Protected Urban Planet: Monitoring the Evolution of Protected Urban Areas Worldwide

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Abstract

This paper aims to introduce *Protected Urban Planet (PUP)*[1], the first tool developed for visualizing, mapping and contributing to information exchange on the evolution of protected urban areas worldwide. Besides locating them, Protected Urban Planet provides communities with means to disseminate and raise awareness for their cultural significance, while monitoring their threats and causes and sharing assessment methods and tools. Protected Urban Planet brings together spatial data, descriptive information and images from various sources, which together are today unrealistic for communities to reach.

1. Introduction

The number of documents and their scattered archives, but also the diversity in focus, approach and methodologies in heritage studies has been disabling the assembly of results from varied research projects and subsequent spatio-temporal analysis and extrapolation of trends on World Heritage management. Cultural and natural heritage properties[2] (e.g. Bolgar Historical and Archaeological Complex, Russian Federation and the Stevns, Denmark) are often analyzed separately[3], except on mixed properties (e.g. Trang An Landscape complex, Vietnam)[4].

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1 http://protectedurbanplanet.net
2 Property is an official boundary to what World Heritage is.
3 UNESCO (2012) *World Heritage Capacity Building Programme.* Paris: UNESCO.
4 Larsen (2012) , P.B. (2012) *Advisory body evaluations of World Heritage nominations in relation to community and rights concerns, an independent assessment*, Gland: International Union for Conservation of Nature (IUCN).

The approaches in heritage studies are often either critical or technical. Critical heritage studies primarily focus on the uses of heritage[5]. Instead, technical heritage studies focus on heritage conservation[6]. Particularly, in cultural heritage, the methodologies employed are either illustrative global interpretations[7] or detailed case studies[8]. The application of automated analysis is already being explored for heritage documents e.g. maps[9] and letters[10]. It is still under-explored for documentation referring to heritage properties, in support of their management.

There is a growing number of tools targeting the support of heritage management practices. Though, they still fail in bridging culture and nature sectors, and supporting spatio-temporal analysis and extrapolation of trends, through the integration of Geographic Information Systems (GIS)[11], data mining[12], personalization and semantic data enrichment[13]. Most of these technologies have already been applied, but seldom on heritage management, crossing heritage categories or in combination[14].

Some remain skeptical about the use of generic tools for heritage management, especially in developing countries[15]. Though, the growth of internet access[16] and mobile-broadband subscriptions are a worldwide trend[17]. GIS has proven beneficial to heritage management and

5 Harvey, D.C. (2001) Heritage Pasts and Heritage Presents: temporality, meaning and the scope of heritage studies, *International Journal of Heritage Studies* 7(4), pp. 319-338.

6 Riveiro, B. , Arias, P. , Armesto, J. and Ordóñez, C. (2011) A Methodology for the Inventory of Historical Infrastructures: Documentation, Current State, and Influencing Factors, *International Journal of Architectural Heritage: Conservation, Analysis, and Restoration*, 5(6), pp. 629-646.

7 Pendlebury, J., Short., M. and While, A. (2009) Urban World Heritage Sites and the problem of authenticity. *Cities* 26, pp. 349-358.

8 Sheng, N. and Tang, U.W. (2013) Risk assessment of traffic-related air pollution in a world heritage city, *International Journal of Environmental Science and Technology* 10(1), pp. 11-18.

9 Simeone, M., Guiliano, J., Kooper, R. and Bajcsy, P. (2011) Digging into data using new collaborative infrastructures supporting humanities–based computer science research, *First Monday*, 16(5), May 2.

10 Cohen, P. (2010) Digital Keys for Unlocking the Humanities' Riches, *New York Times*, Nov. 16.

11 Vileikis, O., Cesaro, G., Santana Quintero, M., Balen, K. van, Paolini, A. and Vafadari, A. (2012) Documentation in World Heritage conservation - towards managing and mitigating change: The case studies of Petra and the Silk Roads, *Journal of Cultural Heritage Management and Sustainable Development* 2(2), pp. 130 – 152.

12 Pechenizkiy, M. and Wojciechowski, M. (2013) New Trends in Databases and Information Systems, Workshop Proceedings of the 16th East European Conference, ADBIS 2012, Pozna, Poland, September 17-21, In *ADBIS Workshops*. Vol. 185 Springer.

13 Wang, Y., Wang, S., Stash, N., Aroyo, L. and Schreiber, G. (2010) Enhancing content-based recommendation with the task model of classification, In Proc. of International Conference on Knowledge Engineering and Management by the Masses (EKAW), pp. 431-440

14 Rashid, A.N.M.B. and Hossain, M.A. (2012) Challenging Issues of Spatio-Temporal Data Mining, *Computer Engineering and Intelligent Systems* 3(4), pp. 55-64.

15 Boccardi, G. (2002) Improving Monitoring for World Heritage Conservation. In *World Heritage Papers 10*. UNESCO WHC and ICCROM, pp. 39–41.

16 MMG, 2013 MMG (2012) *World Internet Usage And Population Statistics*, Miniwatts Marketing Group (MMG).

17 ITU (2013) *Mobile Broadband Subscriptions*, International Telecommunication Union (ITU).

site monitoring[18]. GIS facilitates data management and analysis, far more efficiently and effectively than any other data management system[19]. It also facilitates communication and knowledge-sharing[20].

1.1. Protected Urban Planet (PUP)

Protected Urban Planet (figures 1a and 1b) is the first tool developed for visualizing, mapping and contributing to information exchange on the evolution of protected urban areas worldwide.

