



PROTHEGO

Protection of European Cultural Heritage from Geo - Hazards

Mapping geohazards affecting UNESCO World Heritage sites in the UK using satellite InSAR data: the JPI-CH project PROTHEGO

Dr Francesca Cigna

British Geological Survey, UK

The 2nd Huangshan Dialogue on UNESCO sites and Sustainable Development, 11-15 Sept 2016, Huangshan, China

UNESCO World Heritage List



WHL as of Sept 2016

1052

Properties

34

Transboundary

2

Delisted

55

In Danger

814

Cultural

203

Natural

35

Mixed

165

States Parties

Category of site

Yellow diamond Cultural site Green circle Natural site Green diamond Mixed site

Site inscribed on the List of World Heritage in Danger

Red diamond Cultural site Red circle Natural site Red diamond Mixed site

Kathmandu's Trailokya Mohan Narayan Temple, Nepal



Before the 2015 earthquake...



...after

Land subsidence



Mexico City's Cathedral

20-30 cm/year subsidence

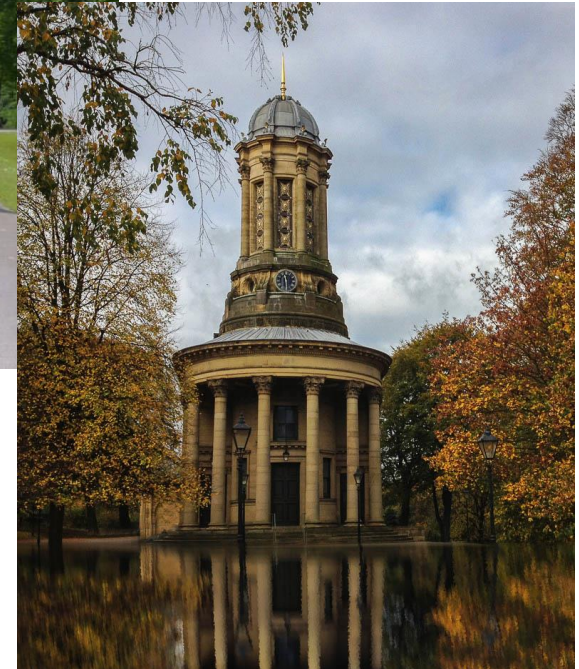


Landslides & flooding

Agrigento's Temple of Concord, Italy



Saltaire, UK



Christmas flood 2015

Volcanic hazards

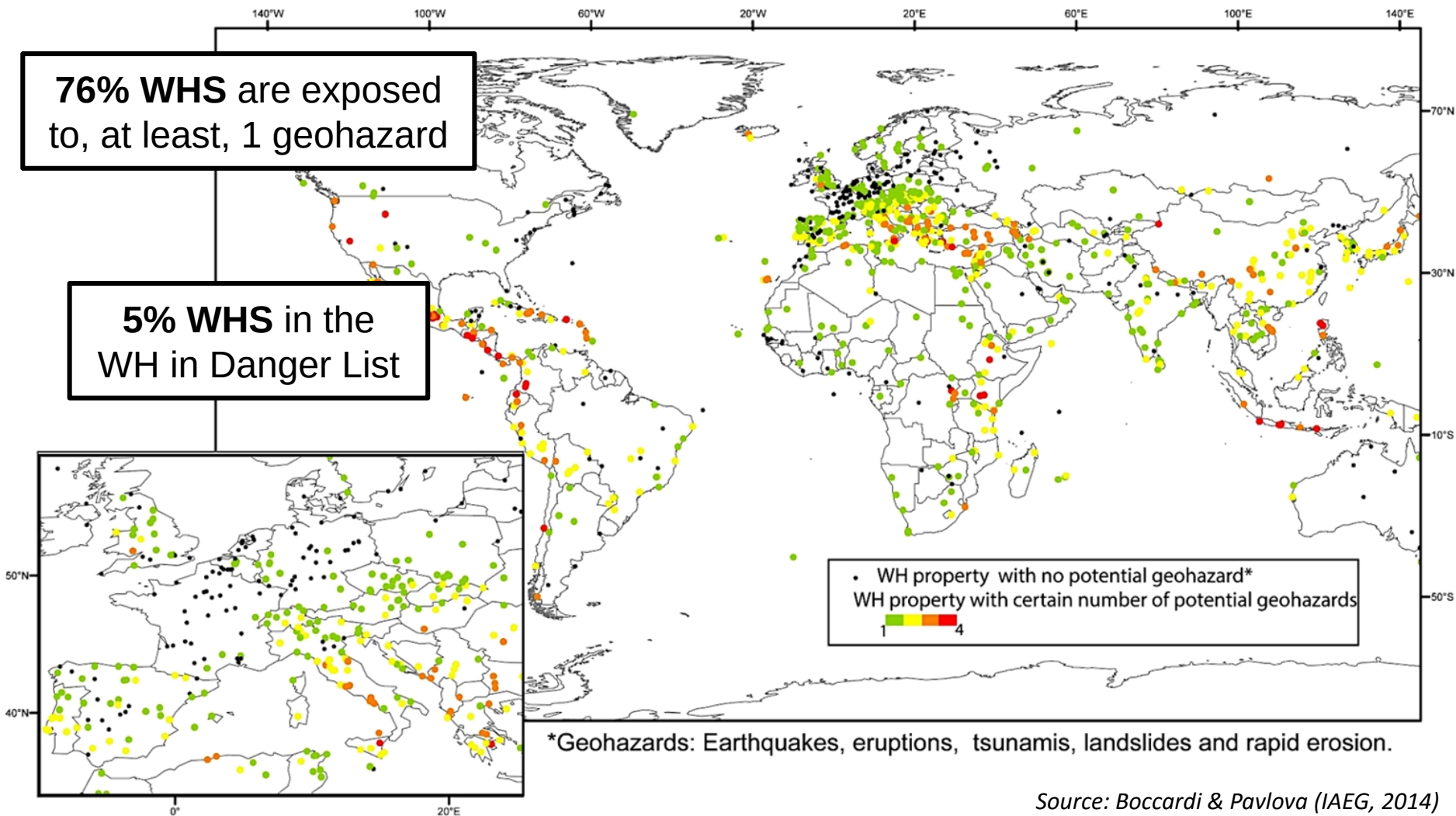
Mount Etna, Italy



Stromboli, Aeolian Islands, Italy



UNESCO World Heritage List

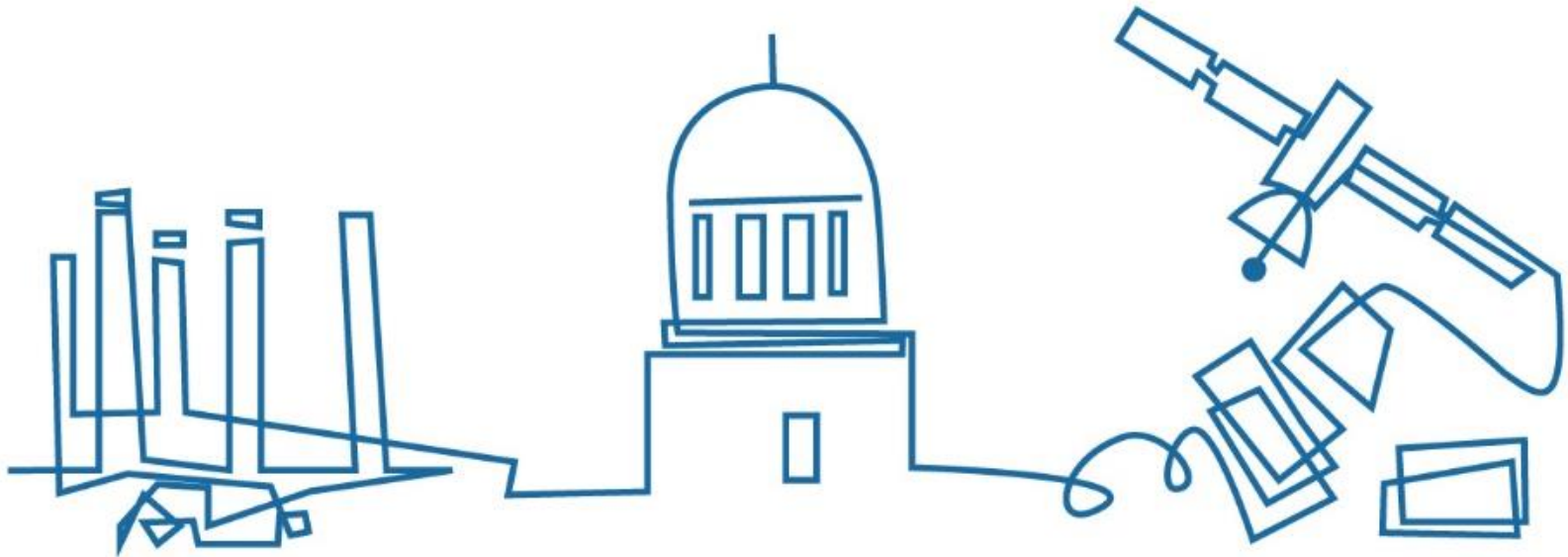


Hazard data from: <http://preview.grid.unep.ch/>

Source: Boccardi & Pavlova (IAEG, 2014)

The project

Objective: To make an innovative contribution towards the analysis of geohazards in the 400+ UNESCO World Heritage sites in Europe



PROTHEGO

Protection of European Cultural Heritage from Geo - Hazards

Funding Call



Joint Programming Initiative on Cultural Heritage and Global Change (JPI-CH)

HERITAGE PLUS Call 2014

under **ERA-NET Plus** and the Seventh Framework Programme (**FP7**) of the EC

Objective: to promote safeguarding of cultural heritage (tangible, intangible, digital)

Call process: EoI (stage 1) + Full Proposals (stage 2)

Budget: 6.6 M€ (National) + 3.1 M€ (EC) = **9.7 M€**

EoIs received: **352**

Invited to stage 2: 61

Full Proposals: 58

Funded: **16**

→ **Success rate < 5% !**

Project Partners



ISPRA

Istituto Superiore per la Protezione
e la Ricerca Ambientale

Institute for Environmental Protection and Research, Italy

ISPRA PI & Project Coordinator: Dr C. Margottini



British Geological Survey

NATURAL ENVIRONMENT RESEARCH COUNCIL

British Geological Survey - NERC, UK

NERC PI: Dr F. Cigna



Cyprus University of Technology, Cyprus

CUT PI: Dr K. Themistocleous



University of Milano-Bicocca, Italy

UNIMIB PI: Prof G.B. Crosta

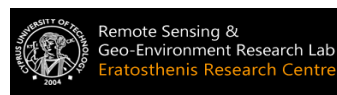
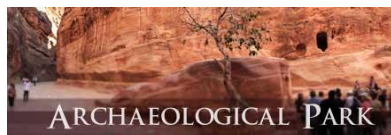


Instituto Geológico
y Minero de España

Geological Survey of Spain

IGME PI: Dr J.A. Fernández Merodo

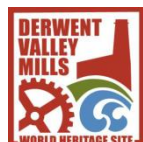
Associate Partners



ΣΥΝΔΕΣΜΟΣ ΚΥΠΡΙΩΝ ΑΡΧΑΙΟΛΟΓΩΝ
Τ.Κ 20058, 1600 ΑΕΤΚΟΛΙΑ - ΚΥΠΡΟΣ
ASSOCIATION OF CYPRIOT ARCHAEOLOGISTS
P.O.BOX 20058, 1600 NICOSIA - CYPRUS
acarchaeologists@gmail.com



