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PROTHEGO

Protection of European Cultural Heritage from Geo - Hazards

JPI-CH Heritage Plus collaborative research project [2015-2018]

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WP2: Harmonisation of available PS data, and creation of digital factsheets

Deliverable: D.02.02

Digital Factsheets with ground stability information for each World Heritage Listed (WHL) site

Version 1.1

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Author(s):	BEE, E.J., SMITH, N.A, HULBERT, A [BGS, NERC] LEONI, G.[ISPRA]	23/05/2018
Reviewed by:	Spizzichino, D [ISPRA]	24/05/2018
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The point locations of the World Heritage Listed (WHL) sites and the descriptive data about these sites were freely, and openly, obtained from UNESCO at the start of the project in 2015. The point data is made available by UNESCO and the following copyright statement references this data within the mapviewer and within this document : Copyright © 1992 - [2015] UNESCO/World Heritage Centre. All rights reserved.

Revision history

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1.1	24/05/2018	BEE, E.J.	Minor edits made after document review.

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Executive summary

The main objective of work package 2 was to define, catalogue and assess available (and processed) InSAR and Persistent Scatterer (PS) datasets for the European UNESCO WHL sites using existing information from satellite InSAR ground motion datasets. This information would allow the team to create digital factsheets for each UNESCO WHL site within Europe, highlighting the information available (and where it is not) and the potential susceptibility of the location to a selected number of geohazards. This report gives an overview of the digital factsheets (D02.02) that have been created for the PROTHEGO project and which are accessible via the PROTHEGO website's map viewer – <http://www.prothego.eu/>

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1 Introduction

The main objective of work package 2 was to define, catalogue and assess available (and processed) InSAR and Persistent Scatterer (PS) datasets for the European UNESCO WHL sites using existing information from satellite InSAR ground motion datasets. This information would allow the team to create digital factsheets for each UNESCO World Heritage Listed (WHL) site within Europe, highlighting the information available (and where it is not) and the potential susceptibility of the location to a selected number of geohazards. This report gives an overview of the digital factsheets (D02.02) that have been created for the PROTHEGO project and which are accessible via the PROTHEGO website's map viewer – <http://www.prothego.eu/>

The PROTHEGO team offer the map viewer as a useful resource for users to obtain a general overview about some of the different geohazards affecting WHL sites in Europe and the satellite information available for them (up to the end of 2016). The point locations of these WHL sites and the descriptive data about these sites were freely, and openly, obtained from UNESCO at the start of the project in 2015 and are 'Copyright © 1992 - [2018] UNESCO/World Heritage Centre. All rights reserved.' As part of PROTHEGO, the outlines of the polygons delimiting the Core Zone, Buffer area and Area of Interest for each WHL site, and their component parts, has been collected or digitised by the PROTHEGO team, as such, they have not been verified by UNESCO, and have not been updated since their initial capture. Whilst every effort has been made to provide useful and accurate information, based on the knowledge openly available to the PROTHEGO consortium, information can very quickly and easily become outdated or obsolete. We therefore advise that the map viewer is used with caution and for obtaining a general overview about the perceived hazards and satellite information affecting the WHL sites only. Where more detailed and/or up-to-date information is required, users should seek this directly from the WHL site or UNESCO. Information about the hazards (and the level of hazard) affecting each WHL site has been obtained from various European datasets (*Giardini, D., et al. 2013, Giardini, D. et al, 2014* and European Soil Data Centre (ESDAC) (2017) The base maps used in the map viewer and in the images of the map viewer in this document are provided by ESRI for the ESRI community to use under ESRI's Master license Agreement ©ESRI.