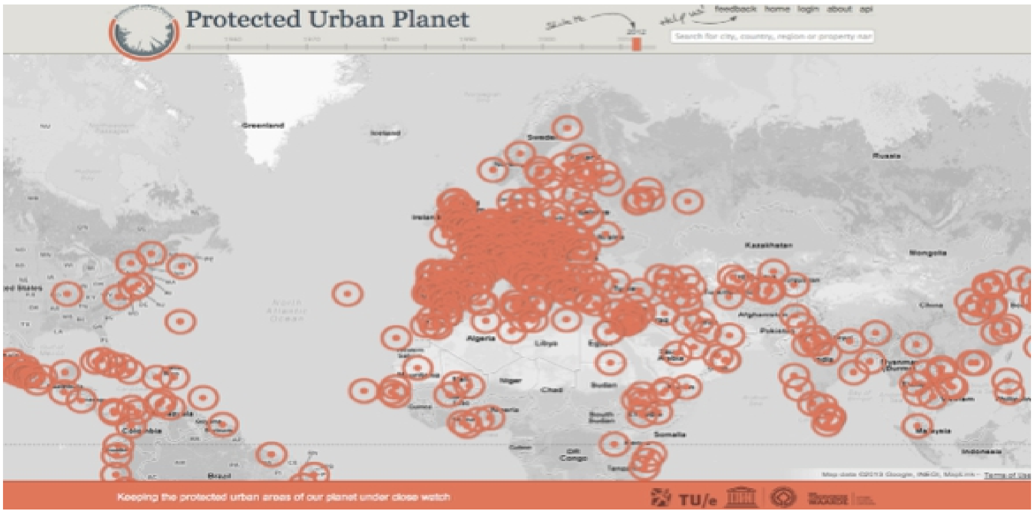

Figure 1a. Protected Urban Planet (PUP): Home page

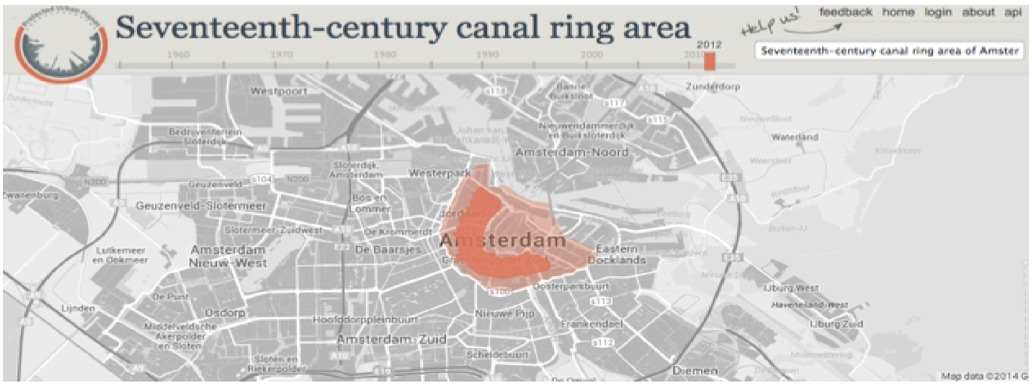

Figure 1b. Protected Urban Planet (PUP): Property *Seventeenth-century canal ring area*

In the paper we look at *Protected Urban Planet* in comparison to (1) three other tools developed for *heritage management* such as Protected Planet[21], Red List of Threatened

18 Hernandez, M. (2002) Use of satellite imagery and geographical information systems to monitor world heritage. In *World Heritage Papers 10*. UNESCO WHC and ICCROM, pp.98–109.
19 DiBiase, D. et al. (2006) *Geographic Information Science and Technology: Body of Knowledge*, Association of American Geographers.
20 Meyer, É. et al. (2007) A web information system for the management and the dissemination of Cultural Heritage data. *Journal of Cultural Heritage* 8(4), pp.396–411.
21 http://www.protectedplanet.net

Species[22], Arches[23]; (2) demonstrators for providing *personalized* access to cultural/world heritage information that are based on CHIP project results[24]; and (3) three tools outside the heritage management field cartoDB[25], CAPA[26] and LearnGlass[27] that could be used for extending the features of PUP. We provide a comparative analysis that discusses the differences and similarities between the tools. 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 tools. The results contribute to setting a research agenda around alike tools, as well as, their contribution to the raise of reliability on research targeting a comparative analysis on the evolution of protected urban areas worldwide.

PUP is contributing to a larger research project titled "Outstanding Universal Value, World Heritage Cities and Sustainability", initiated in 2009, developed jointly by Eindhoven University of Technology (TU/e) and UNESCO World Heritage Centre. *(Q.c. Who?)* Besides locating protected urban areas, PUP provides communities with means to disseminate and raise awareness for their attributes[28] and values of significance, while monitoring their threats and causes and sharing assessment methods and tools. *(Q.b. What?)* It is an online platform to share and disseminate information about protected urban areas, their cultural values and attributes, as well as their protection challenges. PUP brings together spatial data, descriptive information and images from various sources, which together are today unrealistic for communities to reach. *(Q.c. Who?)* Sources range from National governments, Non-government Organizations (NGOs), International conventions and regional Partners, to more proactive members of these communities. *(Q.a. How?)* Combining all these heterogeneous -in size, subject and format- and highly unstructured datasets to one comprehensive portal provides stakeholders a broader overview of all the processes threatening protected urban areas. All of which contributes to a better assessment per heritage property and provides a comparison between properties with similar characteristics, or facing similar threats.

A relational survey between heritage (impact) assessment practices and the sustainable urban development focused on World Heritage cities. The methodology bridged a more universal

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22 http://maps.iucnredlist.org/
23 http://archesproject.org/
24 http://chip.win.tue.nl. CHIP stands for Cultural Heritage Information Personalization
25 http://cartodb.com
26 http://www.win.tue.nl/~mpechen/projects/capa/
27 Leony, D., Pardo, A., de la Fuente Valentín, L., Sánchez de Castro, D., & Delgado Kloos, C., (2012) GLASS: a learning analytics visualization tool. In *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge*, Vancouver, Canada, April, pp. 162-163. ACM.
28 Attribute is the reasons why the property became heritage.

approach, surveying the collective documentation produced while nominating and managing World Heritage properties, such as the decisions adopted at the Session of the World Heritage Committee; to a more local approach taking a limited number of World Heritage cities as case studies. The latter also included a documentation survey, but then, focusing on the existing documentation set produced for the specific World Heritage property. The Netherlands Funds-in-Trust nobly facilitated attendance at relevant meetings e.g. Sessions of the World Heritage Committee and World Congresses of the Organization of World Heritage Cities, so that contacts could be established with national and local governments for the case studies. The Flemish Funds-in-Trust supported the fieldwork in Island of Mozambique and the development of Protected Urban Planet. TU/e has co-financed all fieldwork.

