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World Heritage mapping in a standard-based structured Geographical Information System

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ABSTRACT:
This research aims at the study of the (dynamic) relationship between the World Heritage sites and the related human settlements development. Geographical Information Systems (GIS) can be useful to represent the involved information and to analyze such relationship. However, an effective harmonized structure and unique storage of possibly heterogeneous datasets is necessary to enable it. This initial step is the focus of this paper. First, the description of the structure of the related datasets and the assessment of the availability, quality, and consistency of the available information about the Heritage sites and properties is presented. Among those requirements, the quality of the associated spatial information is critical (e.g. kind of shape, accuracy, georeferencing). Second, considering the structure of the available datasets concerning the world heritage, together with the HERILAND research requirements, a global world heritage GIS is designed. The classification and data model to manage the WH list falls within the wider issue of structuring the cultural heritage documentation, involving both the definition of the semantic content and the geometric representation. In order to comply with the important requirement of data interoperability in science and to strengthen the outcomes of the research, some standardized data models and classifications are considered.

1. INTRODUCTION

1.1 The UNESCO Framework: WH list and Cities

The World Heritage (WH) List is a tool to foster heritage conservation worldwide, developed by the United Nations Educational, Scientific and Cultural Organization (UNESCO), to operationalize the 1972 Convention of Convention Concerning the Protection of the World Cultural and Natural Heritage. Today, it includes a total of 1121 heritage properties, a diverse sample of cultural, mixed and natural heritage, which were inscribed to this list, due to their acknowledged Outstanding Universal Value (OUV), by the World Heritage Committee.

Since 1978, UNESCO states parties (national governments) have been proposing cultural and natural heritage properties to be inscribed in the World Heritage List. The first inscriptions were respectively 13[1], following the classification of natural and cultural sites. By then, the UNESCO states parties who ratified were 14[2], having today grown into 193, making of the UNESCO World Heritage Convention a nearly universal convention.

Problem Field: Urban Heritage
The process of listing 'properties' has been coupled by a continuously activity of analysing and redefining the meaning of Heritage, its classification and its role in the local and global community. The emergence of Heritage studies (Harrison, 2016) as an autonomous academic discipline reveals the importance and the complex processes behind the construction of this theoretical framework but also the effort in developing tools related to the planning and management of 'protected properties.

From the need of protecting heritage as a trace of the past to a more problematic definition of cultural heritage as a driver for development, in a changing global environment (Pereira Roders, 2011), the debate around threats and classifiers for properties has been affected by the new challenges posed by the fast urban global growth and the climate change.

The need to find new global approaches to define the role of urban heritage as a factor of development (Pereira Roders, 2011), but also new system of protection has activated the debate around WH Cities in the last decades. The Urban Heritage listed in the programme reveals in a local scale the paradoxical condition of being a resource closely connected to its context and object endangered by the threats of urban changes or development.

Previous Research
Inside the label of WH Cities, the attempt of investigating a common definition of 'city' was developed by different scholars: From the selection of Historic cities and towns inscribed in the WH List and WH Sites in urban context (Yang, 2003).to a classification of the degree of vulnerability and the threats specific of the urban context (Van Oers, 2009), to the recognition of patterns according to the 'individual/collective character and singular/fragmented/concentrated/absolute distribution of OUV (Pereira Roders, 2010), the varied natures of WH cities have been faced in terms of theoretical categories definition, but rarely as a problem of 'representation'.

[1] https://whc.unesco.org/en/list/&order=year#alpha1978 Accessed 02/05/2020.

[2] https://whc.unesco.org/en/sessions/01COM Accessed 02/05/2020.

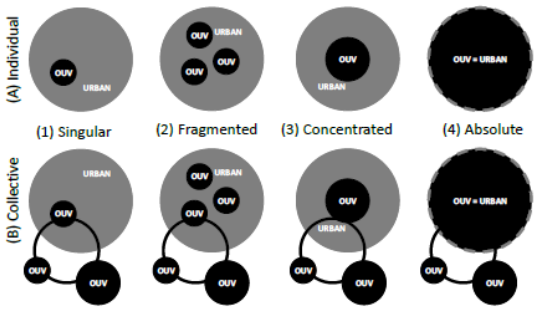

Figure1 Identified patterns (image from Pereira, 2010).