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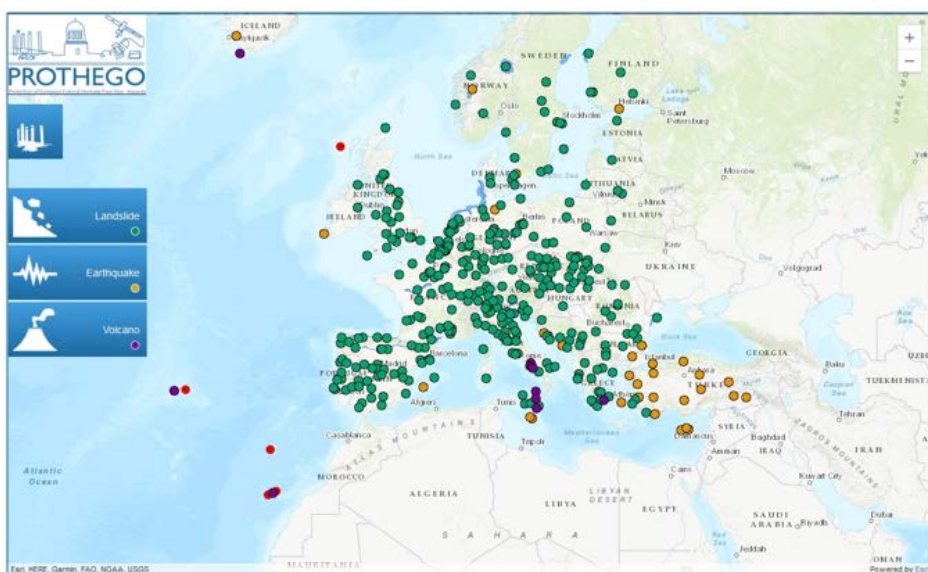
2 Using the map viewer

2.1 The map interface

When the map viewer is opened, the image, as shown in figure 1 is displayed. If users wish to view where hazards (volcanic, earthquake and landslides) are perceived to exist (using European scale data) they can toggle on or off the buttons on the left as demonstrated in Figures 2 and 3.



Figure 1: An image of the map viewer when it is first opened, showing all the World Heritage Listed sites in Europe as points (as of 2015).



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Figure 2: Toggling on/off the world heritage listed site points which represent the three different hazards that are represented by European level data (landslides, earthquake and volcanic hazards). Some points are affected by more than one hazard, but the top most hazard will be displayed if all three toggles are on.

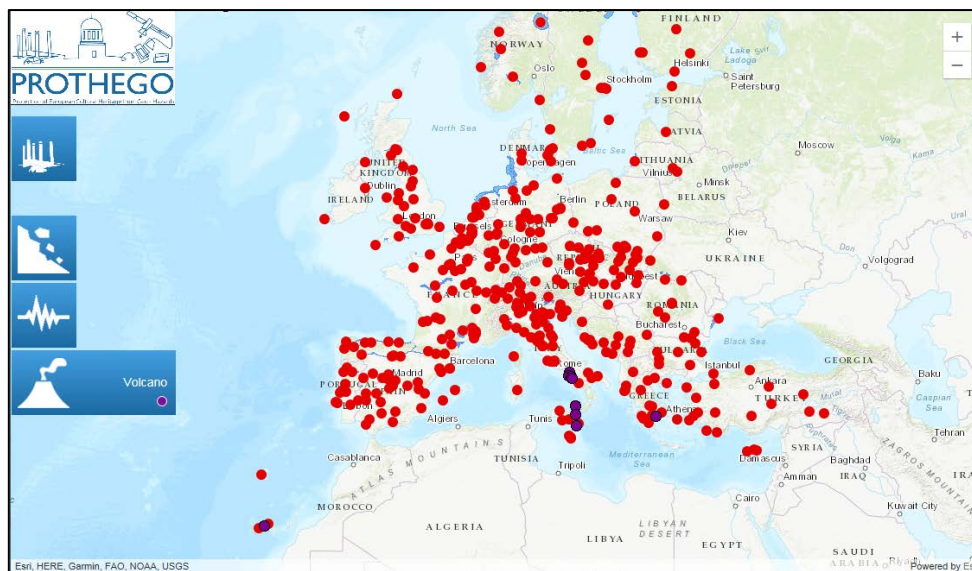
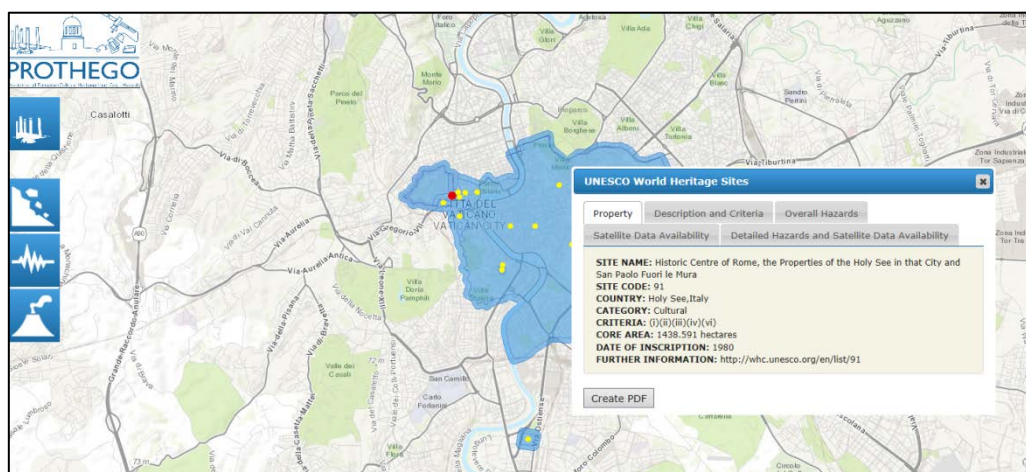


