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INTERCONNECTIONS IN THE MEDITERRANEAN THROUGH TIME: MONTENEGRO AND ITALY

edited by
Lucia Alberti

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Consiglio Nazionale delle Ricerche

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Proceedings of the Bilateral Round Table held at the University of Montenegro (23rd September 2016)

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The bridge's outline shown on the cover is the Millennium Bridge at Podgorica, Montenegro (see pag. 17, Fig. 2).

INDEX

ICT CHALLENGES, EUROPEAN POLICIES AND ARCHAEOLOGICAL RESEARCH PROJECTS IN THE ADRIATIC SEA AREA

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1. Introduction: recent challenges in archaeological computing

The most recent challenges in archaeological computing for research and publication concern the three basic areas of archaeological practice, i.e. fieldwork, laboratory analyses, and cultural resource management[1]. In addition, two important and strategic research areas that go under the general heading of 'Communicating archaeological research' and 'European digital infrastructures for archaeology' are today taking root. While current achievements in the three first sectors are strictly driven by technological progress, the latter two belong to a wider 'open science' approach, now permeating all digital humanities initiatives.

This paper reviews, succinctly, the most dominant trends. The international open access Journal 'Archeologia e Calcolatori'[2], published by our Institute since 1990, will help illustrate the current research situation and, at the same time, will give the readers the opportunity to freely download the articles quoted. Given the venue of our Round Table, special emphasis is placed on the projects carried out in the Mediterranean area, and in particular in the eastern and western coasts of the Adriatic Sea[3]. As a matter of fact, it was right here in the early 1990s that Zoran Stančič coordinated one of the first GIS-based archaeological projects on the Dalmatian islands[4] (Fig. 1); even today the Ljubljana school still remains a very dynamic centre in experimenting with integrated non-invasive research methods for the investigation of complex urban sites[5].

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1 For a general overview see Moscati 2009; 2011; 2013; Moscati 2015.

2 http://www.archcalc.cnr.it/.

3 For the cultural interrelationship between the two Adriatic coasts and the phases of Hellenisation and Romanization of the Adriatic Sea, see the volume edited by Lorenzo Braccesi and Sante Graciotti in honour of Massimiliano Pavan, which is still a pillar for Adriatic archaeology (Braccesi, Graciotti 1999). For the evolution of ancient Adriatic cities, see de Marinis *et al.* 2012.

4 Stančič 1996; 1998; Gaffney, Stančič 1991; 1994, and lastly Gaffney 2006.

5 Slapšak 2012.

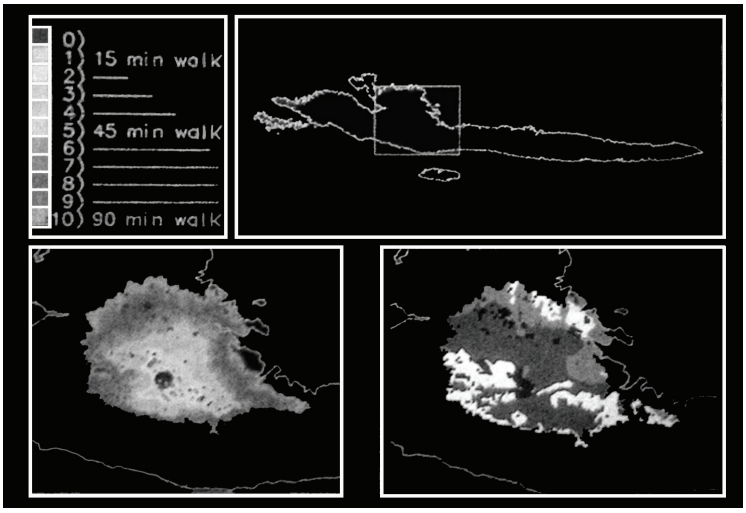

Fig. 1 GIS pilot study of the Adriatic island of Hvar in Croatia, using GRASS: Gračišće territory and soil types (*after* Gaffney, Stančič 1994, Tav. IIb).

2. Urban and landscape archaeology

2.1 *Geographical Information Systems*

Geographical Information Systems (GIS) represent by now the strategic integrated platform on which archaeological terrain data can be managed simultaneously. After more than twenty years of experimentation[6], the main outcome of GIS-based research is a global Archaeological Information System, which by nature involves different geographical scales and fulfils a twofold purpose: a documentary function to preserve archaeological records for the sake of knowledge and conservation, and an analytical function to perform spatial analyses and interpret data distribution models.

In field surveying, innovation is connected to extensive and high-speed prospection campaigns. Laser robotic total stations and differential global positioning systems (DGPS) are increasingly used, and webGIS and GIS cloud techniques are widely spread in helping synchronise field operations and lab data processing. Sampling methodologies for data acquisition are based both on sophisticated satellite and airborne remote sensing techniques and on state-of-the-art GPR systems, and the results are represented through highly accurate and detailed Digital Terrain Models (DTMs).

[6] Moscati 1998; Moscati, Tagliamonte 2002; Moscati 2017.

Many research projects based on GIS applications and technological achievements cover the Adriatic Sea area. First and foremost, there is the international project 'Adriaticum mare', launched in 2010 and aimed at creating a computerised atlas of the ancient Adriatic[7]: the work is based around an online GIS and a general map of the ancient Adriatic, stretching from Albania to Apulia and covering a period spanning the 11th century BC up to the 8th century AD. Other projects focus on the investigation of ancient towns as well as of their surrounding territory – often characterised by river valleys that served as natural inland penetration pathways – from pre-Roman times to Late Antiquity[8]. Two inspiring and long-standing projects concern the study of the Roman settlements of Burnum (Šibenik, Croatia) and Suasa (Ancona, Italy)[9].

The Burnum Project is an international initiative, which has been conducted since 2005 under the aegis of the Centro Studi per l'Archeologia dell'Adriatico (Ravenna, Italy). The project investigates the Roman *castrum* of Burnum by making increased use of new methods and tools, in particular geophysical surveys, Remote Sensing techniques and the systematic interactive management of excavations and survey data through a webGIS system (Figs. 2-3).

