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## VIRTUAL MUSEUMS AND BUILT ENVIRONMENT: NARRATIVES AND IMMERSIVE EXPERIENCE VIA MULTI-TEMPORAL GEODATA HUB

### MUSEOS VIRTUALES Y ENTORNO CONSTRUIDO: NARRATIVAS Y EXPERIENCIAS INMERSIVAS VÍA CENTROS DE GEODATOS MULTITEMPORALES

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#### Highlights:

- Investigation of a narrative approach to develop a theoretical model of virtual museums that can support communication and understanding of built environment and landscape.
- Integration of multi-temporal, multi-scale cartography and geospatial datasets, as a narrative base and information to facilitate the landscape values comprehension by non-expert users.
- Use of low-cost techniques (panoramic photos, 360° videos, 3D models) to design immersive experiences that can increase the interest of people in discovering the built environment.

#### Abstract:

Our built environment is nowadays considered as a dynamic complex, stretching and transforming across space and time, with the interaction of human, social and economic dimensions. It needs to be safeguarded as living places for the future taking into account such complexity. The general aim of this work is to contribute to the comprehension of landscape values, enhancing participation processes by tourists and local communities, considering the built environment as a system: the sum of natural transformation, ancient artefacts stratification and human activities, partially covering the tangible traces, and functioning as a vehicle for the comprehension of intangible values. Multi-temporal, multi-scale and geospatial datasets can play an important role in such knowledge transfer processes by means of narratives and immersive experiences in a multimedia museum approach. In particular, the cartographic heritage, in the form of metric and non-metric maps, can be progressively used as a source of information for innovative narratives. Virtual Museums (VMs) are additional "channels" to disseminate content and to provide knowledge about cultural heritage; they have emerged from the crossbreeding process between museums and digital technologies. Investigating how digital storytelling may support communication and understanding of complex systems, such as the built environment and landscape, it is relevant because cultural awareness may foster the sense of belonging and identity construction of which Europe is thirsty, contributing to the safeguarding of fragile sites. The paper provides useful information for museums that would like to follow this pathway. It retraces the main steps of storytelling production and presents interesting examples of immersive narrative models based on geospatial data and a virtual hub, helping people to retrieve and access information and to recognise places of memory mostly unknown. Moreover, it offers an evaluation of existing tools that can be adopted for this purpose. Eventually, by virtue of the research carried out for the case study of the Virtual Museum of Como Lake Landscape, the paper aims at ascertaining which kind of stories and experiences can be designed, the potential of these tools and possible weaknesses or constraints that deserve future researches.

**Keywords:** virtual museum; digital storytelling; built environment; cultural awareness; digital technologies; immersive experience

#### Resumen:

El entorno construido se considera hoy en día como un complejo dinámico, que se extiende y transforma a través del espacio y el tiempo, con interacción de dimensiones humanas, sociales y económicas. Debe salvaguardarse como lugares donde vivir el futuro teniendo en cuenta tal complejidad. El objetivo general de este trabajo es contribuir a la comprensión de los valores paisajísticos, potenciando los procesos de participación de los turistas y de los autóctonos, considerando el entorno construido como un sistema: suma de la transformación natural, de la estratificación de artefactos antiguos y de actividades humanas, cubriendo parcialmente los rastros tangibles, y vehículo de comprensión de valores intangibles. Los conjuntos de datos multitemporales, a multi-escala y geoespaciales pueden desempeñar un papel importante en dicho proceso de transferencia de conocimiento a través de narrativas y experiencias inmersivas en el enfoque de un museo multimedia. En particular, el patrimonio cartográfico, en forma de mapas métricos y mapas no métricos, puede utilizarse progresivamente como fuente de información para narrativas innovadoras. Los Museos Virtuales (VM) son "canales" adicionales que permiten difundir contenido y proporcionar conocimiento sobre el

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patrimonio cultural; surgen del proceso de mestizaje entre museos y tecnologías digitales. Investigar cómo la narración digital puede apoyar la comunicación y la comprensión de sistemas complejos, como el entorno construido y el paisaje, es relevante porque la conciencia cultural puede fomentar el sentido de pertenencia y la construcción de identidad de los que Europa tiene sed, contribuyendo a la protección de sitios frágiles. El artículo proporciona información útil para los museos que deseen seguir este camino. Describe los principales pasos que deberían considerarse a la hora de producir narrativas y pone ejemplos interesantes de modelos narrativos inmersivos basados en datos geoespaciales y centros virtuales, que ayudan a las personas a recuperar y acceder a información, y a reconocer lugares desconocidos o vagamente retenidos en la memoria. Además, ofrece una evaluación de las herramientas existentes que se pueden adoptar con este propósito. El objetivo es aclarar, finalmente, en virtud de la investigación desarrollada en el caso de estudio del Museo Virtual del Paisaje del *Lago di Como*, qué tipo de historias y experiencias se pueden diseñar, el potencial de estas herramientas y las posibles debilidades o limitaciones que merecen futuras investigaciones.

**Palabras clave:** museo virtual; narración digital; entorno construido; conciencia cultural; tecnologías digitales; experiencia inmersiva

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## 1. Introduction

The theoretical reflections and debate of the last decades have created a breeding ground to acknowledge to landscape a more extended cultural meaning.

The effective raising awareness process about its potential contribution to the local cultures, to the human well-being and identity construction, and to “the sustainable social and economic development” (ICOMOS, 2008a), needs to be supported by a new way to access and understand the rich and complex stratified system of information about it. “The spirit of place is made up of tangible as well as intangible elements” (ICOMOS, 2008b), consequently, they must be both considered in the built environment and landscape analysis.

The research aims to investigate how a series of resources (from different Institutions, Historical Map Archive, Europeana Collections and initiatives) including paintings of the landscapes and landmarks, historic cadastral and territorial maps and panoramas, can be re-used, exploited and valorised (beyond their artistic and aesthetic values), thanks to the opportunity of contextualization and comparison, experimenting innovative geo web-based applications enriched by narratives. The purpose is to offer an overtime space experiences of the landscape that helps users to understand transformations occurred, to identify historic traces and permanence as well as to foster recognition of landscape values.

The final goal is to allow a critical touristic way to share and experience the community identity of a historical landscape, exploiting the possibilities offered by the different emerging digital tools and technologies.

The application is specifically addressed to people interested in visiting the Museum of Landscape of Como Lake (*Lago di Como*) and the Tremezzina area. A multimedia-system has been designed and implemented to support during the virtual museum visit boosting the on-site visit across the unknown themes selected, improving the understanding of the values of the Tremezzina’s landscape among different targets such as tourist and locals.

Different narratives supported by the geospatial space have been tackled as proposed by the Virtual Museum of Como Lake Landscape within the framework of the same name museum, analysing potential and limits of web-accessible data and related information to improve the attractiveness of the places before the visit and during the visit as well.

## 2. Virtual museum to communicate built environment

### 2.1 Built environment and landscape as human value and cultural heritage

Nowadays, the concept of landscape has reached a new maturity that allows us to consider it as a constantly changing archive, a “palimpsest”, a document permeated by human and natural historic traces with richer and broader meaning alongside aesthetic and naturalistic appreciation (Scazzosi, 2003; Scazzosi, 2004).

The European Landscape Convention (2000), and more recently ICOMOS Florence Declaration (2014), corroborate this view and they go further stating: “landscape contributes to the formation of local cultures and that it is a basic component of the European natural and cultural heritage, contributing to human well-being and consolidation of the European identity” (Council of Europe, 2000). “Landscapes are integral part of heritage as they are living memory of past generations and can provide tangible and intangible connections to future generation. [...] Increasing knowledge and cultural awareness of the heritage of a place fosters meaningful inter-cultural dialogue, engenders respect for cultural differences at a personal level. [...] It is the foundation for peaceful co-existence” (ICOMOS, 2014).

Today, we are faced with a new, young and not completely mature Institution as Europe is, placed side by side to the pre-existing national level, adding further complexity to identities issue. People have always possessed different cultural identities (Castells, 2000), so, the matter is not how to replace their national with the European one. We look first of all at Europe because, besides being directly the closest reference environment, it is an entity still in the process of being fully made into its own by society, where the discrepancy between the Institution and “popular feeling” is palpable. Here, probably more than elsewhere, the memory-heritage-identity systemic approach is the main option to trace and image a future according to the view that “how we conceive the future has implications for how we conceive the present and the past – and vice versa.” (Macdonald, 2013).