Furthermore, the description of WH cities is closely bound to the local policies of protection; thus, it relates to the definition of WH boundaries[3] and their core/buffer conditions for each site (Turner, 2009).
The aim of defining an objective measurable framework leads to the analysis of the morphology of cultural world heritage zoning, which classifies the WH zones according to the shape of their buffer and core, integrating the maps and the documents used in the nomination reports and the satellite images of the sites. Starting from the distinction between individual and collective core, the classification proceeds in considering the morphology of the core and the eventual buffer depending on the elements identified as heritage. (Urdaniz, Satoh, 2017).
This morphological classification represents an experiment to process, through a common methodology, the heterogeneity of the documents related to the urban heritage, but again the issue of the geographical representation of WH Cities is far to be faced. However, if the question of 'WH Cities', implies common global framework to classify the heterogeneity of the urban settlements worldwide and their specific local conditions in terms of the relationship between the context, the community and the property, these studies should find in a geographic and standardized representation a bridge to be connected to the current research about urban models and to use the data from geoportal related to the global urban condition (DLR Global Urban Footprint[4], JRC Global Human Settlement[5]).
At the moment, in addition to the UNESCO official website, several digital platforms offer tools of analysis based on the WH list, but very few of them provide a geographical representation more accurate than a simple location point.
Seeking to develop a global approach, considering World Heritage properties worldwide, the information concerning both the heritage properties and the related human settlements needs to be represented with a homogeneous structure and similar spatial features (e.g. accuracy, kind of representation).
This research aims at modelling the role of conservation areas in urban dynamics, developing as a first step an appropriate methodology for classifying, storing, and representing the Urban Heritage in a standardized and interoperable system, to measure the impact on the development and the change of their urban contexts. Such research needs a solid methodology, theoretical framework, methods, and data collection.

Therefore, the selection of datasets containing the needed information and their harmonization is explored in this paper, starting from the geographical representation of the WH list published on the official website, that represents the main reference, with the aim of analysing how the properties are described, how they can be queried, and which specific geographical information is provided.
Furthermore, the structure of the datasets produced within different platforms and projects are considered, together with the specific requirements of the HERILAND project and the available standard data models, to design a suitable and interoperable structure for the HERILAND study.

Taking in account the experience of PUP, the aim of HERILAND Research[6] titled 'Monitoring the role of Conservation Areas in urban settlement' is to investigate the possible intersection between the existing data about heritage in urban context and the information about the urban morphology and the changes derived from multitemporal series of satellite images.

2. METHODOLOGY

2.1 Data extraction

The level of the accessibility of the geographical information and its consistency is the starting point of this research, therefore the chosen perspective is to explore data from the user's point of view, verifying the possibility to get data, the information provided for reading their structure (technical reports, manual), the kind of the format, the tools or supported framework used for sharing the content. This means that the data exploration has followed a front-end approach, in state of the developers' one. Thus, the method for collecting data is not unique, but it has been dependent on the single platforms. Different Python libraries (Pandas, Numpy, BeautifulSoup, Request, Shapely, Geopandas) have been used to interrogate website, to manage the datasets collected and to visualize them, in order to analyze their structure and reorganize the content in a GIS platform.

2.2 Datasets and projects review

The datasets and data structures that have been considered are:

- World Heritage Unesco List[7]
- World Protected Planet[8]
- World Heritage Outlook – IUCN[9]
- Prothego[10].
- Protected Urban Planet[11]
- ResCult[12]

3. DATASET REVIEW

They have been analysed and described, focusing on their structure and, on their geographical content. Finally, the different existing platforms have been compared to obtain a comprehensive image of all the entities, attributes and relationships used and useful to describe the protected heritage. As a reference for this comparative approach[13], the assessment framework was used that was represented the preliminary phase

