



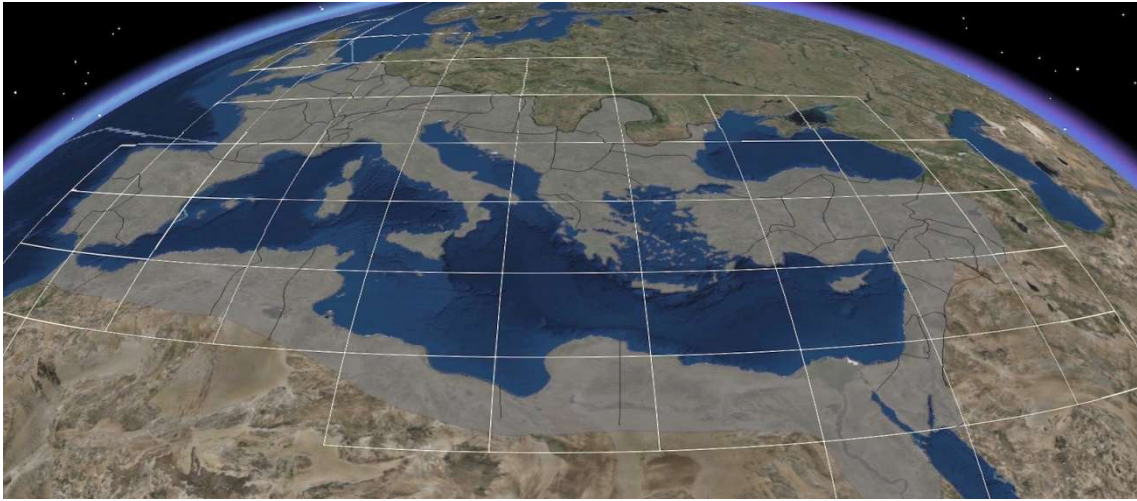
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1st TIR-FOR SYMPOSIUM

From territory studies to digital cartography

Institut d'Estudis Catalans, Carrer del Carme, 47, 08001 Barcelona,
Spain

ABSTRACTS

SESSION 1. *Present and future of the international TIR-FOR project*

Marta Prevosti (IEC and ICAC), **Pau de Soto** (ICAC), **Núria Romaní** (ICAC and Autonomous University of Barcelona, UAB), **Ada Cortés** (Sapienza University of Rome and ICAC) and **Josep Guitart** (IEC)

The new digital TIR-FOR project

The main aim of the project is to create an online map of the Roman Empire shared by all the participant teams, based on a huge online digital application cataloguing and mapping the information on sites and landforms in the Roman Empire. In fact, this application is the sum of two projects: the Tabula Imperii Romani (TIR) and the Forma Orbis Romani (FOR). The TIR is a scientific synthesis map of the Roman world. The goal of the FOR project is an exhaustive collection of all the evidence available from sources, epigraphy and archaeology that can be included on a map. It is like zooming in on a specific region. In addition to identifiers for the site, the database also includes dictionaries of “typologies” and “elements” that can be related to the chronology. It therefore provides considerable flexibility that goes beyond the classic stable *FOR* map as both chronological-typological and element maps can be produced for sites using the same basic information. The online FOR therefore has great research potential. Advanced searches can be made from any of the database fields.

Our scope is to globalise and systematise the information via a single online portal. A unified approach has been developed creating a single database valid for the entire Roman Empire enabling each research team to work locally using this centralised database. It will serve both as a research tool and as a test bed for new dissemination concepts. This multiplies its potential. It has the aim of extending its use to broad sectors of the population and to become a fundamental application resulting in an increase of our knowledge and enjoyment of the archaeological and antiquarian heritage.

Luisa Migliorati, Laura Ebanista and Ilaria Trivelloni (Sapienza University of Rome)

International World Map: a history spanning centuries

Man has always tried to depict the whole world in which he lived. The certainty that the known geographical area was identifiable with the Earth has accompanied populations for a very long time, leading to several attempts to draw the world map. Exactly for the awareness of the Earth sphericity (Anassimandro), mapping the globe has represented a problem ever since. Since no world map drawn by ancient geographers has been preserved, few modern scholars have proposed various reconstructions interpreting texts. Actually, we do have an ancient map documenting the *oikoumene*: the well-known Tabula Peutingeriana. Although it has a specific destination and deformations due to its own purpose, the map can be considered as an IWM of antiquity.

In 1928 O. G. S. Crawford brought back to peoples' attention the importance of a European historical drawing (a new Tabula, the TIR) choosing to represent it on a worldwide scale map: the *l'International Map of the World (IMW)*, subdivided in sheets at 1: 1.000.000 scale. The choice of a base map with high denominator scale provided the intent to realize an archaeological map of the Roman world. For many decades the general image of the *TIR* was a black and white map of the Mediterranean basin with the sheets outlines.

The transition from the printed cartography to the digital one has significantly modified the connotation of the *TIR* and a 'non-speaking' map no longer suffices to the research purposes.

This intervention (ri) proposes the implementation of the new general visualization system of the *TIR-FOR* project: an interface that allows the users to have an immediate sense of space and place of the study area. In fact, the passage almost complete to the Web allows to integrate the basis cartography with various detailed information that can help the research topic of the users.

However, nowadays, when digital cartography is imposing itself in various research fields and in dissemination, critical issues open up, such as the question of positioning precision.

The last part of the paper will deal with the complex mechanism of transposition of data from printed maps to the most modern GIS and WebGIS systems, through the conversion of the coordinate systems referred to the appropriate datum. In this context it becomes essential considering the approximation of the perception of human eye at the different graphic scales which, in the case of printing, is static and therefore calculable and approximate in terms of precision. In a GIS system the problem of the scale is overcome by the punctual precision of the system of coordinates. Transition can be done in reverse order where the GIS system, properly processed, is exported to produce printable cartography useful for scientific publications.

Florin-Gheorghe Fodorean (Babes-Bolyai University Cluj-Napoca)*TIR-FOR Romania. State of research*

Approximately 5 years have already passed away since the start of this digital, updated version of the TIR project. The Romanian team joined the project with enthusiasm and eager to fulfill the proposed objectives. We will present in our communication prepared for this prestigious scientific event the results of our research. Online, using the platform developed by our generous colleagues from the Institut d'Estudis Catalans in Barcelona, we have succeeded to introduce, so far, 1400 sites. Some of these sites are described in detail. Our presentation will provide some examples of such sites using the on-line platform. It will also provide information about our future plans, related to the continuation of this project in close connection with the FOR part.

Judyta Rodzińska-Nowak (Jagiellonian University in Kraków)

Mapping the barbarian world - outline of the issues

The paper deals with the difficulties and limitations of interpretation of cartographic shots of the barbarian world. These difficulties concern mainly the possibility of defining the seats of individual peoples known from written sources, the range of archaeological cultures, the course of trade and communication routes.

Georgios Zachos (Academy of Athens, Research Center for Antiquity) and **Vyron Antoniadis** (National Hellenic Research Foundation, Institute of Historical Research)

From map to gazetteer and back again

Tabula Imperii Romani, as the name indicates, begun as a map. This was one of the first attempts to visualise a database in geographic terms. However, due to the vast amount of archaeological date, Tabula was converted to a gazetteer. Maps became a mere supplement to this index. With the GIS mapping and online databases (in the future), maps have regained importance in the TIR project.