The concept of cultural identity is strictly related to the authenticity of our cultural heritage and the associated values (ICOMOS, 1996). The goal of preserving, sharing and disseminating cultural heritage must be approached by aiming at identifying and enhance the deeper tangible and intangible values of a site. The process of identifying and transferring those values is not always agreed upon

by the various people involved in the landscape analysis, conservation and planning, and it requires adaptable and implementable tools. Innovative digital tools represent a new possibility to narrate different histories on a site, always to be considered as a partial point of view of a most complex and articulated situation.

## 2.2 Virtual museum and digital storytelling for the dissemination of landscape knowledge

In recent years, museums have been attempting to do more than preserving and conserving artworks and remains. Prioritising themes, ideas and relationships may be considered one of the strengths of the modern museum (Hooper-Greenhill, 2005). This trend offers the opportunity to define new methods of interpretation that are especially suitable for presenting complex system such as the built environment (BE) and landscapes in a museum.

Additionally, museums have been called to open up their doors to an increasingly wider audience. This has asked them to define alternative modalities of encounters that may be especially appealing for those categories who are not usually accustomed visitors, and to push for using cultural heritage as a tool to foster a reflective behaviour and sense of belonging within societies. Investing in VMs development lies in the fact of their greater flexibility compared to traditional museums that makes them an ideal environment to propose a new method of communication, to offer innovative ways to encounter heritage, to extend the paradigm of experience (AT home-IN museum-ON site) as well as to engage different communities.

Up to today, VMs have been many things. There is not a single model of VM, and it is not merely a matter of definition of course (Caspani, Brumana, Oreni & Previtali, 2017). Under the name of VM are virtual tours, digitalised collections, and dedicated web pages which are commonplace. VMs appear often as a sort of “simple” digital replica of the real one. However, in all the forms already tried out, they have supported a more democratic access to culture. An important project such as Google Art & Culture or Europeana (<http://www.europeana.eu>) could do something more. They have offered access to different museums or collections from a single webpage, making users life easier and enriching the experience in term of content available and content automatically suggested thanks to a well-structured internal system of semantic research. However, they still struggle to show what there is beyond the digitalised object in itself.

A narrative is a powerful tool for museums and VMs because it follows in structure how people learn. Human beings make sense of the world and themselves through narrative and it is basically the instrument for making meaning (Bruner, 1991). The scenario opened by the narrative approach may contribute to making accessible and comprehensible the tangled relations that in other ways are difficult to be appreciated and understood by the public as often happen in the case of the landscape. The digital narrative may be used to show how objects of culture have different valences in different parts of Europe. It may be the glue to connect the various points of view about controversial historical events as well as it may support a sense of belonging and identity construction, especially with regards to field sites which

have controversial and tangled histories, of which Europe has many <sup>1,2,3</sup>.

Storytelling is a method of interpretation, a way to inspire an internal dialogue and ensure a real connection with visitors as well as a strategy for realising an environment where visitors are encouraged to create their own meaning (Bedford, 2001; Wong, 2015).

A museum is defined by the International Council of Museums (ICOM) as “a non-profit, permanent institution in the service of society and its development, open to the public, which acquires, conserves, researches, communicates and exhibits the tangible and intangible heritage of humanity and its environment for the purposes of education, study and enjoyment”. Within the framework of Virtual Multimodal Museum (ViMM) EU project<sup>4</sup>, an updated definition of virtual museum is on course of discussion, underlining the role of narrative in augmenting the information through the interactivity and content enrichment: “virtual museum (VM) is usually, but not exclusively, perceived as a digital entity that draws on the characteristics of a museum, in order to complement, enhance, or augment the museum experience through personalization, interactivity and richness of content”. An expert Advisory Group in building the ViMM Framework, involves decision-makers and expert practitioners in defining and resolving issues spread across 7 interlinked Thematic Areas: TAs (‘the 7 Ds’): Definitions–Directions–Documentation–Dimensions–Demand–Discovery–Decisions: particularly ongoing Reports on Cultural Metadata Standards and three-dimensional (3D) Standard formats highlight the progressive role of 3D data content improving knowledge transfer potential.

## 3. The built environment of Tremezzo and its communication

Tremezzo is located on the left side of Como Lake. This area has a complex landscape structure which is the result of the natural characteristic of sloping terrain morphology facing on the beautiful Lake of Como and the different uses of the land from the agricultural activities of the past until to the tourist vocation started from the 19<sup>th</sup> century. Nowadays, it is characterised by the famous water view front on the lakeside with a high pressure of aggressive tourism, an underestimated

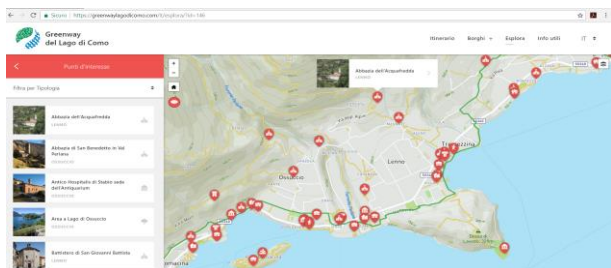
<sup>1</sup> See the Manifesto of the HORIZON 2020 project CulturalBase (Social Platform on Cultural Heritage and European Identities) <http://culturalbase.eu/>

<sup>2</sup> For instance, the no-profit association CHwB (Cultural Heritage without borders) in its strategic plan 2013-16 declares “cultural heritage is used as a tool for creating a better understanding of our shared and diverse pasts and as a building block in the effort to promote democratic development.”

<sup>3</sup> EUROPEAN COMMISSION, 2014, *Towards an integrated approach to cultural heritage for Europe*.

<sup>4</sup> ViMM (<https://www.vi-mm.eu/>) is a high-visibility and participative action under the H2020 CULT-COOP-8-2016 EU, which brings together Europe and the world’s leading public and private sector organisations working on Virtual Museums and in the wider sector of Digital Cultural Heritage (DCH), to support high quality policy development, decision making and the use of technical advances.

hillside band (with beautiful landscape, drywall terraces and palaces, that is living a phasing-out of the ancient cultivations, that made famous and rich Tremezzo during the 17-19<sup>th</sup> centuries, with a lack of maintenance and lack of identity by the inhabitants) and mountain pastoral agroforestry on transformations (Brumana et al., 2015a). In recent years many different projects have been funded by the Municipality and the Lombardy Region<sup>5</sup>, in order to support studies on this landscape, to enhance its history and consequently to promote a sustainable tourism (Fig. 1). To this aim, the complex, interactive and multimedia digital techniques can have an important role in supporting the comparison between past and present landscape.



**Figure 1:** The website of Como Lake greenway (2002-2007) (<https://greenwaylagodicomo.com/it/esplora/?id=146>).

In particular, the theme of the voyage through cultural routes, by land or by lake, allows today to reconstruct and reconnect the history of places, villages and people who in the past lived and transformed this landscape. As indicated by ICOMOS (ICOMOS, 2008a), cultural routes:

include a joint system which enhances their significance. This integrated, interdisciplinary and shared framework creates new relationships among them by means of an innovative scientific perspective that provides a multilateral, more complete, and more accurate vision of history. A Cultural Route can be a road that was expressly created to serve this purpose or a route that takes advantage either totally or partially of pre-existing roads used for different purposes. But beyond its character as a way of communication or transport, its existence and significance as a Cultural Route can only be explained by its use for such specific purpose throughout a long period of history and by having generated heritage values and cultural properties associated to it which reflect reciprocal influences between different cultural groups as a result of its own peculiar dynamics.

An example is the ancient "lemons road" that was used, since 15<sup>th</sup> to 19<sup>th</sup> century, by the merchants (in particular Brentano Family and other famous families) to bring citrus from Tremezzina to Riva di Chiavenna, Lindau and finally to Amsterdam and Frankfurt markets (Pini, 2003).

This breadth of scale is fundamental in the analysis of the landscape to understand the richness got in the past, and importance today of Tremezzina and the connected built heritage, considered as a whole system.

#### 4. Built environment and the experience of the Virtual Museum of Como Lake Landscape

The territory of Tremezzina (Como Lake) is historically well known for its beautiful landscape and built environment with many architectural emergencies of great attractiveness, as Villa Carlotta, or the star-system Villas. In the recent years, the enhancement of its cultural heritage (in the extended definition) has been a key issue for local bodies that have invested (also thanks to funded Interreg projects) in realizing a new dedicated museum and creating a network among the local cultural Institutions to exploit the touristic capacity of catalysts such as Villa Carlotta (about 200,000 visitors/year) with the hope to enhance and support a widespread micro tourism across all the area spanning about 20 km from Como to the North.