[3] The definition of boundaries of WH property is mandatory to be inscribed into the WH List.
[4] https://www.dlr.de/eoc/en/desktopdefault.aspx/tabid-9628/16557_read-40454/ Accessed 02/05/2020.
[5] https://ghsl.jrc.ec.europa.eu/ Accessed 02/05/2020.
[6] https://www.heriland.eu Accessed 03/02/2020 Accessed 02/05/2020.
[7] https://whc.unesco.org/en/list/ Accessed 03/02/2020
[8] https://www.protectedplanet.net/ Accessed 07/04/2020
[9] https://worldheritageoutlook.iucn.org/ Accessed 07/04/2020
[10] http://www.prothego.eu/ Accessed 07/04/2020.
[11] http://2011.protectedurbanplanet.net Accessed 02/05/2020.
[12] https://www.rescult-project.eu Accessed 02/05/2020.
[13] The comparison has three focal points: (a) *how* data is analyzed and visualized, (b) *what* is analyzed, and (c) *who* contributes and benefits from the tool (Verbruggen 2014).

for the development of the experimental PUP platform.

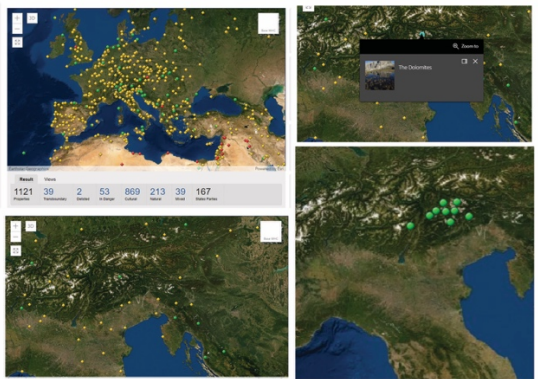

Figure2 WH List detail of the Dolomites properties (from the global location to the local subpoints representation).

WORLD HERITAGE List. Up to 2020, the World Heritage List dataset is composed by 1121 records (one for each property). The list is published in different formats (RSS, XML, KML, XLS), directly available for download on the UNESCO website. The XLS is structured in 37 columns: two identifiers (one unique number and one UNESCO id number), the name, a brief description and the justification of the inclusion in the list (both in English and French), the year of inscription in the list, the inclusion of the property in the endangered list (expressed in a binary values), along with the period of presence in the endangered list or the year of inscription (both the data are stored in the same column, with an Y before the year and a P before the period) and the last year of inclusion, the criteria of admission (stored both in separate columns, one per criteria, with binary values and in one column with the criteria divided by brackets), the category (cultural, natural, mixed), the state and geographical region in which they are located (with names and iso codes). The spatial information is stored in two columns: one for the latitude and one for the longitude. Thus, each property is represented by a point feature; even if the CRS is not declared, the coordinates refers to the WGS-84 system.

The UNESCO website also provides a global interactive web-map, where the WH List properties are represented as a points layer. The eligible basemaps are the Satellite World Imagery (provided by ESRI ArcGIS through its REST services), with spatial reference 3857 and a maximum resolution of 0.3 meters; or the topographical one supported by OpenStreet Map, whose resolution depends on the availability of data in different zone of the world.

The points are visualized on the map through an HTTP GET request, which returns the collection of features in GeoJSON format: the features are points and the geographic coordinates are expressed in decimal format. The collection contains, as fields, the UNESCO id number, the title/name, the inclusion in the endangered list (in binary value), the category (expressed in integers) and the icon (in integers) to show on the map. In fact, the points on the map present different colours, depending on the category and on the inclusion in the endangered list.

The request can be filtered defining some parameters through an advanced query mask. In particular, it is possible to select the properties by criteria, subdivided in Cultural (i,ii,iii,iv,v,vi) and Natural (vii,viii,ix,x), category (cultural, natural, mixed), condition of danger (if they belong to the danger list), nomination file, presence of historical description, transboundary condition, media related, instruments of conservation, themes (Cities, Cultural landscape, Forest, Marine & coastal, Earthen Architecture), keywords, or by a combination of more filters at the same time.

The interactive map is in this case just a tool to select and visualize the distribution of the UNESCO sites all over the world. Through the selection of a point it is possible to open a pop-up with a link to a detailed webpage of the single property.