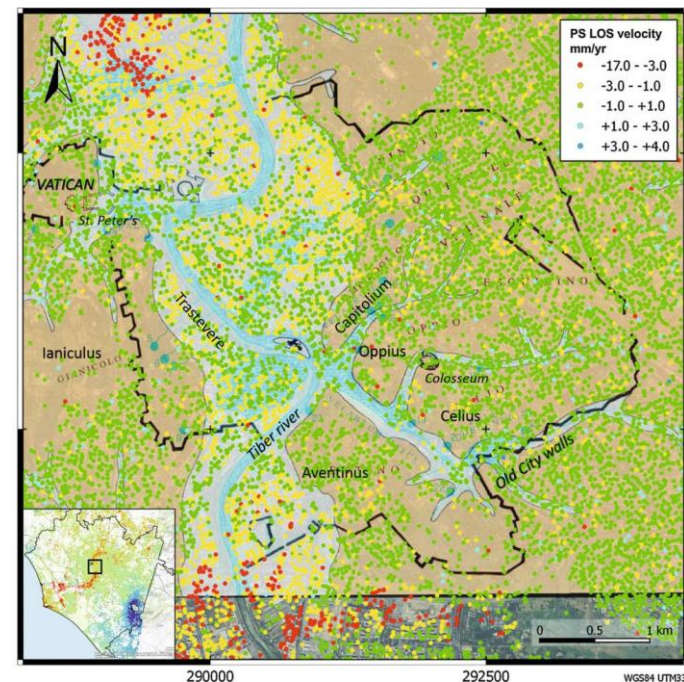
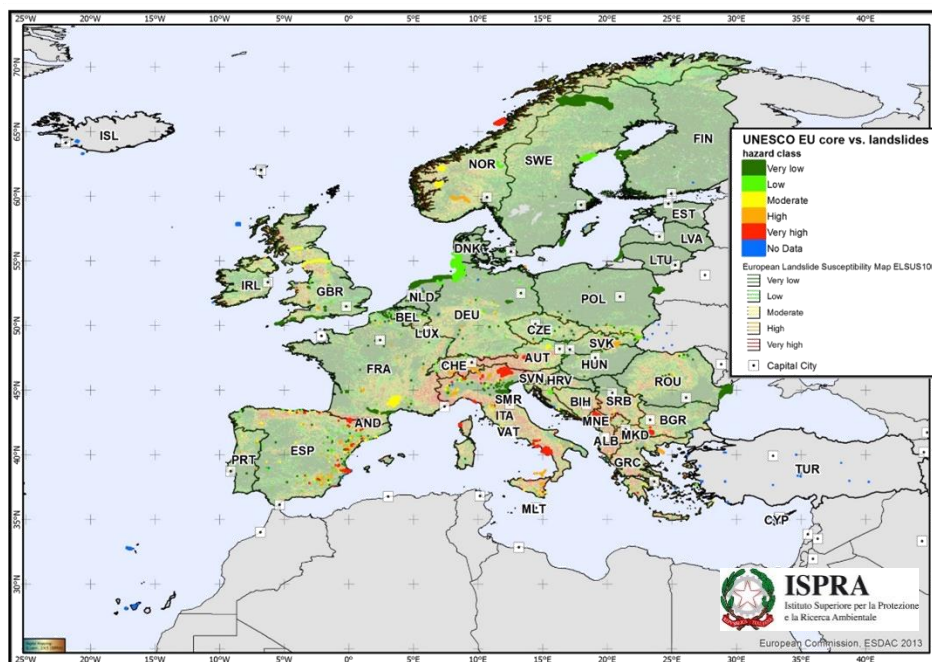
Patronato de la Alhambra y Generalife
CONSEJERÍA DE CULTURA



Partner	Typology	Role
UNESCO WHC, Climate Change and Natural Hazards focal point	United Nation Agency	Steering Committee
ESA – European Space Agency	European Agency	
EGS – EuroGeoSurveys	Association of EU Geological Surveys	
Petra Archaeological Park - Jordan	World Heritage Site	
ICL International Consortium on Landslides	International Research consortium	Stakeholders
ISCR Istituto Superiore per la Conservazione ed il Restauro	Public Agency	
CRSS Cyprus Remote Sensing Society	SME	
Politecnica Madrid - Alert geo-materials Royal Academy of Sciences Seville	Public University	
CSPfea	SME	
Association of Cypriot Archaeologists	Non-profit Scientific Association	Demo. Site Stakeholders
Patronato de la Alhambra y Generalife	Public Authority	
Sovrintendenza Capitolina – Roma Capitale	Technical body of the municipality of Rome	
Landscape Research & Management	Geo-archaeological landscape consultancy	
Derwent Valley Mills World Heritage Site	World Heritage Site Board	
Trent & Peak Archaeology and the York Archaeological Trust	Archaeological heritage Service provider	

PROTHEGO's objectives

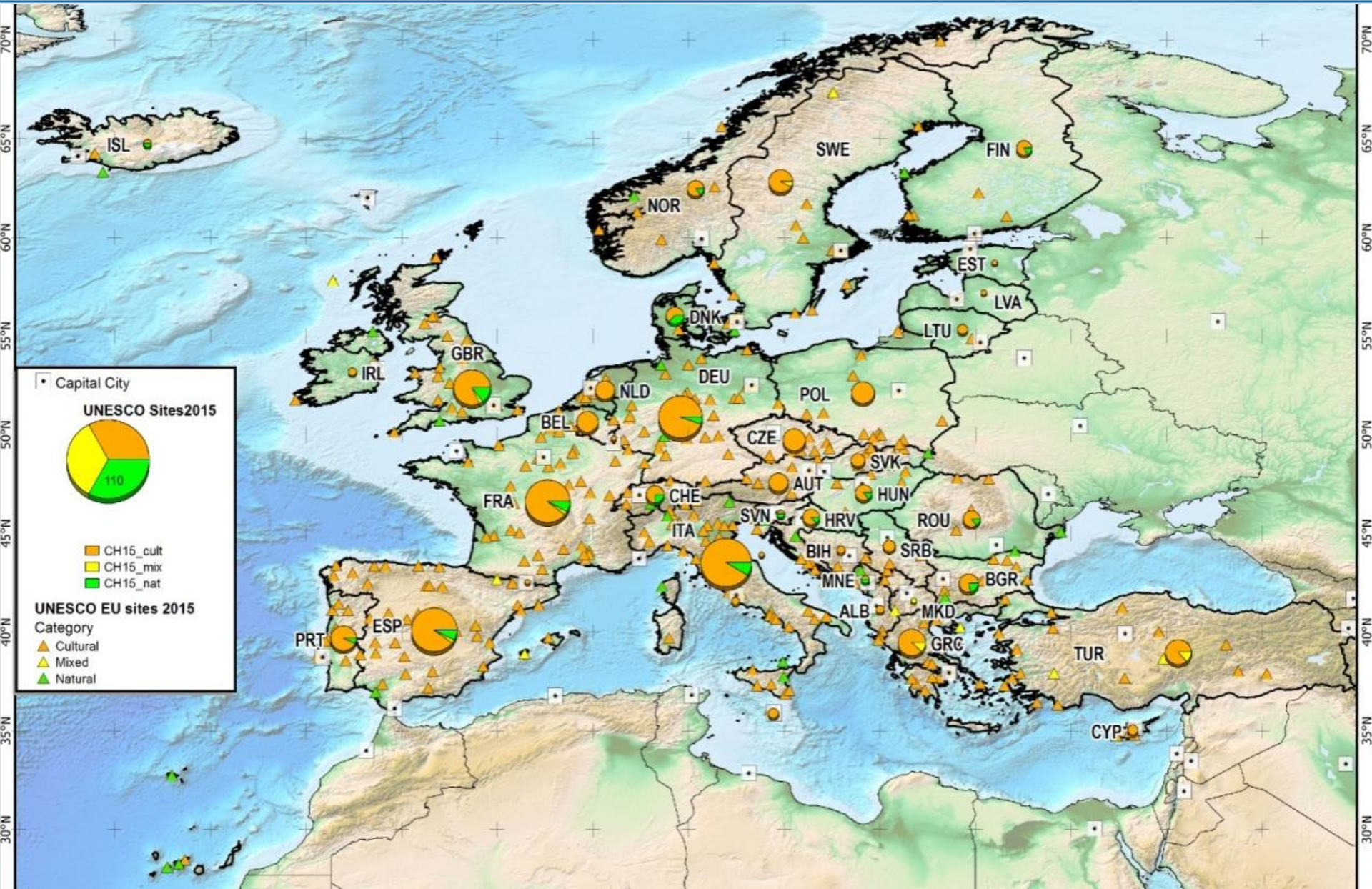
- To apply novel space technologies and remote sensing methods (e.g. InSAR) to monitor monuments and sites potentially unstable due to geohazards
- To identify the most endangered sites across Europe
- To showcase the methodological approach at the local scale for a set of demo-sites



Work Packages

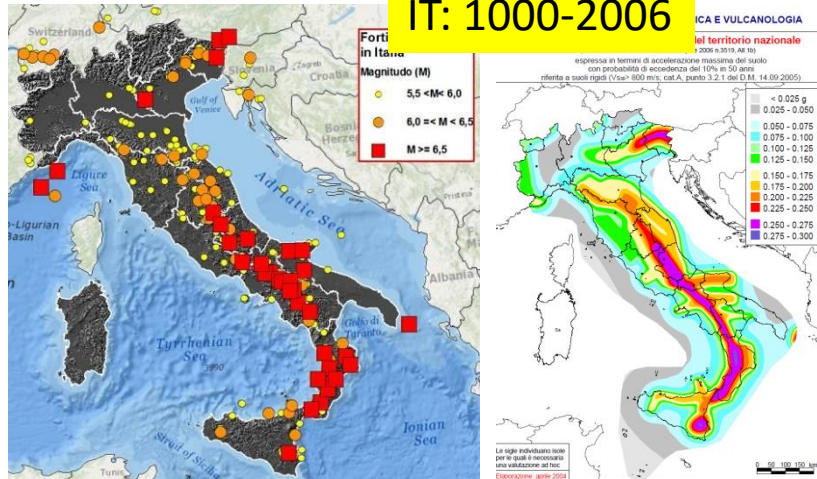
ID	WP Title	Lead Organisation
WP1:	UNESCO Cultural heritage vs. Natural hazards at European scale	 ISPRA Istituto Superiore per la Protezione e la Ricerca Ambientale
WP2:	Harmonisation of PS data, and creation of digital factsheets	 British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL
WP3:	Integration of PS and geo-hazard products and implementation of multi-criteria methodology	
WP4:	Identification of most endangered sites	
WP5:	Local-scale monitoring	
WP6:	Local scale investigation and Advanced modelling	 Instituto Geológico y Minero de España
WP7:	Dissemination and communication	 British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL
WP8:	Project Management	 ISPRA Istituto Superiore per la Protezione e la Ricerca Ambientale

European scale

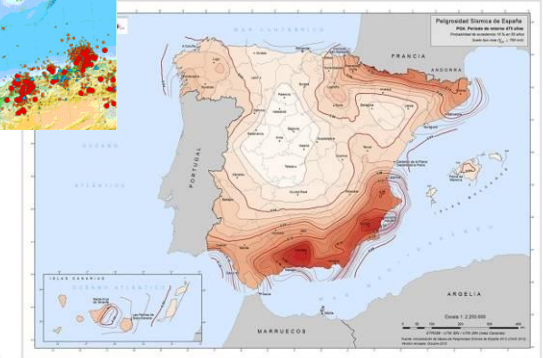
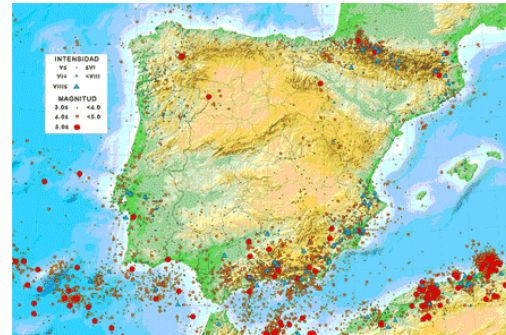