Fig. 2 Geophysical survey in the Roman *castrum* of Burnum (*after* Giorgi *et al.* 2012, fig. 1).

7 http://adriaticummare.org/en/the-project/the-computerized-atlas.

8 Cf. e.g. some articles collected in Vermeulen *et al.* 2012 and, more recently, the book of abstracts of the Conference *TRADE – Transformations of Adriatic Europe* (2nd-9th *c.*) (http://www.iarh.hr/~trade/userfiles/downloads/Trade%20Zadar%202016_Abstracts%20book.pdf).

9 Boschi, Giorgi 2012; Destro, Giorgi 2012; Giorgi *et al.* 2012; and lastly Campedelli, Dubbini, Martina 2017.

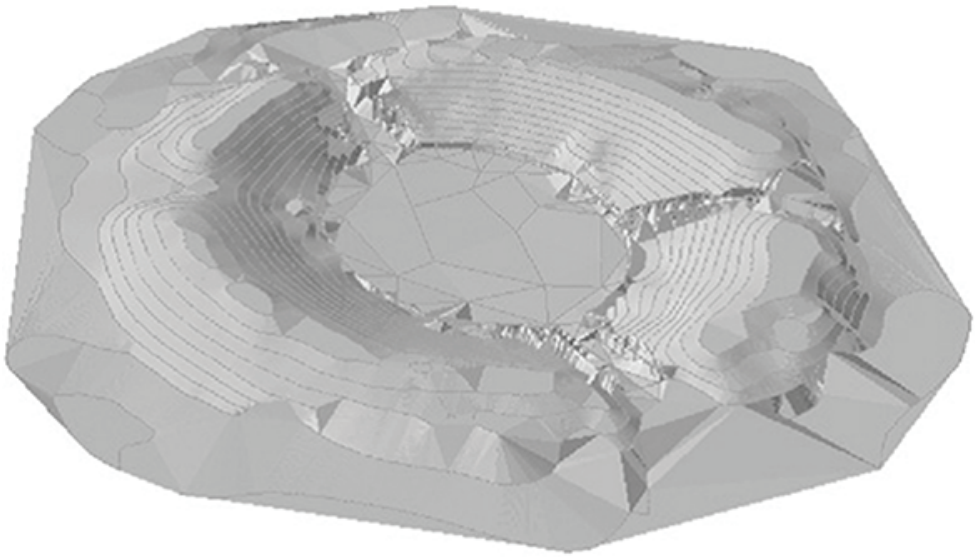

Fig. 3 DEM of the Roman amphitheatre in Burnum (*after* Vecchietti 2012, fig. 6).

The Roman settlement of Burnum, situated in the valley of the Krka river in the Krka National Park, required the planning of an integrated strategy for the preservation, enhancement and promotion of the natural, cultural and archaeological heritage. The town of Suasa, located at the Adriatic outlet of the *Regio VI*, demanded the design of an integrated platform on which historical traditional and modern technical documentation could be assembled. Thanks to the provision of special funds, the Bologna University archaeological team took up this challenge and set up a harmonised project within a single long-term webGIS environment (Figs. 4-5).

As far as landscape archaeology is concerned, the role of Remote Sensing techniques combined with DTM is to replace archaeological distribution maps, which were one of the earliest outcomes of GIS applications. The 3D digital representation of ground-surface topography has provided archaeologists with unprecedented opportunities, such as the possibility to visualise complex events that contributed to settlement dynamics and to investigate space distribution models with the aim of predicting the location of archaeological sites.

The application of spatial analysis techniques in the field of settlement archaeology, especially on a regional scale, was being tested as early as the 1990s by the research team of the Salento University's Laboratory of Archaeological Computing[10]. Based on data gathered during

[10] See in particular D'Andria, Semeraro 1993, and Semeraro 2007.

Fig. 4 Geophysical survey and aerial photography of the urban area of Suasa (*after* Giorgi *et al.* 2012, fig. 2).

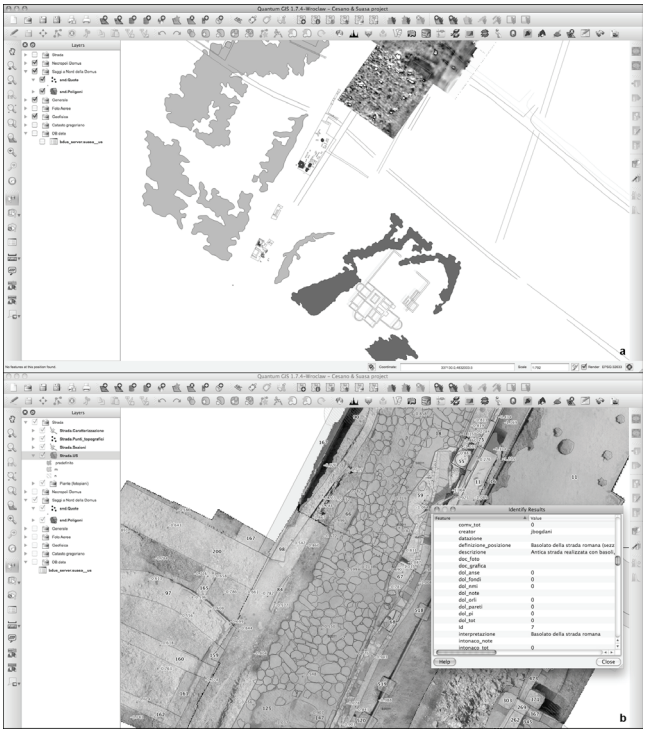

Fig. 5 GIS and webGIS of the archaeological area of Suasa (*after* Giorgi *et al.* 2012, fig. 6).

extensive surveys and excavations, the creation of a rich database and a GIS system enabled the analysis, both synchronically and diachronically, of some pre-Roman sites in the Salentine peninsula (e.g. Otranto, Vaste, and Oria) (Fig. 6) and in the Daunia region. In particular, in recent years, viewshed and cost surface analyses allowed archaeologists to investigate different distribution models of the Iron Age settlements, as part of a complex physical and human landscape system (Fig. 7)[11].