The website contains three sections with a more detailed description of the site: a synthetic table with some general information (country of reference, year of inscription, name, criteria, area of the property and of its buffer zone), a brief description of the property (in eight languages), a synthesis of the Outstanding Universal Values (OUV), a link to the documentation provided for the nomination (when available), and again a map to locate the site. At this level the geographical definition becomes more accurate: the HTTP GET request returns a JSON dataset where all the places, monuments, sites related to the selected property are stored as single items. The attributes define the category (expressed in integers), the endangerment (expressed in binary value), the name, the latitude and the longitude (in decimal format). The JSON lacks of a proper id for these subpoints; however, in the website of each property, there is a specific section for the map, with (again) the interactive web-map and a table that shows, for each sub-location, the id (composed by the property id and a three numbers sub id), the name, the country, the area (in hectares) and the buffer zone (in hectares). Therefore, there is on one hand a more general dataset, where each property is represented by a single point feature in a global scale, and a more 'local' map, where in case of a 'system of properties', i.e. cultural landscapes, it is possible to detect subpoints to define more accurately the location of the single elements. Put numbers of subpoints on the total amount of the dataset.

In the same page, there is also a table with a link (or more than one) that connects to the UNESCO document(s) where the map is stored, along with its title, date and a thumbnail preview.

These documents, which represent another distinct level of information, collect the digitalized original document used for the nomination: the material is very heterogeneous, the maps, when they are presented, are saved in JPEG or PDF format and usually in different scales. The lack of a common procedure to submit geographical data is evident in the heterogeneity of material and representations present in this section and of course it makes no possible to create comparable dataset without a proper digitalization.

However, these documents contain a more accurate information about the 'form', the quality of the sites in the terms of spatial issues. They are the only geometrical representation, available on the UNESCO website, of the area of the properties. In fact, the size of the area of the properties, and of their sub-elements, and of their buffer zones is just declared in the page's tables, but the interactive maps, both at a global as at a property level, lacks of polygonal features related to the form, geometry and shape of the property. There are no polygonal geometries connected to the properties and it is also the source of the data about the areas and buffer zones are not mentioned, nor the method in which they have been defined.

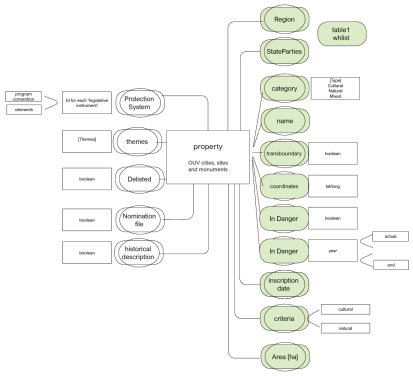

Figure3 Scheme of WH list data model.

Even if the UNESCO website provides some statistical analysis of its dataset, the potential of the geographical application is not explored. The lack of a common geographic representation and the format in which it is provided is for the moment nothing more than a rich collection of documents in jpeg and pdf format, which need to be digitalized in order to be usable for further geomatics application. The problem of representation and the data specification about properties has been faced by other digital platforms. Starting from the core data provided by the WH list, it has been implemented the SOC system which includes a 14 threats classifier to describe the main risks of heritage to be damaged or not preserved in their essential characteristics. However, it does not add new spatial information.
In conclusion, the WH List web-map and website aim to represent the consistency of the world natural and cultural heritage, and it gives a partial but more accurate geographical representation of the original dataset.

IUCN. IUCN World Heritage Outlook maps the global assessment of Natural World Heritage, evaluating its conservation status, through a common standardized methodology developed in collaboration with IUCN World Heritage Outlook technical advisory group, UNEP World Conservation Monitoring Centre staff and World Heritage site manager. This unique global methodology allows to compare the global assessment of protected natural areas, assigning a 'conservation outlook' value (expressed by evaluations of the status as good, good with some concerns, significant concern, critical), in order to arise awareness and worries about the threats of the sites, encouraging the implementation of the tools of protection and safeguard. The storage of temporal data also allows to register the change of status of each site in this framework, becoming a useful instrument to evaluate the policies and the tools provided by local institutions to defend the sites from the threats, also assessed by IUCN in appropriate categories and used as indicators of the risks for each sites. In the 'Sites benefits sections', another sequence of thematic indicators is used to give a more qualitative interpretation for the 'natural sites': food, water, cultural and spiritual values, health and recreation, knowledge, Environmental Services, Material, Contribution to local economy are the topic for grouping positive and characteristic attributes of each site. The map is connected to Google UNESCO map and it is used just to locate the sites. The feature class is one, with points, and the base map used is supported by Google Maps in WGS84 coordinates reference system. Apart from that, no more geographical data is provided.