National scale

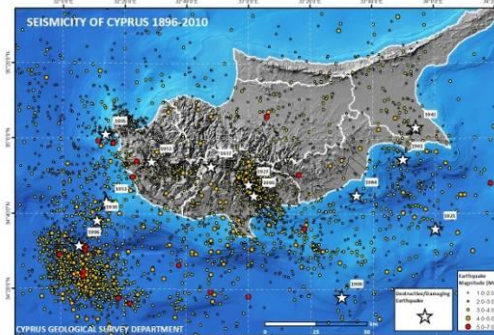
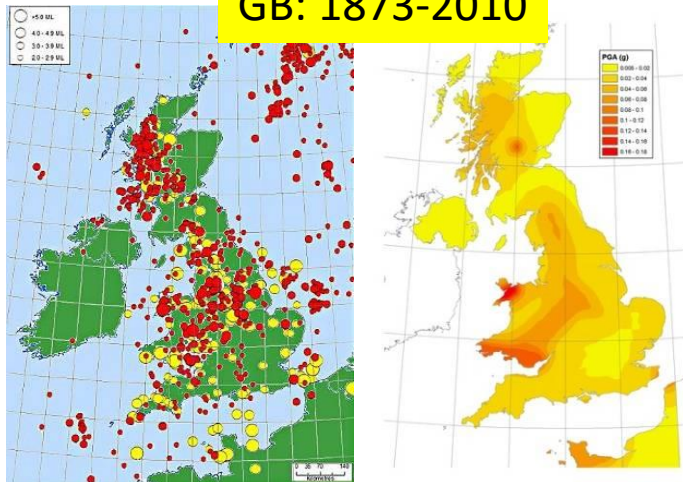
IT: 1000-2006



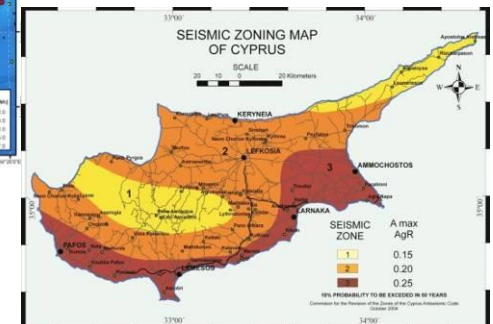
ES: 1019-2003



GB: 1873-2010



CY: 1896-2010



Demonstration sites

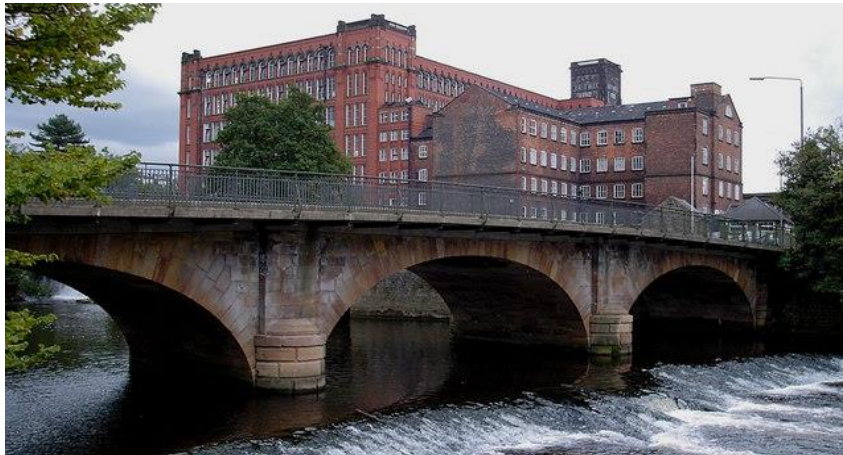
Historic Centre of Rome (Italy)



Alhambra (Spain)



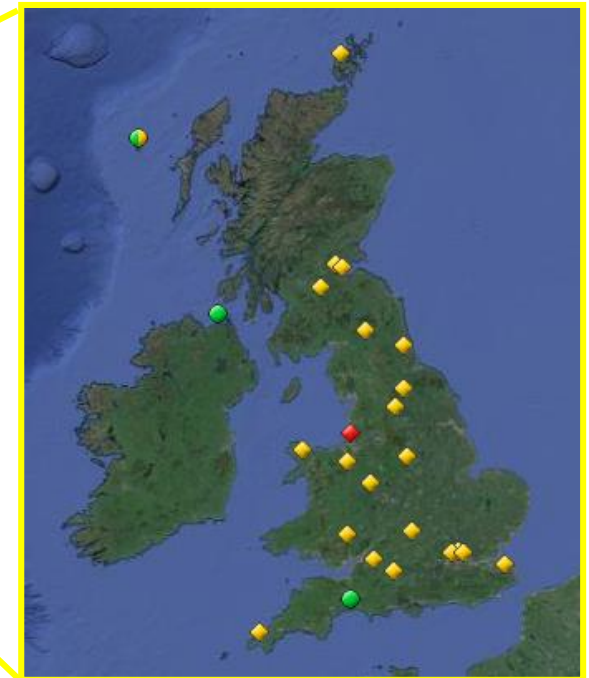
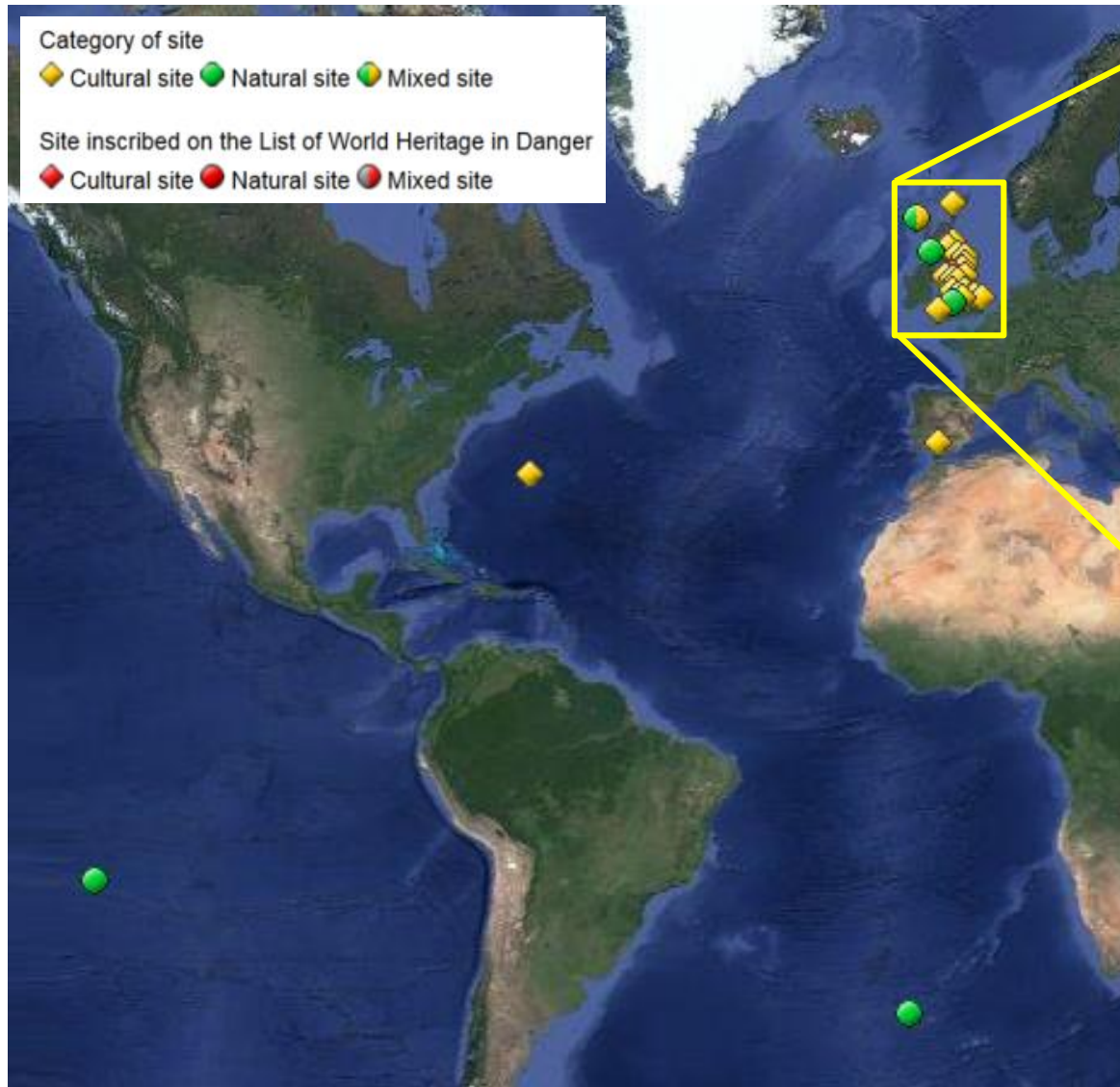
Derwent Valley Mills (UK)



Choirokoitia (Cyprus)



UNESCO WHS in the UK



- 26 in Great Britain & N. Ireland
- 4 overseas
- 25 Cultural heritage
- 4 Natural heritage
- 1 Mixed
- 1 in Danger



