

An aerial photograph of a river delta, likely the Nile, showing intricate branching waterways and sediment patterns. A semi-transparent blue overlay covers the top half of the image, serving as a background for the title text.

NEW TECHNOLOGIES AND RENAISSANCE STUDIES IV:

THE CHANGING SHAPE OF DIGITAL EARLY MODERN STUDIES

Edited by Randa El Khatib and Caroline Winter

New Technologies and Renaissance Studies IV

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Studies IV:
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Modern Studies

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Contents

Introduction: The Changing Shape of Digital Early Modern Studies <i>Randa El Khatib and Caroline Winter</i>	1
1. Visualizing the Sidney Network: Using Network Analysis to Understand Women’s Place <i>Catherine Medici</i>	15
2. Print Networks of Early Modern Astronomy in Galileo’s Library <i>Crystal Hall</i>	35
3. The Republic of Tweets <i>Jessica Marie Otis</i>	61
4. Opening Up the Scriptorium: The Theory and Ethics of Transcription Methods from the Handwritten Page to the Web Page <i>Sarah Banschbach Valles and Sarah J. Sprouse</i>	85
5. New Solutions for Old Problems: Digital Publication, the Linguistic Study of Medieval Vernacular Texts, and the EDV Project <i>Nadia Cannata</i>	109
6. Moving Images and Text on Leonardo’s Codices: The Evolution of Drawing a Digital Edition <i>Giuditta Cirnigliaro</i>	127
7. FRIDA: A Multilevel Digital Atlas for the Ephemeral Renaissance, La Serenissima Venice, 1450–1550 <i>Francesca Bortoletti, Giuseppe Gerbino, Paolo Ciuccarelli, Beatrice Gobbo, and Tommaso Elli</i>	149
8. “Dear Galileo”: Letters as Data on Astronomy <i>Caterina Agostini</i>	197
9. Penelope Rich: Mapping the Mobility of a Sixteenth-Century Aristocratic Woman <i>Gerit Quealy</i>	227

10. GEA: Invisible Sieneese Women Made Visible
Elena Brizio and Luis Meneses 261

11. Beyond a Digital Catalog: Rethinking Musical and Cartographic Sources through Digital Humanities
Angela Fiore and Sara Belotti 279

12. Interacting with Big Historical Data of the Dutch Golden Age: Golden Agents and Virtual Interiors
Charles van den Heuvel 307

13. Northeye (Re)Constructed: Augmented Reality of an Abandoned Medieval Village
Steven Bednarski, T. C. Nicholas Graham, Robin Harrap, Zack MacDonald, and Andrew Moore 341

14. The Place of Reading in VR: Pedagogy, Spenser’s Kilcolman Castle, and Amoretti 65
Thomas Herron 381

15. Designing an Educational Video Game for Shakespeare’s *Hamlet*
John Misak and Kevin LaGrandeur 397

16. Does the *kunstammer* Need a Digital Future?
Andrea M. Gáldy 423

Contributors 447

Chapter 11: Beyond a Digital Catalog: Rethinking Musical and Cartographic Sources through Digital Humanities

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The House of Este was a princely dynasty that played a great part in the history of Renaissance Italy. Ferrara, the first seat of the family, became a significant center of culture thanks to Este patronage (Durante and Martelotti 2005; Lockwood 1984). The family included several patrons of music; in particular, Leonello, Ercole I, and Alfonso II made Ferrara one of the greatest laboratories of musical experimentation of Italy's Renaissance.¹ In 1598, the Papal States, ruled by Clement VIII, came into possession of Ferrara, and following the "Conventions of Faenza," the Este were forced to quickly move to Modena, the duchy's second most important city. The entire cultural heritage of the Este family—consisting of illuminated codices, fine sixteenth-century books, works of art, instruments, and musical manuscripts—was consequently transported in a hurry during the dramatic days of the court's relocation.² Following the transfer and the new arrangement of the court, attempts were made to replicate Ferrara's former artistic and musical splendor in the Este's new capital. During the seventeenth century, the three succeeding dukes of Modena—Cesare I, Francesco I, and Francesco II—contributed to the cultural and musical development of the city. The court entertained various relationships with some city institutions, contributing to the cultural growth of the city. However, it was during the reign of Francesco II d'Este,

¹ In particular, the interest of Alfonso II for the music and above all for the madrigal was realized not only in financing the publication of musical works but also in the establishment of musical ensembles, including the famous Concerto delle Dame Principalissime.