The Academy of Athens participates in the TIR project since 1972. The first volume (Philippi) was published in 1993 and covers part of the eastern Macedonia and the Greek part of Thrace. Over the last decade an effort has been made to publish the entire area of Greece. Four new volumes are now available (Aegean Islands, Epirus, Central Greece from Pagasetic Gulf to Ionian Sea, Attica), two in press (Boiotia, Thessaly) and one is under preparation (Macedonia).

The research group and authors of TIR volumes in the Academy of Athens are currently exploring new ways for presenting and analysing the data of the published books. The first example of this process is Western Greece (Aitolia-Akarnania and Epirus) in the forthcoming conference. With a series of interactive density maps, we will present the changes in the settlement pattern and we will try to give answers to historical issues like the impact of the Roman presence in the area. This case study can serve as a model for the rest of Greece.

Fathi Bejaoui and **Moèz Achour** (National Institute of Heritage, Tunisia)

Le projet TIR-FOR et la Carte Nationale des Sites Archéologiques et des Monuments Historiques

En 2017, l'Institut National du Patrimoine (Tunisie), représenté par le professeur Fathi Béjaoui a intégré le projet de la carte de l'empire romain la « TABULA IMPERI ROMANI- FORMA ORBIS ROMANI ». Il avait alors, formé une équipe, sous sa direction, ayant pour objectif, l'insertion des données des sites archéologiques tunisiens, publiés déjà, par la Carte Nationale des Sites Archéologiques et des Monuments Historiques.

Cette équipe, a été formée à Barcelone à l'[Institut d'Estudis Catalans](#) pour la manipulation de la base de données et de l'application accessible en open-source sur le net.

Il s'agit ici, de présenter l'état d'avancement de l'équipe tunisienne dans ce projet ; de présenter le projet de la CNSAMH et enfin de le comparer avec le Projet TIR-FOR.

SESSION 2. *Digital maps of the Roman world and specialised applications*

Johan Åhlfeldt (University of Gothenburg)

Digital Maps and historical gazetteers: function and importance for digital historical research

Jacopo Turchetto (University of Padova)

From 'Flatland' to the real world. Archaeological mapping in the digital age

While conducting researches on the historical landscape of central Anatolia (Cappadocia) and on its transformation through time (from the Greco-Roman age to the early Byzantine period), the need has arisen of approaching the archaeological mapping of that territory from a different perspective and from different 'points of view' than those traditionally adopted in that area so far.

In particular, the exploitation of the potential of the 'third dimension', whether in a 2.5D or a real 3D GIS environment, appeared to be of great usefulness. That approach, indeed, allowed to 'extrude' all the Cappadocian morphological features (the mountain chain of central Taurus, the deep valleys dug into the tuffaceous rock, the isolated volcanic peaks and the semi-flat uplands stretched along the middle course of the Kızılırmak river), enhancing their representation in the maps, thus enabling a multi-parameter-based interpretation of the archaeological record and stimulating the application of more detailed and targeted GIS analyses. With reference to the layout of the routes, for example, such a mapping not only permitted to visualise the connection between point A and point B, but also to 'perceive the difficulties' (slope) of travelling along them, due to the direction of the roads (outbound or inbound, ascending or descending). It allowed also evaluating settlements inter-visibility, their topological relations, their connection with the road system and, in general terms, with the geomorphological data.

The aim of this oral presentation is twofold: (A) to discuss some case-studies in which the application of a three-dimensional approach in the process of the archaeological mapping stimulated different and alternative ideas/hypotheses; (B) to share the first results of an archaeological and topographic WebGIS dedicated to Graeco-Roman Cappadocia, which will both represent a share tool for researchers and make general public experience history and archaeology in a more direct, stimulating and involving way, fostering the potential of digital interactive technologies and deepening our knowledge on the Cappadocian historical landscape.

Francis Tassaux (Ausonius Institute –Bordeaux Montaigne University)

AdriAtlas - Atlas informatisé de l'Adriatique antique

AdriAtlas - Atlas informatisé de l'Adriatique antique - a été mis en ligne en novembre 2013 grâce à un programme de l'Agence Nationale de la Recherche, piloté par l'Institut Ausonius de Bordeaux ; il est l'œuvre collective de chercheurs des Instituts archéologiques de Tirana et de Ljubljana et des universités de Zadar, Pula, Rijeka, Trieste, Vérone, Padoue, Ferrare, Macerata, Foggia, Bari et Lecce ainsi que de l'Ecole française de Rome et des Unités Mixtes de recherche d'Aix-Marseille (Centre Camille Jullian), Besançon (Chrono-Environnement), Bordeaux (Ausonius) et Dijon (Arthist). Il prend en compte tous les sites importants des régions qui bordent le bassin adriatique, depuis le XI^e s. a.C. à la date symbolique de 751 p.C. (fin de la civilisation urbaine antique nord-adriatique). Il s'agit d'abord de tous les toponymes donnés par les sources écrites antiques et tardo-antiques, puis des sites dont on possède un plan d'ensemble ou partiel ou encore qui sont d'un intérêt historique ou archéologique majeur, soit à l'heure actuelle près d'un millier de notices.

Depuis mai 2020, AdriAtlas fait partie des activités majeures du CISA (Centro internazionale di Studi sulla Storia e l'Archeologia dell'Adriatico), basé à l'université de Macerata .

AdriAtlas, consultable sur le portail AdriaticumMare.org, est un SIG composé de 3 éléments : une base de données postgreSQL multilingue, un géoportail et une bibliographie collaborative Zotero. Chaque notice de site de la base de données se compose d'une fiche-mère et de fiches-filles par époques, avec 12 rubriques. Le géoportail met en œuvre une carte dynamique, cherchant le maximum de précision dans la géolocalisation des sites.

AdriAtlas est suivi par AusoHNum, le service des humanités numériques d'Ausonius (Nathalie Prévôt et Clément Coutelier), et il est hébergé par la *Très Grande Infrastructure de recherche des Humanités Numériques* du CNRS (TGIR de Lyon-Villeurbanne), sous la responsabilité de Gérard Foliot.

Consultable en *open access* et régulièrement mis à jour par des spécialistes de chaque secteur géographique, c'est à la fois un atlas proprement dit, une encyclopédie et un instrument de recherche et de publication.

<http://adriaticummare.org/fr/bdd> ; http://adriaticummare.org/Map_Adriatlas/

Clement Coutelier and **François Didierjean** (Ausonius Institute –Bordeaux Montaigne University)

Aquitaviae, projet de carte dynamique participative des voies de l'Aquitaine romaine

The Aquitaviae project was born from the observation that many factors are obstacles to knowledge about the ancient road network of the Roman Empire: dispersion of sources, heterogeneity of studies, variable uncertainties on the chronology and on the tracks, as well as problems of multi-scalar representation. Fortunately, these difficulties can be overcome to a large extent, thanks to new digital tools for data management, representations and spatial analyzes.

The main idea is to create a map gathering information on the whole province of Aquitaine (France), as defined under Augustus, over a period going from the Roman conquest to the end of Antiquity. This map is designed as dynamic and participative, with the most diverse collaborations: research institutes, Regional Archaeological Services, preventive archaeological organizations, learned societies, local researchers etc. Information holders are invited to integrate, in a provisional version of the map, the elements they have. The reliability of the information is ensured by a network of referents, each responsible for a territory, gathered in a reading committee which validates the data proposed for an insertion in the final map.