The "Museum of Como Lake Landscape" (Villa Mainona, Tremezzo, Como) concept framework was explicitly designed to raise awareness about such values of this territory and to spread knowledge about its history among local communities and tourists (Figs. 2 and 3).

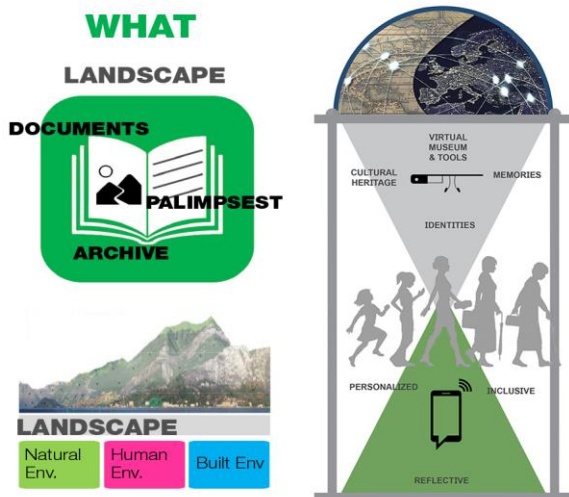
In fact, nowadays, tourists remain nearby the lake for summer sports. The lack of information and awareness of the richness of the studied area, with its values and ancient traces, has led to a deserted environment in fall and winter.

The European Landscape Convention stated the important link between the role of connecting people, for the growing of a reflective society, and knowledge creating in safeguarding cultural heritage, proposing specific measures for the identification and assessment (Council of Europe, 2000). According to that, the project



**Figure 2:** Concept framework of an innovative model of VM for Built Environment & Landscape.

<sup>5</sup> *Accordo Quadro di Sviluppo Territoriale (AQST) Magistri Comacini, and Ecolarius, Lombardy Region, 2005.*



**Figure 3:** Multi-temporal narratives based on historical maps related to the current space can facilitate inclusive processes through people involvement and identity rising.

of the museum aims to raise the awareness of landscape, the objective of this research is to identify a dissemination methodology, correlating and managing, as many of the remained traces, the viewable, the less viewable and the untraceable values experimenting a sort of Geo-SWOT (Strengths, Weaknesses, Opportunities, Threats) chart analysis, combining values with metric and non-metric multi-temporal view maps, ancient and current.

The Museum of Como Lake Landscape (partially opened to the public in September 2016) offers a traditional permanent exhibition of historic panoramas of Como Lake. It is complemented by a highly innovative multimedia system, designed by Gicarus Lab of the Politecnico di Milano and developed in collaboration with an SME private company (NEMES SRL). It provides an immersive and interactive mode to discover the landscape combining different digital data, information and contents with the intermediation of geographic space to help the visitor to understand the history of these places with the subtended aim to encourage the visit on site.

#### 4.1. The multi-media system: multi-temporal geospatial data navigation

Multi-temporal data access has been progressively exploited during the last decade (Cuca, Brumana, Scaioni & Oreni, 2011) as a starting point to be enriched by related information, documents and pictures.

To reach this goal an interactive navigation system has been developed within the 'Multimedia system of the landscape of the Municipality of Tremezzina on the Lake of Como'<sup>6</sup>.

<sup>6</sup> PORL FESR 2007/2013 (European Funding Research and Development) 'Multimedia system for the presentation and participated recognizing of the environmental values of the landscape of the Lake of Como' (*Sistema multimediale per la presentazione e per il riconoscimento partecipato dei valori ambientali del paesaggio lariano*), Asse 4 Tutela e Valorizzazione del patrimonio naturale e culturale, Line 4.1.1.1 Promozione e diffusione di una fruizione sostenibile,...

Two touch screens, connected each one to a wall projection, involve people with different sections that visitors can choose during the navigation (Fig. 4).



**Figure 4:** Virtual Museum of Como Lake Landscape (collection, the multimedia system by ©Gicarus Lab). The multi-media system based on multi-temporal geospatial data navigation.

The multimedia system has been based on different multi-temporal geospatial data supported by historical maps related to the current ones. Different map navigations have been implemented taking into account two different typologies of the maps:

- Non-metric maps, i.e. the ancient Waterview front maps, or perspective maps (Monti *et al.*, 2009);
- Georeferenced metric maps, i.e. historical cadastral, and territorial military maps (Brumana, Cuca, Oreni, Prandi & Scaioni, 2010).

The virtual museum visit has been conceived for different visitors, from non-digital experts (including ageing people, both tourists and local inhabitants) until 'digital natives' with 3D navigation functionalities, in order to help people recognising the past and valorising the traces of the historical anthropic landscape. In particular, the following sections are available:

- Multi-temporal landscape navigation: historic water view front map correlated to the current panorama of the lake, obtained along 20 km of coasts, helping to recognise the landscape historical values;
- 3D historic map registration (Brumana *et al.*, 2010; Barazzetti, Brumana, Oreni & Roncoroni, 2013): a section visualising the historic cadastral maps georeferenced to the current map with overlapped themes remotely managed on Google Earth®;
- Tremezzo itineraries on Google Earth®: Google Earth® interface presenting the themes and subthemes of the territory in a 3D 'Virtual Globe' allowing exploration and navigation of different itinerary trips for the visiting people;

*Realizzazione e promozione di itinerari turistici per la fruizione sostenibile delle risorse culturali e ambientali.* Province of Como scientific responsible, with the support of Polimi (Prof. S. Della Torre, R. Brumana for the construction of the Tremezzina multimedia museum).

- History of Tremezzo in Europe: Google Earth© interface presenting the EU geo-tree of the merchant families of lemon across Europe;
- Isola Comacina: the historical site of the Isola Comacina, viewed by the 3D drone orthoimage of the archaeological site to achieve better detail than Google's Imagery (Brumana et al., 2013).

#### 4.2. Interactive offline non-metric panoramas navigation, today and in the past

An interactive map navigation has been implemented offline, correlating the ancient perspective view of the waterview front and the current panoramic cones obtained from the opposite lake-side image acquisition along the treat of the coast from Como city, through Comune di Tremezzina until Menaggio (Barazzetti et al. 2013).

In particular, it was digitalised a precious historical map, known among the inhabitants the "*Panoramica da Como a Menaggio e da Bellagio a Como*" (Gaetano Brigola, 1863), that represents the waterfront of the two sides of this part of the Como Lake, indicating the names of the landscape natural and anthropic valuable evidences: the top mountains names with the still recognisable ridges, the hills characterised by the rich network of cultivated terraces and drywalls, the main villas and palaces' name on the lake and in the hamlets, the famous parks, and so on.

The historic and current water view fronts have been navigated through a simple co-relation code, based on homologous points recognised in the two maps, thus allowing to avoid stretching the correlated portions, introducing too high map deformations, and, at the same time, helping people to recognise the correspondent places, as in the case of the ridges of the mountains, represented by different point of views in the two maps, or the waterfront places. All the texts, coming from the ancient map, have been made available with a small explanation (EN/IT) and related to pictures and videos to allow a wider comprehension among people.

Three different landscape layers have been highlighted with an immediate level of perception (three transparent bands, at the waterfront level, at the hillside and at the mountain level): a deeper narrative has been implemented and superimposed on the two maps, as a game-checker with coloured thematic icons following the three coloured band-layer, to help the multi-temporal correlation in order to help visitors to navigate across the three landscape layers during the tourist trips and the multimedia museum visits. An easy interactive navigation along the coast is made possible by turning on/off the different layers.

The landscapes views have been enriched by a series of information to support visitors to perceive the value of the built environment as a whole, avoiding limiting it just to the lakefront, inviting them to a visit inside the landscape across the richness of the hillside.