In 4 years' time, a young and committed research team was built up. More than 1000 urban areas have been identified to include protected urban areas designated as World Heritage[29,30]. *(Q.a. How?)* The information related to these properties and municipalities has been assembled in GIS, with a considerable share located. It also includes information on their affecting factors[31,32], until now distinguished in threats (changes) and causes (change agents). Thirteen World Heritage cities have been taken as case studies, illustrative for 4 out 5 UNESCO regions, except for the Arab States: Willemstad[33], Oporto, Evora, Guimarães[34],

29 Pereira Roders, A. (2010a) Revealing the World Heritage cities and their varied natures. In *Heritage 2010: Heritage and Sustainable Development*, Evora, Portugal, June, v.1 pp. 245-253. Barcelos: Green Lines Institute.

30 Pereira Roders, A. (2013) *World Heritage cities: revealing the protected urban areas of outstanding universal value*. Eindhoven: Eindhoven University of Technology (working document)

31 Pereira Roders, A. (2010b) Revealing the level of tension between cultural heritage and development in World Heritage cities - part 1. In Proceedings of *IAPH 2010: 4th International Conference on Cultural Heritage and Development Cooperation*, (*pp. 343-351*). Seville: Fundación de las Tres Culturas.

32 Turner, M., Pereira Roders, A. and Patry, M. (2012) Revealing the level of tension between cultural heritage and development in World Heritage cities. *Problems of Sustainable Development - Problemy Ekorozwoju*, 7(2):2.

33 Speckens, A., Pereira Roders, A. and Gonzalez-Manuel, C. (2010) Enhancing the Outstanding Universal Value assessment practices of Willemstad. In *Heritage 2010, Heritage and Sustainable Development,* Evora, Portugal, June, v.1 pp. 271-281. Barcelos: Green Lines Institute.

34 Tarrafa Pereira da Silva, A.M. and Pereira Roders, A. (2010) The cultural significance of World Heritage cities: Portugal as case study. In *Heritage 2010, Heritage and Sustainable Development*, Evora, Portugal, June, v.1, pp. 255-263. Barcelos: Green Lines Institute.

Salamanca[35], Edinburgh[36] and Amsterdam[37] in Europe and North America; Galle[38] and Macao[39] in Asia and the Pacific; Zanzibar[40] and Island of Mozambique[41] in Africa; and Valparaiso and Queretaro in Latin America and the Caribbean.

2. Assessment Framework

Table 1 lists the assessment criteria, divided in three categories:

(a) how data is analyzed and visualized, (b) what is analyzed, and (c) who contributes and benefits from the tools. The results contribute to setting a research agenda around alike tools, as well as, their contribution to the raise of reliability on research targeting a comparative analysis on the evolution of protected urban areas worldwide. First category, how, includes four criteria: Web-based GIS, Spatio-Temporal Analysis, Automated Analysis, and Comparative Analysis. Second category, what, includes four criteria: Protected Areas, Significance, Affecting factors, and Management tools. Third category, who, includes three criteria: data analysts, providers and references.

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35 Pons, A., Pereira Roders, A. and Turner, M. (2011) The sustainability of management practices in the Old City of Salamanca. *Facilities*, *29*(7/8):5

36 Bennink, R.H.J., Bruin, J.A.C., Veldpaus, L. and Pereira Roders, A. (2013). Knowledge is power : policy analysis of the World Heritage property of Edinburgh. *SPANDREL- Journal of SPA: New Dimensions in Research of Environments for Living*, *4*(7), pp. 27-35.

37 Veldpaus, L., Swart, J.J. & Pereira Roders, A. (2013). Amsterdam as World Heritage city : a sustainable historic urban landscape? Part I. Conference Paper : *proceedings of the International Sustainable Development Research Conference (ISDRC19), 1-3 July 2013, Stellenbosch, South Africa*, (*pp. 974-984*). Stellenbosch, South Africa.

38 Boxem, R., Fuhren, R., Pereira Roders, A., Veldpaus, L. and Colenbrander, B.J.F. (2012) Assessing the cultural significance of world heritage cities : the historic centre of Galle as case study. In Proceedings of the *Measuring Heritage Conservation Performance*, (*pp. 75-81*). Olinda and Rome: CECI and ICCROM.

39 Tarrafa Pereira da Silva, A.M., Imon, S.S. and Pereira Roders, A. (2009). Tackling tourism-driven development in World Heritage cities: A comparison between Macao, China and Evora, Portugal. In S.S. Imon (Ed.), Proceeding of the *Urban Heritage and Tourism: Challenges and Opportunities*, pp. 1-10. Institute for Tourism Studies: Macao.

40 Vroomen, Y.G.J., Hoope, L.D. ten, Moor, B., Pereira Roders, A., Veldpaus, L. and Colenbrander, B.J.F. (2012). Assessing the cultural significance of world heritage cities : Zanzibar as case study. In K. Similä & S.M. Zancheti (Eds.), *Measuring Heritage Conservation Performance*, (*pp. 67-74*). Olinda and Rome: CECI and ICCROM.

41 Damen, S.G., Derks, R., Metgod, T.L.M., Pereira Roders, A., Veldpaus, L. and Silva, A.T. (2012) Revealing relationships between the state of authenticity/integrity and the factors affecting Island of Mozambique. In *HERITAGE 2012: Proceedings of the 3rd International Conference on Heritage and Sustainable Development*, v.1 pp. 31-40. Barcelos: Green Lines Institute.