² This event is known as the "devolution of Ferrara." After the death of Duke Alfonso II, who left no direct heir, the pope did not renew the investiture of the feud of Ferrara to the Este, and it therefore returned to the Papal States. The transfer of the court, led by the new Duke Cesare, took place on the eve of 29 January 1598.

the tenth duke of Modena and Reggio Emilia from 1674 to 1694, that the city's cultural splendor reached its peak.³

Francesco II promoted extensive cultural initiatives in the city, including the renewal of the university, the activities of literary academies, the continuation of artistic and architectural works in the Palazzo Ducale, and the reorganization of the ducal library. The ducal court welcomed new musical genres and forms under the cultural stimulus of Francesco II: oratorios, operas, and cantatas by the leading composers of the time, such as Alessandro Stradella, Alessandro Scarlatti, Giovanni Bononcini, Bernardo Pasquini, and Alessandro Melani, were performed in Modena.⁴ In particular, from the mid-seventeenth century, several theaters in the city also began to host opera performances, offering a busy, high-quality calendar of events supported by the court. With the investiture of Modena as the capital of the Este duchy, we see not only a cultural and musical development but also a process of urban renewal to give the city an aspect more suited to its new function.

The musical history of this city and its urban evolution are attested today by the music and cartographic collections kept at Modena's Estense Library (Biblioteca Estense Universitaria). While the music collection of the Estense Library testifies how, over the centuries, the Este dukes were generous patrons of music, the cartographic collection shows how the Este court saw the world outside the duchy, thus describing the cultural landscape and interactions with other geographical and cultural contexts. Their differences notwithstanding, the two collections contain common elements concerning the history of Modena, and their comparative study aids our understanding of the urban and cultural evolution of the city.

This chapter describes how our study, initially dedicated to the cataloging and digitization of sources, has given rise to the creation of a digital project dedicated to the reconstruction of the historical soundscape of early modern Modena. As we will explain, the digital tools applied to this historical research could be useful in demonstrating significant relationships between

³ Francesco I was succeeded by Alfonso IV. Following Alfonso IV's death in 1662, the heir to the throne, Francesco II, was only two years old, and Alfonso IV's widow, Laura Martinozzi, took charge of the duchy's governance. Laura Martinozzi's reign ended in 1674 when her son Francesco II regained power by conspiring against her.

⁴ Duke Francesco II had a special admiration for Stradella's musical works and collected his compositions even after the musician's death. Thanks to the Este sovereign, about half of Stradella's musical productions are now preserved in the Estense Library music collection (Gianturco 1983).

data coming from different types of sources and helpful in outlining the process of construction of the sound of a ducal city during the seventeenth century. Therefore, we will show the genesis and the structure of the Este Soundscape project, an online platform dedicated to the reconstruction of the historical soundscape of seventeenth-century Modena. Thanks to the use of state-of-the-art web development tools and geographic information systems (GIS), the platform will feature an interactive search and navigation environment, plus an interactive map with geo-localized objects and events. This will offer new points of view to study a city and its historical and spectacular development.

The Este Heritage

The Biblioteca Estense Universitaria is one of the most important European libraries linked to the history of a princely family. It was, in fact, established by the House of Este in the fifteenth century in Ferrara, Italy, and was subsequently transferred to Modena in the seventeenth century. Throughout the Renaissance and in the following centuries, the Estense Library continued to expand its collection of both local and international materials, including holdings acquired through the suppression of religious orders in Italy and through the bequests of celebrated librarians such as Ludovico Antonio Muratori and Girolamo Tiraboschi. The library moved to its current location at the Palazzo dei Musei in 1882 and became part of the new Gallerie Estensi in 2016. Today, the Estense Library's collections consist of numerous noteworthy manuscripts, illuminated codices, precious printed editions and incunabula, ancient maps, and musical sources.

The Este Digital Heritage project began in 2018 and focused on the creation of the Estense Digital Library (edl.cultura.gov.it), an online digital repository dedicated to the enhancement of the Este manuscript collections. The project is the result of a collaboration between Gallerie Estensi, the Fondazione di Modena, and the University of Modena and Reggio Emilia. Today, the digital library lets us benefit from an important documentary resource by offering the possibility of comparing and annotating over 700,000 pages of manuscripts preserved at the Estense Library. The platform is based on the International Image Interoperability Framework (IIIF), a protocol for standardized image retrieval created by a community of the world's leading research libraries and image repositories (iiif.io). Through this technological tool, high-definition images of the rare manuscripts, maps, and musical sources in the Estense Digital Library can be edited, freely annotated, compared with others, and shared. Furthermore, as we will explain in the following pages,

the study and cataloging of this heritage has fostered the creation of a digital platform dedicated to the two most important collections of the Estense Library: the musical sources and the cartographic collection.