3.1 Natural protected areas.

Figure4 WDPA map of natural protected areas in a polygonal representation.

WPDA. The Protected Planet website is a complete source of information on protected areas, updated monthly with submissions from governments, non-governmental organizations, landowners, and communities. It is managed by the United Nations Environment World Conservation Monitoring Centre (UNEP-WCMC) with support from IUCN and its World Commission on Protected Area'. The website is the interface to explore the World Database on Protected Areas (WDPA), a database aimed to collect the current state of the protected natural areas but also to be a platform for institutions, stakeholders and professional to monitor and implement policies through the comparison between similar areas located worldwide (check). The website offers the possibility to download the dataset in different format and an accurate guideline manual for collecting new materials. In this case, the database is finally stored as a proper geodatabase made up of two datasets and one source table. Spatial data are organized in two datasets: one with polygons and the other with points, used in case of lack of more accurate spatial information. The main structure of this database is so composed by a double layer of spatial data (polygons and points) connected to a tabular information, plus a one source table, which contains all the information about the data provider, currency of dataset and other metadata. The WDPA ID is the globally unique identifier for each protected area and it depends on its designation, it means that for the same geographical area is possible that elements with different WDPA insist on that. The UN List is incorporated into the WDPA.
The platform is thought as a collective one in terms of use of data and also for the definition of its content, therefore the first step has been to give a semantic definition of the concept of 'protected area' as "a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural values" (Dudley, 2008) and also, for an agreement between CBD Secretariat and IUCN, as "a geographically defined area, which is designated or regulated and managed to achieve specific conservation objectives"[14]. Not all the natural sites can be classified as 'protected areas', therefore WDPA is developing a new entity to include also all the sites with a specific and not standardized condition in terms of conservation policies, the so-called OECM areas[15]. This class of specification is relevant to be able to make the database inclusive and effective to host all the situation developed by local institutions.

[14] Article 2 of the *Convention on Biological Diversity*. This definition is further expanded under Article 8 of the Notre-Dame convention (Lopoukhine and Dias 2012).

[15] "A geographically defined area other than a Protected Area, which is governed and managed in ways that achieve positive and sustained long-term outcomes for the in situ conservation of biodiversity, with associated ecosystem functions and services and where applicable, cultural, spiritual, socio–economic, and other locally relevant values" (Convention on Biological Diversity).

The global rise of urbanization lead to consider new threats for the cultural and mixed properties. The problem of their representation in order to monitor the status of their conservation related to the continuous and fast changes of urban settlement is nowadays urgent as much as the protection of natural areas. But in this case, the process of abstraction and modelling of all the issues connected to urban settlement, cultural identity and values becomes more complex according to the complexity of a global framework.