How?	Web-based GIS	A Web-based Geographic Information System (GIS) for analyzing and displaying geographic information
	Spatio-Temporal Analysis	The spatio-temporal analysis per property and/or summing the results in time per municipality, country, region or total
	Automated Analysis	The automated documentation analysis, aimed at the raise of understanding for ontological, sentiment and behavioral trends
	Comparative Analysis	The ability to compare results on more than one property, municipality, country or region
What?	Protected Areas	The overview of data related to the geographical context of the protected areas
	Significance	The overview of data related to the attributes and values conveying the heritage significance of the protected areas
	Affecting factors	The overview of data related to the changes and change agents affecting the heritage significance of the protected areas
	Management tools	The overview of data related to the management practices and tools, applied to the protected areas
Who?	Data analysts	A team providing the data analysis and scientific valuation
	Data providers	The data guardians contributing to raw data and its validation
	Data references	The reference to scientific publications backing up the data analysis
	Community of users	A community of users exploring the data, but also contributing to their collection and validation

Table 1: The assessment criteria

3. Tools for Comparative Analysis

In this section we discuss a number of tools for world/cultural heritage domain that we can consider related to PUP - Protected Planet, Red List of Threatened Species, Arches, CHIP and its follow up demonstrators, as well as a number of tools outside the heritage management field that we consider for extending PUP functionality - cartoDB, LearnGlass and CAPA. Particularly, Protected Planet and the Red List of Threatened Species are the confirmation that long term scientific monitoring systems can endure (over 30 years), with the contribution of governments, NGOs and researchers.

3.1. Protected Planet (PP)

(Q.a. How? Q.b. What?) The Protected Planet (figures 2a and 2b) is the new face of the World Database on Protected Areas (WDPA), a joint initiative between IUCN[42] (Union for Conservation of Nature) and UNEP-WCMC[43] (United Nations Environment Programme World Conservation Monitoring Centre).

Figure 2a. Protected Planet (PP): Home page

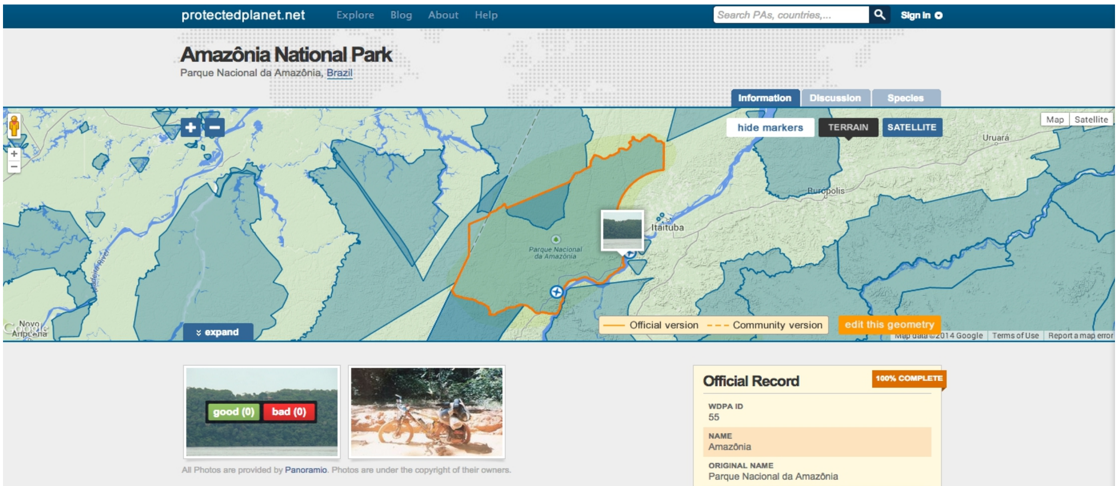

Figure 2b. Protected Planet (PP): Property *Amazônia National Park*

Its humble beginnings started 30 years ago as a basic global list of national parks and has evolved into the only global, spatially referenced information source on parks and protected areas. *(Q.c. Who?)* Protected Planet was not only created to showcase this wealth of information but also gives tools to willing 'citizen scientists' who can feed their knowledge about protected areas into the WDPA. The World Database on Protected Areas is managed at UNEP-WCMC in Cambridge, UK supported by IUCN staff and World Commission on

42 http://www.iucn.org/
43 http://www.unep-wcmc.org/

Protected Areas members all over the world. It relies on the magnitude of work carried out by staff in institutions covering every country on the planet. Without this work from governments and NGOs alike, there would be no World Database on Protected Areas.

3.2. Red List of Threatened Species (RL)

(Q.a. How? Q.b. What?) The IUCN Red List of Threatened Species™ (figure 3a and 3b) is widely recognized as the most comprehensive, objective and global approach for evaluating the conservation status of plant and animal species. From its small beginning, the IUCN Red List has grown in size and complexity and now plays an increasingly prominent role in guiding conservation activities of governments, NGOs and scientific institutions. The introduction in 1994 of a scientifically rigorous approach to determine risks of extinction that is applicable to all species, has become a world standard. *(Q.c. Who?)* In order to produce the IUCN Red List of Threatened Species™, the IUCN Species Programme working with the IUCN Survival Commission (SSC) and with members of IUCN draws on and mobilizes a network of scientists and partner organizations working in almost every country in the world, who collectively hold what is likely the most complete scientific knowledge base on the biology and conservation status of species.