The Music Collection and Its Urban Meanings

Toward the mid-seventeenth century, Modena effectively became one of the music capitals of Italy. The city turned into a repository of innovations and artistic trends supported by an enlightened court that was surprisingly sensitive to the musical ferment of the baroque period. Social life in Modena gradually became entwined with art music. The city's physical locations participated in the evolution of musical language, influencing the ways in which music was produced, performed, and listened to. Musical sources produced and collected by the House of Este between the mid-fifteenth and mid-nineteenth centuries form one of the most prestigious Italian music collections today. The study of this collection also helps us reconstruct the city's historical soundscape: in fact, certain sources bear witness to the various sonic experiences in which the court and the city participated.

The collection owes a lot especially to Francesco II: the duke felt compelled to collect and commission music for his own leisure and practice as well as for entertainment at court. The Estense Library today preserves sources related to the musical events commissioned by Duke Francesco II and organized at the court or city's institutions. As an essential part of court life, music accompanied the duke's daily devotional activities as well as extraordinary or dynastic ceremonies, which were often organized in the city's churches. One of the most notable sacred institutions was the Oratorio di San Carlo Rotondo, a place of worship for the Theatine congregation of San Carlo, destined to become a notable center of music production. Built in 1634, the institution hosted the oratorial performances commissioned by Duke Francesco II during Lent.⁵ Oratorios took root in Modena thanks to the work of the congregation of San Carlo and Francesco II's personal interest in these compositions. The Estense Library today includes about 80 oratorios relating to the seventeenth century and produced in Modena between 1680 and 1691.⁶

The presence of a ducal theater was an essential requirement for the social life of a duchy's capital. From the mid-seventeenth century, several theaters in the city began to host opera performances, offering a busy and

⁵ The oratorio was named *Rotondo* (round) in reference to its octagonal design.

⁶ Oratorios were brought to Emilia from Rome by the Philippine Fathers, who originated this genre (see Crowther 1992).

high-quality calendar of events. Scores and libretti of the court's brilliant operatic activity can be found in the collection. Furthermore, sources in the Estense Library also appear to testify to a more intimate and sophisticated musical practice at court: the sounds that accompanied the everyday life of the Este court, in line with the official culture of the Italian courts, consisted of high-quality musical production that coexisted with forms of art inspired by popular culture.⁷ The genre of *cantata da camera* is associated with this "reserved" context. The cantata was particularly suitable for performances in the interior spaces of noble palaces, featuring, as it did, poetic and eulogistic texts sometimes written by the nobles themselves. Francesco II was obsessed with this musical genre, as evidenced by the disproportionately large number of cantata anthologies in the Este collection compared to other genres. In fact, around 300 miscellaneous volumes of cantatas have been preserved: some volumes contain just a few dozen pieces; others comprise hundreds. Intended for a select audience of connoisseurs, chamber cantatas became a significant part of Francesco II's cultural agenda, partly thanks to the activities of the literary academies, in particular the *Accademia de' Dissonanti*. Founded in 1683, the *Accademia* was a place for cultural exchange between artists, musicians, and poets.⁸

The Estense Library also contains sources related to the outdoor events that characterized the streets and squares of the Duchy of Este's capital. Spectacular feasts included musical accompaniment by mainly wind and percussion instruments such as trumpets, fifes, and drums. Musicians were tasked with filling the streets and squares with sound preceding a procession, emphasizing every ritual and involving the urban fabric.

However, the present collection only partly corresponds to the House of Este's former musical repository. Between the eighteenth and nineteenth centuries, the original corpus was joined by other important assortments of music from foreign collections, bequests, and donations. The largest of these is the collection of the Electoral Prince of Cologne and Archbishop of Bonn

⁷ The Este music collection also encompasses anthologies of dances, arias, and songs of folk tradition, as well as a large number of madrigals and various forms of poetry for music, which interweave poetry, music, and literature.

⁸ The history of the foundation of the *Accademia de' Dissonanti* is somewhat controversial and debated. It is not clear what role Francesco II played in its creation: the duke probably merely supported its establishment. The repertoire dedicated to this institution mostly consisted of cantatas or *accademie* for vocal soloists and basso continuo with one or more obligato instruments. The texts were part of the academic poetry that aimed to glorify the prestige of the Este family (Jander 1975).