The objectives of this new map are multiple. First, it provides a state of knowledge in a homogenized form. Then, it makes it possible to respond to research hypotheses on the ancient road network and its functioning, in particular by spatial analysis. Finally, it contributes to the protection and enhancement of the road heritage.

The online map has been designed for users of various computer levels. The handling is therefore easy and the functionalities available are limited to the essentials: display of map data, graphical and descriptive data entry, filter on the data to generate a personalized display on the map, etc. But the tool remains scalable as needed.

The map allows archaeological interpretation thanks to seven types of data: the sections of tracks - essential information -, the observation points - still visible signs of passage of a track -, the sites bordering a track, the milestones in place, ancient agglomerations, revealing toponyms and odonyms.

The Aquitaviae project focuses on taking into account the uncertainties of the entered data. Thus, the physical layout of each section and the level of reliability with regard to the use made of the track during the ancient period (but also in protohistoric and medieval times) are defined and specified. Each addition to the map must be associated with one or more sources and the spatial data must be supported by bibliographic references. This is why the AquitaZot group was created on the free Zotero tool. Graphic documents such as aerial photos can be viewed from the online map. In addition, it is synchronized with a cartographic application on a smartphone, allowing recognition in the field, as well as drawing new data thanks to the location function.

Ultimately, the dynamic map should be used as a regional tool for safeguarding endangered heritage.

Aquitaviae, projet de carte dynamique participative des voies de l'Aquitaine romaine

Résumé (français)

Le projet Aquitaviae est né du constat que de nombreux facteurs font obstacles aux connaissances sur le réseau routier antique de l'Empire romain : dispersion des sources, hétérogénéité des études, incertitudes variables sur la chronologie et sur les tracés, ainsi que des problèmes de représentation multiscalaire. Ces difficultés peuvent heureusement être surmontées dans une large mesure, grâce aux nouveaux outils numériques de gestion des données, de représentations et d'analyses spatiales.

L'idée directrice est de créer une carte rassemblant les informations sur l'ensemble de la province d'Aquitaine (France), telle que définie sous Auguste, sur une période allant de la conquête romaine à la fin de l'Antiquité. Cette carte est conçue comme dynamique et participative, avec les collaborations les plus diverses : instituts de recherche, Services Régionaux de l'Archéologie,

organismes d'archéologie préventive, sociétés savantes, chercheurs locaux etc. Les détenteurs d'informations sont invités à intégrer, dans une version provisoire de la carte, les éléments dont ils disposent. La fiabilité des informations est assurée par un réseau de référents, chacun chargé d'un territoire, rassemblés dans un comité de lecture qui valide les données proposées pour une insertion dans la carte définitive.

Les objectifs de cette nouvelle carte sont multiples. D'abord, elle fournit un état des connaissances sous une forme homogénéisée. Ensuite, elle permet de répondre à des hypothèses de recherche sur le réseau viaire antique et son fonctionnement, notamment par l'analyse spatiale. Enfin, elle contribue à la protection et à la valorisation du patrimoine routier.

La carte en ligne a été conçue pour des utilisateurs aux niveaux informatiques divers. La prise en main est donc facile et les fonctionnalités disponibles sont limitées à l'essentiel : affichage des données de la carte, saisie graphique et descriptive des données, filtre sur les données permettant de générer un affichage personnalisé sur la carte, etc. Mais l'outil demeure évolutif en fonction des besoins.

La carte permet l'interprétation archéologique grâce à sept types de données : les tronçons de voies - information incontournable -, les points d'observation - indices encore visibles de passage d'une voie -, les sites bordant une voie, les bornes routières en place, les agglomérations antiques, les toponymes révélateurs et odonymes.

Le projet Aquitaviae s'attache à prendre en compte les incertitudes des données saisies. Ainsi, le tracé physique de chaque tronçon et le niveau de fiabilité quant à l'usage fait de la voie durant la période antique (mais également aux époques protohistorique et médiévale) sont définis et précisés. Chaque ajout à la carte doit être associé à une ou plusieurs sources et les données spatiales doivent être étayées par des références bibliographiques. C'est pourquoi le groupe AquitaZot a été créé sur l'outil libre Zotero. Des documents graphiques comme des photos aériennes peuvent être consultés depuis la carte en ligne. Par ailleurs, elle est synchronisée avec une application

cartographique sur smartphone, permettant la reconnaissance sur le terrain, ainsi que le dessin de nouvelles données grâce à la fonction de localisation.

A terme, la carte dynamique devrait se positionner comme outil régional de sauvegarde d'un patrimoine en danger.

Pau de Soto (ICAC)*Viator-e. The roads of the Western Roman Empire*

Viator-e proposes to fill the absence in the Roman archaeological research of a complete study on the transport routes by creating the first detailed model of open data of the transport network system of the Western Roman Empire. This project will also be considered an outstanding improvement in the quality of the knowledge of the Roman transport networks due to its geographical scope and its detailed information. The digitisation of the entire communication routes of the Western Roman Empire will offer an incredibly useful tool for all the Roman researchers who will be able to find a free and open resource to incorporate into their own projects. The Viator-e online platform will be a public interface where researchers and all the society will be able to search, find and download all the roads of the Western part of the Roman Empire. This project is also designed, from the Roman transport network model, to analyse the social, political and economic repercussions of the construction of transport infrastructures in a wide geographical area, the Western Roman Empire.

Jesús Ignacio Jiménez Chaparro and **Alicia Ruiz Gutiérrez** (University of Cantabria, Group AHIR)

Digital resources for mapping the population movement in the Roman Empire

Digital resources applied to epigraphy are a useful tool for mapping geographic mobility in Roman times. This is the aim of the MIGRA project (HAR2017-84711-P), whose starting point is the development of an epigraphic database linked to a Geographic Information System (GIS), which allows to reflect the intensity and direction of migratory movements. Roman inscriptions documenting population movements between cities are collected in MIGRA's database. These displacements are usually detected through the homeland of origin (*origo*) mentioned after the individuals' names, or through other explicit references provided by the epigraphic texts. Digital cartographic of the Roman Empire allows to contextualize the epigraphic sources. Geographical layers in MIGRA are being designed from available digital resources. The georeferencing of both the places where the inscriptions were found and the corresponding cities of *origo* facilitate the mapping of displacements, thus showing demographic trends and migratory flows.

Los recursos digitales aplicados a la epigrafía son un instrumento útil para cartografiar la movilidad geográfica en época romana. Este es el objetivo del proyecto MIGRA (HAR2017-84711-P), cuyo punto de partida es la elaboración de una base de datos epigráfica asociada a un Sistema de Información Geográfica (SIG) que permite reflejar la intensidad y dirección de los movimientos migratorios. En la base de datos MIGRA se recogen las inscripciones romanas que documentan desplazamientos de población entre ciudades. Normalmente estos desplazamientos son detectados a través de la indicación de la patria de origen (*origo*) que complementa la onomástica de los individuos, o bien por medio de otras referencias explícitas contenidas en las inscripciones. El empleo de cartografías digitales sobre el Imperio romano permite contextualizar las fuentes epigráficas. A partir de los recursos disponibles se está realizando las diferentes capas geográficas usadas en el

proyecto MIGRA. La georreferenciación tanto de los lugares de hallazgo de las inscripciones como de las ciudades de *origo* correspondientes facilita el mapeo de los desplazamientos, poniendo así de manifiesto tendencias demográficas y flujos migratorios.