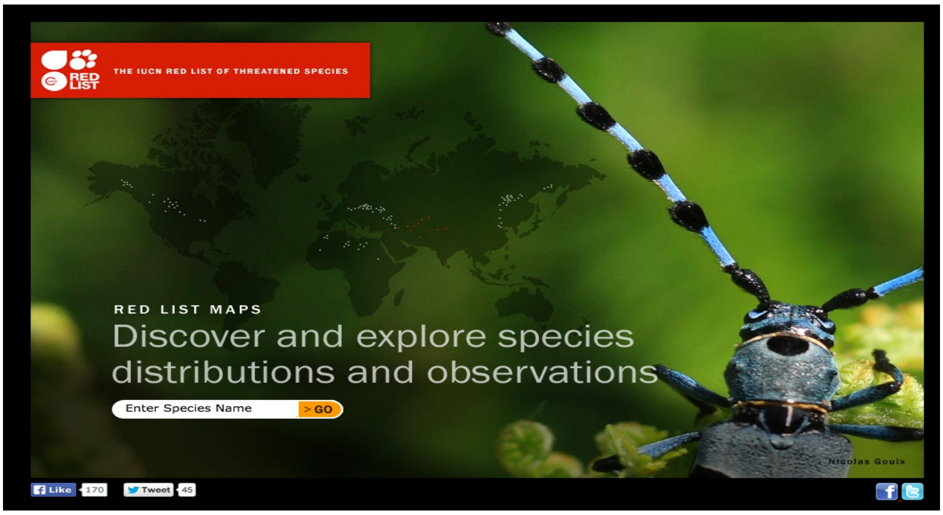

Figure 3a. Red List of Threatened Species (RL): Home page

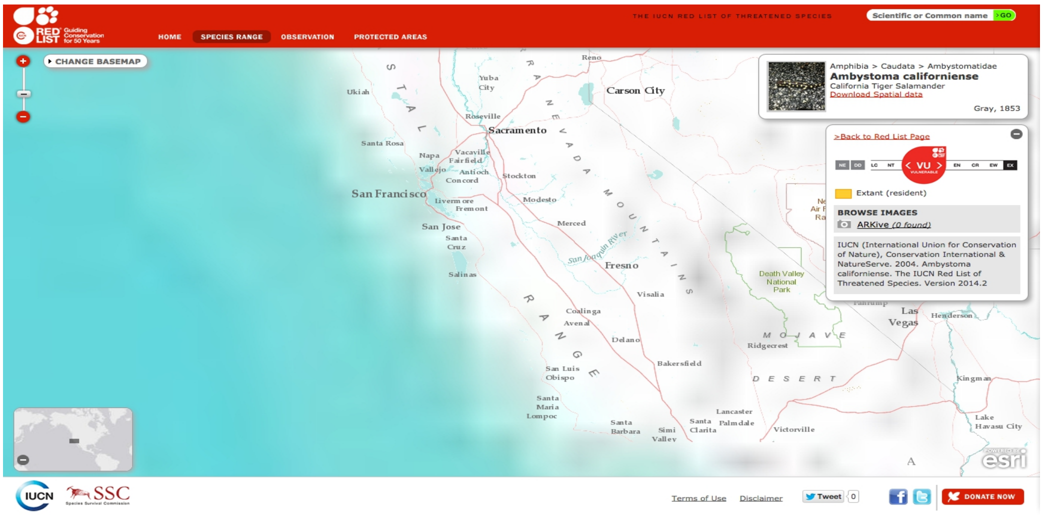

Figure 3b. Red List of Threatened Species (RL): Attribute (species)

3.3. Heritage Inventory & Management System (Arches)

(Q.a. How? Q.b. What?) Arches (figures 4a and 4b) is a new open-source geospatial software system for cultural heritage inventory and management, developed jointly by the Getty Conservation Institute and World Monuments Fund. Arches grew out of the collaborative effort to create the Middle Eastern Geodatabase for Antiquities, and the widespread need within the heritage field for low-cost electronic inventories that are easy to use and access. Arches combines state-of-the-art software development with *(Q.c. Who?)* the insights and perspective of heritage professionals from around the world. The need for functional heritage inventories has grown over the last decades, together with the rise of a global awareness of the importance of heritage management. Nevertheless, inventories remain complicated to establish and maintain, and frequently rely on costly proprietary software that does not always fit the needs of the heritage field.

Figure 4a. Arches: Home page

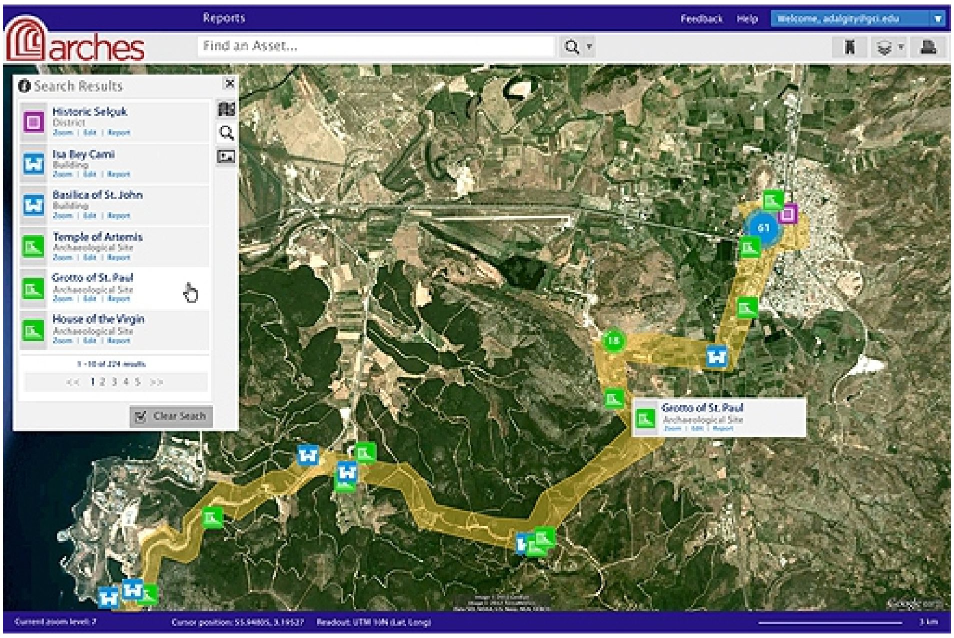

Figure 4b. Arches: Property *Grotto of St. Paul*

3.4. Personalized Access to Cultural Heritage Information with CHIP Tools

Within the CHIP project, a collaboration between Eindhoven University of Technology (TU/e), Rijksmuseum Amsterdam and Telematica Institute in the Netherlands, and follow up research[44,45], an open-source tool was developed for providing personalized access to Cultural/World Heritage information (figure 5). *(Q.a. How?)* The prototype helps visitors in creating *personalized* museum and city tours based on their individual interests. The tours can be prepared in advance through Web-based tools called *Art/Sightseeing Recommender* and *Tour Wizard* and can be visualized on a museum map (in a museum environment), on Google maps, a historical timeline, through faceted views upon the list of points of interest (POI) in a museum (artworks) or city (attributes of cultural significance) or as carousel of POIs (figure 5). Recommendations are based on *semantically enriched* collection data. By semantic enrichment we mean connecting the data to standard vocabularies (such as Getty thesauri[46] and Iconclass[47]) and adding extra semantic relationships from these vocabularies such as *student of*, *teacher of*, *broader/narrower*, etc. which were not present in the original data. The software also includes the prototype of a *Mobile Guide* that is meant to help the user on the

44 Stash, N., Veldpaus, L., De Bra, P., Pereira Roders, A., Creating Personalized City Tours Using the CHIP Prototype, In Online Proc. of PATCH workshop of UMAP2013, the 21st Conference on User Modeling, Adaptation and Personalization, Vol-997, Rome, Italy (2013)

45 Stash, N., Veldpaus, L., De Bra, P., Pereira Roders, A., The Protected Urban Planet App "PUP Sight Guide": Amsterdam as Case Study, In Proc. Conference Culture and Computer Science (KUI2013), Berlin, Germany, pp. 67-80 (2013)

46 http://www.getty.edu/research/tools/vocabularies/

47 http://iconclass.org

spot – navigating in the physical museum or in the city. This Web-based tool is presented by means of case study of the *Rijksmuseum* as museum location[48] and Amsterdam, specifically its World Heritage property *Seventeenth-century canal ring area of Amsterdam inside the Singelgracht*[49] as urban location.