Liverpool – Maritime Mercantile City

UNESCO WHS in the UK: geology

CIGNA et al. (2016) *SPIE Proceedings*

 UNESCO WHL sites

Sedimentary rocks

Cenozoic

Quaternary, Neogene and Palaeogene

Mesozoic

Cretaceous

Jurassic

Triassic

Palaeozoic

Permian

Carboniferous

Devonian

Silurian

Ordovician

Cambrian

Upper Proterozoic

Neoproterozoic

Metamorphic rocks

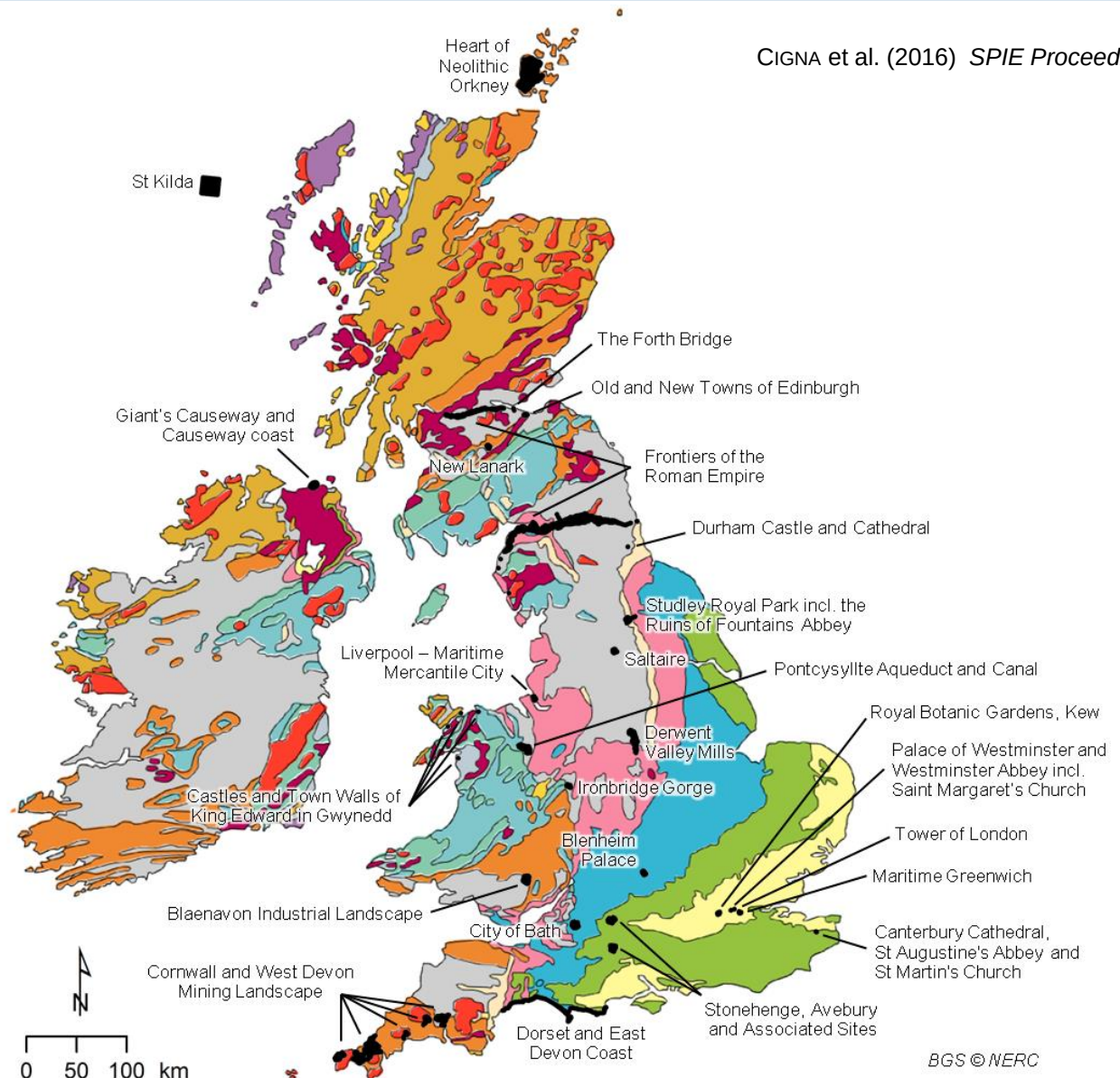
Lower Palaeozoic and Upper Proterozoic

Lower Proterozoic and Archaean

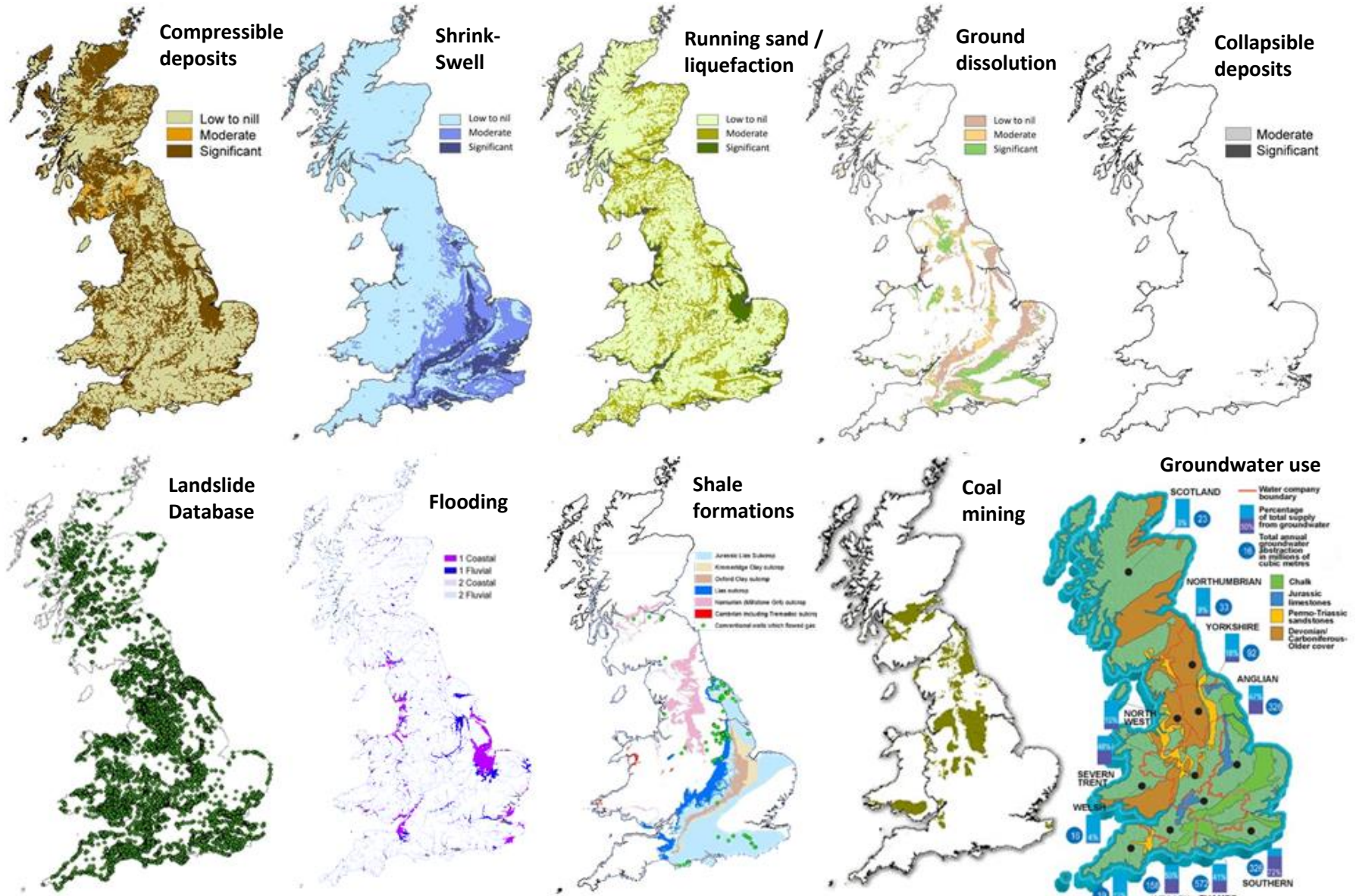
Igneous rocks

Intrusive

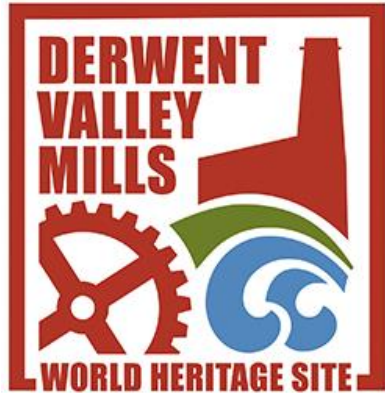
Volcanic



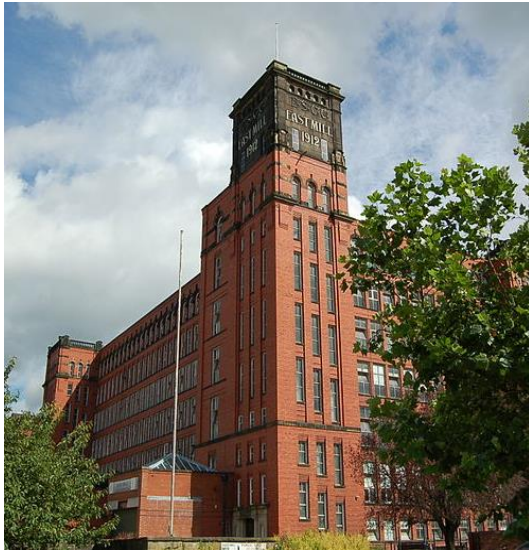
Geohazards: natural and human-influenced



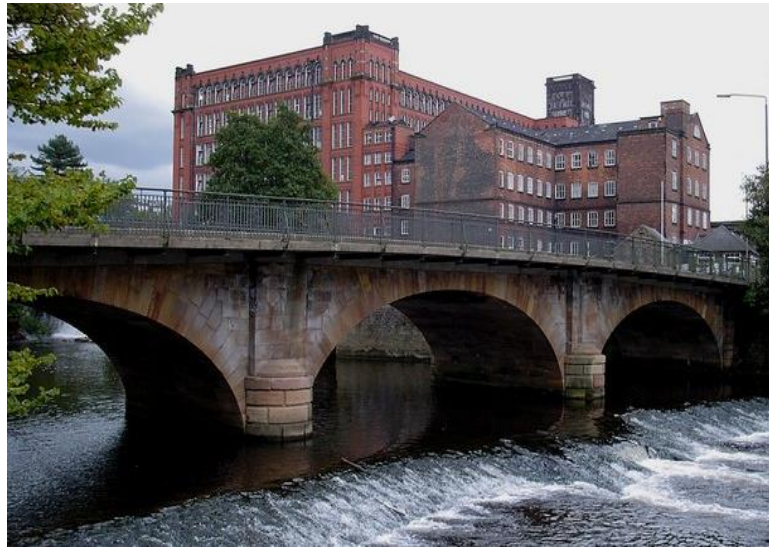
Derwent Valley Mills: heritage



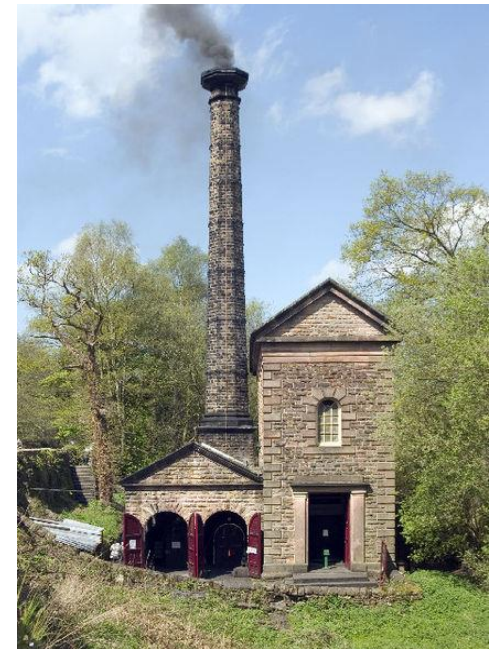
- Development of manufacturing industry and technological innovation
- Birth of the factory system; new types of building were erected to house ground-breaking technology for water-powered manufacturing
- First modern industrial communities; mill owners provided housing and facilities to attract and retain a workforce



East Mill, Belper



North Mill, Belper



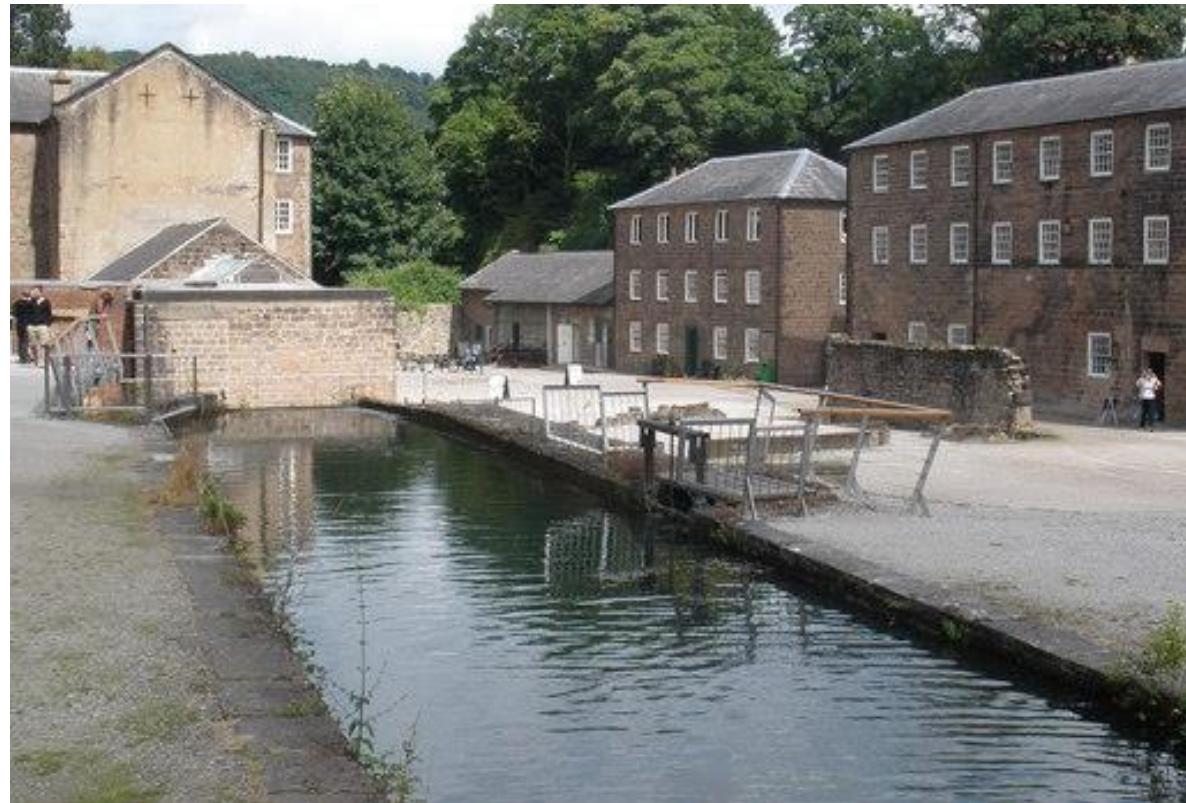
Leawood pumphouse

Derwent Valley Mills: heritage

- The site contains a fascinating series of mill complexes, the watercourses that powered them and the settlements developed for workers
- The factory system of the DVM was copied in many parts of Britain and abroad