Figure 3: Toggling on/off the World Heritage Listed site points which represent the volcanic hazard risk that are represented by European level data. Where there is no perceived hazard, points are displayed in red.

The user is able to click on a WHL site point to find out more information about the site. Once clicked, the application zooms the user into the extent of the world heritage site and a dialogue box with attribution appears (figure 4). If the World Heritage site has a number of different assets or core and buffer areas associated with it, yellow points will appear in the viewer to represent these. The user can click on these to obtain further information.



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Figure 4: The user clicks the World Heritage Listed site and the application zooms the user into the extent of the selected world heritage site. A dialogue box with attribution appears. Where there are several assets within a designation, such as the historic centre of Rome displayed in this image, those sites have a yellow point which the user can select to find yet further information.

2.2 The dialogue boxes with attribution information

The dialogue boxes of information that appear having selected a WHL site from the opening screen contain information about the site (including description and criteria), its overall hazard susceptibility level and an idea about the types of processed satellite data available for the site (as of end of 2016). Examples are shown in figures 5a-f.

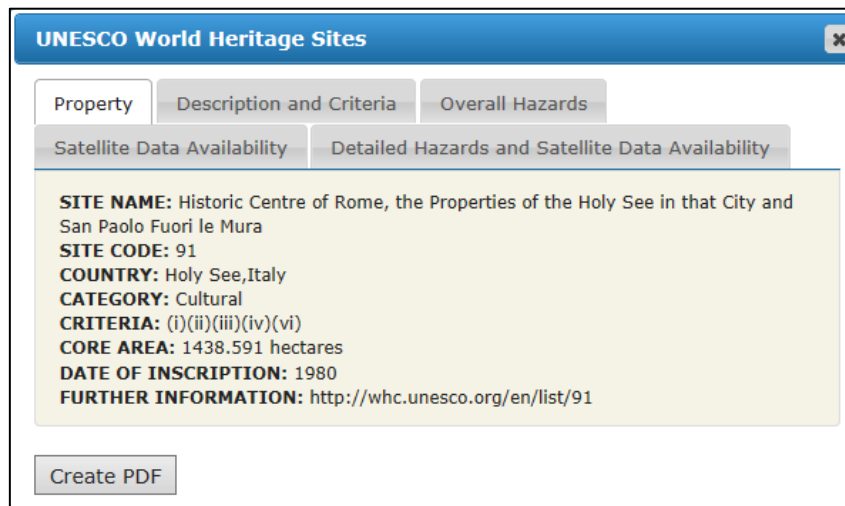
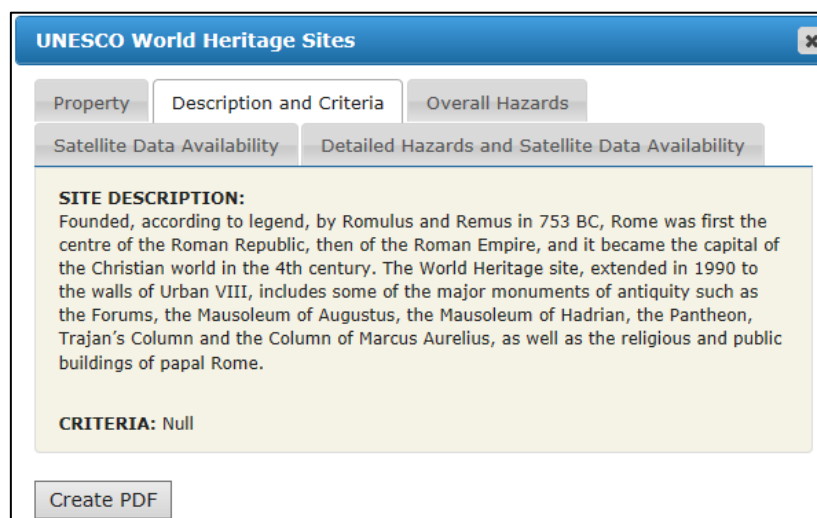