Through data visualization[50] we can provide the visitor not only with different perspectives upon the POIs in the tour – historical, geographical, etc. but also help discovering interests that were not so apparent. The tool does not apply any complicated 3D visualizing techniques as few other city/museum guides do. The main focus is on personalization. The strong point of the tool is its generic character which means that it can be used with the data of other museum or city as well. Appreciation of certain POIs, artists, styles and art topics in the museum can generate recommendations for an urban tour and vice versa.

(Q. b. What?) The prototype currently works on previously collected and categorized data on cultural/world heritage. Recommendations as to what visitors might find interesting are based on previous ratings are only *content-based*, they do not take into account information about what other visitors liked/disliked.

(Q.c. Who?) At the moment the tool is meant for *art curators* (*data providers*) willing to share the available information with the city/museum visitors (*community of users*). By using a city guide application to not only share, but also collect information from the users, it can become a tool to promote heritage properties as well as better understand how heritage is valued and perceived, and even to map and monitor the WH properties with the help of the public.

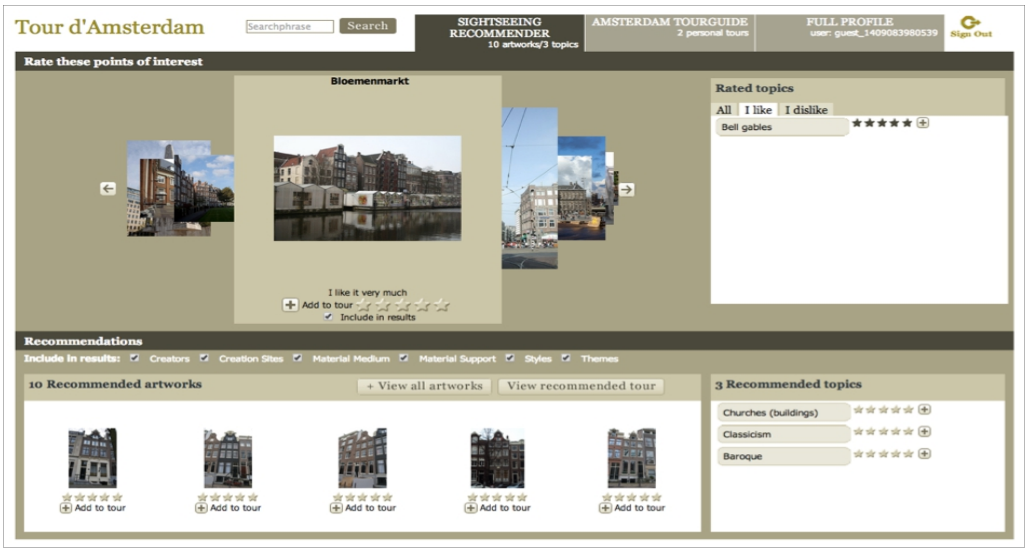

Figure 5. CHIP-based tools: Sightseeing Recommender, Tour Wizard and Mobile Guide

3.5 CartoDB

(Q.b. What?) CartoDB is a cloud-based system to store, analyze and visualize geospatial data. *(Q.c. Who?)* The main objective of the software is to provide an easy way to create visualizations based on maps. *(Q.c. How?)* This is achieved by the provision of two elements: CartoDB Editor and CartoDB Platform.

CartoDB Editor has two main sections: tables and visualizations. A table, as in relational database systems, is the element in which a user will store geospatial data. In this abstraction, the columns of the table represent the fields and each row represents a record stored. A table in CartoDB has four mandatory fields: the record ID, the date and time of creation and last update, and the location. Being a geospatial database, the location field is mandatory and can be either a single point on the map or a set of them to form an area, each point represented by the pair latitude-longitude.

The data stored in a table can be visualized on a map in addition to the grid layout, an example of this view is presented in figure 6. This visualization is only available for the user that has logged into CartoDB, and there are many situations where the visualization are meant to be shared with a larger audience or made completely public. This is the role of visualizations, which can include the data of several tables within the same map. They can also be customized with a specific design and enhanced with legends and descriptive texts.

The other element in the system is CartoDB Platform which offers access to both data and maps in scenarios that need a higher level of customization. *(Q.c. Who?)* The platforms is a set of development tools that allow programmers to interact directly with the data and the maps created within CartoDB. The elements that compose the platform are a JavaScript library called CartoDB.js and two application programming interfaces: SQL API and Maps API.