Eduard Angelats (Technological Centre of Telecommunications of Catalonia, CTTC/CERCA - Geomatics division), **Francesc C. Conesa** (ICAC), **Catalina Mas Florit** (University of Barcelona, UB - Archaeological and Archaeometric Research Group, ERAAUB), **Marc Salom** (independent researcher), **Miguel Ángel Cau Ontiveros** (UB-ERAAUB)

Multi-sensor and multi-temporal mapping of the Roman city of Pollentia (Alcúdia, Mallorca): the ARCHREMOTELANDS project approach

In recent years, technological advances in remote instruments such as RPAS or drone platforms, miniaturized sensors, GNSS positioning systems and photogrammetric software have certainly contributed to the consolidation of drone-based studies beyond experimental projects. Nowadays, this available technological toolkit is indispensable to archaeologists as shovels and trowels. Reliable remote sensing observations, however, are highly dependent on the accurate positioning of both the platform and the sensor employed, and a key challenge that remains seldom investigated is the integration (i.e. the co-registration) of newly acquired drone imagery with other geospatial datasets. These include multi-temporal drone orthomosaics from multiple flights (including multi-sensor imagery from distinct drone platforms and systems), as well as complementary aerial data (e.g. national orthophoto maps) and historical datasets such as topographical and geophysical legacy data.

This work summarises the ongoing drone-based research workflow being developed by the interdisciplinary team of ARCHREMOTELANDS (HAR2017-83335-P, University of Barcelona). The main aim of the project is to understand the evolution of the rural landscape in the hinterland of the Roman city of *Pollentia* (Alcúdia, north-western Mallorca). In particular, this contribution focus on 1) the generation and co-registration of multi-sensor and multi-source high-resolution drone orthomosaics and DEMs using public and freely available aerial data archives; 2) the automated delineation and vectorisation of visible archaeological remains from such orthophotos; and 3) the synergistic exploitation of multispectral and thermal bands to identify subsurface archaeological remains.

Our preliminary results show examples from the Roman city of *Pollentia*. We first examine how publicly available Spanish' *Plan Nacional de Ortofotografía Aérea* (PNOA) can be used to precisely identify GCPs and orthorectify multi-source and multi-temporal orthomosaics at subpixel resolution, thus reducing the need for alternative time and cost-consuming approaches such as topographical GCPs or precise drone GNSS-RTK positioning. Secondly, we discuss the possibilities of using open-source Orfeo ToolBox (OTB) libraries, including machine-learning methods, for the accurate classification of multi-band orthomosaics (i.e. VNIR and DEM bands). In particular, we have focused on the automated delineation of visible structural and architectural remains. Finally, we briefly outline the use of multispectral and thermal sensors to detect and map partially-buried features. This research workflow offers a set of open and freely available tools that can be used for effective and reliable documentation, site management and decision-making for future surveys and explorations, with an additional focus on data sharing and product dissemination to both scientific and non-expert audiences.

Giovanna Cera (University of Salento)

The contribution of the digital cartography to the reconstruction of the ancient walls of Brundisium

This work aims to explore some aspects related to the definition of the urban landscape of the roman town of *Brundisium* (Brindisi), a latin colony founded in 244 B.C. along the Adriatic coast of Southern Italy (Puglia).

As well known, historical maps provide in many cases important topographical information for knowing the geography of the past. Thanks to the application of GIS technology, we intend to perform the comparison between historical and contemporary cartography to improve the understanding of urban layout, in particular in relation to the reconstruction of the ancient walls.

With the contribution of digital cartography, we intend moreover to examine the distribution of archaeological evidence useful for our research. Not only the remains belonging to the ancient walls, but also other findings that can indirectly suggest the layout of their circuit: burials and necropolis areas, for example. Our contribution will also focus on the issue related to the location of the Roman gates, which in some cases could overlap those belonging to the Aragonese fortifications.

Considering the close relationship that usually exists between walls and geomorphology, we purpose to offer a new analysis perspective, based on the overlap between the archaeological data and the digital terrain model of the Roman city area.

Daide Mastroianni (Gruppo di Ricerca per il Mezzogiorno Medievale, GRIMm)

La lettura del paesaggio antico per la definizione dell'Ager Hatrianus interno. Il pagus di Cellino Attanasio

Plinio, nella descrizione della *Regio V Augustea*, elenca, da sud verso nord, i centri abitati costieri e paracostieri, gli idronimi e le comunità che li abitavano. La prima città menzionata è *Hadria*, l'odierna Atri, in provincia di Teramo, in Abruzzo, abitata dagli "adriani". Il *Liber Colonialium* cita che la città, nel corso del suo processo di romanizzazione, passando da colonia latina a *municipium*, fu riorganizzata come segue: *il territorio di Hatria (Atri) <fu assegnato> con limiti che guardano verso il mare e con limiti gallici, che noi chiamiamo decumani e cardini. È delimitato con arche, sponde, canali, e canali di drenaggio che si costruiscono con tegole. In altri luoghi invero con muri, muretti a secco, mucchi e pile di pietre, pietre non rifinite, termini augustei, e il corso di fiumi.* Dalle ricerche condotte emerge un quadro molto ben preciso. L'*Ager Hatrianus* era racchiuso all'interno di limiti geoidrografici costituiti dal Vomano a nord, dal Mavone e da un tratto del Fino ad ovest, dal Fino e dal Saline a sud e dal mare Adriatico ad est. All'interno di questo esteso quadrilatero sono state riconosciute due macro aree: una costiera, avente come fulcro culturale, economico e politico la città di *Hatria*, ricca di versanti collinari coltivati a vite, aree dove si produceva ceramica e, soprattutto, uno scalo portuale, il porto romano presso Torre di Cerrano, in grado di gestire e mantenere scambi e commerci attraverso l'Adriatico; l'altra interna montana, il cui centro corrisponde all'odierno territorio di Cellino Attanasio che, con i *vici* di località Monte Cellino Vecchio, Telesio, Case di Sante, i numerosi abitati rustici, le fasce collinari e di media pianura lungo il fiume Vomano, dove sono state riconosciute le suddivisioni agrarie di età augustea votate allo sfruttamento agricolo e pastorale, formerebbe un grande distretto rurale. I siti antichi e la loro disposizione sul territorio farebbero supporre l'esistenza di un *pagus* a Cellino Attanasio (*pagus Cillinam?*), attestati da una iscrizione presso Monte Cellino Vecchio che menziona due magistri, *Marco Petrucidio* e *Lucio Pacidio*, i quali eseguirono i lavori per la costruzione di un tempio, con crepidini e colonne. L'area costiera e quella montana, collegate attraverso una fitta rete viaria, assicuravano un'economia florida in tutto l'*Ager Hatrianus*.

SESSION 3. *Studies of landscape, settlement and archaeological topography and digital cartography*

Héctor Orengo and Josep M. Palet (ICAC, Research Group GIAP)

Integrated landscape analysis: moving beyond site distribution

This talk aims to showcase current research at the Landscape Archaeology Research Group (GIAP) at the Catalan Institute of Classical Archaeology (ICAC) to illustrate our aim to produce a set of tools and procedures for integrated past landscape analysis.