Moving northwards along the Italian Adriatic coast, the Potenza Valley Survey was one of the earliest projects to apply a computer-based interdisciplinary, non-invasive and technologically integrated approach for the study of the evolution of an Adriatic valley in Central Italy (Fig. 8). Undertaken since 2000 by Ghent University as an example of 'townscape archaeology'[12] and coordinated by Frank Vermeulen, the project aimed at measuring social complexity around the Roman coastal colony Potentia[13] (Marche Region),

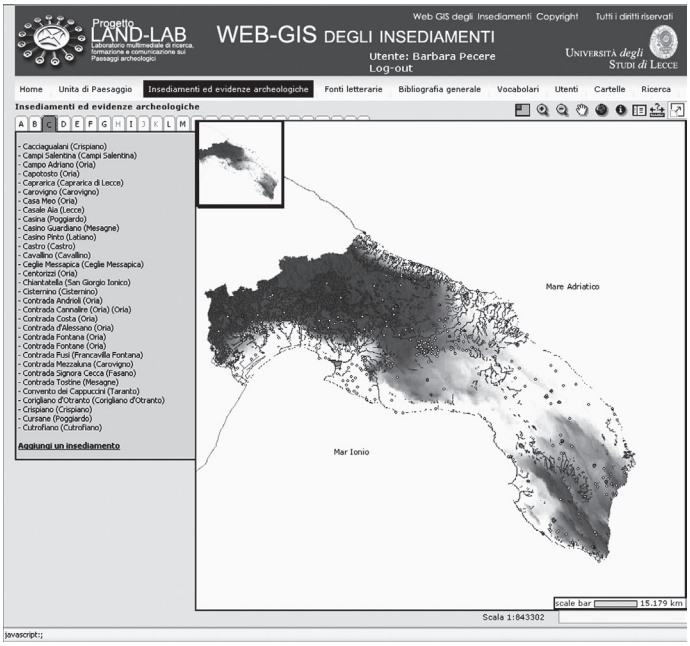

Fig. 6 WebGIS of the Salento pre-Roman settlements (*after* Semeraro 2007, fig. 3).

[11] Pecere 2006.

[12] F. Vermeulen has recently used this term with reference to the study of four abandoned Roman towns in central Adriatic Italy (Marche region): the coastal colony of Potentia and the inland *municipia* of Ricina, Trea and Septempeda (Vermeulen 2017).

[13] For the project's rich bibliographical apparatus, see the References page in the website: http://www.potenza.ugent.be/node/20.

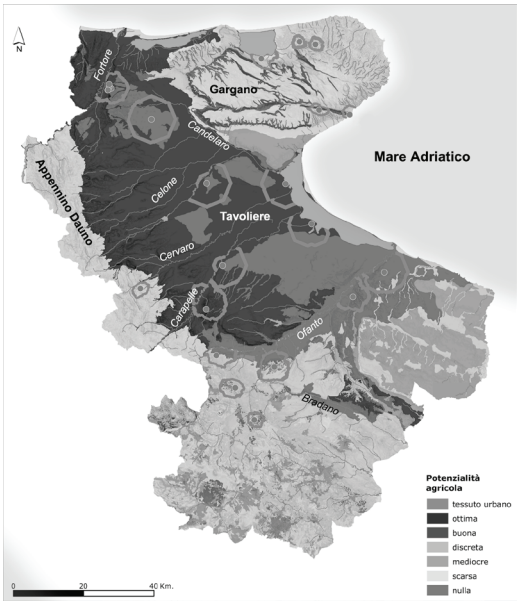

Fig. 7 Pre-Roman Daunia Iron Age settlement system (*after* Pecere 2006, Tav. VII).

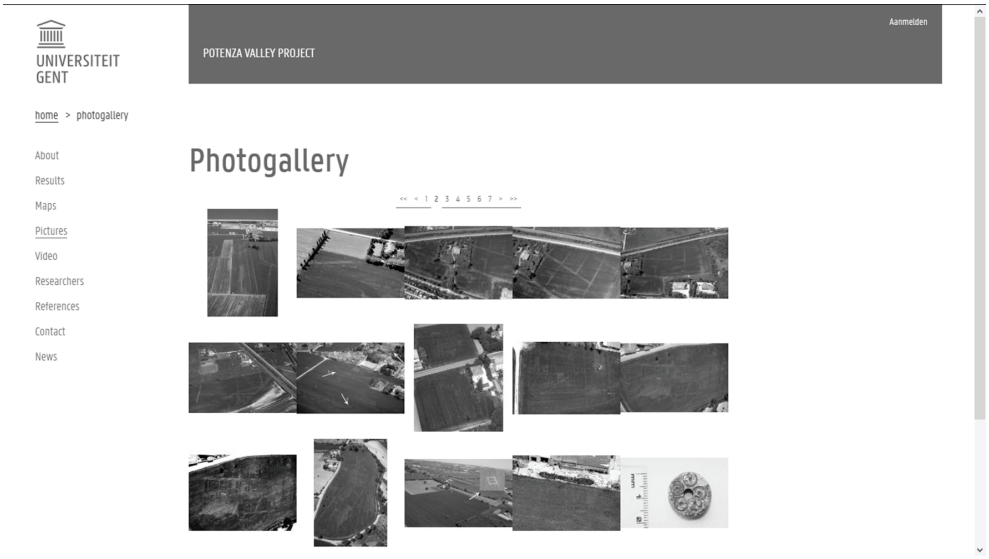

Fig. 8 Potenza Valley Project. Photogallery shown in the website dedicated to the project (http://www.potenza.ugent.be/node/29).

based on the historical evolution of the occupation in the territory, from the protohistoric to the Roman and early medieval periods. As early as the beginning of the new millennium, during the Liège UISPP Congress, Frank Vermeulen and Zoran Stančič had already laid out their vision for the need for transversally integrating various methods, from GIS to Virtual Reality techniques, when they organised an ad-hoc session in the congress[14].