Cromford Mill



Derwent Valley Mills: geohazards

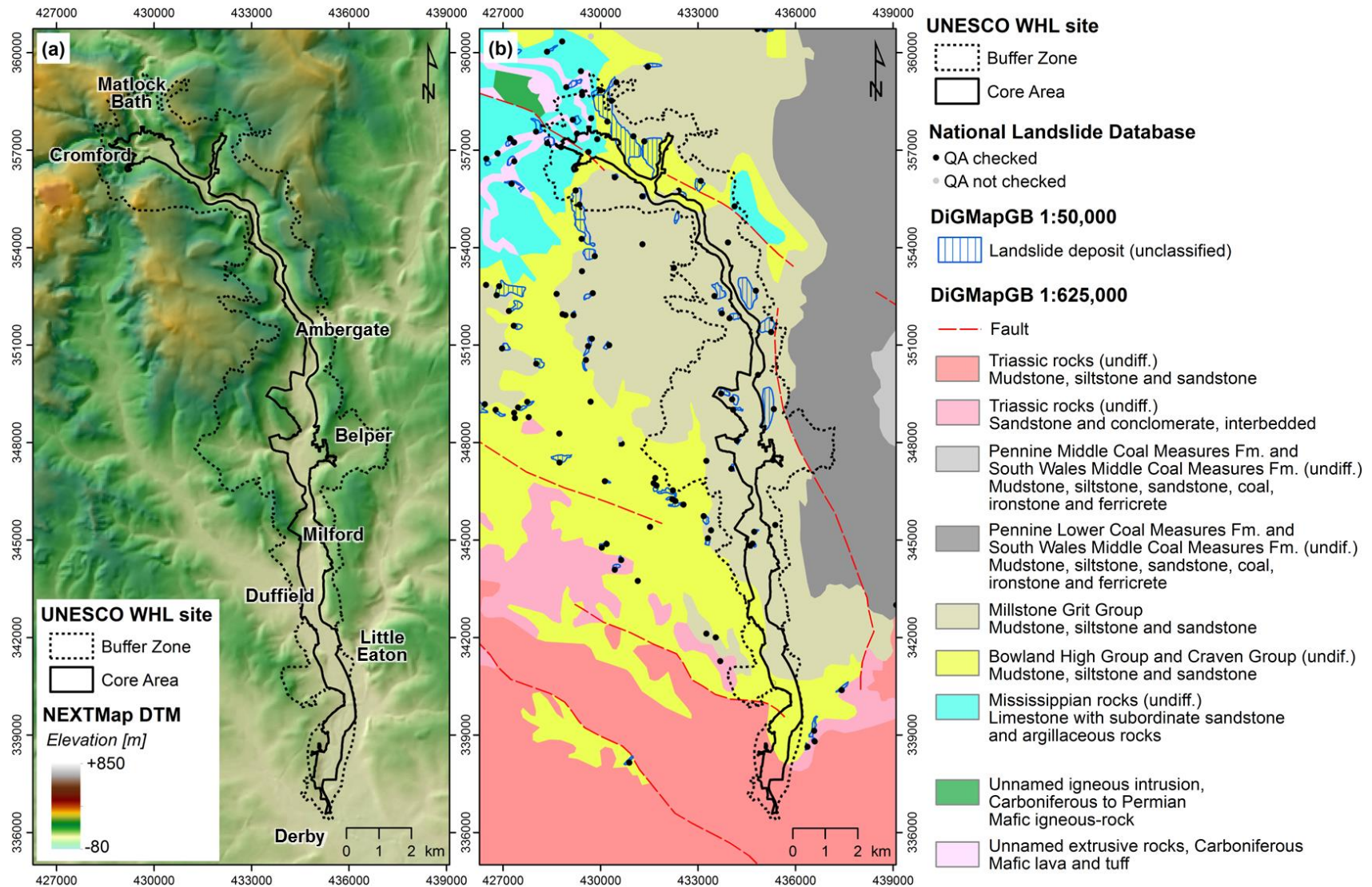
Derby Silk Mill (April 2013)



The river Derwent in flood in Belper (Jan 2013)

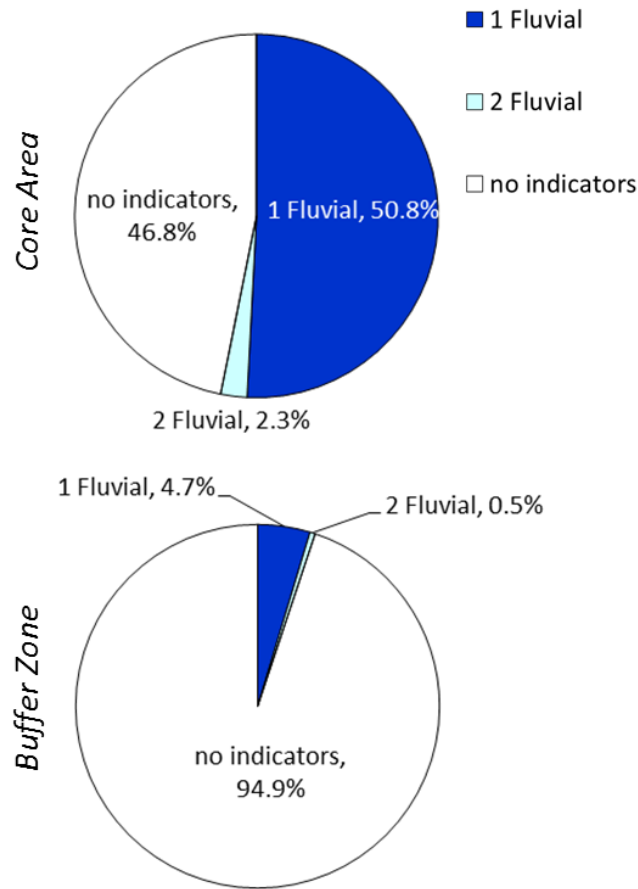


Derwent Valley Mills: geohazards

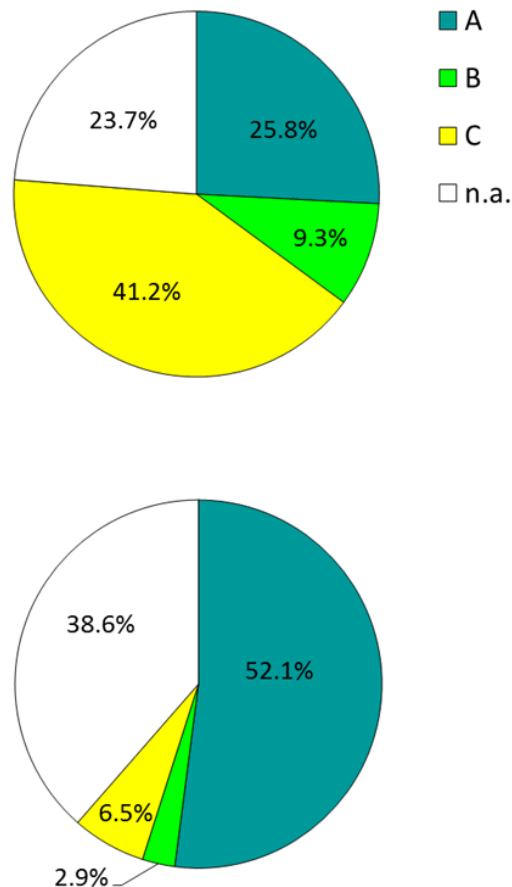


Derwent Valley Mills: geohazards

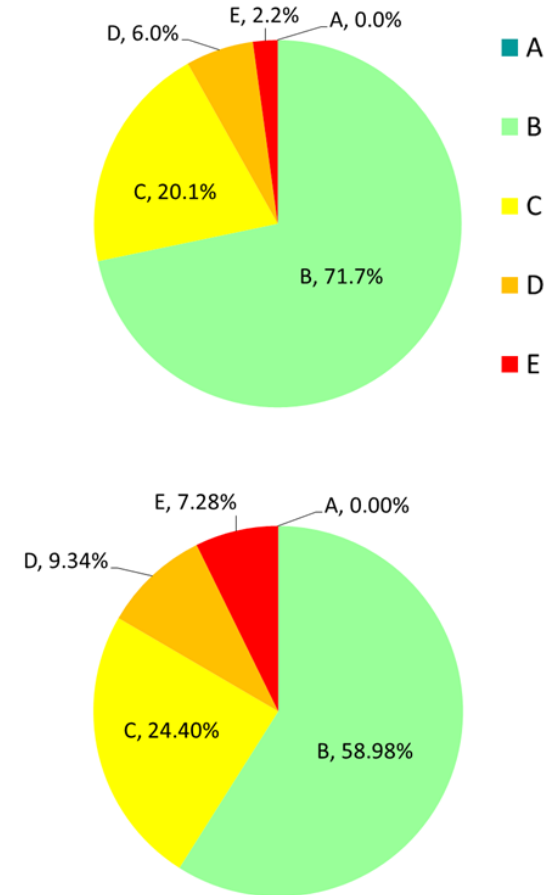
(a) Geological Indicators of Flooding



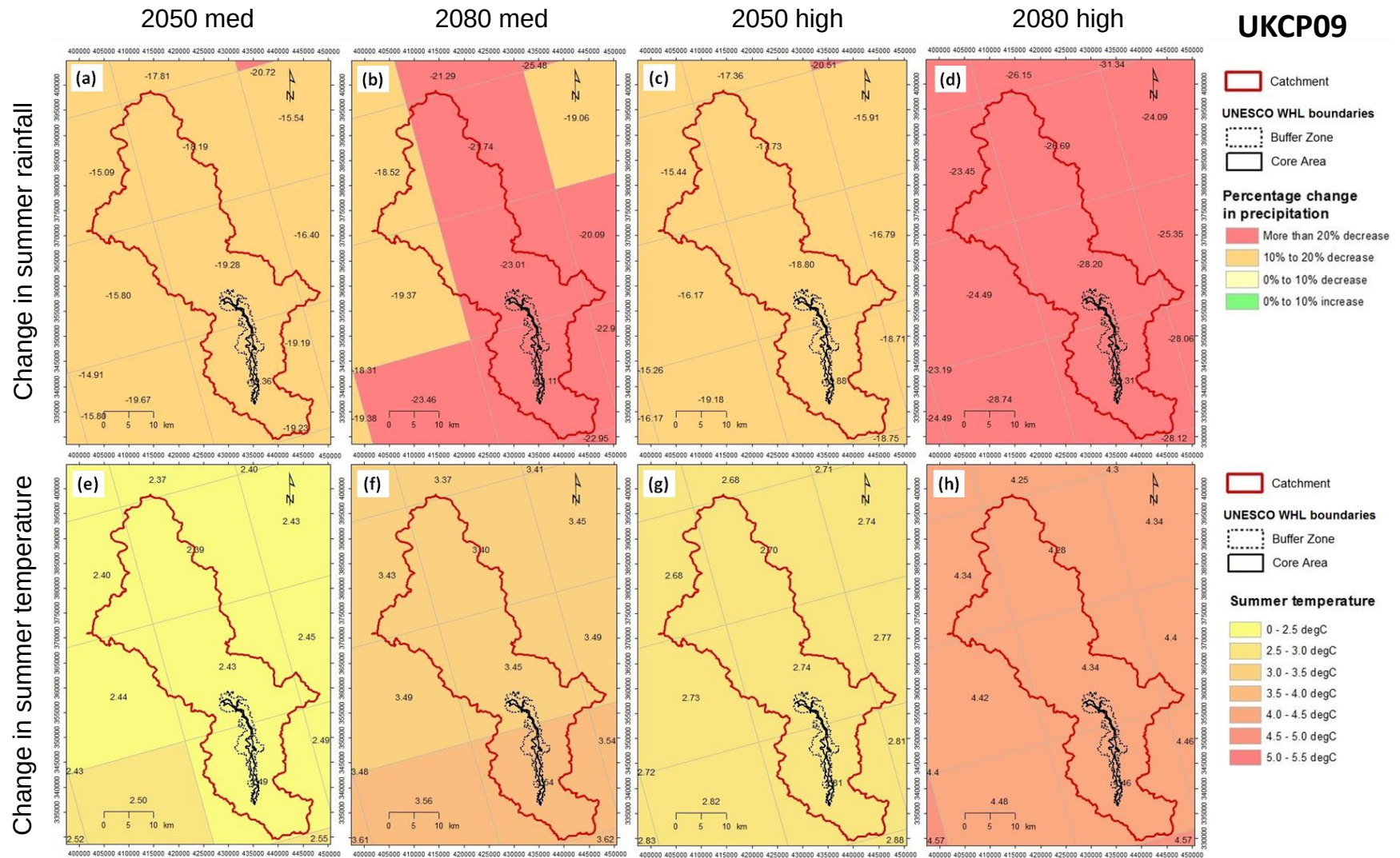
(b) Susceptibility to Groundwater Flooding