3.2 Cultural and Mixed Heritage

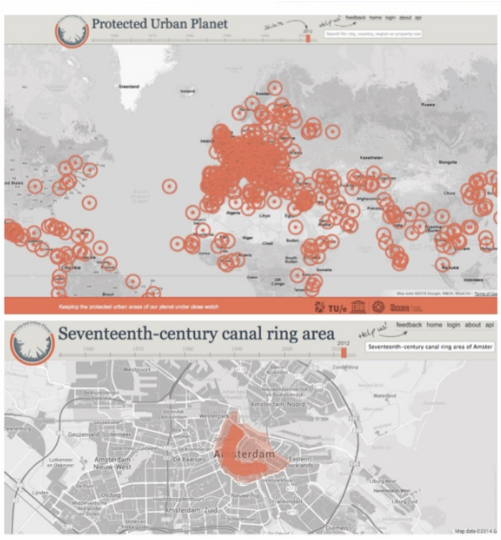

Figure5 PUP Global Map and detail of protected area of the city of Amsterdam

PUP. An attempt to start to focus on a more detailed analysis of the cultural and mixed properties is the core of the Protected Urban Planet project, a digital platform developed in the framework of the research titled 'Outstanding Universal Value, World Heritage Cities and Sustainability' started in 2009 and developed jointly by Eindhoven University of Technology (TU/e) and UNESCO World Heritage Centre.
During the project almost 1000 protected areas designated in the World Heritage list have been analysed combining spatial data information about their protection state and extension and their main threats and attributes, in order to define new indicators to measure their impact and values. Protected Urban Planet 'is the first tool developed for visualizing, mapping and contributing to information exchange on the evolution of protected urban areas worldwide' and it represents the public access to the data collected and elaborated during this project.
It was developed as a bridge to collect and bring together different sources from UNESCO, National governments, Non-government Organizations (NGOs), International convention and regional Partners related to the development of the WH Cities specification, and also a window to show this information and let the community be involved in the process of the building values.
The PUP dataset represents an implementation of WH List. The main challenge of the PUP database has been the integration of new spatial information related to the surfaces of core/buffer areas of urban sites, maintaining the connection to the original WH list dataset and providing it with a new classification. Therefore, it is possible to highlight some nodes of information connected to the original WH list attributes for the properties: (i) location, where it is specified the urban settlement connected to the property. The location's attributes specify the UNESCO geographical macro-regions, the country and the typology of settlement, referring to the administrative entities recognized in Wikipedia database (village, town, city). This connection allows to link all the wiki data about the population, the administrative definition of the urban settlement and the coordinates expressed in decimal numbers. This information is shown in the description section of all the PUP sites.
Other significant nodes of information are (ii) the typologies, that consist of a new classification connected to patterns identified in the relationship between the WH properties and the urban context (Pereira Roders, 2010); (iii) the values, as combination of attributes, threats and causes (Pereira Roders, 2008); (iv) the contributors, classified by name, contacts and link to their professional page, according to the idea of a participatory platform and a collaborative process of integration and implementation of data; (v) the publications, related in some way to each site, to access to other kind of documentation; (vi) the zones, which contain the spatial data referred to buffer/core areas, according to the availability of data, each site could keep both categories overlapped in the visualization.
All this information is connected through the PUP id, that works as the unique identifier which allows to bring together the different datasets. The PUP id is also connected to the WH information dataset, corresponding to the UNESCO id of each property; so, it is always possible to come back to the information provided by UNESCO.
Basically, the spatial data are divided into two feature classes: one of points (stored in the property table), just to locate the sites, and the other one polygonal (stored in the zones table), which has been classified as buffer or core according to the availability of this data for the site; this information has been digitalized from the heterogenous material represented by UNESCO documentation for nomination manually by the TU Eindhoven team involved in the project till 2014.

The aim of the PUP classification (Pereira Roders, 2010) is to model the relationship between heritage properties and the human settlements according to to the nature of their outstanding value on two main variables: character (individual, collective) and consistency (singular, fragmented, consolidated and absolute) (Pereira, 2010). The nature of the relationship between the OUV and its context is therefore classified considering the properties in combination to building, location and urban settlement, while the definition of WH cities maintain a general value and it regards all settlement with properties inscribed at the WH list located in or at outskirts of their urban areas.

Prothego. PROTHEGO project (PROTection of European cultural HEritage from Geo-hazards) aims at making an innovative contribution towards the analysis of geohazards in areas of cultural heritage using specialized remote sensing techniques.
The innovative element is the intersection of Raster layer of information provided by the Satellite images and the vector shapefiles used to describe the protected sites. The source of the polygons connected to cultural and mixed properties have been different: UNESCO documentation collected in the processes of nomination were digitalized in a first part of the project by the ISPRA and NERC teams as well as National Government Dataset, NGO ones and Open Data Catalogues. The variety of sources and materials has imposed the need to manage different Coordinate Reference System simultaneously, both geographic and projected: WGS84 (EPSG 4326), WGS84 -Pseudo Mercator (EPSG 3857), ETSR89/LAEA Europe (EPSG3035) are the most used. For the official administrative boundaries, it has been used