Figure 5a: The dialogue box presents information about the World Heritage Listed site. This information has been obtained directly from downloading data from UNESCO (UNESCO, 2016).



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Figure 5b: The description and criteria tab on the dialogue box describes the World Heritage Listed site and the criteria used to classify the site if available. This information has been obtained directly from downloading data from UNESCO (UNESCO, 2016).

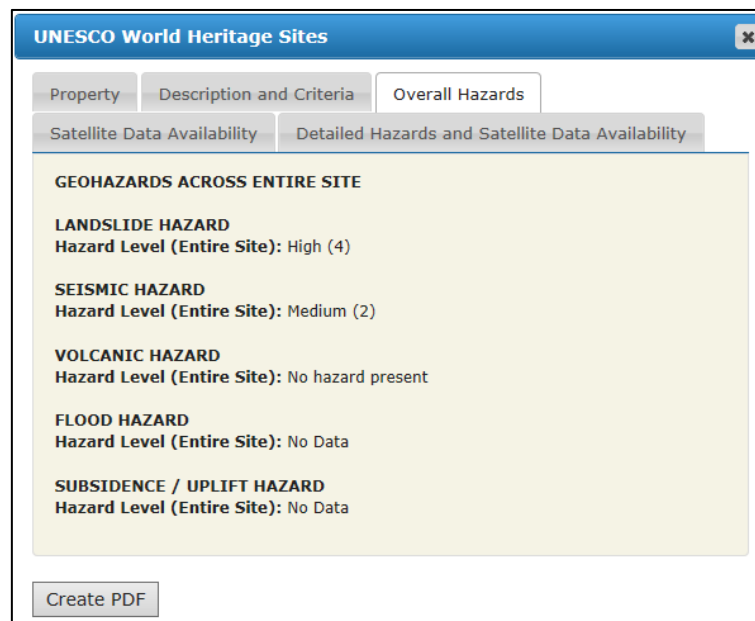


Figure 5c: The overall hazard tab on the dialogue box describes the overall susceptibility level of a geohazard occurring (hazard susceptibility) in the World Heritage Listed site based on information obtained from European datasets. See appendix A for full descriptions of attributed information.

The information displayed in the dialogue box shown in figure 5c is taken from data obtained from European geo-hazard maps derived out-with the PROTHEGO project. Landslide hazard refers to the 'Classified European Landslide Susceptibility map v1.0' (ELSUS1000), referenced in Panagos (2012) and the European Soil Data Centre (ESDC). The classification of hazard given to the WHL site, is a rating of either between 1 (very low), 2 (low), 3 (moderate), 4 (high), or 5 (very high). Where several ratings appear across the core or buffer area of a site, the highest (maximum) rating is reported in this dialogue box.

Seismic hazard was taken from data compiled by the 'Seismic Hazard Harmonization in Europe' (SHARE) project (Giardini, D., et al. 2013, Giardini, D. et al, 2014). The Peak Ground Accelerations were classified into 4 classes (-1 = NoData; 1 = Low; 2 = Moderate; 3 = High) as shown in table 1. The ranges to form these classes are discussed in Spizzichino (2016). Where several ratings appear across the core or buffer area of a site, the highest (maximum) rating is reported in the dialogue box.