A number of themes and subthemes of the territory, highlighted by semantic icons, have been designed and referenced in the two maps displaying the three landscape layers, with a brief description (EN/IT) (Fig. 5):

- Layer I (cyan) – Water view front – foreground layer: it is characterised by the famous Villa systems and Parks. The view front, nowadays under the pressure of the traffic road (commercial and touristic), represented in the past an important connection to the North of Europe (the ancient Roman road on the lake has been partially destroyed and lost due to the transformations during the last centuries). The navigation aims to relate the waterfront to the richness of the background, to diminish the touristic pressure on the Lake, and to underline the important connection to Europe in the past, as explained hereafter (Fig. 5, cyan icons).
- Layer II (magenta) – Hills and Hamlets – 1<sup>st</sup> background layer: it is characterised by the mostly unknown hamlets, which are unfortunately characterised by lack of preservation and awareness by the local people, nor visited by the tourists. The navigation aims to highlight the traces of a rich dense network of the cobbled ancient paths, of the vaulted passages under the palaces, the historical land use traced by its artefacts (i.e. terraces on the hill slopes, paths, water sources, canalization, drywall), and lemon terraces cultivations now abandoned (Fig. 5, magenta icons).
- Layer III (green) – Mountains – 2<sup>nd</sup> background layer: the navigation aims to transfer the meaning of the ancient history of anthropic landscape (Fig. 5, green icons), with the old pathways for the seasonal grazing and pasture transfer (muleteer), still viewable, that could be inserted in a local centred sustainable agriculture, increasingly growing in Lombardy Region (i.e. sheep wool and cheese production).

The section interactive offline non-metric panoramas was conceived to encourage free user navigation and discovery. It means that there is not a user's pre-defined order to follow, or pre-set navigation tours of the map. Indeed, the main drivers are user's interest and curiosity.

The two compared maps act as a canvas of the narrative. The division in three levels (each layer of analysis, in the abstract, can be seen as a story composed by many "subsections", as many as the landscape elements identified using the icons) was made to highlight the differences of this built environment, but also to offer a simple and not too much invasive guidance that can foster an organic and logic narration.

#### 4.3. Web3D navigation through the historical cadastral maps

For the native-digital public, and people using GoogleEarth© based 3D navigation, it has been implemented a proof-of-concept Web3D application that allows the navigation across the centuries by mean of the historical cadastral map series with all the richness of details allowed by the scale (1:2000) with the help of signs and graphic representations still recognisable on the current state of the art.

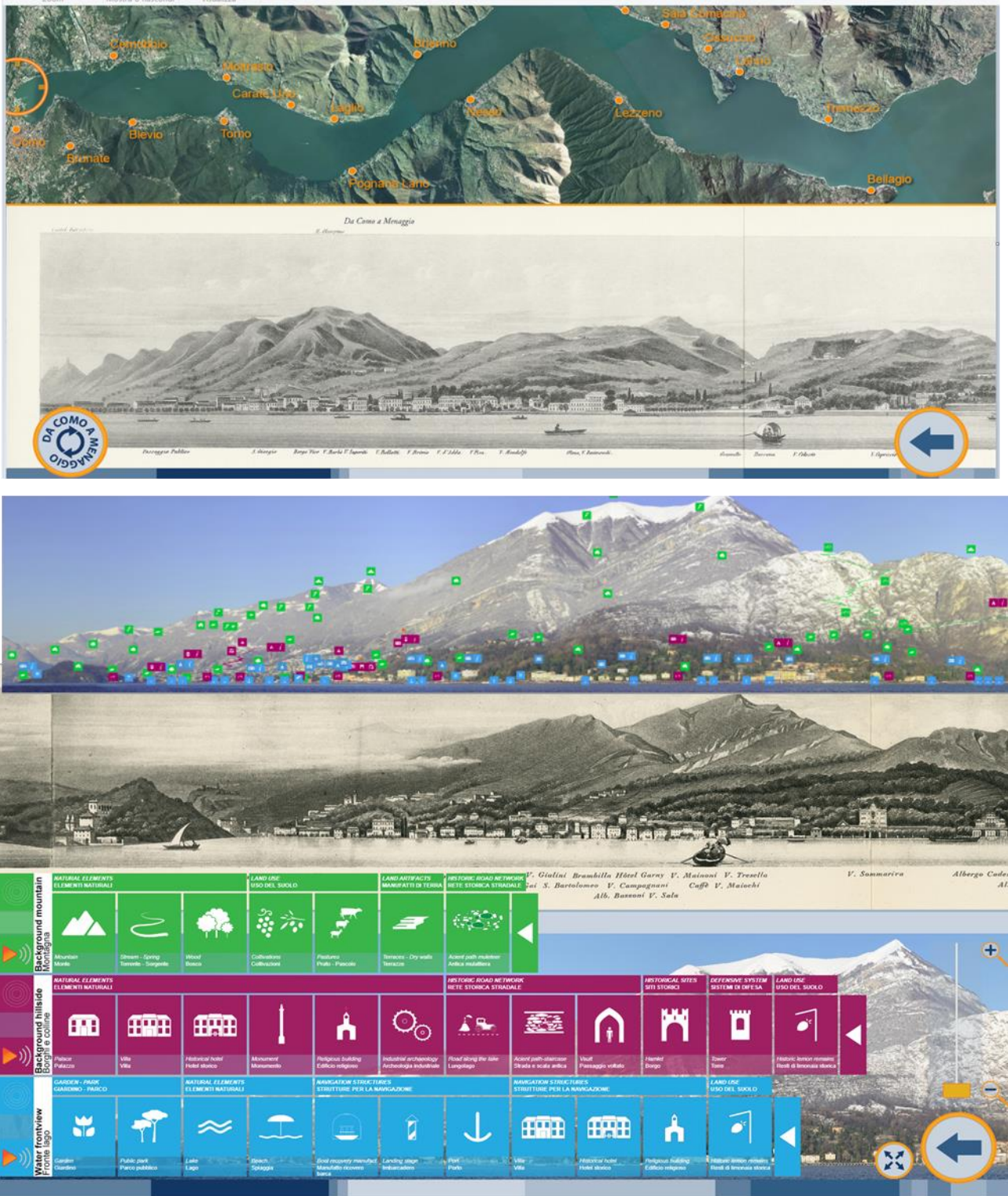


Figure 5: Interactive map navigation correlating the ancient perspective map view from Como to Menaggio and the current panoramic cones enriched by the semantic thematic icons (i.e. hamlets, villas, ancient paths, drywall terraces).

Such experiment may be scaled and adopted, in its framework and architecture, by other Institutions to stimulate people awareness about stratified values of the built environment. The use of correlated cadastral maps can facilitate recognition of historical centres and place them on the timeline. This kind of maps, in fact, can become an important vehicle of information from the past to the present especially when there is a lack of existing permanence.

The starting point of a geo-web based navigation has been motivated by the idea to attract people visiting the Lake of Como, using a common geographic based navigation interface (in this case Google Earth©) accessible both during the museum visit and during the 'on-site' visit. Furthermore, we have bet on the potential support arising from the use of a geographical space well-known in order to reduce to a minimum the technological barrier at least.

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In order to navigate across the multi-temporal maps of the historical cadastre in a three-dimensional environment, a Google Earth© based web solution has been firstly chosen as an easy and flexible solution. At the time of the choice (2014-15-16), a number of API were available to customize the interface in order to obtain different targeted thematic virtual visits across the hamlets, the ancient paths, the terraces, the villas, and the hills.

The geographic layers have been enriched by the GIS thematic layers generated to facilitate the fruition and comprehension of the historical maps series and the current transformation and permanence: ArcGIS© layers have been converted in KML layers and then imported into Google Earth© for accessible navigation. Each added layer brings specific information according to the themes that were carefully identified and selected during the student internship of Ms Daphne Roels, in collaboration with Leuven team, for dissemination purpose taking into account the results of geo-swat analysis previously made on Tremezzo area.

Among them, the digitization of the ancient paths and buildings on the current maps have been extracted, assigning different colours, where recognizable the historic permanence, characterizing the current map canvas: pink –Catasto Teresiano (XVIII)–, purple –Catasto Lombardo Veneto (XIX)–, brown –(Cessato Catasto (XX)– (Fig.6a). The choice to work on the vectorial layers of the current maps was motivated by the importance to underline the transformation, permanence and mutations, occurred from the past (readable on the ancient maps) till to the current state of the art. Current buildings in the hamlets, villas and palaces, together with the road network have been highlighted and coloured evidencing the features surveyed by the different historical cadastral maps (Fig. 6b).

This approach allows to deeper investigate the level of conservation, maintenance and use transformation in order to sensitise people toward the conservation aims.