for Europe, EUROSTAT[16], NUTS2013, 1:1 Million Scale and when necessary this source has been integrated to 'Global Administrative Areas'[17] Project data. The implementation of the Spatial Dataset consists of adding the information layer about buffer/core zone collecting polygons and splitting them in single entities. Each site was described by a minimum set of attributes: (i)official ID Site, (ii) official ID Site part SUB ID for Multiple Locations Site, (iii) Core/Buffer, (iv)zone typology, (v)data source, (vi)progress check code. The scale for representation of the polygons supported mainly by OpenStreet Map as basemap depends on the scale of the original dataset: to trace the raster images it has been adopted a maximum 5x zoom level referred to the original nominal scale.

3.3 Semantic issues in geographical representation

The available information, provided by these platforms, lacks the necessary standardization, to guarantee the interoperability of the data and the uniformity of the geographical representation.

However, there are some projects, not specifically based on the WH list, that have developed more accurate frameworks for the semantic and geographical representation of cultural heritage, integrating vocabularies and pre-existing standards, with an interoperability perspective.

A specific standard ontology for Cultural Heritage is the "CIDOC conceptual reference model" (recognized as a standard ISO 21127). Initially conceived for the representation of museum objects, its possibility to structure high-level concepts can shift its application to architectural heritage and heritage landscapes. The advantages of this system concern also the possibility to link the existing information on the web. In this sense, the ARCHES project and the World Monuments Fund (both based on the CIDOC-CRM) are useful references of open source, interoperable web-based information systems for cultural heritage.
Another fundamental reference for the classification of information on Cultural Heritage are the Getty Institute's vocabularies, that provides structure of terms to describe works of art and architecture, permitting also to identify different denominations of a cultural item over time.
For the representation of geo-information about urban areas, the 'Infrastructure for spatial information in Europe' European Directive[18] (INSPIRE), as a part of the European Directive for an interoperable cartography in Europe, is a necessary reference, because it will be compulsory adopted in Europe by 2020.
In this model, the representation of UNESCO heritage is already included. However, even if INSPIRE includes some features of CityGML (an international standard for representing mulstiscale 3D information about city objects), it is built to represent wide territories and it suffers of limitations in the more detailed definition of architectural heritage.

EID. The problem of the interoperability in terms of semantic and geographical information is tackled by the European project **ResCult** (Increasing Resilience of Cultural Heritage) funded by European Union Humanitarian Aid and Civil Protection, in the DG-ECHO program, aimed to provide a tool to monitor and prevent the impact of natural or man-made disasters on cultural heritage (Colucci et al, 2018). The key outcome of the project has been the development of European Interoperable Database (EID), a composite tool designed to support emergency operators, authorities and decision-maker in protecting cultural heritage against natural hazards[19], a 3d European Heritage Map was realized according to the Sendai Framework[20] principles (UNIDSR, 2017). The scope of the ResCult project is the representation of cultural heritage in semantic and geographical terms, therefore the premise for the development of the database has involved on one hand the cartographic standards connected to the process of digitalization of maps and 3D architectural models on the other the links to other sources about data content, through the analysis of cultural heritage classification at different levels: for the European scenario ResCult classification has been integrated . In particular EID Conceptual Data,Model deals with three main parts of INSPIRE data model: (i) 'Protected Site', theme of the Annex I, for representing objects needing protection due to various reasons (ecological, biological, cultural) and legally acknowledged; (ii) 'NaturalHazard' theme (Annex III) for connecting directly the object exposed to the risk, according to the specific aim of the project ResCult; (iii) 'Building' theme (Annex III) to collect useful features to archive effective information for architectural heritage.
The INSPIRE extension combined to the reference to CityGML for the specific semantics about city objects, including the Level of Details (LoDs) concept, enable a multiscale 2D and 3D representation of city and buildings accomplishing the idea of an international, harmonized and interoperable database.