Table 1: Seismic hazard levels classified by three SHARE ranges of PGA

Seismic Hazard	Peak Ground Acceleration (g)
Low	$ag < 0.10$
Moderate	$0.10 < ag < 0.25$
High	$ag > 0.25$

As Spizzichino et al. (2016) discuss, Volcanic hazard assessment of WHL Sites was based on the type of volcano and its characteristic eruption style (explosive or effusive) and evolution over the time. These characteristics, along with data and maps, have been obtained from different local and international institutions and observatories. For each considered volcano, hazard maps and models were examined, then these data were cautionary interpolated to a buffer radius according to the magnitude of the known potential eruption. Given the characteristics, location and available technical literature of each volcano, two different circular buffers were preliminary defined around the vent to define the hazard level:

- high level - proximal area potentially reached by lava and pyroclastic flows and fall of bombs, tephra and ash;
- low level - distal area potentially reached only by ash fallout.

The data for volcanic hazard is therefore classified as the area having either high susceptibility to the hazard, low susceptibility to the hazard being present or no hazard present.

Flood hazard and subsidence/uplift hazard have been included in the dialogue box, with the view that should European scale data be made available for these hazards, their susceptibility ratings could be incorporated into the map viewer.

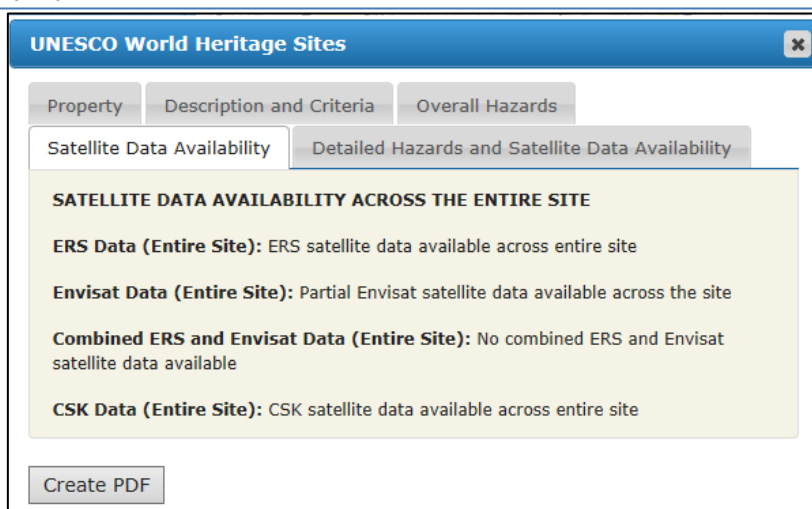


Figure 5d: The dialog box, clicked from the red point, shows information about the availability of processed satellite information.

Information about satellite data availability for each WHL site can be viewed through the dialog box (figure 5d). This information is based on data collected by the PROTHEGO project as described in Cigna, F and Tapete, D (2017). The satellites used to explore satellite data availability are listed in table 2. Where data were available, the min, max and average velocities of the data were calculated by the PROTHEGO project team and these are displayed in the dialog box alongside information about the number of points and density of points in the calculations.

Table 2: A list of satellite missions for which data availability across the European world heritage sites has been analysed by the PROTHEGO project.

Name of satellite data	Date
European Remote Sensing (ERS) satellite data	(1992-2002)
Envisat satellite data	(2002-2010)
Combined ERS and Envisat data	(1992-2010)
Cosmo-SkyMed satellite data	(2011-2014)

The final tab in the dialog box shows detailed information about the hazards present and satellite data availability for the sub parts of the WHL site. If the user has accessed the dialog box through one of the 'red' WHL site points, then the information on the tab will reflect what is shown in figure 5e.

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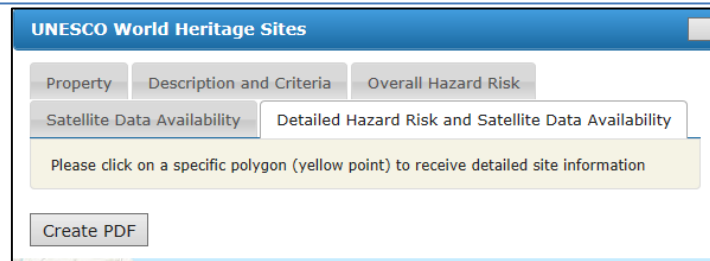


Figure 5e: The dialogue box highlights to the user that they need to select a yellow point in order to receive more detailed information about hazards present and satellite data availability.