(c) Landslide susceptibility



Derwent Valley Mills: climate change

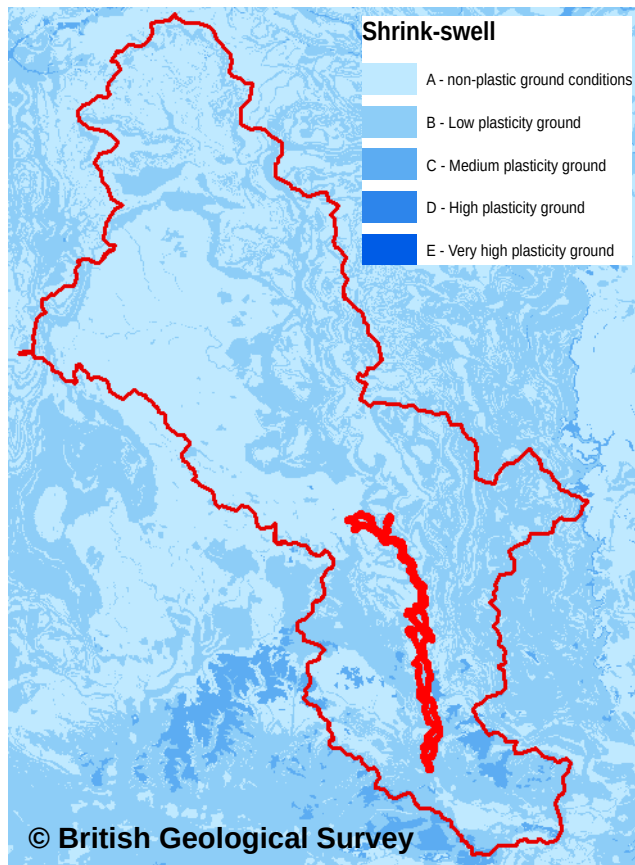


In 2050 and 2080, the catchment is projected to experience drier warmer summers, wetter winters, higher intensity winter rainfall.

Derwent Valley Mills: climate change

Subsidence

- Clay shrink-swell is controlled by variations in soil moisture, driven primarily by rainfall
- Drier weather and increased summer temp. can exacerbate drying out and favour shrinkage
- Impacts to buildings and infrastructure might occur

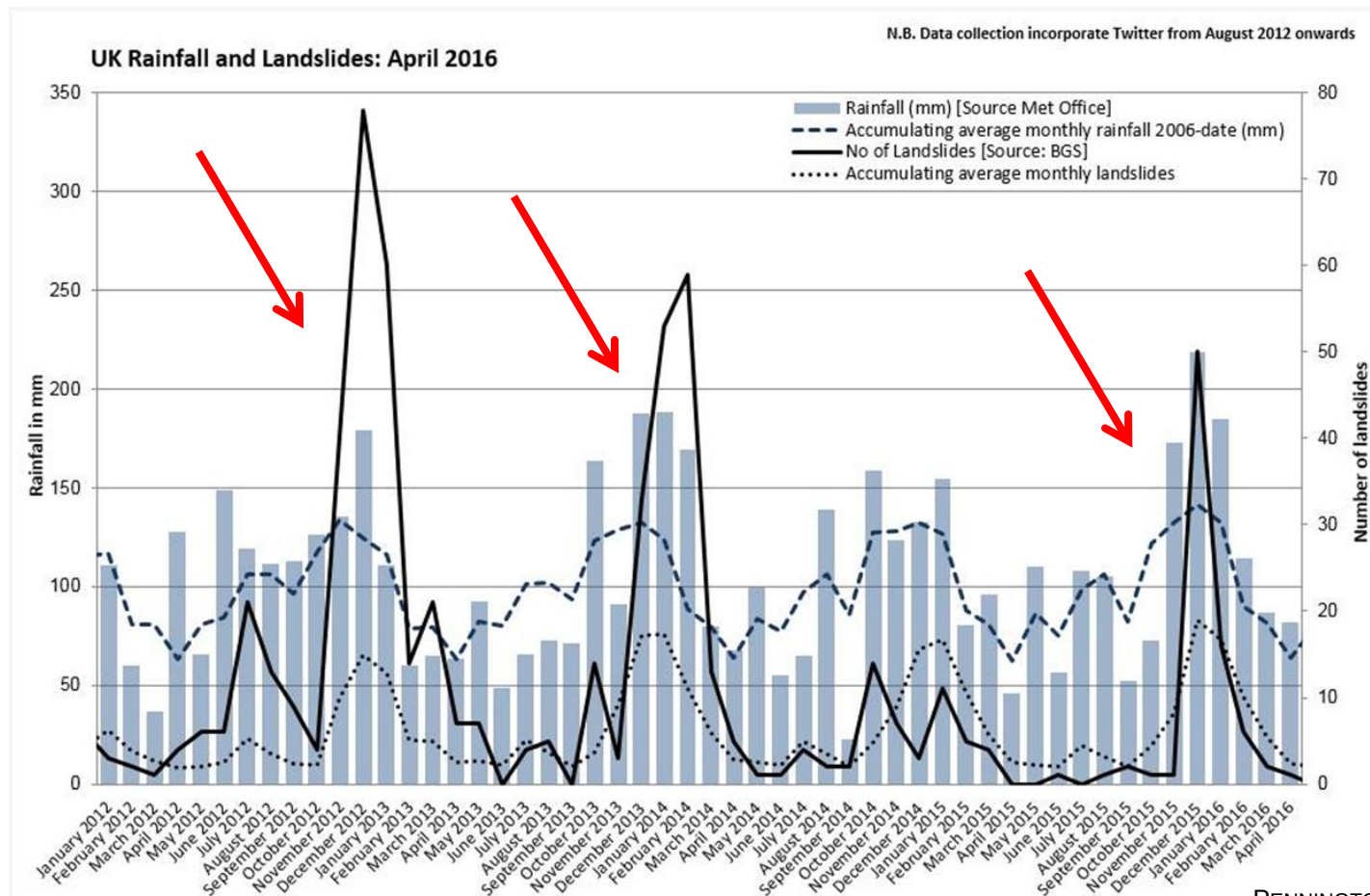


Mill foundations (18th-19th centuries) might have difficulties withstanding enhanced ground movement that may occur through climate change

Derwent Valley Mills: climate change

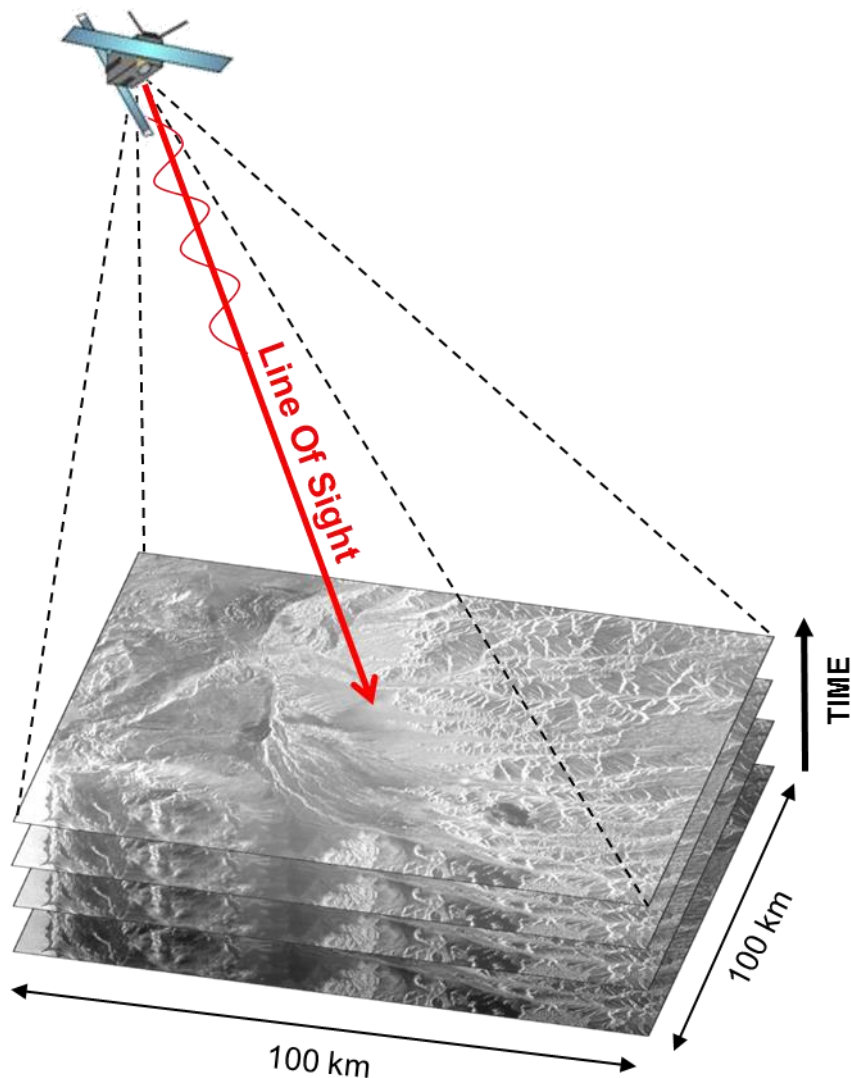
Landslides

Shallow translational and rotational landslides are strongly controlled by antecedent effective rainfall, with increases in susceptibility following a high intensity rainfall event

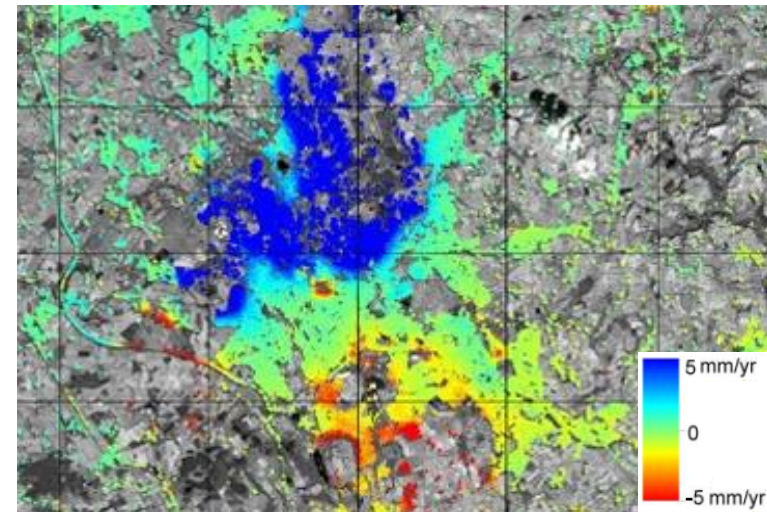


Increased winter high intensity rainfall will lead to increased susceptibility to associated landslide-prone areas