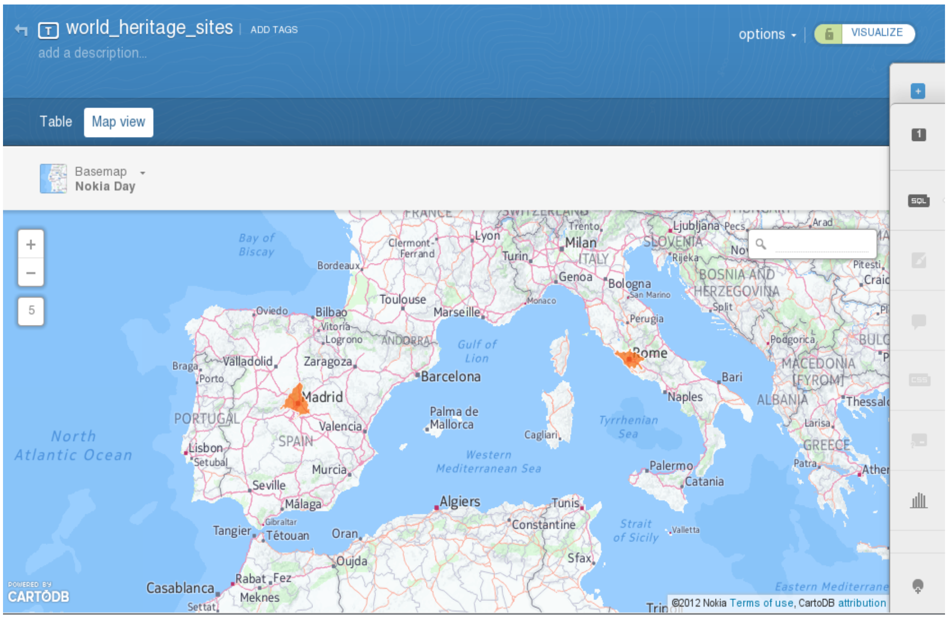

Figure 6. Map view of a table in CartoDB Editor, showing two areas: Madrid and Rome

3.6. Learning/Web Analytic Tools

In this section we discuss the Learning and Web analytics tools LearnGlass and CAPA which we consider for extending PUP. The field of web analytics aims at understanding the behavior of users in web-based applications through the analysis of server logs. A final goal of understanding users is usually to improve the usability and user retention of the system, although this depends on the domain in which the web application is working. Web analytics uses several tools to obtain defined metrics of interest, such as amount of visits, number of unique visitors, and top sources of incoming users.

Learning analytics intends to understand and optimize learning experiences and the environment where they occur. This includes the tools, resources and activities that learners are interact with when they participate in an educational activity. In order to achieve this goal, learning analytics not only involves the analysis and reporting of data about learners and their surroundings but also the processes for measuring and collecting these data. Learning analytics can apply web analytics to infer information of the activity of learners in a web-based learning system but it will often require other tools such as surveys, specialized software and sensors for data gathering; statistics, machine learning and artificial intelligence algorithms for data analysis; and visualizations for data reporting.

3.6.1. LearnGlass

(Q.b. What?) LearnGlass is a platform that enables the development of visualizations based on a common dataset of events occurring in a learning activity. The objective of this platform is to provide a way to create and publish of visualizations on the web without having to develop features of a web system such as user management, a database to store actions done by learners, and a dashboard interface.

(Q.b. How?) The visualizations are added to the platform through the installation of modules. A module is composed of a set of scripts and resources used to display one or more visualizations. The visualizations can be accessed through the system menu and the platform provides a set of filters that can be applied on the data displayed. Examples of these filters are date ranges, user groups (classes or project teams) and specific users. In order to interact with these parameters, the visualization can include elements to modify the selected value of each filter. In addition, visualizations can have a simplified version meant to be embedded into the user's dashboard. In this situation, the simplified visualization will keep the selected values for each filter, making it possible to present many insights with the same visualization. For instance, figure 7 presents a dashboard with four simplified visualizations generated by one single module. Visualizations at top-left and bottom-right have been generated with the same interactive visualization but with different parameters. The same occurs with examples at top-right and bottom-left.

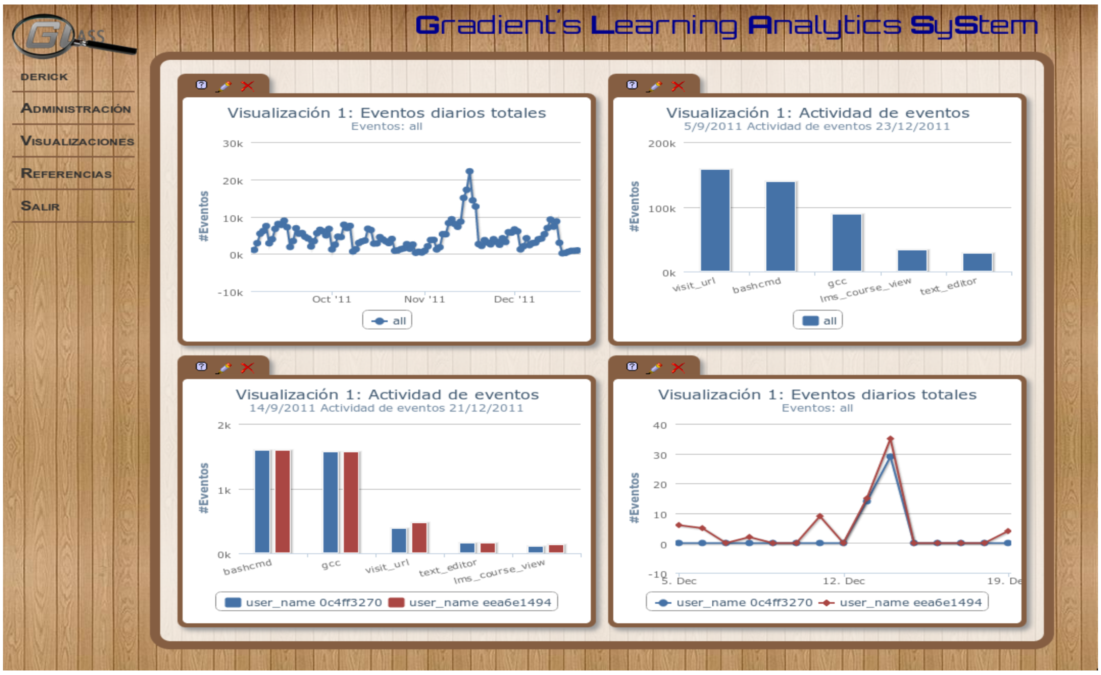

Figure 7. Dashboard of a user in LearnGlass, showing four visualizations of events in a learning activity

3.6.2. Context Aware Predictive Analysis (CAPA)

(Q.a. How?) CAPA project involves Web analytics for understanding behavioral patterns of users of various Web-based applications or information services to predict user intensions on the Web, such as accessing information resources, in order to achieve better personalization to diverse user needs and interests. User behavior may vary depending on the *context*, such as user activity, location, time, weather, etc.. (*Q.b. What?*) CAPA develops mechanisms to identify what the (current) context is and to integrate it into predictions.