In the Marche region, in the early 1990s – when GIS were hardly known amongst European archaeologists – the town of Urbs Salvia was home to a computerised project[15], as part of a more multifaceted research on Roman centuriation in Central Italy (Fig. 9). Particular attention was paid to the evolution of Roman cadastre along the Fiastra valley, in the territory of Urbs Salvia, during the Early Middle Ages and Middle Ages, and important results were gathered thanks to the use of the software AutoCAD for numeric cartography and Paradox 5.0 for data recording in a relational database.

Fig. 9 Computer-based proposal of Roman centuriation in the *ager* of *Urbs Salvia* (*after* Moscatelli 1996, fig. 1).

2.2 *The case of Doclea*

Other Roman centres are today under investigation: here the use of modern acquisition techniques, as well as data georeferencing in a GIS environment, is a fact.

[14] See Vermeulen 2002, in which the author highlighted the importance of integrating several techniques, from GIS to Virtual Reality, Internet and multimedia systems, but at the same time underlined that GIS remains clearly the driving engine of any efficient study, rational management and attractive disclosure of the archaeological data and results.

[15] Moscatelli 1996.

We can quote, for example, the case of the Roman town of Doclea, which is attracting the interest of several research groups. In all Roman towns, and in particular in the case of Doclea – the most thoroughly explored town in the south-eastern part of the Roman province of Dalmatia – all efforts are concentrated on both re-interpreting archaeological remains and integrating new technological outcomes with past documentation, coming from research and excavations that were often not systematic.

In 2017, a new ISMA international bilateral project, coordinated by Lucia Alberti and Tatjana Koprivica, has been promoted as part of the CNR Laboratori Archeologici Congiunti initiative. The project is now in progress (Alberti 2019). One of its first actions was to gather past and new archaeological documentation onto a single digital platform. As far as methodological computer-based achievements are concerned, two previous important coordinated initiatives are worth of notice: the New Ancient Doclea Project and the project dedicated to Doclea in the Late Antiquity and early medieval periods.

The first initiative is a joint project sponsored by the Municipality and the Museum of Podgorica. The British School at Rome together with the Archaeological Prospection Services of Southampton conducted the geophysical survey, and the Urbino University Carlo Bo undertook the topographic and building survey[16]. The results achieved, thanks to various methods of data survey, allowed archaeologists to implement the results on a GIS platform, to develop a new digital map and a DEM of the Roman town, and to reconstruct parts of the ancient *forum* on the basis of laser scanner surveying techniques (Fig. 10)[17], with the ultimate goal of safeguarding and enhancing the cultural heritage of Doclea.

Fig. 10 3D digital model of the east-west front of the Doclea *forum*,
obtained by a laser scanner survey (*after* Rinaldi Tufi, Baratin, Peloso 2010, fig. 6).

[16] Rinaldi Tufi, Baratin, Peloso 2010, with references.

[17] The extensive use of the laser scanner for archaeological survey is also reported in the excavations of the city of Stari Bar, where it was used for documenting the so-called Palazzo del Doge: Cardaci, Versaci 2013.

The second project, also sponsored by the Podgorica Municipality, was conducted by the Venice University Ca' Foscari[18]. The project mainly focused on the later phases of the settlement, with particular reference to the ecclesiastical buildings. Thanks to a new digital survey of the main structures, the superimposition of their plans on the numerical map of the town (Fig. 11), and the census and comparison of the wall techniques, the presence of three main buildings (basilica A and basilica B, and the cruciform church C)[19] has been confirmed and five main architectural phases have been detected.

Fig. 11 Satellite image of the Doclea archaeological site, with the area of the ecclesiastical buildings highlighted (*after* Gelichi *et al.* 2012, fig. 1).

2.3 *Underwater archaeology and archaeology of architecture: two innovative research views*

Returning to the topic of recent technological progress, in the last few years research results in the sphere of underwater archaeology too have grown exponentially, thanks to the introduction of highly sophisticated sonar technologies, further enhanced by the use of robotics. One example may stand for all: the Montenegrin Maritime Archaeological

[18] Gelichi *et al.* 2012, with references.
[19] See Sfameni, in this volume, § 1.1.

Research Project[20], a joint initiative between the Museum of Bar and the University of Southampton's Centre for Maritime Archaeology, focusing on one of the favourite shipping routes in the ancient and medieval Mediterranean (Fig. 12). The project began in 2010, following some discoveries in Maljevik Bay (Municipality of Bar). An archaeological survey was then undertaken as a first step in a large and ambitious project aimed at documenting and conserving the maritime heritage of this stretch of the Montenegro coastline, subjected as it is to sprawling touristic development.

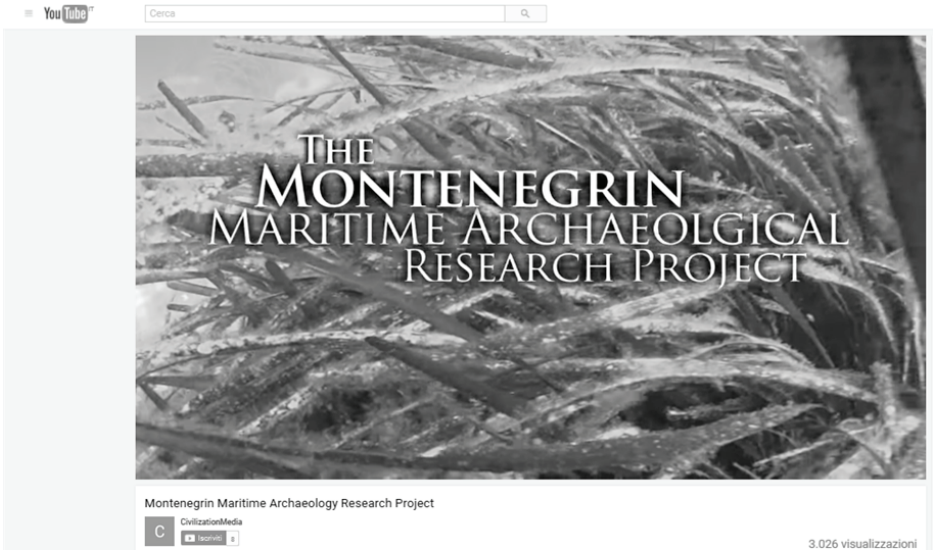

Fig. 12 Online video illustrating the Montenegrin Maritime Archaeological Research Project (https://www.youtube.com/watch?v=OMu-FQblvYo).