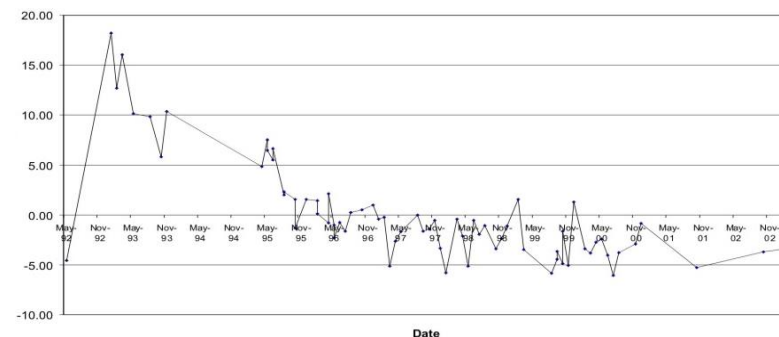
Persistent Scatterer Interferometry



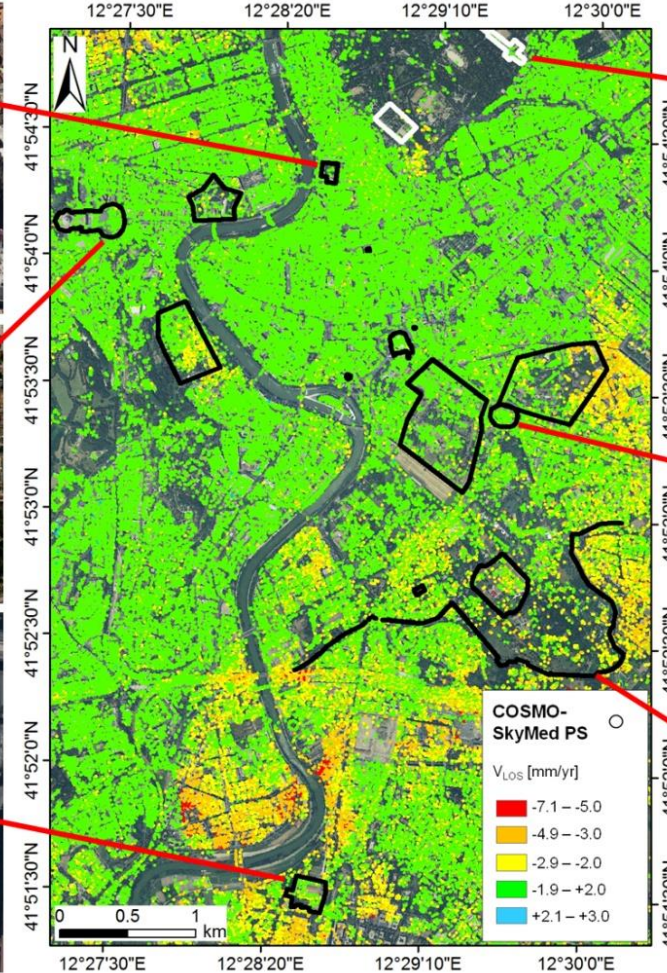
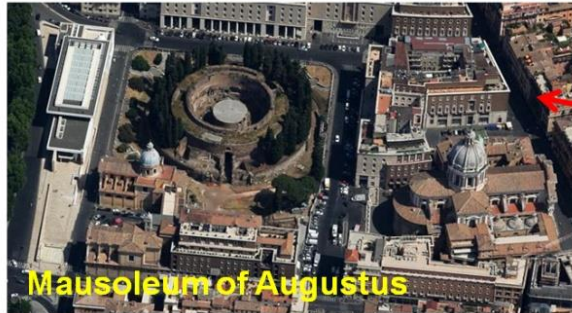
Average motion velocity
(precision up to ~ 0.1 mm/yr)



Motion time-series
(precision up to ~ 1 mm)



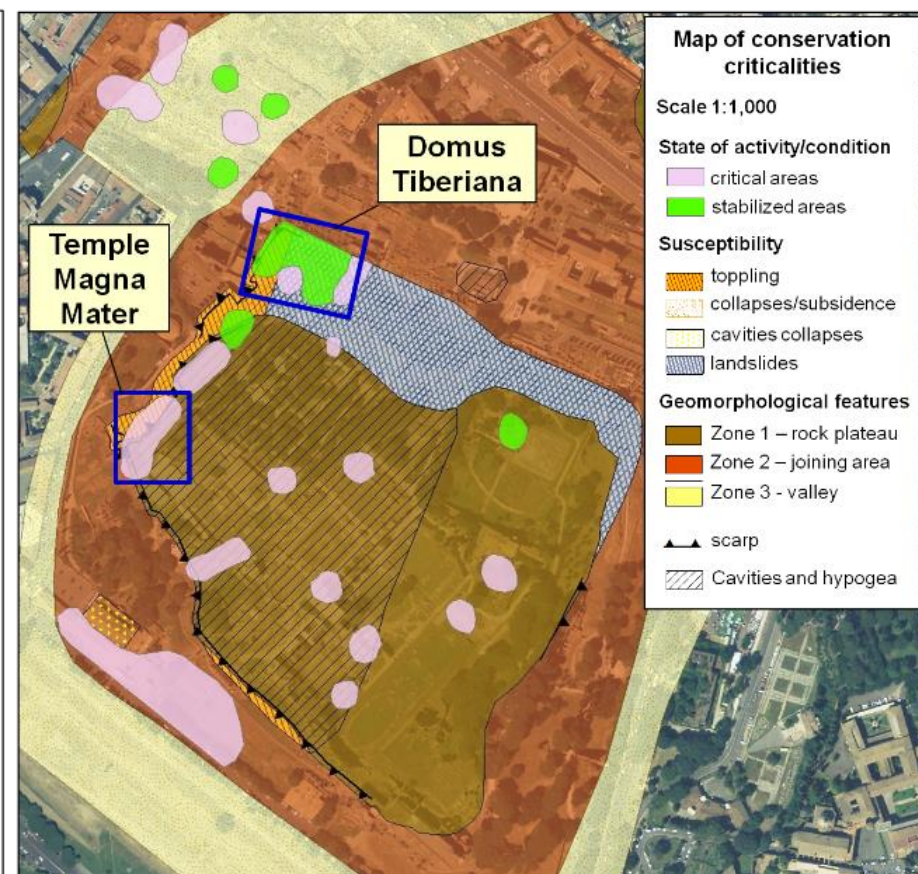
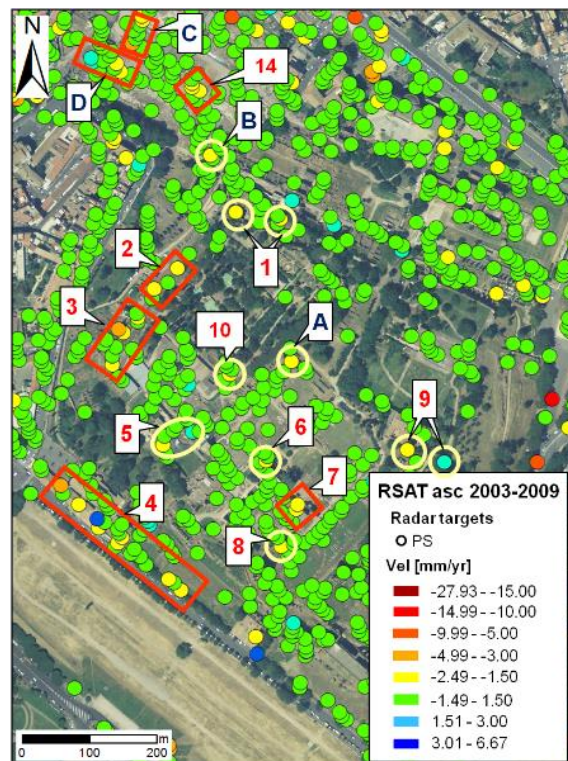
Case studies: Rome, Italy



CIGNA et al. (2014) *Remote Sensing*

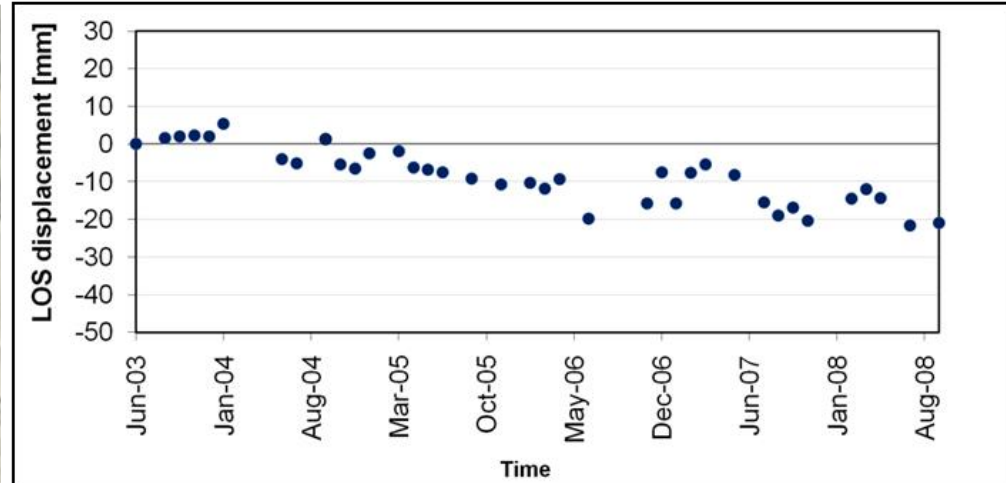
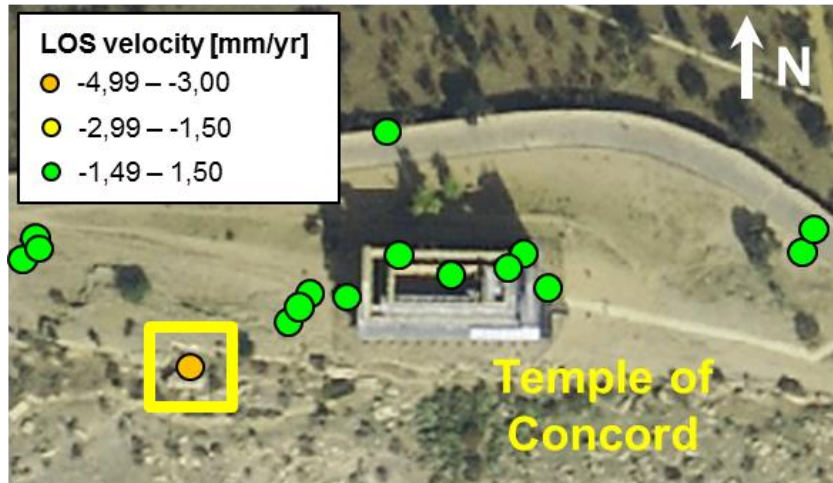
Case studies: Rome, Italy

- Land subsidence and compressible soils (high occurrence across Europe)
- Slope instability, local collapses
- Identification of most endangered sectors



Valley of the Temples

- WHL site since 1997 (stand-alone monuments)
- Rockfall, topples, lateral spreads
- Ground motion velocities and time series analysis