Unfortunately, during the thematic implementation of the virtual museum, the policies of Google Earth© changed, the customization of the graphics interface was no more allowed to the developers, nor free of charge nor paying costs.

As results, all the narratives implemented couldn't be separately managed, enriched by *ad hoc* legend, explaining tests, with some evident critical issues for the visiting people, obliged to select among many layers the interesting ones.

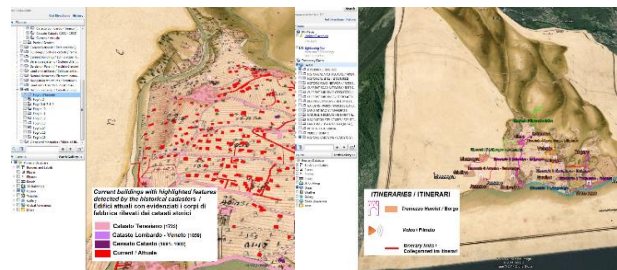
This unexpected circumstance has drastically reduced the possibility to customize the graphic design of the environment and contents. The geospatial interface, in fact, can host information only as an additional layer. This aspect makes difficult an independent navigation and a full understanding of the relation among landscape's elements by common users if they are not guided by museum operators, as underlined during the inauguration of the museum.

The Google Earth© interface implemented, even attractive for the 3Dnavigation and richness of themes, has shown a critical limit in the fruition by the people, having too many choices in the layer selection with no one graphic customizable support to help in the choice

nor in the explanation, for this reason, a number of legends, in the form of static JPG picture, have been added to help in the multi-layered map reading.



(a)



(b)

**Figure 6:** The Google Earth © implementation: a) use of historical cadastral map series to read of transformation permanence and mutation and allocate, for instance, architectural heritage in time; b) example the geo-thematic layers generated from ArcGIS© on the historical cadastral map series (©POLIMI, dABC LAB - Gicarus).

### 5. Geopan App - VM: toward open data hub for VM hamlets fruition

In the vein of what above, the research seeks to develop new communication tools that take benefit also from re-use of open data (Cuca, Previtali, Barazzetti & Brumana, 2017) generated on the historical georeferenced maps combined with other cultural digital resources in a geo-temporal better customisable interface.

The aim is to enhance the current level of the geographic data fruition by remote Web3D access, implementing an available application developed to boost the redistribution of geographic open data, tuning it for the specific case of virtual museum access, a 'Geopan App - VM' driven.

Open Access Atlas and related services, Open Geospatial Consortium (OGC) and Inspire compliant, have been introduced among the historical map services for many years, allowing a number of analysis of transformations of the built environment in order to support sustainable planning and a better knowledge of the state of the art (Brumana, Oreni, Cuca, Rampini & Pepe, 2012). The bet is to gradually use such



opportunities within the virtual museums to improve narrative storytelling empowered by the open access services developed on the historical maps. Virtual Hub brokering and accessing services, based on temporal-spatial and semantic subsetting, have been recently introduced and applied to the large dataset as in the case of GEO global Earth Observation (Nativi, Craglia & Pearlman, 2013).

GeoPan Atl@s APP (<http://www.atlas.polimi.it/energic-od/geopan-atls/>) was born from Polimi –dABC LAB-Gicarus, providing rapid and facilitated access to multi-temporal historical cadastral and topographical maps (Brumana et al., 2015b) through an open source geoportal using a European Virtual Hub (Previtali, 2017). It can integrate geographic data as well as open data thanks to an advanced brokering system and exploitation of virtual hubs potential that was made possible in the last development within the three-year project ENERGIC-OD (<https://www.energic-od.eu>) funded under Competitiveness and Innovation Framework Programme (CIP). The Geopan App web-based application has been developed for desktop and mobile; it can rely on a double modality of access, via a web browser or via an Android application, for a flexible use (on site, at home, etc.). Thus, it is ready to be tuned in support of geo-based narratives to raise awareness among visitors of an unknown piece of history, as the hillside area of Tremezzo.

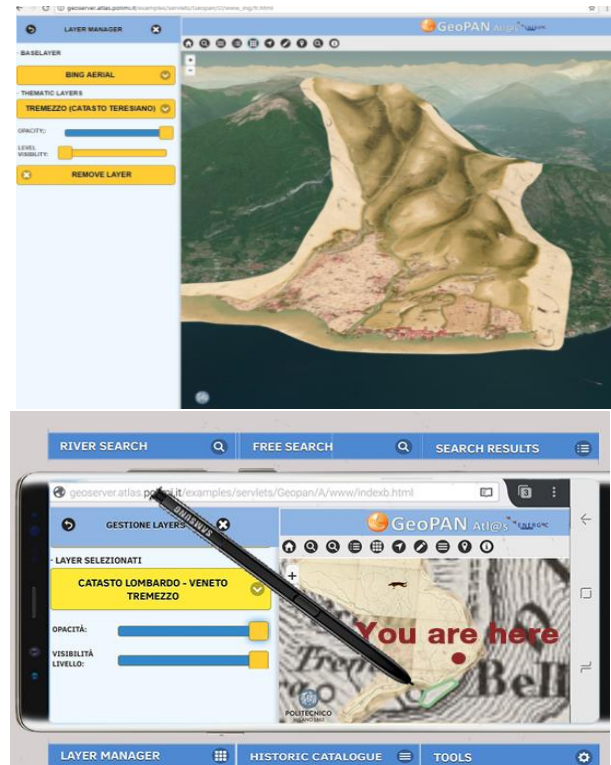
With this aim, the application, Geopan App ([http://geoserver.atlas.polimi.it/examples/servlets/Geopan/A/web\\_APP/index.html](http://geoserver.atlas.polimi.it/examples/servlets/Geopan/A/web_APP/index.html)) have been updated - using a Virtual Hub brokering and accessing services - with the series of historical cadastral maps and with the open layers of Como Lake generated for the Google Earth® application. It supports multiple thematic modalities of research based on semantic and temporal subsetting; a simultaneous visualization of different superimposed historic maps facilitated by the layers manager implemented. Furthermore, it offers basic features such as: drawing on the map, take video, geolocation, path tracking that may encourage an active users' involvement and contribution.

It can contribute to allowing the visitor to know the territory of Tremezzina and Lake Como giving access to a richer "multi-institutional" collection of historical panorama views of Como Lake (part of the collection of Museum of Como Lake Landscape and additional resources available in Europeana) within a geo-temporal web base environment, that can be used within the museum, at home and on-site for an extended experience.

Last but not least, it is characterized by a friendly and intuitive interface in virtue of continuous involvement of customer and stakeholder, showing the favourable response from final users (Fig. 7).

The migration of all the data, layers, images and video from the Google Earth® interface (enriched by explanations and related information) is ongoing. The possibility to use search functionalities based on semantic word and temporal selections can be used to personalize and develop the different narratives in function of the visiting preferences.

The interface can be personalised, selecting few themes for each storytelling, focusing single themes in the museum visits. For instance, the history of the



**Figure 7:** The Geopan APP allows users to personalise the graphics interface simplifying user access to the different contents; it also supports thematic searches content focusing: research based on semantics, re-use of geographic information and open cultural data (© POLIMI, dABCLAB - Gicarus).

merchants across Europe through the 'lemon route', coming from Tremezzo getting European cities to sell lemons cultivated in the 17<sup>th</sup> century on the Lake of Como, and particularly in Tremezzo. They exchanged such precious products, antibiotics were not available at that time, buying spices arriving from the north harbours (i.e. Rotterdam, Amsterdam) building a dense network of Emporium across European cities (i.e. Lipsia, Berlin, and many others) through the network of relatives, sons cousins and so on. Getting rich, they built precious Palaces and Villas in Tremezzo that are still existing (i.e. the Brentano's family Palaces, the Carli's family Villas).