Firstly, we will show how multi-temporal remote sensing procedures in combination with machine learning using a multi-sensor sources are applied at different scales and landscape settings for the location, analysis and monitoring of sites and past landscape features.

Secondly, we will demonstrate how new technologies can help modelling past routes and communication networks at different scales using legacy archaeological data.

Lastly, we will show how the combination of these data can be analysed using archaeomorphology, spatial analyses, network analysis, agent-based modelling, statistics and archaeological and environmental contextual information to produce hypotheses on past movement, transport, commerce, long-term settlement patterns and past social identities.

Florin-Gheorghe Fodorean (Babes-Bolyai University Cluj-Napoca)

Landscape archaeology in northern Dacia. Potaissa and its surroundings

We have prepared for this section a communication focused on the one of the most important archaeological sites in Romania, Potaissa (today Turda, Cluj County, Romania). We consider this site emblematic because of several important reasons. First, the place where the legionary fortress is located is, since 1978, an archaeological reservation. Therefore, the site was protected. Secondly, the results of the archaeological research were constantly published. Of course, many data are now known in connection with the legionary fortress, due to uninterrupted archaeological researches started in 1971. But we know also data regarding the ancient city and its topography. Our presentation will provide data about the most important aspects of the topography of the ancient city and the legionary fortress.

Antoni Martín Oliveras and Victor Revilla (UB-CEIPAC), **Lisa Stubert** (University of Potsdam - Institute of Environmental Sciences and Geography) **and Sebastian Vogel** (Leibniz Institute for Agricultural Engineering and Bioeconomy, ATB)

Geospatial-economic studies and archaeological data analysis applied to ancient viticultural landscapes. The case of Laetanian Roman wine, Hispania Citerior Tarraconensis

Viticulture played an important role in the economy of the Mediterranean coast of *Hispania Citerior Tarraconensis* between the 1st century B.C. and the 3rd century A.D. Vineyards, wineries, and pottery workshops are usually found clustered in specific areas, such as the Laetanian region located on the northeast coast of the Iberian peninsula. Their spatial and temporal distribution has been previously interpreted as proof of the existence of an intensive and specialized wine-making economy associated with large-scale production and trading of wine in bulk quantities targeting, predominantly, overseas markets.

Despite the significance of wine-growing activity in the territory and its role in the empire-wide economy, the processes involved in production, trade and consumption of Laetanian wine and its evolution over time have never been quantified using predictive modelling and GIS based analyses combined with empirical economic models and further econometric methods. A semi-automatic predictive model with the programming language Python was created to accelerate and simplify the process of geospatial and statistical analysis to calculate the suitability of the locations of known archaeological sites associated with viticulture and to determine the underlying factors of their distribution. A microeconomic explanatory data analysis of the function of this ancient wine production was also developed, paying particular attention to the yields of vineyards and wine-making facilities.

With the knowledge gained from both approaches, the ancient cultivated area of a property and the number of wine presses needed for processing the harvests can be extrapolated. The algorithm developed in this predictive model and the microeconomic yield ratios obtained for vineyards and wine-making have been

designed in a way that can be easily used with other data sets for future studies in different territories.

Laia Catarineu (Autonomous University of Barcelona)

Assentaments militars romans del nord-est de la Hispania Citerior (Catalunya i la vall de l'Ebre) en les primeres etapes de la romanització. Estudi del cas i proposta de caracterització i identificació

El període comprés entre la Segona Guerra Púnica i la Primera Guerra Civil Romana comporta nombrosos canvis i modificacions del territori hispà. La següent proposta de comunicació pretén realitzar un estudi del poblament durant aquest primer segle d'ocupació romanorrepública i de la introducció d'una nova política de control. Amb l'objectiu de donar a conèixer les primeres dècades de la implantació, administrativa i militar romana al nord-est de la *Hispania Citerior*.

Es procedirà a realitzar la catalogació i ubicació dels jaciments que corresponen a les primeres fases de la implantació militar i administrativa romana a la zona de Catalunya i la vall mitjana de l'Ebre. Un dels principis més importants és la utilització d'una sèrie de criteris essencials a tenir en compte per poder identificar els jaciments que presenten algun tipus d'ocupació militar romanorrepública. A partir d'una sèrie de criteris, basats en la situació geogràfica, l'arquitectura i els elements mobles, s'ha efectuat aquesta selecció de jaciments per estudiar-la de forma conjunta.

Aquest estudi es realitza mitjançant la sistematització de dades arqueològiques, de la utilització d'unes fitxes i una base de dades que permeti poder realitzar un estudi de conjunt. La creació d'aquesta BBDD està concebuda com una eina de investigació a partir de la qual podrem estudiar les primeres dècades de la romanització al nord-est peninsular, sempre tenint en compte la disposició geogràfica. L'ús d'eines de GIS (*Geographic Information System*) han permès realitzar estudis interpoblacionals i relacionar tots aquests assentaments de caire itàlic amb el paisatge i el territori de l'entorn. A través d'aquesta catalogació i disposició geogràfica, s'ha procedit a desenvolupar una sèrie d'estudis de tipus cronològic, tipològic, evolutiu i de poblament

L'estudi de conjunt d'aquests jaciments ha permès percebre com en el període estudiat sorgeixen noves tipologies d'assentaments. Aquests canvis són

impulsats per la República romana que reordena les estructures de poder existents per adaptar-se a les seves pròpies necessitats. Les transformacions, que segueixen models itàlics, afecten el conjunt del territori preexistent, però de forma heterogènia. La multiplicitat de tipologies és evident: mentre que alguns d'aquests assentaments semblen ser estrictament militars amb un fort component defensiu, d'altres tenen un paper productiu o logístic, o s'han assimilat a centres administratius o a residències de la nova elit romana establerta a *Hispania*. Tot això evidencia una gran variabilitat constructiva i tipològica, que revela les complexes relacions de poder entre Roma i les societats indígenes. Aquest treball pretén exposar la gran variabilitat de casos i de processos de romanització.

L'estudi de totes aquestes transformacions de forma conjunta pot ajudar a observar els canvis en l'urbanisme, el territori i les transformacions socials produïdes en aquest territori durant les primeres etapes de la romanització, proporcionant un nou enfocament que ajudarà a comprendre la implantació administrativa i militar romana.

Aquest treball interdisciplinari s'emmarca en el procés d'elaboració de la tesi doctoral desenvolupada per l'autora a la Universitat Autònoma de Barcelona i en el marc del Doctorat Interuniversitari en Arqueologia Clàssica de l'ICAC, la UAB i la URV.

Luis-Gethsemaní Pérez-Aguilar (Institute of Archaeology - Merida, CSIC - Junta de Extremadura)

La realización de mapas de densidades para la investigación del poblamiento antiguo. El entorno del Bajo Guadalquivir (SO de España) entre los siglos II y IV d.C. como caso de estudio.

La parte occidental de la provincia romana de la Bética experimentó en época altoimperial un momento de bonanza económica fundamentada en pilares productivos como del aceite, las salazones y salsas de pescado o la minería. Dicho auge económico coincide en el tiempo no sólo con la monumentalización de los espacios urbanos, sino también con un aumento general de los asentamientos rurales volcados a las distintas actividades productivas.