Innovation is also part of the 'archaeology of architecture'. Data recording and processing aim at documenting built heritage elements to produce a complete and reliable reconstruction of historical buildings, by integrating lost architectural elements. As an example, we can quote the research work conducted in the archaeological area located between Ravenna and Classe, which has been the focus of a scientific investigation by the University of Bologna and the Ravenna Antica Foundation[21]. In particular, the town of Classe (Ravenna) – with its long tradition as a maritime centre and the harbour of the

[20] http://www.southampton.ac.uk/archaeology/research/projects/montenegrin_maritime_archaeological_research_project.page.

[21] Fiorini, Archetti 2011; Fiorini 2015.

Roman and the Byzantine fleets for the military and economic control of the Adriatic Sea – and in particular the Monastic Complex of San Severo have been thoroughly investigated (Figs. 13-15)[22].

As an example of a methodological synthesis, in the process of 'reading the walls' to document plane surfaces (such as the façades of historic buildings), the combined use of monoscopic photogrammetry and 3D laser scanner is gaining ground, replacing the use of direct survey methods and instruments. In addition, photomodelling is rapidly spreading its influence, as a user-friendly documentation technique: this makes use of digital cameras to capture 2D images and then to produce 3D metric stratigraphic models manageable in a GIS environment.

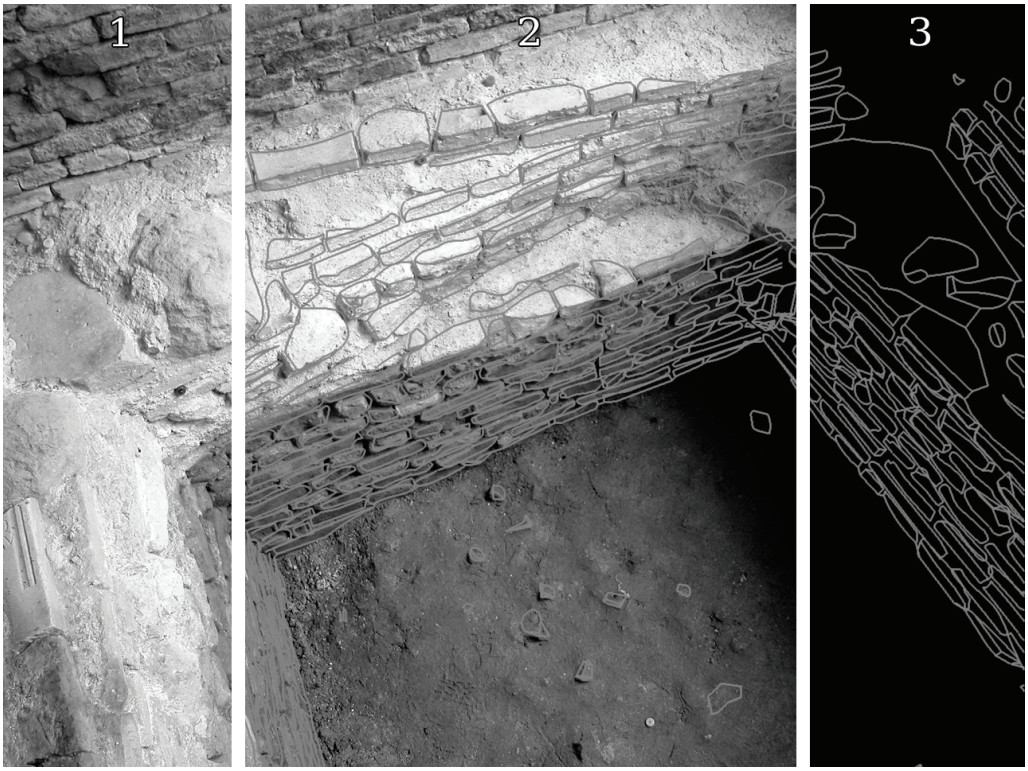

Fig. 13 Digital documentation phases of the medieval bell-tower of the Basilica of San Severo (Classe, Ravenna) (*after* Fiorini, Archetti 2011, fig. 1).

[22] Boschi 2012; Urcia, Montanari 2012.

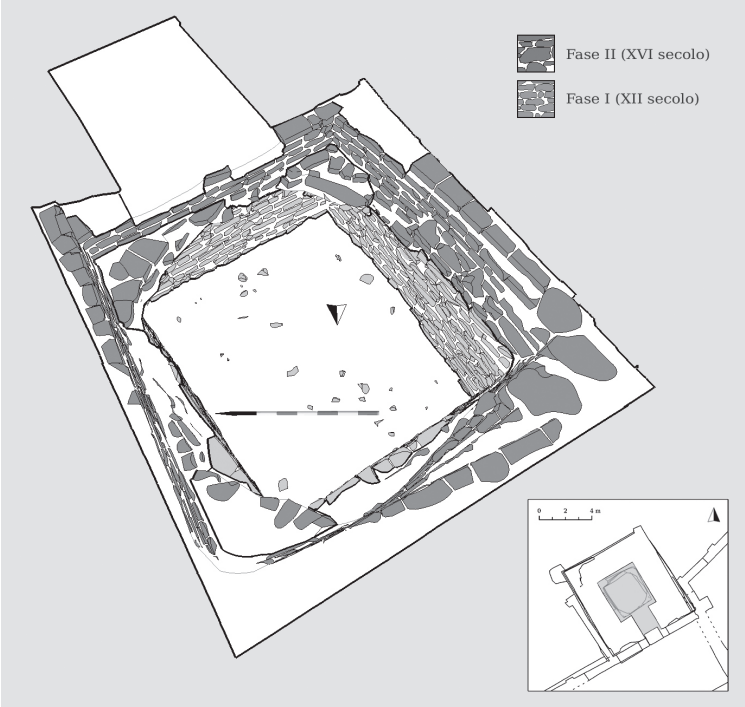

Fig. 14 3D restitution of the medieval bell-tower of the Basilica of San Severo (Classe, Ravenna), achieved by photomodelling and stereophotogrammetry techniques (*after* Fiorini, Archetti 2011, fig. 10).