4. RESULT AND DISCUSSION

4.1 Comparison of digital platform

Dataset	Context	Geo Map	Meta data	Access	Consistency
Wh List	World	Points/ Subpoints	-	open	1121 4562
SOC	World	-	-	limited	3796 (Reports) 574 properties
IUCN	World	Points	-	open	
Natural Heritage					
WDPA	World	Polygons	Yes	open	2179555
Cultural and Mixted Heritage					
Prothego	Europe	Points/ Polygons	Yes	close d	1000
PUP	World	Points/ Polygons	-	close	936
RESCULT	Europe	Points/ Polygons/ 3d Models	Yes	limite d	

The exploration of the web resources reveals a structured availability of data for natural protected areas in state of cultural and mixed ones, probably due to the longer history and a more universal meaning connected to natural resources and on the other hand to the problematic process of defining common categories for the cultural and mixed properties.

The choice of the analysis of the impact of heritage in urban settlements implies to set up a concrete framework about how we can classify 'urban' settlement and in particular what is urban and what can be consider 'City' in this research.

[16] https://ec.europa.eu/eurostat/web/gisco/overview Accessed 08/04/2020
[17] https://gadm.org/ Accessed 08/04/2020
[18] https://inspire.ec.europa.eu Accessed 03/02/2020
[19] https://www.rescult-project.eu/european-interoperable-database/ Accessed 02/05/2020
[20] https://www.undrr.org/implementing-sendai-framework/what-sf Accessed 02/05/2020

For the reviewed dataset, the definition of the context in qualitative and geographical terms seems to be not represented.
Narrowing the question to the internal debate of WH Cities[21]:there is no direct reference to World Heritage Cities in UNESCO documents, the term 'historic town and town centres' is preferred and three categories are provided according to the kind of properties present and the state of use of the town (towns no longer inhabited, inhabited historic towns and new towns of twentieth century - UNESCO 2008), even in the UNESCO THESAURUS the term 'Cities' is replaced by a more general and wider 'Urban Area'[22] This reference allows to be inclusive in considering the heterogeneity content from the different web resources considered, but at the same time is the weak point for the comparison of the data in a multiscale approach. Basically, the databases analysed in the review do not take into account the problem of the scale, visualizing the polygons information without any reference of scale and resolution, and always in a cartographic map. This is not enough to distinguish the variety of human settlements worldwide and can generate confusion even in understanding the 'size' of a phenomena. According to a multidisciplinary approach, a clear reference to a specific model for the representation of human settlement[23] could be useful to compare and classify the role of urban heritage in the cities, connecting their morphologies and their changes highlighted by temporal sequence of satellite images to the qualitative classification connected to the information provided by the protection condition of their OUV properties.

4.2 HEUB - Heriland Urban Heritage Db

The result of the existing datasets review and comparison has set the base for the first proposal of a conceptual model for a database integrating the information stored in such databases for the aim of analyzing development pattern of human settlements related to heritage properties, according to the aims stated in section 1.
It should represent different objects: points, to locate all the sites selected from external sources (WH list, WDPA, PUP, Prothego, but eventually also from more general dataset as EUROSTAT, OpenStreetMap etc.), polygons to store the protected areas; and another polygon to collect their system of protection (buffer or any kind of external possible protection condition). In order to analyze the change in the policy and also to compare different sites it is necessary to distinguish the proper 'area' of the sites from the measures used to protect it and add the date in which the protection program started. The initial source for this information has been the PUP dataset in zone section.
In that case buffer and core were different values of the same fields and it is not possible to easily distinguish the sites, protected areas from their system of protection. However, to build a more adaptable dataset, the two attributes (core and buffer) could be split in different tables.
Furthermore, following the example of WDPA, it could be introduced a parameter to monitor the state of accuracy and completeness of the database, considering the presence of information about the state of conservation, the data provider, the reference system, the consistency of data.

5. CONCLUSION

This new Urban Heritage Database, that integrates the available information on WH list and WH cities in a standard and interoperable model, is the first step to support the development of a web GIS platform, where this information can be compared with the related human settlement maps, likely obtained from satellite images and other available datasets.
The historic series obtainable from Satellite image processing help in finding the data useful to understand the possible patterns ruling the heritage-human settlement relationships in a global perspective, as a base for new heritage management strategies and approaches.

A Global Dataset needs a clear protocol to define the input and collection data process, specifying the sources and giving the correct information to be used, shared and usable in the future steps and by other users.

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