The user will need to click one of the yellow points, which represent a sub feature within the WHL site classification, to gain some additional summary information about the hazards present and statistics about the satellite data available (figure 5f).

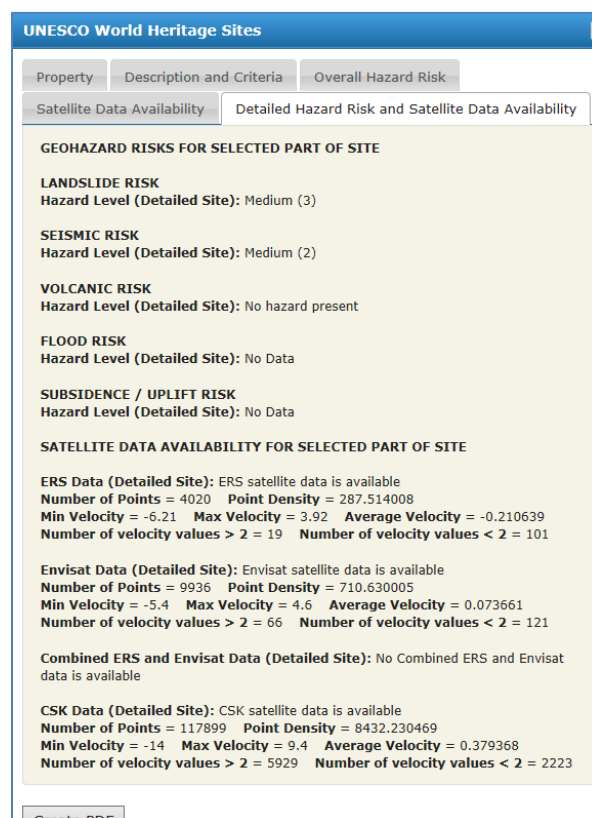


Figure 5f: The dialogue box shows more detailed information about hazards present and satellite data availability.

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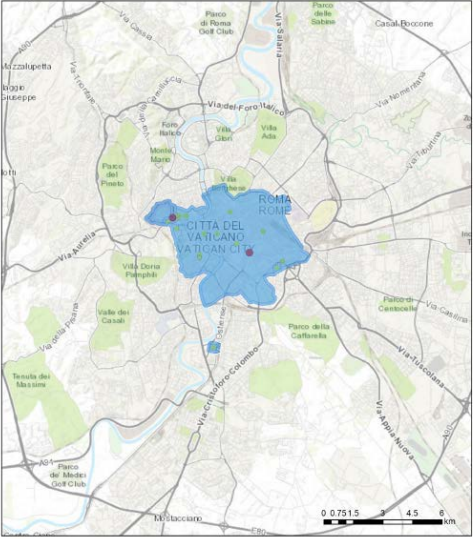
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2.3 The PDF creator

At the bottom of every dialogue box there is an option to 'create PDF'. Once the PDF has been created, the user will receive the notification in the dialogue box, as shown in figure 6, and can press the 'open PDF in new window' button to open the PDF.



Figure 6: The notification to say the PDF has been created.