En este contexto, el bajo cauce del río *Baetis* (Guadalquivir) se convierte en una auténtica arteria económica. La navegabilidad del mismo para barcos de mediano y gran calado facilitaba el comercio y permitía también abaratar costes, interconectando esta región con otras zonas del mundo mediterráneo y atlántico tanto en términos de importaciones como de exportaciones.

Estas condiciones contribuyeron a la eclosión del poblamiento humano en el entorno del Bajo Guadalquivir. Sin embargo, tal bonanza económica mengua en el occidente bético a partir de la segunda mitad del siglo II d.C., iniciándose un proceso de contracción de la red de asentamientos que terminaría estabilizándose en la segunda mitad del siglo III, volviendo a crecer en el IV d.C. bajo la nueva realidad socioeconómica de la época tardorromana en la zona.

Para hacer una aproximación cuantitativa y visual de todo este proceso histórico desde la arqueología del territorio, hemos muestreado los yacimientos de 4 zonas del Bajo Guadalquivir fechados entre los siglos II y IV d.C. El objetivo ha sido la realización de mapas de densidades mediante SIG que permitan visualizar espacialmente la tasa de crecimiento/decrecimiento de la red de asentamientos durante estas centurias. **Página 2 de 2**

La modelización del cálculo de la densidad se ha llevado a cabo a partir de un análisis de estimación de densidad de núcleo (*kernel density estimation*) a

partir de la función K_2 de Silverman. Para la determinación de la varianza del radio del núcleo o ancho de banda (h) encontramos dos procedimientos en arqueología espacial. De un lado quedan aquellos investigadores (p. ej. J. Conolly & M. Lake) que proponen estimar el ancho de banda a partir de criterios de tanteo cualitativo. Otros, en cambio, prefieren estimar el ancho de banda mediante cálculos estadísticos (p. ej. M.J. Baxter, C.C. Beardah & R.V.S. Wright). En el caso de estudio que hemos desarrollado para el Bajo Guadalquivir planteamos la posibilidad operativa de combinar ambos criterios como una forma flexible, a la par que estadísticamente coherente, de agilizar el análisis.

Francisco Javier Catalán González (University of Cadiz)

Dehesa de Bolaños y Cortijo de Frías. Análisis histórico-arqueológico e interpretación de su paisaje en época romana.

Using Geographic Information Systems applied to the territory, the aim is to give an interpretation of the ancient landscape around the Dehesa de Bolaños and Cortijo de Frías, in the municipality of Jerez de la Frontera (Cádiz). To do this, a comparison will be made between the historical orthophotographs of the National Plan for Aerial Orthophotography and the use of new tools such as LiDAR sensors and their historical-archaeological visualization and interpretation models.

A partir del uso de los Sistemas de Información Geográfica aplicados al territorio, se pretende dar una interpretación del paisaje antiguo del entorno de la Dehesa de Bolaños y el Cortijo de Frías, en el término municipal de Jerez de la Frontera (Cádiz). Para ello, se realizará una comparativa entre las ortofotografías históricas del Plan Nacional de Ortofotografía Aérea y la utilización de nuevas herramientas tales como los sensores LiDAR y sus modelos de visualización e interpretación histórico-arqueológica.

Pierfrancesco Izzo (independent researcher) and **Giuseppina Renda** (University Campania Luigi Vanvitelli)

The Calore river: Settlements and Roads in the Roman Time

The study aims to present the results of a first territorial investigation along the lower valley of the Calore river, a tributary of the Volturno and privileged way for contacts to and from the hinterland, updating the state of the art and highlighting the centrality of this area to movement, regional and interregional.

Along the banks of the Calore river, there are numerous archaeological evidence, especially Roman, in close relationship with a new approach to the territory and in relation to nearby Telesia, in the municipality of San Salvatore Telesino (BN).

This vitality and the high degree of land exploitation are well exemplified by the numerous archaeological evidence that unfolds on the terraces overlooking the river valley and in particular in the territory of Solopaca, on the left bank of the river, where there are various attestations of rustic villas, often accompanied by plants for the production of wine and oil.

The use of the GIS software gave another perspective to the archaeological research of this area: mapping the archaeological sites and finds along the river valley allowed to evaluate the development of settlement over the time in this area.

Josep Maria Palet (ICAC), **Maria Jesús Ortega** (ICAC) and **Carme Miró** (Archaeological Service of Barcelona)

The territory of Roman Barcino: methodological advances applied to the study of a centuriated landscape

Landscape archaeology has greatly contributed to the advance of centuriation studies, which was the most characteristic way of structuring, dividing and squaring rural areas in the *ager* of ancient cities. However, during the last decades the study of centuriations has been considered a marginal discipline. This is largely due to the multiplication of unreliable studies on centuriations developed from the 70s to the 90s, some of which have been proved wrong by large-scale archaeological excavations. Nonetheless, the last decade has seen a revival of centuriation archaeomorphology-based studies that has helped putting this discipline 'back on the map'. Current research has adopted multidisciplinary approaches, which include archaeological survey, spatial analysis and palaeoenvironmental data. Environmental sources offer important insights on the effects a *deductio* had on the landscape. Environmental data applied to centuriation analysis show a complex relationship between Roman structuration systems, settlement and land-use. In addition to this, the incorporation of new digital methods and Geographic Information Systems (GIS), represents a major qualitative leap forward in terms of the planimetric accuracy of the restitution of field systems. They have meant an improvement of the quality and reliability of archaeomorphological analyses. These new methodological advances have been largely develop in the territory of Roman *Barcino* in which interpretation has moved from economic or materialistic approaches to more social and cultural focussed explanations. The results allow to reconsider centuriations under a new light and to enhance the conceptual dimensions of this form of territorialisation, identifying possible relationships between the city of *Barcino* and its territory, thus enhancing our comprehension of the *urbs-ager* dynamics during the Roman period.

Bartomeu Vallori Márquez (University of Barcelona - ERAAUB)

Rescue archaeology data and GIS redefining a classical town: the Roman city of Palma (Mallorca, Balearic Islands)

The modern city of Palma (Mallorca, Balearic Islands) has its origins in the Roman city cited by Pliny and Strabo, and lies beneath the city centre. Its remains have been partially known since centuries ago thanks to casual finds such as coins, pottery or surviving city walls. Throughout the 19th and 20th centuries some attempts have been made to propose an urban shape for the Ancient city: extension, street layout, city walls and different areas.

During the last 20 years, building works in many cities have lead to an equal increase of archaeological rescue excavations. In Palma, this new set of information is controlled by the Regional Government (Consell de Mallorca) and has a strong potentiality for the study of the Ancient city, sometimes helping to challenge previous hypotheses.

Thos old finds and these new ones have been gathered together and restudied recently, together with ancient cartography, architecture and written Medieval and Modern sources. All these elements have been introduced in a database, with their accurate coordinates, chronologies, and a reliability index, among other data. These elements are being managed spatially through a GIS project in order to map features such as different kinds of structures, site dispersion, palaeotopography, ancient hydrography and urban grid. One of the main points is to guarantee data transparency of any resulting graphic material. These maps will allow to reformulate previous hypotheses and to explore new possibilities concerning the extension of the Roman city, its limits, function of different areas, ancient topography and orography. This project has to be a first step, a strong starting point towards a myriad of possibilities concerning research and dissemination of cultural heritage.