One of the scenarios to use CAPA to extend PUP includes suggesting protected urban areas in the proximity of user's current location. Another scenario is to discover interesting patterns from user search queries and to use this information for recommending “closest/nearby” places to look for. For example, if the user searches for *Amsterdam,* based on historical data and some preferences, (s)he could get recommendation for *Paris*. In fact there maybe be no link between Amsterdam and Paris in the data description but the analysis of user behavior could show that.

(*Q.c. Who?*) The tool can help users in finding interesting information related to the previous search queries, it can also help solving the *cold start problem* for the first time PUP Web site users by providing recommendations based on available context information.

4. Comparative analysis

The results of the comparative analysis are presented in table 2. The assessment values are as follows: ☺ Available; 😐 Getting there; ☹ Not available.

Concerning applications (*Q.a. How?*), most key projects already make use of GIS and are Web-based. To see Arches and CAPA in action you have to download the code. PUP is the only tool that provides for a spatio-temporal analysis on the protected urban areas listed as World Heritage, even if only at global level. It provides a list of respective properties and also provides for a cumulative overview per municipality, country, region and total on protected areas. The presented projects do not provide for comparative analysis of content data e.g. do not compare two properties to each other although it is possible to some extend in CHIP (plus) prototypes. The presented Web/learning analytic tools are more focused on comparing users of applications rather than content.

The focus (*Q.b. What?*) of key projects is on (World) heritage properties – PP and RL on the nature sector, and PUP, Arches, CHIP on the cultural sector. CHIP prototype originally developed for the cultural heritage domain can be applied on World Heritage properties as well. CAPA researchers are particularly interested in e-commerce applications. For the experimental study they used web-portal MastersPortal.eu that provides information about various study programmes in Europe[51]. All key projects provide the most recent analysis, disabling the spatio-temporal analysis. They also relate analysis to the protected areas, rather than to specific entities e.g. significance, affecting factors. The overview in management tools is a common lack, already lightly tackled by RL and Arches.

Last, the stakeholders involved *(Q.c. Who?)* always include scientific data analysts. They also try to enroll the data providers, being PP, RL and Arches the most successful in integrating them among the community of users. They all somehow involve the broader public and research community in the exploration of information and data analysis, thus the community of users benefits from all tools. Only PP and CHIP are providing the services to personalize their use and revise the data analysis.

		PP	**RL**	**PUP**	**ARCHES**	**Carto DB**	**CHIP (plus)**	**CAPA**	**Learn Glass**
How?	Web-based GIS	☺	☺	☺	😐	☺	☺	☹	☹
	Spatio-temporal analysis	☹	☹	😐	☹	😐	😐	☹	😐
	Automated analysis	☹	☹	☹	☹	☹	☹	☹	😐
	Comparative analysis	☹	☹	☹	☹	☹	😐	☺	☺
What?	Protected areas	😐	😐	😐	😐	☹	😐	☹	☹
	Significance	😐	😐	😐	😐	☹	😐	☹	☹
	Affecting factors	😐	😐	😐	😐	☹	☹	☹	☹
	Management tools	☹	😐	☹	😐	☹	☹	☹	☹
Who?	Data analysts	☺	☺	☺	☺	☺	☺	☺	☺
	Data providers	☺	☺	😐	☺	☺	😐	☺	😐
	Data references	☹	☺	😐	☺	☺	☺	☺	☺
	Community of users	☺	☺	😐	☺	☺	☹	☹	☹

Table 2: The assessment results, per criterion and tool

5. Conclusions/Future Work

51 Kiseleva, J., Hoang Thanh, L., Pechenizkiy M., Calders, T.: Discovering temporal hidden contexts in web sessions for user trail prediction. In: Proceedings of TempWeb@WWW'2013, pp. 1067-1074 (WWW Companion Volume)

Protected Urban Planet is crucial both to the integration of research results, and to the dissemination of the research outcomes. Yet, the first prototype was far beyond our targets. More resources are needed to develop it properly. Moreover, while surveying the documentation produced while nominating and managing World Heritage properties, in both global and local approaches, it became clear that more efficient methods, targeting automation, would be needed to reach a larger sample of World Heritage properties, as well as, a higher number of documents per case study.

In the paper we presented the comparative analysis that discusses the differences and similarities between Protected Urban Planet a number of related tools within and outside heritage management. The comparison had three focal points: *how* data is analyzed and visualized, *what* is analyzed, and *who* contributes and benefits from the tools. Even though, each has its own advantages and disadvantages, there is still no tool to perform semi-automated analysis and extrapolation of spatio-temporal trends on World Heritage ontologies from the ever growing documentation produced while nominating and managing World Heritage properties. The authors, therefore, recommend the following research agenda for the future work:

5.1. Research challenges

- E-research: The application of e-research to support the semi-automated analysis and extrapolation of spatio-temporal trends from documentation, which otherwise would not be possible to develop, taken the ever growing nature of the documentation, the required amount of resources (time, facilities and analysts) and worldwide coordination.
- World Heritage Ontology: The elaboration on a dynamic domain-ontology for the World Heritage field and researchers, derived from data mining analysis of the documentation, and incorporating varied international heritage documentation standards, from both culture and nature sectors.
- Mapping World Heritage: The elaboration on the variety of locations and definition of boundaries, including buffer zones, as well as the context of World Heritage properties and their proximity.
- Analysis and Trends: The establishment of a long term scientific monitoring practice which allows spatio-temporal analysis and extrapolation of trends on World Heritage ontologies, bridging the gap between both culture and nature sectors.

5.2. Technical challenges

- GIS: The application of spatio-temporal analysis enabled by geographic information systems, to support the location and definition of boundaries deduced from ever growing, heterogeneous (in content and format) and highly unstructured information sources.
- Data mining: The application of automated analysis enabled by spatio-temporal data mining technologies, including opinion mining, to support ontological knowledge construction of ever growing, heterogeneous (in content and format) and highly unstructured information sources.
- Personalization and semantic data enrichment: The application of software developed for spatio-temporal personalized access to semantically enriched art collection, evolving from a collection of movable tangible objects to a variety of predominantly immovable objects, including intangible attributes.