Since the beginning, this story was identified as one of the most representative of the main transformations occurred on Tremezzina landscape, attractive and suitable to rethink the presentation according to a storytelling approach. Since 2017, after a preliminary investigation of available software and platform that move forward traditional GIS architecture towards a storytelling presentation (Caspani et al., 2017), it has been made a first attempt that has taken advantages of the web-application Story Map from Esri. In this case, the story was "written" using a model of pre-ordered full frame sections (central frame for the main source of information, the lateral band for text and secondary contents) one after the other. In each section «thematic map» (designed to present only relevant GIS data, migrated, in our case, from the more reach and an all-inclusive map of Google Earth) are usually the story driver with a starring role. Story workflow has foreseen: storyboard of the narrative for its segmentation (how many sections, main topic of each one, presentation order), selection of «relevant information» KMZ layer that should be migrated from Google Earth and, finally,

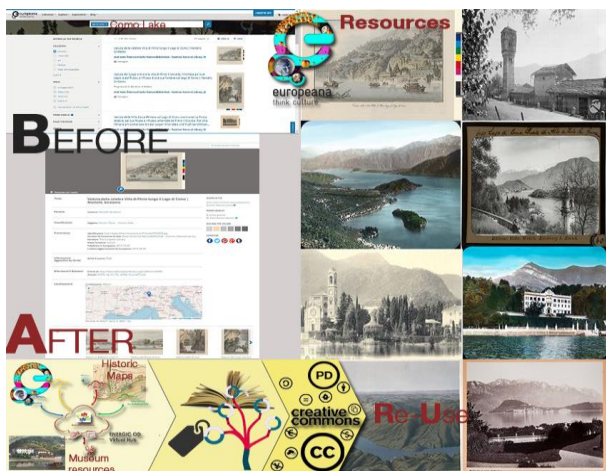
development of additional contents that enrich the story and open the door to immersive experience.

Wanting to avoid a solely rely on a non-proprietary software and wishing to open up to the possibility of integrating open data as additional contents, it has been embraced the idea of using Geopan App, which can better guarantee customisation perspectives. The work of structuring the narrative, as a series of thematic maps with additional contents, was repurposed for the development in Geopan App.

### 5.1. Toward web-based historic panoramic view related to current views: Europeana Collections OD

These promising aspects in the enhancement of storytelling instruments, supported by geospatial data, are interesting premises that suggested implementing the Geopan Atl@s App - VM to integrate the geolocated historic panoramic view of Como Lake, coming from available Europeana Collection, within a multi-temporal geographic environment.

A potential adoption of the Geopan App - VM of Como Lake Landscape - as well as to put in place a possible re-use of open cultural data already available in digital repository such as Europeana (historic panorama of Como lake, paintings depicting customs and traditions, influential people, etc.) could enrich even more informative and communicative dimension of the exhibition of the ancient maps (Fig. 8).



**Figure 8:** The conceptual framework for a possible re-use of Europeana open data collection: historical perspective views of the Como Lake (courtesy of Sara Caspani).

The main objective is to implement a friendly and intuitive interface in virtue of continuous involvement of customer and stakeholder. Given that, comprehension of ancient perspective views is often hard for the public, it has experimented with the potential of geo-based redistribution of such views for helping people to better correlate them to the current space.

The research would like to offer the opportunity to enrich the app with a new feature of images comparison (historic panorama and current views) by correlation of the homologous points as obtained in the upper described case (see Section 4.2).

By way of example: JuxtaposeJS, imgSlider, Cocoon, Image Comparison Slider, have been considered and

compared. In this way the experience of the territory in the past will span from the traditional 2D-3D representation to the integration of the ancient perspective views, correlating the 2D-3D metric representation to the non-metric perspectives.

Geo-localization plus tracing of optical cones within the geographic space will drive the user to contextualise the panorama with respect to the territory (also a time contextualization thanks to the integration of historical maps as navigation base) with the support of an illustrated timeline. Linking historical 2D and 3D information (maps and panoramas) is intended to help users, even non-experts, through the recognition of the ancient optical cones of view registered by the ancient maps and to correlate and appreciate the current ones enriched by stratified values. In this regard, it is expected to implement an easy and intuitive user-friendly feature to compare images relating historical and current views.

The main purpose of this further enhancement is to boost the understanding of the ancient panorama exhibition, realised in the Museum of Como Lake Landscape, coming from very precious collection but, sometimes, not fully comprehensible by the large public (Fig. 9).



**Figure 9:** Panoramas in Geo-Context (on development): a historical perspective view of Ossuccio and the optic cone of the view referred to the historical military map (19<sup>th</sup> century).

The intention of the direction of the Museum is to promote a better comprehension of the exhibition valorising the ancient maps of the lake landscape with their beautiful views, helping the discovery and recognition of the current corresponding views, developing an *ad hoc* interface to locate historic 'Panoramas in a Geo-context' in order to highlight the 'Panorama's changes over Time' and also to valorise the conic views and bird views maps available as open data belonging to Europeana digital data set (resources about ComoLake at <https://www.europeana.eu/portal/it/search?q=Lago+di+Como>), being that the maps exposed in the Museum have not been yet digitalised due to the museum opening matters (Fig. 10).



**Figure 10:** Concept framework for a geo-time space application to valorise landscape knowledge by an innovative access to digital cultural open data (courtesy of Sara Caspani).

The Geopan App - VM 'Panoramas in Geo.Context' would like to:

- Present the app and its functionalities to refer to the ancient perspective views on the historically registered 3D maps, through the optic cone view (with posts and short videos);
- Create a digital simplified timeline of the history of Como Lake with the contents from Europeana and external resources (enriched by short stories about the represented place) with the aim to raise awareness about Como lake, the existence of Europeana collection and, more in general, of digital cultural heritage;
- Offer a space where the community is encouraged to share resources (e.g. current and historic pictures of Como Lake inside dedicated Facebook albums), to propose keywords for an intuitive research of data inside Europeana (for instance with a campaign Write your #Hashtag) and, eventually, to leave feedback about the app (useful to evaluate points of further developments);
- Stimulate the use of the tools within many other applications re-using the huge map heritage already available within Europeana, boosting the impact at an EU-Scale.

A direct involvement of the Museums and local touristic offices is foreseen to reach a wider public.

## 6. Maps and narrative: storytelling and immersive navigation

The progressive increase of visual, spatial and temporal based storytelling tools can be probably explained as an

adaptation and reply of the market to the current trend of digital contents consumption. Spatial dimension is leading this evolution, and, as proven by the test, 5/8 tools assume maps in quality of fundamental content. The possibility of "read-and-write" online maps has given rise to the geospatial web. Maps have become common in everyday life, people are accustomed to using web services such as Google Maps that have popularised and democratised the power of maps by enabling people to add and share cartographic contents (Giaccardi & Fogli, 2008). Maps are more and more commonly used as an analytical tool to explore the spatial dimension of narratives (Caquard, 2013). The appearance of terms such as 'Story maps' (by Robert MacFarlane), 'fictional cartography', 'narrative atlas' and 'geo-spatial storytelling' is an evidence of the growing interest in the relationship between maps and narratives. Maps may take on the role of "showcases" of the plot of relations. They may: host multiplicity of point of views, enlarge the angle of prospective or be used like a hand lens, welcoming a deeper meaning understanding.

A growing number of map-based storytelling tools (i.e. 1. Google Tour Builder, 2. Google My Map, 3. Story Map ArcGIS Esri, 4. Odyssey, 5. Storymap JS Knight Lab, 6. Timeline JS Knight Lab, 7. Meograph, 8. Atavist), testifies the interest to boost storytelling starting from the map contents. To provide a useful comparison and assessment about completeness and flexibility of the tools, the following main parameters have been considered: modality of the log, digital contents supported and compatible channels where sharing the story (particularly oriented in tracing interoperability with social media platforms), live web access.

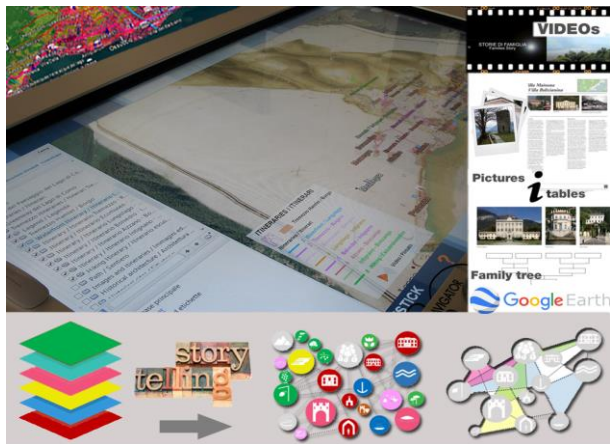
On the base of this analysis, the requirement of live web access and its capacity to manage different data (GeoTIFF, pictures, vectorial layers, videos, explaining text) has been chosen in the case of the Virtual Museum of Como Lake Landscape.