<p>Historic Centre of Rome, the Properties of the Holy See in that City and San Paolo Fuori le Mura</p>  <p>Source: USGS, NOAA, NASA, COARI, GEBCO, N/Beaumar, NCEAS, NLS, OS, NINA, GeodesyLab and the GIS User Community Page(s) outline are approximate</p>	<p>Property Classification and Description</p> <p>SITE NAME: Historic Centre of Rome, the Properties of the Holy See in that City and San Paolo Fuori le Mura SITE CODE: 91 COUNTRY: Italy See Italy CATEGORY: Cultural CRITERIA: 100/109/104 CORE AREA: 1438.501 hectares DATE OF INSCRIPTION: 1980 FURTHER INFORMATION: http://whc.unesco.org/en/91/</p> <p>SITE DESCRIPTION</p> <p>Founded, according to legend, by Romulus and Remus in 753 BC, Rome was first the centre of the Roman Republic, then of the Roman Empire, and it became the capital of the Christian world in the 4th century. The World Heritage site, extended in 1990 to the walls of Urban VIII, includes some of the major monuments of antiquity such as the Forum, the Mausoleum of Augustus, the Mausoleum of Hadrian, the Pantheon, Trajan's Column and the Column of Marcus Aurelius, as well as the religious and public buildings of papal Rome.</p> <p>CRITERIA</p> <p>Null</p>
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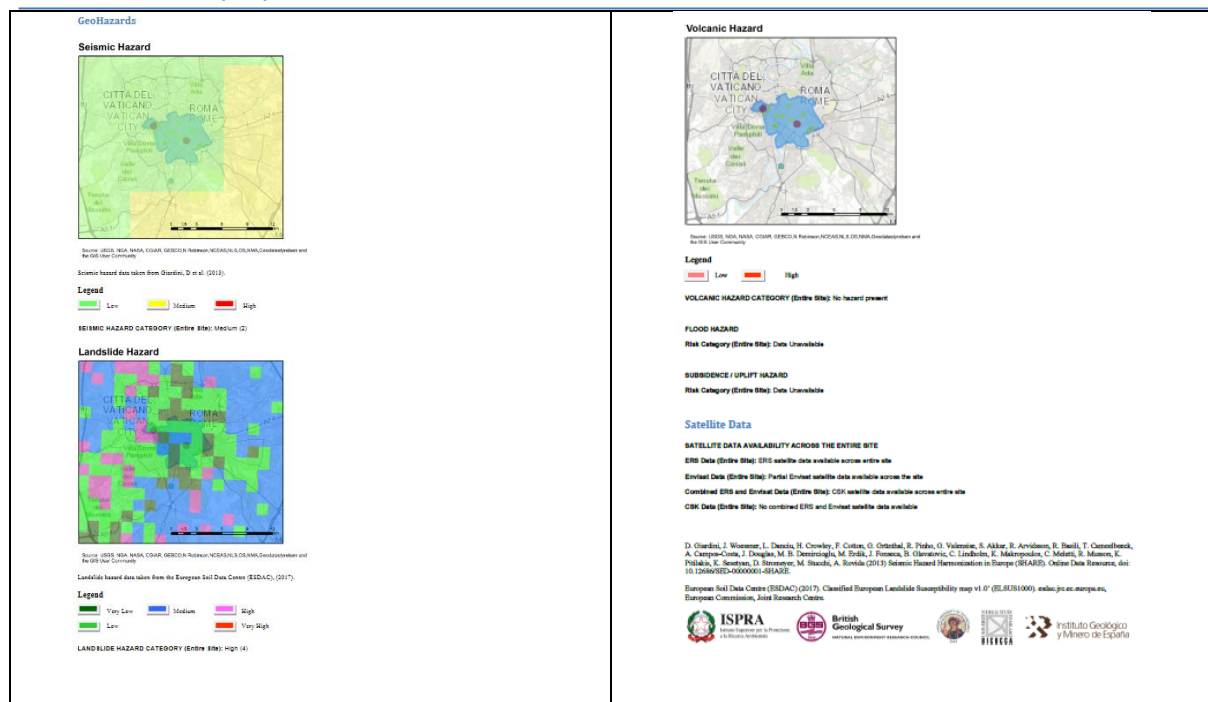


Figure 7: The pages of the PDF created through the PDF creator.

The PDF facility allows users to obtain a summary report about the WHL sites and displays the information about hazard susceptibility in a report which encompasses maps showing the European seismic, landslide and volcanic hazard map data alongside the WHL site. Once clicked, the user will be notified that the PDF creation is complete and asked to 'open PDF in a new window'.

3 Conclusions

The systematic analysis carried out in this work package has allowed the identification of the European UNESCO heritage sites not yet covered by satellite PS ground motion data, thus highlighting the knowledge gaps and suggesting in which countries these techniques can be further promoted. The collation of polygonised core and buffer areas for each WHL site, and the analysis of satellite information available for those sites, when displayed through the interactive web viewer, provides a useful (and potentially dynamic) tool for UNESCO and their WHL sites site managers. The tool enables users to observe the availability of satellite information for each site to understand whether it can be obtained and used to perform more detailed analysis from. It also provides a useful tool to highlight the presence and the level of some geohazards to these sites at a regional scale,

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