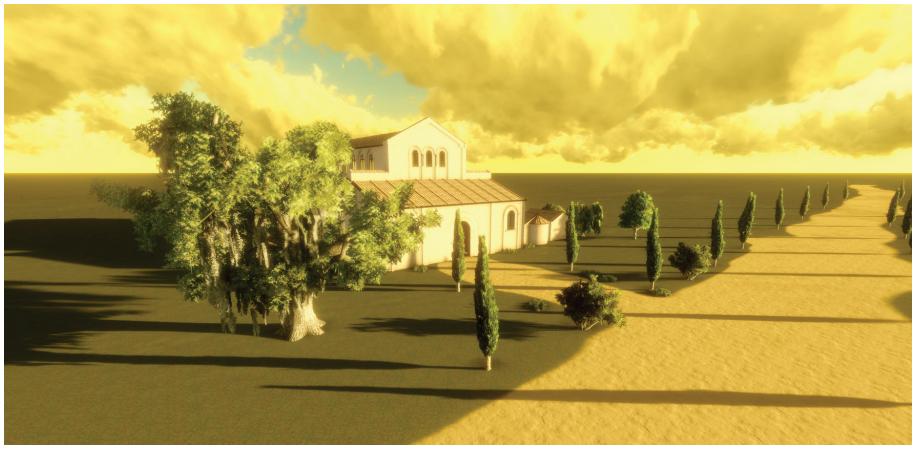

Fig. 15 Virtual reconstruction of the San Severo (Classe, Ravenna) archaeological site at sunset (*after* Urcia, Montanari 2012, fig. 16).

3. From archaeological databases to European e-infrastructures for archaeology

3.1 *Archaeological laboratories*

According to the traditional categorisation of archaeological research, that of laboratory analysis mainly focuses on the recording and classification of archaeological finds and the interpretation of data collected in surveys and excavations. As we have already mentioned, recent developments of ICTs today have allowed lab work and field research to operate more in sync. However, it is still worth laying out the evolution of some research sectors that have always embraced computer applications.

I refer in particular to artefact classification, a conceptual and methodological approach which is still represented by two different trends. Primarily, the long-standing statistical approach – still a well-established methodological reference model – can support archaeologists in the decision-making processes during the organisation and synthesis of knowledge. Then there is the process of cataloguing and recording archaeological objects: database management systems and their recent evolution towards multimedia information systems allow users to implement, consult, and share data via the web.

In particular, the computer-based analysis and classification of mosaics have attracted the attention of scholars. Two databases have been promoted as part of the European Union programmes dedicated to cross-border, transnational and interregional cooperation (see *infra* § 3.2). The University of Padua has developed the distributed database system TESS[23], which aims at providing a key tool for the identification of the origins of iconographic themes, their geographic distribution and the development of local fashions (Fig. 16). The International Mosaic Documentation Centre – a section of the city of Ravenna's Art Museum – in cooperation with ENEA-Bologna Research Centre, has promoted and implemented a computerised networked system, enabling the storage of information on mosaic decorative aspects (Fig. 17)[24] .

When government departments, universities, research institutes, regional and local authorities make a joint effort to promote and coordinate cultural heritage conservation and planning policies, the cataloguing and management of large archaeological datasets is generally centralised at a national level. Accordingly, coordination is requested at a global level: supranational representation standards and data transmission protocols for dissemination as well as e-infrastructures and services are all planned to facilitate interoperability between the

[23] http://tess.beniculturali.unipd.it/; for the earliest results, see Ghedini *et al.* 2007 and, more recently, Ghedini 2016.

[24] http://www.mar.ra.it/eng/CIDM/DATABASE/Mosaic-Database/.

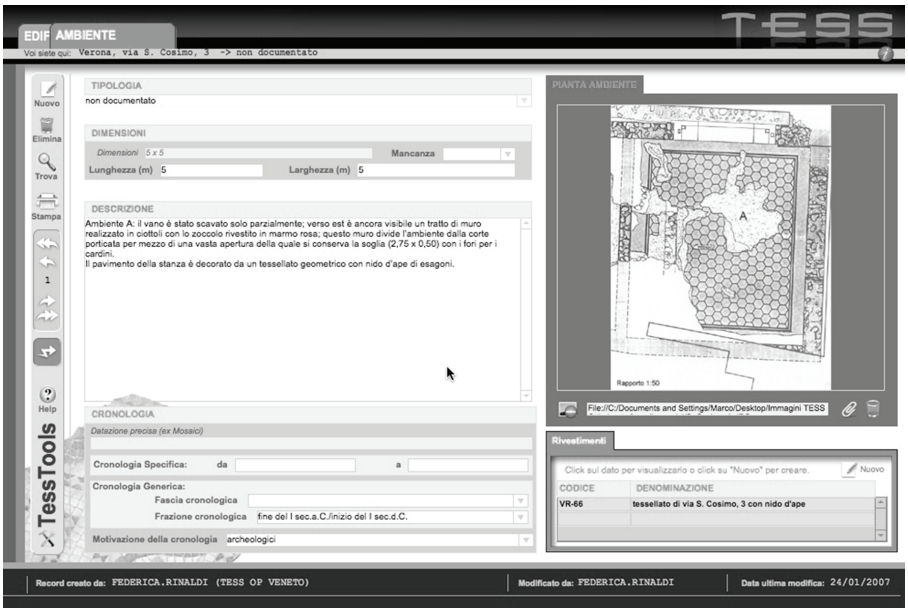

Fig. 16 The database system TESS for mosaics, including informative files regarding building and rooms, location, relevant bibliography and mosaic pavement (*after* Ghedini *et al.* 2007, fig. 5).