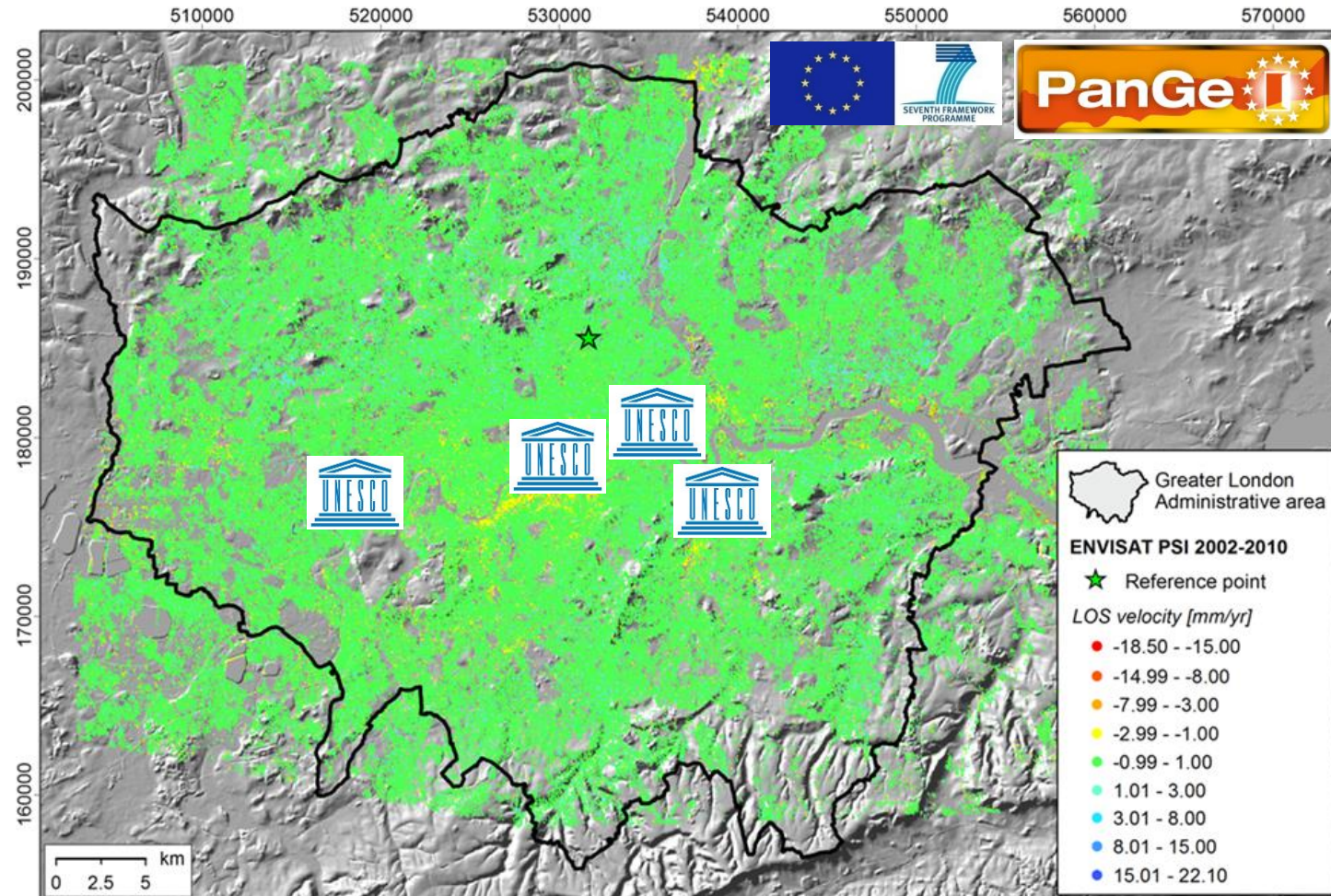


TAPETE D. & CIGNA F. (2012) *Materials Research Congress*

Case studies: London, UK

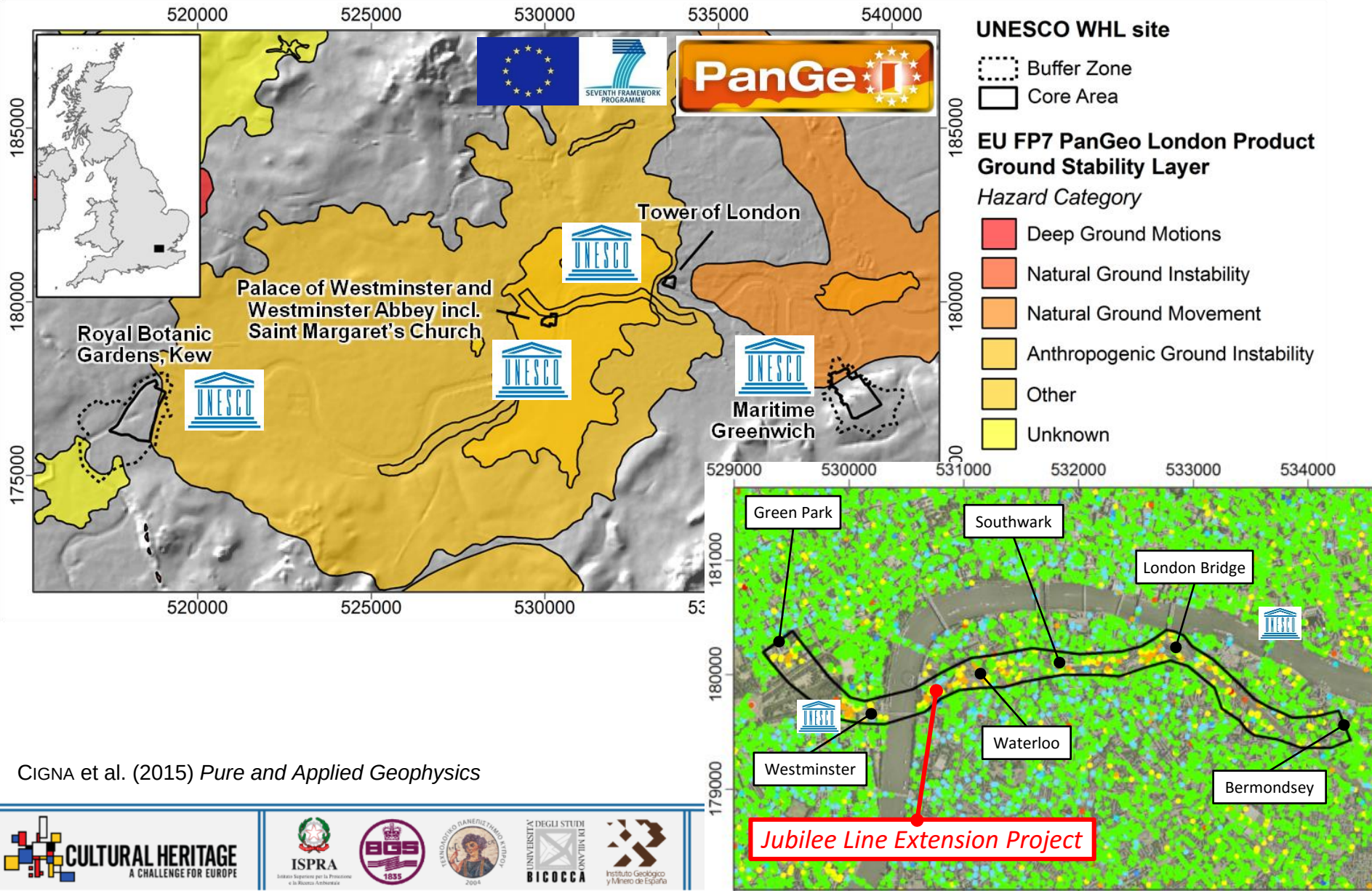
Urban heritage

- 4 WHL sites spread across the city
- Ground motion information for 1990s & 2000s
- Natural and anthropogenic geohazards
- Generated geologically interpreted product from PSI ground motion



CIGNA et al. (2015) *Pure and Applied Geophysics*

Case studies: London, UK



CIGNA et al. (2015) *Pure and Applied Geophysics*

By mid 2018, PROTHEGO will:

- **Map geohazards in the 400+ WHL sites of Europe** using geological and satellite InSAR ground motion data
- Generate a baseline layer **identifying potential threats** to each WHL site at European-scale
- **Downscale** to national and local scales using high-resolution datasets
- **Demonstrate the approach at local scale** through advanced monitoring, geotechnical modelling, and validation of InSAR techniques
- **Publish ATLAS** of European UNESCO sites and geohazards
- Promote the use of InSAR to **enhance cultural heritage management practices** and strengthen disaster preparedness at heritage properties in the future



PROTHEGO

Protection of European Cultural Heritage from Geo - Hazards



Home

Project

News

Partners

Downloads

Partners area

Home

Latest news

4–8 April 2016

PROTHEGO's second project meeting

24–26 February 2016

From Stone Age to Space Age keynote lecture

04 December 2015

User consultation workshop

12–13 November 2015

ESA's workshop "Advances in remote sensing for cultural heritage: from site detection, to documentation and risk monitoring"

28–30 October 2015

EOEG annual meeting and landslide/subsidence EuroGeoSurveys (EGS) working group

Tweets by @PROTHEGO

JPI-CH PROTHEGO

Rebroadcast

Welcome to PROTHEGO

PROtection of European Cultural HERitage from GeO-hazards



Funded in the framework of the Joint Programming Initiative on Cultural Heritage and Global Change (JPICH) – HERITAGE PLUS, under ERA-NET Plus and the Seventh Framework Programme (FP7) of the European Commission, the project PROTHEGO aims to make an innovative contribution towards the analysis of geohazards in areas of cultural heritage in Europe.

Tangible cultural heritage includes various categories of monuments and sites, from cultural landscapes and

Funding



Ministero
dei beni e delle
attività culturali
e del turismo



www.istruzione.it



Arts & Humanities
Research Council



Research
Promotion
Foundation



Twitter: @PROTHEGO



Home About

Search Twitter



Have an account? Log in



TWEETS 399 FOLLOWING 44 FOLLOWERS 63 LIKES 471

Follow

JPI-CH PROTHEGO

@PROTHEGO

Official account of the JPI-CH Heritage Plus project PROTHEGO, posting updates about the project and news on UNESCO WHL heritage & geohazards sensed from space

prothego.eu

Joined March 2016

19 Photos and videos



Tweets Tweets & replies Media



JPI-CH PROTHEGO @PROTHEGO · Jun 4

PROTHEGO uses #space #radar to assess Europe's #heritage sites
[@DVMillsWHS tinyurl.com/zgcgatu](https://tinyurl.com/zgcgatu)



Trends

#WorldRefugeeDay

30.7K Tweets

#summersolstice

11.8K Tweets

#TohChaleinKyaMumbai

Started trending in the last hour

#LDNTechWeek

Trending for 2 hours now

100% FDI

Started trending in the last hour

#FlexballSuccessSutra

Trending for 2 hours now

Baroness Warsi

12.6K Tweets

Thoko Didiza

Started trending in the last hour

MAKE WAY FOR SULTAN

Trending for 4 hours now

Mumbai and Hyderabad

NEWS

Find local news 

Home

UK

World

Business

Politics

Tech

Science

Health

Education

Entertainment & Arts

Video & Audio

More ▾

Science & Environment

Space radar to assess Europe's historic sites

By Jonathan Amos
BBC Science Correspondent

🕒 5 May 2016 | [Science & Environment](#)



Top Stories

Osborne: EU exit threatens 820,000 jobs

George Osborne's Treasury says leaving the EU would tip the UK into recession, but Boris Johnson says the study is "more propaganda".

🕒 3 hours ago

Curry boss jailed over peanut death

🕒 44 minutes ago

Van Gaal sacked as Man Utd manager

🕒 1 hour ago

Features



PROTHEGO USES SPACE RADAR

to assess Europe's heritage sites



PROTHEGO

Protection of European Cultural Heritage from Geo - Hazards

PROTHEGO USES SPACE RADAR TO ASSESS EUROPE'S HERITAGE SITES

The Derwent Valley Mills World Heritage Site is delighted to be a part of a new project to assess the geological hazards facing the 400+ European monuments and sites of the UNESCO World Heritage List.

Known as PROTHEGO, the initiative will run for two years. Data from radar satellites will be used to map the ground movements that might threaten these historic places. The aim is to produce a monitoring "toolkit" that UNESCO and national authorities can use in the future management of World Heritage Sites worldwide.

Related



Places to visit



Getting there



Events

Category

Belper

Book

Community Groups

Derby

Volunteers

Refine by Date

May 2016 (4)

April 2016 (4)

March 2016 (3)



PROTHEGO

Protection of European Cultural Heritage from Geo - Hazards

Dr Francesca Cigna

British Geological Survey

fcigna@bgs.ac.uk



www.prothego.eu



@PROTHEGO