Maximilian Franz of Habsburg. The collection arrived in Modena after the unification of Italy in 1861. Maximilian Franz's collection contains sacred, instrumental, and operatic music from the late eighteenth century, mostly by German, French, Austrian, and Bohemian composers such as Carl Philip Emanuel, Johann Christian Bach, Franz Joseph Haydn, Wolfgang Amadeus Mozart, Josef Myslivecek, Christoph Willibald Gluck, and André Grétry.⁹

Today, the music collection of the Estense Library is therefore the result of the aggregation of multiple groups of musical sources, which arrived in Modena in different periods. Only a part of it is identifiable with the ancient music collection set up by the dukes of Este over the centuries. Over time, the lack of a unique catalog has hindered the understanding of the different aggregation phases of the collection. During the nineteenth century, various inventories and catalogs were made of the collection, their completeness and usefulness depending on the aims of the individual compiler.¹⁰ Hence, our study conducted on musical sources aims at clarifying the formation process of this important collection. At the same time, the digitization and cataloging of sources will organize this heritage collection and make it publicly accessible.

The Cartographic Collection

The cartographic collection of the Estense Library of Modena consists of documents produced between the fifteenth and early twentieth centuries,

⁹ Other important groups of music sources present in the Este collection include the music collection of the brothers Luigi, Giovanni, and Bonifazio Asioli; the collection of "fragments," loose parts missing an attribution; the music collection of the marquis Campori; and the music collection of the noble family Forni, recently donated to the Estense Library.

¹⁰ Over time, numerous attempts to reorganize the musical collection by the librarians of the Estense were made. The first inventory, drawn up around 1750, is due to Giovanni Antonio Panelli and Pellegrino Loschi. In 1816, Giovanni Battista dell'Olio compiled a new catalog dedicated to manuscripts and prints, followed by the inventories of Federico Röther and the musicologist Angelo Catelani. However, the above-mentioned catalogs exclude the music collections added to the Estense library later. A more complete examination of the Estense collection and its late aggregations arrived in 1892 with Alessandro Giuseppe Spinelli's handwritten *Catalogo alfabetico descrittivo della Raccolta musicale estense*. Currently, the catalog in use was written by Pio Lodi and published in 1926. It is the most complete among the others at our disposal, even though it excludes several groups of sources. Finally, the more recent reorganization and indexing work carried out by Alessandra Chiarelli should be cited (Chiarelli 1987).

characterized by the presence of some rare handwritten documents of ancient copper engravings and more modern prints. The temporal extension of these documents allows us to appreciate the change in the cartographic technique. At the same time, the collection shows the different visions of the world that have characterized the past centuries.

The current collection had a slow constitution: born from the Este family's interest in geography, it continued to grow, in more recent years, with donations from private libraries of some important Modenese families. As early as the fourteenth century, works of famous travelers such as Marco Polo and Mandeville enriched the Este family's library, as did the great novels of chivalry that narrated imaginary journeys around the world written by Ludovico Ariosto, Matteo Maria Boiardo, and other illustrious authors (Donattini 2000). Subsequently, the geographical horizon progressively widened thanks to the practice of pilgrimage, starting with the one organized by Niccolò III d'Este in the Holy Land in 1413 for both religious and political purposes. In the same period, explorations across the oceans started. This gave rise to an important process of redefining space that aroused interest in European courts, including that of Ferrara, for the opening of new trade routes and the traffic of new raw materials.

The Estense Library preserves numerous cartographical treatises. Among them is a famous copy of the *Geografia di Tolomeo*,¹¹ dedicated to Borso d'Este in 1466 (Bertoni 1903). Other cartographic works of inestimable value are the *Mappamondo catalano estense* (1450–60) and the *Carta del Cantino* (1502), one of the first representations of the American coast. The Este family's interest in geography represents a particularly important means of facing the challenge of Ferrara's spatial and political marginality,¹² since these maps summarize the information brought to Europe by explorers, navigators, and markets, which was useful in establishing new trade agreements and alliances (Salmson and Moretti 1984).

¹¹ It is a richly decorated, handwritten reproduction of the treatise written in Greek by Claudius Ptolemy in Alexandria around 150 CE. It was translated into Latin in 1406 and was highly influential on the geographical knowledge and cartographic traditions of Renaissance Europe.

¹² After the opening of new trade routes through the oceans (thanks to the impulse of the Portuguese Prince Henry the Navigator), the Mediterranean Sea lost its central role in trade, the Mediterranean courts were thrown into crisis, and the world balance was changed.