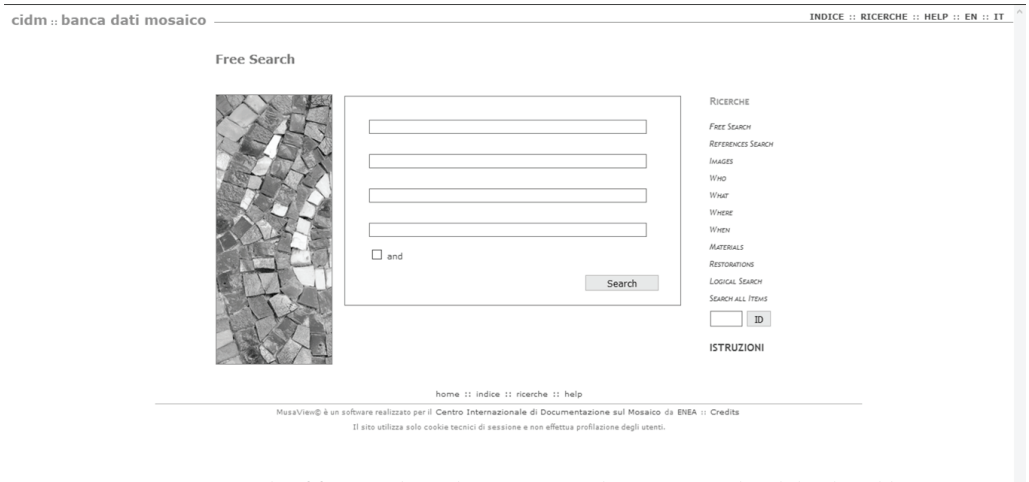

Fig. 17 Example of free search in The Mosaic Database, promoted and developed by the International Mosaic Documentation Centre (CIDM).

digital repositories. The model of data storage, management and preservation being sought coincides with that promoted in digital libraries: comprehensive collection, management and the preservation of a rich digital content for the long term, so as to provide user communities with specialised functionality, according to codified policies.

3.2 *European e-infrastructures for archaeology*

As early as the first decade of the 21st century, many European projects were aimed at setting up digital infrastructures for the census of natural and cultural resources and for preventing risk factors in the Adriatic Sea area. We can quote, as examples, the Interreg III projects, developed in response to the call for increasing all types of cooperation between bordering regions[25], and also the IPA Adriatic Cross-border Cooperation Programme 2007-2013[26]. The latter gave birth to many research projects. Among them are EX.PO AUS (EXtension of POtentiality of Adriatic UNESCO Sites), aimed at setting up a network between the UNESCO World Heritage Sites of the Adriatic Sea area; PArSJAd - Archaeological Park of the Northern Adriatic Sea, aimed at enhancing the archaeological heritage of the Adriatic coasts, from the coast of Emilia to the Slovenian one[27]; and finally AdriaMuse[28], aimed at creating new tools and services, supported by ICT and able to help organisations in tourism, museums and cultural bodies to implement innovative ways of attracting audiences to exhibitions.

In addition, within the AdriaWealth Project[29], which capitalises on the results of previous projects financed by the IPA Adriatic Programme, the project Archeo.S (System of the archaeological sites of the Adriatic Sea)[30] tested a new approach in enhancing cultural heritage sites as attractive tourist destinations, with the help of cultural operators and live art events. At a more general level, the EU Strategy for the Adriatic and Ionian Region (EUSAIR) is worthy of note: a macro-regional strategy adopted by the European Commission in 2014 to strengthen regional cooperation and promote a solid basis for the European integration process[31].

The list of projects devoted specifically to the Adriatic Sea and its criticalities would take too long to present and anyway is outside the scope of this paper. However, we can

[25] http://www.welcomeurope.com/european-funds/interreg-iii-499+399.html#tab=onglet_appel.
[26] http://www.ipadriaticbc.eu/.
[27] http://www.parsjad-3d.eu/en/parsjad.html.
[28] http://www.adriamuse.org/.
[29] http://www.adriawealth.eu/.
[30] http://www.adriawealth.eu/project/archeo-s/.
[31] http://www.adriatic-ionian.eu/.

reiterate here that GIS constitute the ideal IT platform capable of generating risk-assessment maps and of estimating the level of aggressiveness from physical, chemical, biological and environmental factors and presenting a vulnerability index.

Concerning European e-infrastructures for archaeology, I wish to expound a little on the Ariadne project[32], defined as a key European initiative in the field of archaeological digital research infrastructures. Bringing together the expertise and assets of a large number of institutions or initiatives, it gathers and integrates existing archaeological data collections so that researchers can now have access to various distributed datasets.

Just like many other digital research infrastructures in the arts and the humanities – e.g. the emblematic case of Europeana[33], but also as exemplified by recent initiatives like DARIAH[34] and CLARIN[35], Ariadne has revitalised the scope and affordability of metadata schemes, as a prerequisite for the future reliability and usefulness of archaeological information held in registries, finds databases, excavation archives, or digital libraries. Descriptive metadata needs to be rich enough to provide researchers with information useful for specific queries, but also responsive to the needs of automated data recording, processing and extraction. Research work has been driven by the identification of ontological structures for data classification to achieve a more targeted retrieval, as requested by the CIDOC Conceptual Reference Model[36] and by its extension, CRMarchaeo[37], specifically implemented for archaeological purposes. CIDOC CRM is promoted by the International Council of Museums and is oriented towards extracting domain taxonomies in the cultural heritage sector, while assisting researchers to navigate across the information maze of the Internet.

4. Communicating archaeological research

4.1 *Open archaeology*

Today, the documentation and curation of archaeological records are expected to promote the interconnection of data interpretation with the new paradigm of data sharing in science and education. To face this important challenge in archaeological and humanities

[32] http://www.ariadne-infrastructure.eu/. A brief account of the Ariadne project is also set out in *Archeologia e Calcolatori*: see lastly Niccolucci 2017.
[33] http://www.europeana.eu/portal/it/.
[34] http://it.dariah.eu/sito/.
[35] https://www.clarin.eu/.
[36] http://www.cidoc-crm.org/.
[37] http://new.cidoc-crm.org/crmarchaeo/.

computing, ICT is the best experimental area to achieve the goal of openly communicating research data and of ensuring its efficient exploitation.