In the vein of what is stated above, the last consideration about the tested software for digital storytelling: these tools are addressed to a wide range of stakeholders and not properly developed for museum storytelling. In this aspect, we ascribe a plausible reason for which 3D and immersive contents are not yet fully supported. We believe that this aspect is a paramount interest that deserves further researches and developments in IT solutions, but also projects such as Europeana that has been developing and disseminating 3D cultural contents, may offer cues of the solution in the nearest future.

The main objective is to help people, during the museum visit and on-site visit, to be aware of the complexity of landscape themes and values, in a way customisable for the users. For this matter, as the first step, it has been chosen to implement a geo-based web interface. As previously reported, the technical constraints emerged during the design process with Google Earth, have been overcome by the new Geopan App interface. From this starting point, it has been hypothesised a storyboard in order to facilitate the content comprehension by the visitors geolocating immersive virtual tour.

In the case of the virtual museum of Como Lake Landscape, a number of landscape themes of the Lake of Como, with a focus on the hamlets (i.e. Volesio, Intignano, and many others) of the Tremezzina area, have been selected in order to attract people visiting the background landscape of the hillside. A storytelling

dashboard has been drafted in order to boost the comprehension by the people and it will be fully implemented in the future as soon as the fundraising will allow its enhancement (Fig. 11).



**Figure 11:** Example of contents and the schematic proposal of an alternative approach offered by digital storytelling. 'augmenting' the geocontent in a more explicit and comprehensible way for the visitors.

People visiting the virtual museum can navigate the ancient hamlets and paths highlighted by the cadastral maps layers of the new Geopan App interface, enriched by the GIS layers of the current maps integrated in the interface, using the map contents as a canvas to recognise pictures and videos georeferenced to the maps, about the hamlets and different places to visit.

### 6.1. Virtual immersive tour across the historic vaulted passages of the hamlets

It has been decided to enrich the virtual museum geocontents with a virtual tour across the vaulted passages and an ancient path connecting the hamlets.

The objective is to allow people to access the immersive tour across the 3D vaulted passages, from a number of predefined points, distributed on the maps (Fig. 12).



**Figure 12:** The ongoing implementation of the webpage to allow people the access to the immersive tour across the 3D vaulted passages, from a number of predefined points on the Geopan App map. A sample has been developed on Volesio hamlet for which, within the related GeoWeb map, it is possible to enter the hot spots cardboard to visualise immersive panorama with incorporated sounds of the environment.

This part of the territory is rich of historic buildings and paths, the atmospheres of the past can almost "be breathed", but it is still little known, out of main tourist routes and poorly valued.

A specific investigation about use and development of immersive contents has been carried out for the

Tremezzina, as a case study of the PhD thesis of which this work is part.

We focus our attention on Tremezzina hamlets with its picturesque architectural perspective and historic vault passages that contribute to the charm of these places. Valorisation, in this case, also passes through an increasing visibility. If the web allows reaching a bigger audience, immersive content (panoramic photos, 360° videos, three-dimensional models) can be captivating tools able to attract the public's attention.

The following goals are set:

- making the audience curious;
- offering the chance to have a first experience or retrieve the experience made on site;
- adding extra information, where possible.

Three different low-cost 'ready to use' immersive contents (or quasi-immersive) have experimented on the common theme of the vaulted passages virtual tour:

- Panoramic photos (cardboard fruition);
- 360° videos (YouTube access);
- 3D photogrammetric model fruition from web platform (Sketchfab navigation).

The different solutions are underway to make them available in the future within the multimedia system of the Virtual Museum of Como Lake Landscape, by remote access, in the different allowed formats.

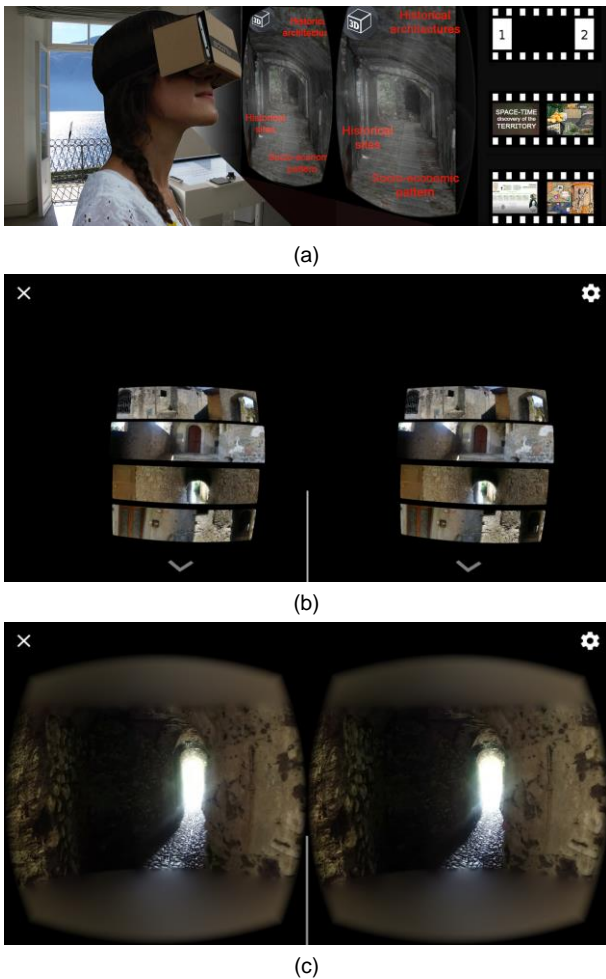
#### 6.1.1. Low-cost panoramic photos for cardboard fruition

To present a series of typical corners of the hamlet we used panoramic photos made directly by the smartphone applications. Most of new smartphones or tables are equipped by native applications for panoramic photos but, a step ahead is offered by application specifically designed to view panorama with an entry level of VR headsets. For instance, Google offers free of charge Cardboard Camera or can be easily acquired with a low-cost cardboard.

The result allows to have an immersive experience using cardboard, planned to be available within the museum visit, and remotely accessible 'at home' having a low-cost equipment. The contents developed for the immersive experience of Tremezzina hamlets, underlines the values of the passages connecting the historical hamlets, with a suggestive amazing experience (Fig. 13). The visitors can choose among different thematic tours visualised on the different strips.

Taking photos is quick and intuitive. The sense of presence and the feeling of being there are emphasised because the sounds of place can be included activating the microphone of the device during the recording. The contents have a satisfactory quality, even if they do not return a fully 360° perception of environment due to the modality of recording along with a 360° strip, instead of a sphere, showing at the top and bottom wide grey area without data.

The visitors using the cardboard can choose, from the access page, different contents by means of an intuitive interface, pointing to the different options with the eyes movement. This way it is possible to enter the immersive different trips across different hamlets and passages.



**Figure 13:** a) Low-cost solution of panoramic photos & cardboard fruition: the contents developed for an immersive experience of Tremezzina hamlets (Volesio); b) The visitors can choose among different thematic tours visualised on the different strips; c) One of the immersive tour available and one of the suggestive opening facing on the landscape.

### 6.1.2. 360° videos enriched by information (YouTube access)

To provide an overview of what can be seen in each hamlet, we have been developing immersive structured itineraries using 360° videos tour. A Samsung 360° Gear camera was chosen for recording. Editing has been carried out with Adobe Premiere Pro CC2017 environment where also written basic information can be added: as the name of the hamlet, the name of the palace or building, and the name of the historic family who lived there, and so on. Videos will be uploaded to YouTube, where 360° is already supported, and possibly integrated within the storytelling. However, VR view is possible only if a video is directly accessed from the hosting platform (mobile version) using VR headset (cardboard or similar). Such product can be considered complementary to the previous one.