Francesca Carinci (Sapienza University of Rome) and **Antonio Leopardi** (Università del Salento)

Modellazione e analisi dei geodati per la ricostruzione del paesaggio di Privernum (Priverno, Lazio, Italy)

La deduzione della colonia di *Privernum*, nel corso del II sec. a.C., segna il completamento del processo di romanizzazione del settore meridionale dell'area pontina.

La città era al centro di una conca intermontana, tra i rilievi calcarei dei Monti Lepini, Ausoni e Seiani, lungo un corridoio naturale di collegamento tra la valle Latina e la Pianura Pontina, quindi fra le grandi arterie - la via Latina e la via Appia - che, in età antica, univano Roma con la Campania. Il territorio ascrivibile a *Privernum* è caratterizzato da una varietà di contesti geomorfologici e da un complesso reticolo idrografico, con abbondante scorrimento sia superficiale che sotterraneo delle acque. Verso sud, la cosiddetta "duna rossa di Priverno", addossata alle propaggini dei Monti Seiani, digrada verso la Pianura Pontina in un settore caratterizzato da vaste aree depresse. I vari tentativi di bonifica che si sono succeduti nel corso dei secoli, dall'età romana ai nostri giorni, hanno comportato enormi cambiamenti nella rete idrografica, così come pesanti trasformazioni del territorio sono dovute alle attività di coltivazione di cava per inerti e alle miniere per l'estrazione di sabbia silicea, che hanno creato nette soluzioni di continuità tra le aree rilevate e quelle pianeggianti.

Al fine di comprendere le dinamiche di trasformazione del paesaggio privernate e proporre una rappresentazione del territorio in età romana, si è proceduto ad un'analisi degli aspetti ambientali e antropici mediante la trascrizione in ambiente GIS dei dati derivanti dalle diverse fonti della ricerca topografica (ricognizione di superficie, notizie d'archivio, cartografia storica, fotointerpretazione, indagini ecopedologiche e geologiche, etc.). In particolare, per far fronte all'eterogeneità delle informazioni e consentire una corretta interazione dei dati spaziali, la loro modellazione è stata avviata con l'individuazione di livelli di accuratezza quanto più simili ed elevati possibili – da intendere come differenza fra valore reale e quello riportato di una certa misura, in larga parte dipendente dalle scale e dai sistemi di rappresentazione impiegati

nelle diverse fonti – da utilizzare anche per la rappresentazione dei dati archeologici non acquisiti direttamente o con verifica sul campo. Per quanto concerne l'assetto idrografico, ad esempio, attraverso l'utilizzo incrociato di cartografia storica, fotointerpretazione e analisi pedologiche, è stato possibile interpretare e trascrivere le informazioni ad alta risoluzione, svincolando la geolocalizzazione e la restituzione della morfologia degli elementi dalle carte storiche – è il caso dei bacini lacustri della piana di Mezzagosto, dei laghi dei Gricilli e del palealveo del fiume Ufente.

Il contributo prova a fornire, quindi, una panoramica quanto più completa possibile dell'insieme dei geodataset prodotti, evidenziando il processo di acquisizione, modellazione e rappresentazione dei dati spaziali, anche nell'ottica della produzione di cartografie tematiche a più scale. A tal proposito, la tematizzazione dei dataset relativi ai dati archeologici è stata oggetto di un'attenzione particolare finalizzata ad una proposta di simbologia da adottare per i tipi editoriali della *Forma Italiae*.

Thomas Schattner (German Archaeological Institute)

Munigua (Villanueva del Río y Minas, Sevilla)

En la comunicación se pretende informar sobre este proyecto, que se está llevando a cabo actualmente en Munigua.

Después de más de 60 años de investigación en Munigua, se ha llegado a un punto que permite comprender y representar la ciudad en su conjunto y en su entorno. La combinación de datos epigráficos, arqueológicos y científicos da como resultado la imagen de una red diversa, variada y ramificada en la que la ciudad y sus habitantes estaban inseridos. La densidad de los datos es excepcional y tan grande que destaca a lo largo y ancho no solamente en el ámbito de las ciudades de la Bética. De esta manera, el pequeño municipio de Munigua adquiere un carácter modélico. Esta densidad de datos no sólo se limita al período romano. Con su fase turdetano-ibérica (s. IV-I a.C.), las fases romanas (s. II-I a.C. hasta s. IV/V d.C.) y la fase islámica (hasta el s. XII), el desarrollo diacrónico en su profundidad histórica de más de 1000 años se hace evidente.

Por lo tanto, la creación de una serie de mapas SIG en los que se fusionen los datos descritos anteriormente es un proyecto piloto. Sirve como modelo para el tema "conurbaciones", en el que el departamento de Madrid está centrando su investigación cada vez más según su plan de investigación y estará a disposición de todos los demás participantes en el proyecto. Además, está integrado en la plataforma DAI-Gazetteer del Instituto Arqueológico Alemán. Al almacenarse en: www.idai.geoserver como "Munigua-GIS" estarán a disposición del público general.

Gracias a las exhaustivas investigaciones en el terreno dirigidas a estudiar las bases económicas de la ciudad y también la reconstrucción en 3D, se ha realizado una gran cantidad de trabajo preliminar, tanto a pequeña como a gran escala. Además, podemos recurrir a un gran conjunto de mapas topográficos de Munigua y sus alrededores (60 x 80 km). Además de las propias fotografías del terreno, ortofotos, levantamientos por sfm y mucho más documentación en la propia zona de la ciudad, hay mapas Lidar y más material cartográfico de la Junta de Andalucía, que son de libre acceso y representan una base suficiente.

Al final, se crea un modelo en la medida en que todas las relaciones exteriores de la ciudad están representadas en el SIG y pueden ser descritas y examinadas en consecuencia. Dado que ninguna ciudad romana en Hispania o en el Imperio Romano dispone de fondos documentales tan extensos, el proyecto tiene un carácter piloto.

Dario Canino and **Alessandro Vecchione** (Sapienza University of Rome)

Peltuinum. City and landscape between tradition and new techniques

Peltuinum was a Roman city located in central Italy, approximately in the middle of a wide valley defined by the highest mountains of the Apennines. The first investigations of Sapienza University took place in the years 1983-85, then a new series excavations started in 2000 and since 2001, the excavations are carried out annually. The archaeological area is known above all for its monumental remains: the walls, the theatre and the sacred complex of the *forum*, these latter built around the second half of the first century BC, in the central-southern area of the plateau. In addition to public buildings, past archaeological investigations have enabled the recognition of various residential structures.

Within the broader archaeological project, a three-year research project (2016-2019) was carried out in order to collect aerial photogrammetric data regarding the walled city and the very first suburban area. The goal of this activity was highlighting new anomalies from aerial photography, exploiting the low cost digital technologies available and creating a three-dimensional hub capable of collecting and linking traditional archaeological documentation to 3D geometry.

From a digital data management point of view, the experience gained through this case study was particularly interesting and stimulating: the different work phases were shaped by several items such as the consistency of the data, the visualization and archiving workflows.