The term 'open access' is mainly used in the academic field, and refers to the possibility of free access to scientific publications ('open science'). However, the concept of openness is not merely concerned with free access, but involves ethical issues such as the freedom to use and to reuse published contents and research products, especially if deriving from public funding. Therefore, delicate and controversial legal, technical, economic and scientific angles come into play in open data theory, which encourages free reuse of contents according to the criteria of 'sharing economy'.

Today, national and international political agendas are increasingly focusing on data-access policies, in so much as they comply with administrative transparency and with the right of citizens to access to information of public interest. Cultural heritage is, in its own right, an item involving just such dissemination of public interest information, as it is an essential component of the cultural life of the people and therefore can be fairly considered a human right.

During the last five years, great effort has been devoted to the defining of standards and guidelines for the national and international implementation of open access policies. Among the most active projects of such a nature are the MedOANet (Mediterranean Open Access Network)[38] and RECODE (Policy Recommendations for Open Access to Research Data)[39], both involved in implementing policy guidelines for open access to scientific research data and in promoting their care and protection. More recently, the OpenAIRE[40] and FOSTER[41] projects confirm this line of conduct, as does OpenGLAM, an initiative run by Open Knowledge that promotes free and open access to digital cultural heritage held by galleries, libraries, archives and museums[42]. In addition, the European Research Council has recently updated the guidelines to promote open access to scientific publications and data resulting from research funded under Horizon 2020 projects[43].

4.2 *'Archeologia e Calcolatori' and the dissemination of archaeological research results*

Having been involved in the dissemination of archaeological research results for more than thirty years, the achievements of ISMA ICT (laboratory) are a good starting point to illustrate the benefits of an open access policy. In particular, the digital repository

[38] http://www.medoanet.eu/.
[39] http://recodeproject.eu/.
[40] https://www.openaire.eu/.
[41] https://www.fosteropenscience.eu/.
[42] https://openglam.org/.
[43] http://ec.europa.eu/research/participants/data/ref/h2020/other/hi/oa-pilot/h2020-hi-erc-oa-guide_en.pdf.

of 'Archeologia e Calcolatori', from which most of the archaeological case studies mentioned above were extracted, is an unprecedented benchmark example.

The Journal has been pioneering principles in the open access and open archives movement[44]. Not only did it join the Open Archives Initiative as early as 2005, but it has also promoted the debate on Open Science by publishing various editions of the ArcheoFOSS[45] workshop and by giving relevance to contributions of expert scholars addressing the theme of open digital archives and open access archaeological publishing[46].

A digital repository, conforming to the OAI-PMH protocol, contains the metadata description of the articles published in the Journal and in the Supplements (more than 800 papers by more than 1,000 authors all over the world). All articles published from 1996 onwards are freely accessible. Publication is free of charge for authors and access for readers is made available immediately on publication. Recently, we have launched a support campaign entitled 'Knowledge-sharing in culture and cooperation in research'[47], seeking to share our entire collection of articles, to sustain the open access movement in archaeology, and to contribute to the dissemination of interdisciplinary archaeological research within a more collaborative and creative open science environment.

In particular, we tested a new form of presentation for an interdisciplinary research sector in a journal's website environment. The presence of theme issues, conference proceedings, databases, publication statistics, and additional documents demonstrates that the website is no longer a simple venue for collecting, preserving, and deploying scientific articles, but a conduit for the increasingly enhanced capillary activity of knowledge dissemination. Focus is shifted towards the community of readers, introducing them to a more complex information system; innovative communication strategies are tested out, to reach scientific achievements and so produce an important impact on knowledge and education. As a result, scholars can diversify the channels through which their knowledge is made available, with the support of a cognitive and communicative approach.

Its participation in the Open Archives Initiative has made the Journal not only a dissemination tool, but also an online research point of reference, freely available for scholars and students. Tangible evidence of its role was provided during the implementation of the Virtual Museum Archaeological Computing[48], a research project that the CNR-ISMA is

[44] Barchesi 2006 and lastly Moscati 2018.

[45] Cignoni, Palombini, Pescarin 2009; Serlorenzi 2013; Basso, Caravale, Grossi 2016.

[46] See e.g. Caravale, Piergrossi 2012 and some of the articles published in the SITAR Conference Proceedings (Serlorenzi, Leoni 2015; Serlorenzi, De Tommasi, Jovine 2017).

[47] http://www.archcalc.cnr.it/support2.htm.

[48] http://archaeologicalcomputing.lincei.it/.

leading in partnership with the Accademia Nazionale dei Lincei[49]. The articles published in the Journal have been a source for documenting all the different aspects of the history of studies and institutions. This alone is sufficient to display the value of the scientific interdisciplinary approach and the international perspective of studies promoted since the Journal's outset. Technology has thus enhanced our engagement in giving immediacy and ease of access to archaeological data and research results that scholars have the ethical duty to make public.

5. Conclusions

The bilateral aim of our Italian-Montenegrin joint Laboratory on Doclea is to openly publish the archaeological results to be achieved, in accordance with the European guidelines and following a data sharing and dissemination policy. The choice of 'Archeologia e Calcolatori' as one of the publishing platforms will subsequently make it possible to record data first in the CNR SOLAR database (Scientific Open-access Literature Archive and Repository)[50] and thence in the CNR Science and Technology Digital Library[51]. In addition, the choice to share the content of the Journal's repository in CulturaItalia[52], the Portal of Italian Culture, will make data available to other heritage portals, such as Europeana – of which CulturaItalia is the national aggregator – or CLARIN-IT[53], the Italian Common Language Resources and Technology Infrastructure.

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[49] Moscati, Orlandi 2019.
[50] http://eprints.bice.rm.cnr.it/.
[51] http://stdl.cnr.it/it/.
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