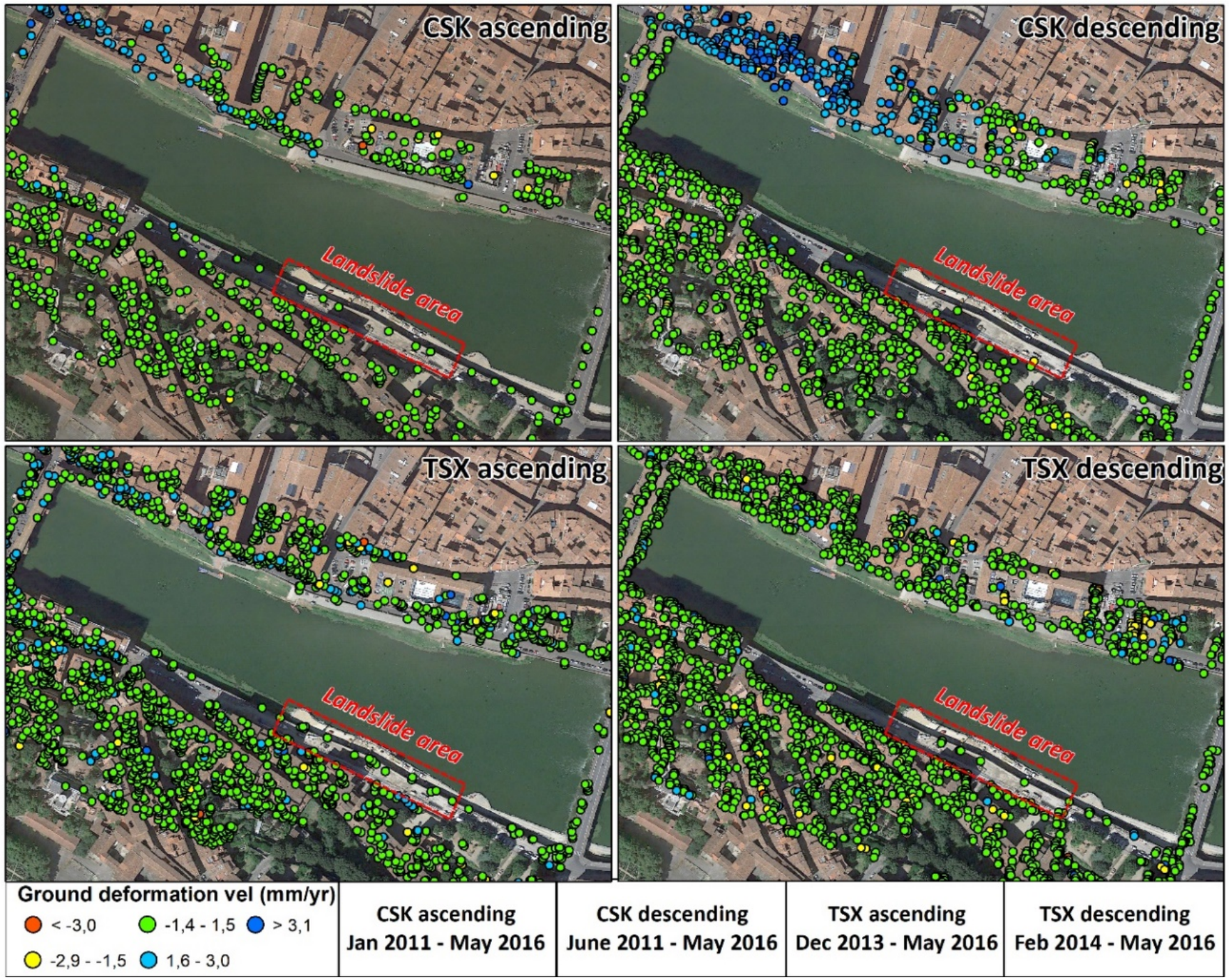
The analyses was conducted considering the limit equilibrium method outlined by Morgenstern and Price (1965)



• factor of safety

Radar satellite analysis

COSMO-SkyMed and TerraSAR-x satellite acquisitions (pre-collapse conditions)



Conclusions

- On May 25th, 2016, a portion of the artificially built riverbank (1865-1871) collapsed next to the historic centre of Florence (Italy).
- To preserve the cultural heritage site and the emergency activities a real time monitoring system was installed.
- The instruments used for the control of the possible scenario evolution was also use to study the area and to reconstruct the event.
- The riverbank stability analysis result demonstrates that a lower safety factor was obtained with the complete saturation of the filling material and a low level of the river.
- The satellite analysis showed absence of movement in the days preceding the collapse.
- The major cause of the collapse can be attributed to the loss of water from the local subterranean pipes in the moments preceding the event.