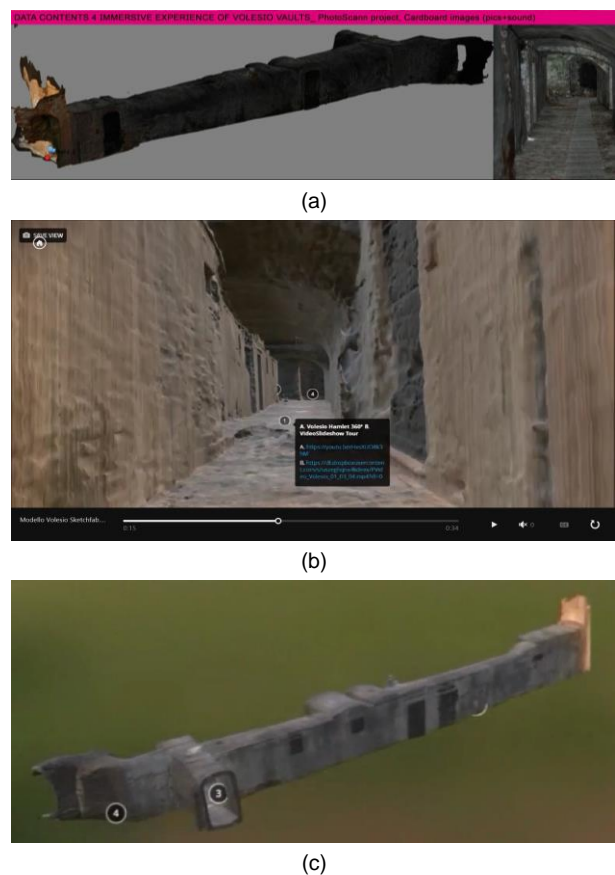
### 6.1.3. 3D photogrammetric model fruition (Sketchfab)

A more complex elaboration phase to integrate the quick immersive panorama solution has been experimented to show the vaulted passages with detailed true 3D models that could highlight geometry and materials of the architectural space, as the vaulted passages. Many

growing experiences of higher accuracy, from laser scans and photogrammetric surveying adopted for High Resolution Level of Details (HR LOD) modelling, have demonstrated the capability to enhance the comprehension of the historical construction techniques.

In general 3D detailed output could be useful for the virtual museum fruition. In this case, a 3D photogrammetry technique was selected for low-cost equipment and reasonable time of the survey. 3D textured model, as result of image blocks processing (Agisoft Photoscan Professional v. 1.2.6.2834), can be easily presented within web platforms supporting the 3D format (as a .OBJ format).

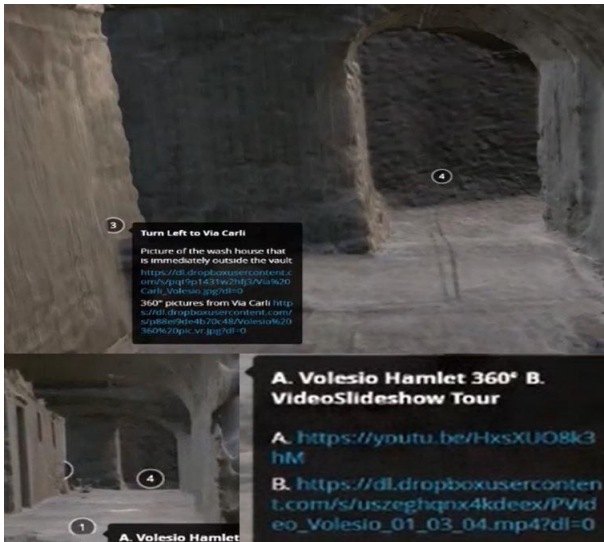
Among the few available, Sketchfab offers a basic option for structured navigation of the model by defining points of interest (annotations) with the option to add texts and links of external content useful to implement storytelling (Fig. 14).



**Figure 14:** The immersive experience of reality through the 3D textured model of one vaulted passage (Volesio Hamlet): a) 3D detailed photogrammetric textured model object; b) 3D model accessible by Sketchfab navigation; c) Final navigation.

The result allowed a fruition of the model navigation enriched by simple useful information helping people orientation referring it to the web map (shared by the Geopan-VM maps). Moreover, an embryonic of VR display is available but currently limited to a 360° point of view within the model (Fig. 15).

The different immersive contents developed (panoramas, 360 video tours, 3Dmodels) are not always fully embedded within web-platforms or applications for geo-based narratives, such as Story Map from ESRI or Geopan App. Direct enjoyment within these last more



**Figure 15:** The virtual tour across the historical hamlet vaulted passages is assisted by numbers highlighting the directions to the different hamlets, the name of streets, palaces and families helping people orientation referring it to the web map shared by the Geopan-VM maps (Volesio Hamlet).

structured digital storytelling tools has often a low grade of immersivity because the use of VR headset is not foreseen, therefore fully immersive experience is possible only if re-directed to the external apps or platforms of generation (e.g. Cardboard app, Youtube VR mode, Sketchfab). The need to use more than one comprehensive tool (with repeated jumps back and forth) reduces the appeal of the story and it may discourage users with low expertise.

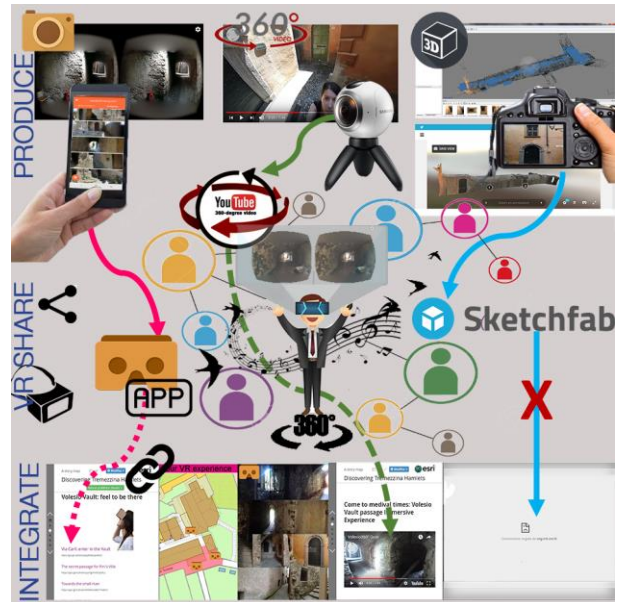
The contents developed, despite their diversity, offer a satisfying immersive experience of the physical space and geometry of the hamlets. They show a still limited attitude to be enriched with extra information (already possible to add static texts, audio descriptions and hyperlinks). Therefore, they seem currently more suitable to be used as "promotional" contents, available on popular web platforms for prospective visitors interested in additional opportunities, as pre-visit experiences and first attractive encounters with Tremezzina environment. Besides, it might be used during museum or on-site visits, if integrated within more complex storytellings (Fig. 16).

Complementary integration among the different solutions may allow developing, under the common constraint of low-cost output, more variegated virtual immersive experiences that may be adopted to improve Geopan App and more in general virtual museums. Moreover, under the simple pre-condition of internet availability, they may be used during all different phase of the extended paradigm of museum experience (AT home – IN museum, ON – site).

For these embryonic "experiments" with immersive low-cost contents generated with ready-to-use solutions, a low level of customisation and low opportunity of self-development is foreseen without the support of IT specialists.

## 7. Conclusions

Built environment and landscape values, as the result of dense stratified transformations across the centuries,



**Figure 16:** Comparison of the different immersive solutions and web accessibility, considering the different following variables: production, VR data sharing and integration.

can be transferred to the public to increase their awareness and identity. Thus, it can contribute to developing a sustainable informed tourism, growing social-economic opportunities and, at the same time, contributing to the safeguarding of the authenticity and richness of such fragile canvas. VMs, as in the proposed ongoing case study of the Museum of Como Lake Landscape, can enhance narrative and storytelling based on the use of multi-temporal geospatial data.

Temporal, visual and geospatial dimension are offering additional peculiar models ready to be exploited within the VM circuits, spanning from GeoTIFF data experimented for metric historical maps, enriched with informative layers, until navigation methods based on map correlation to locate, for instance, 'Panoramas in Geo-context', helping people to retrieve the ancient traces of the past, permanence and mutations, to recognise the ancient perspective optic cones of views on the current ones and vice versa. Virtual hubs brokering, discovering and accessing open data, can be a useful support for semantic-based researches and 3D Geospatial Web (GeoWeb) based applications that could be remotely accessed before the visit, during the museum visit and during the on-site visit. It offers valuable opportunities to re-use, disseminate and valorise digital open data as Europeana data collections.

Tools of digital storytelling have shown that new models of map narrative are growing too and they can be used, at least the pre-structured narrative models, by users with low expertise, given that they are based on the simple sequence of maps related to pictures, concept-sketches. Immersive narratives, based on advanced 3D models remotely accessible, need to be better improved implementing the storyboard potentials, working on compatibility with innovative AR/MR/VR devices and interface implementation that can enhance the story in terms of experience, empowering remotely accessible 3D narrative models, contributing to attract the public, transferring knowledge by means of enriched 3D geocontent.

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data and his support in developing the PhD research of which this paper presents a summary of preliminary findings.

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