The heterogeneity of the formats recorded (RGB images, multispectral images, micro-relief analysis, DSM analysis) has led to the creation of web pages with multiple layers, in order to divide raw data, processed data, and traditional documentation. The visualization of them via 3DHop web tools, available also via mobile devices, had positive effects even during the data recording campaign in the field, since it allowed to compare the results of the different missions, to note any changes to be made and to highlight the traces observed on site.

Observing the landscape from a privileged point of view, such as the aerial one, and virtually modeling the archaeological structures excavated during the different annual excavation campaigns, gave us the chance to identify with more accuracy potential buried buildings, necropolises and several evidences relating to the city road system.

Furthermore, the possibility of merging aero-photogrammetric data with Lidar or SLAM dataset would allow in the near future to deepen the knowledge of those sectors that have slowly been reconquered by the wooded areas, significantly expanding the possibility of carrying out targeted investigations, even in areas that previously had not returned traces of anthropization on the surface.

The Navelli *plateau* (the area where the ancient city insisted) has always been characterized by a low population density with a strong agricultural vocation. This feature would facilitate the collection of very interesting data through this method of investigation, in order to understand the settlement dynamics of the area both in the ancient, Roman and pre-Roman ages, and during late antiquity.

Marc Ferrer Fernández (UB)*Las vías pecuarias medievales del Baix Montseny y el método del camino óptimo*

La comunicación tendrá dos objetivos. Primero, presentar un estudio sobre la probable adscripción altomedieval de las vías pecuarias tradicionales de la primera mitad del siglo XX del Baix Montseny (Cataluña). El segundo objetivo, es mostrar un análisis de la idoneidad del método de trazado del *camino de coste óptimos* en la reconstrucción de caminos de montaña a escala comarcal.

El área de estudio es la comarca natural del Baix Montseny (Cataluña) situada entre la provincia de Barcelona y Girona. El sector tiene una ocupación ininterrumpida desde el neolítico hasta nuestros días, siendo, por lo tanto, una buena zona para estudiar la continuidad en el uso de las vías de comunicación tradicionales. Otro aspecto destacable es la orografía de la comarca; con un fuerte desnivel de más de 1500 metros, presenta una clara dicotomía entre el llano y el monte, lo que permite poner a prueba el método del *camino de coste óptimo* en un relieve complejo.

Las principales vías pecuarias catalanas van de los pastos de invierno, normalmente en el Pirineo, a los pastos de verano situados a la costa y el Prelitoral. En el Baix Montseny es cruzado por tres cañadas destacables; el camino de Sant Elies, la carrerada de Viladrau a Hortsavinyà y el camino de la Marina. Estas carreradas jugaron un importante papel en la articulación del territorio ya en la antigüedad y la alta edad media; siendo utilizadas muy probablemente para uso ganadero, pero también como vías de comunicación regional. Una afirmación que queda respaldada por el análisis de los mapas resultantes de superponer los yacimientos de la región junto a los trazados de las vías pecuarias.

El método de trazado de los *caminos de coste óptimo* parte de la premisa de que si una persona dispone de un número determinado de caminos para ir a un punto y no hay efectos externos que se lo impida, elegirá siempre el camino más corto y con menos desgaste. El método se basa en aplicar un algoritmo para buscar redes de drenaje sobre un mapa de costes acumulativos de

desplazamiento. El método del *camino de coste óptimo* es utilizado en estudios geográficos para encontrar corredores naturales de paso de animales en la actualidad; pero también se ha utilizado en la arqueología para restituir vías de comunicación antiguas y prehistóricas. La comunicación valorará la idoneidad de este método en estudios a escala comarcal y en una región montañosa, a partir de la comparación entre los trazados teóricos realizados con el método del *camino de coste óptimo* y los trazados de las cañadas tradicionales.

Marçal Díaz Ros (UB)*Factors de localització de les comunitats monàstiques del Penedès medieval*

Les fonts bibliogràfiques i documentals permeten localitzar per l'àmbit del Penedès històric (ARNABAT 2014) un total de vint-i-dues comunitats monàstiques entre els segles X i XIII. Els cenobis registrats són de tipologia variada, incloent cel·les dependents del monestir de Sant Cugat del Vallès, priorats benedictins de fundació senyorial, comandes hospitaleres i abadies urbanes.

Prenent la proposta de Jordi Bolòs (2004) sobre els diferents factors que poden condicionar la localització d'un assentament, s'ha dut a terme una anàlisi espacial sobre la realitat monàstica penedesenca. La metodologia d'anàlisi s'ha fixat tenint en compte experiències prèvies d'altres investigadors (Bosch 2017; Fernández 2019; Negre 2013) i aplicant les eines que ofereixen els Sistemes d'Informació Geogràfica. L'ús de dades històriques facilitades per treballs de recerca previs (BATET 1996; BOSCH 2017; VIVES 2007) així com la utilització de dades actuals, ha permès delimitar l'entorn més immediat i accessible de cada cenobi calculant l'àrea de captació de recursos.

Aquest àrea, tot i les seves limitacions teòriques i metodològiques, ha estat considerada com l'espai d'anàlisi adient per aproximar-se als factors de localització dels diferents assentaments. Dins d'aquest àmbit s'ha dut a terme un estudi de la morfologia del terreny per determinar el grau d'accessibilitat i capacitat defensiva dels assentaments, així com la potencialitat agrícola del territori que els envoltava. Sobrepasant l'abast de l'àrea de captació de recursos, també s'han tingut en compte les característiques hidrogràfiques i hidrològiques de la zona i la connectivitat dels cenobis amb la xarxa viària.

Els resultats de la recerca han estat expressats mitjançant taules estadístiques i cartografia temàtica que han permès combinar una doble visió històrica i geogràfica sobre la realitat monàstica del Penedès medieval.

Els resultats de la recerca cal emmarcar-los en el procés de realització de la tesi doctoral *Poblament i assentaments al Penedès (segles X-XIII)* realitzada pel mateix autor i dirigida per les doctores Marta Sancho i Maria Soler del

departament d'Història i Arqueologia de la Universitat de Barcelona. Aquesta investigació ha estat finançada mitjançant un *Ajut per a la contractació de personal investigador FI* concedit per l'AGAUR i s'inclou dins del projecte de recerca *Muntanya viva: assentaments, recursos i paisatges a la Catalunya medieval (segles IV-XIII)* [CLT009/18/00041].

Marco Moderato (University of Chieti–Pescara)

Integrating historical cartography, written accounts and satellite images for the reconstruction of past landscapes: the case of Madayi (Kerala, India)

The coasts of Southern India have historically been the center of an important commercial network that brought the West (and the Mediterranean) into contact with the Far East. After the fall of the Roman Empire, other commercial actors came into play and Arab and Jewish merchants began to travel the ‘Western’ routes, as attested by written sources at least starting from the IX century AD.

In this context, the archaeological surveys campaign, conducted in Madayipara (Kannur District, Kerala) have shown evidence of a complex network of settlement in the delta of the Taliparamba and Kuppam river which is almost disappeared nowadays; also, natural landscape has changed over time, as the coastline slowly advanced and the rivers changed their courses and their function as well. Traces of this hub or entrepot can be found in the rich body of historical sources and cartography of the region, which suggests the presence of lively ports often associated with Jewish and Muslim communities as well as in later maps drawn by European explorers. The historical sources together with the satellite imagery and the results from the archeological surveys can help us reconstruct a complex settlement pattern, fully embedded in the trade networks of the medieval Indian Ocean.