In 1859, due to riots unleashed by the arrival in Modena of the army of King Vittorio Emanuele II, some documents were stolen from the library and disappeared. The *Mappamondo catalano estense* and the *Carta del Cantino*, for example, were only found 11 years later by the Modenese collector Giuseppe Boni, who donated them to the Estense Library (Milano 1991; Milano and Battini 1995). Then, the annexation of the Este Duchy to the Kingdom of Sardinia in 1860 marked a new phase for the library; in this period, the collection of geographical maps expanded thanks to numerous donations from several Modenese noble families. Due to these events, the maps of the Estense Library are now included in various catalogs. The main one is the *Inventario dei portolani, carte nautiche e geografiche della R. Biblioteca Estense*, transcribed in 1892 by Clemente Lazzarini, a single list relating to all the maps owned by the library up to the unification of Italy.¹³

Besides this, there are catalogs of the collections donated, acquired, or purchased by the library. Among them, the most notable is the map collection of the Modenese nobleman Giuseppe Campori. Deposited in the library in 1893, the collection contains few, but unique, manuscripts of nautical cartography of the seventeenth century as well as some handwritten atlases. In 1920, the Estense Library map collection increased with the collection donated by Chiffredo Hugues, a Modenese intellectual. The Hugues collection preserves over 100 topographic maps and city plans, mainly from the nineteenth century produced by the main topographic institutes of the time, such as the Royal Austrian Military Geographical Institute and the Italian Geographical Military Institute. After about 20 years, between 1945 and 1946, the collection of Antonio Bertacchini-Mattioli enriched the Estense Library: it is based on 18 maps produced in the second half of the nineteenth century, some printed in Gotha (Germany) by Justus Perthes, a famous publishing house of geographical maps of the time.

In 2007, the collection of the Forni family was added to the Estense Library. The history of this collection begins with the Modenese cleric Matteo Paggiaroli (1716–77), who in the first half of the eighteenth century formed a rich library; later, it passed to the Forni counts by inheritance and over time expanded with new accessions until it was donated to the Estense Library. The Forni's collection holds several geographical maps, divided into two groups. The first consists of four albums bound in 1834 by Francesco Vignoli:

¹³ No previous catalogs are present today in the Estense Library; only some sporadic lists of the maps can be found. This situation does not make it easy to reconstruct the original nucleus of the collection.

it contains over 200 maps produced by various cartographers between the eighteenth and nineteenth centuries. The second group consists mainly of topographic maps, plans, and city views made in the nineteenth century.¹⁴

Over time, these donations were also accompanied by important purchases, including the Pio Falcò di Savoia collection, containing a dozen maps produced between the end of the seventeenth and the beginning of the nineteenth century.¹⁵ Another excellent purchase by the Ministry for Cultural Heritage and Activities in 2000 is the *Planisfero Castiglioni*, created in 1525. According to tradition, the Planisphere was donated as a sign of benevolence by the Emperor Charles V to Baldassarre Castiglioni, a talented military man and man of letters and the apostolic nuncio to Spain. This Planisphere is one of the most important documents currently owned by the Estense Library. It represents an example of the so-called *Padrón Real*, a secret Spanish master map.¹⁶

Finally, two series of maps are also part of the Estense cartographic heritage: the *Piante di Modena e dello Stato*, in which about 30 maps of the city and province have been grouped, and the *Serie Atlantica*, containing about 60 maps from different parts of the world, both created between the eighteenth and nineteenth centuries by various authors, including Guillaume De L'Isle. Overall, the collection now includes about 1,000 maps in loose sheets and numerous atlases, including those of Gerhard Kremer and the Blaeu family.¹⁷

Considering the richness and heterogeneity of the material present in the Estense Library, the project started in 2018 to create the Estense Digital Library was focused in particular on cartography in loose sheets. The aim was to prepare a unique inventory of the maps owned by the Estense Library with a descriptive entry for each map. A unique, digital catalog now provides users today with a better knowledge of and accessibility to this important heritage.

¹⁴ This part of the collection is currently being cataloged and has only been partially digitized.

¹⁵ The Pio Falcò di Savoia collection was purchased by the Italian Ministry for Cultural Heritage and Activities (Ministero per i Beni e le Attività Culturali, MiBAC) and then gifted to the Estense Library in 2001.

¹⁶ The *Padrón Real* map was constantly updated based on the news that came from exploration trips. It was jealously guarded by the Spanish crown to avoid commercial espionage.

¹⁷ Gherard Kremer (Gerardus Mercator) was a geographer and cartographer who introduced the use of the term *atlas* for a collection of maps. The Blaeu family ran a famous workshop of maps and globes in Flanders.

Investigating the Historical Soundscape

The study and cataloging that we have conducted on these collections has permitted us to read these sources from a wide-ranging perspective. Comparing musical manuscripts, historical maps, and archival sources is particularly useful for grasping the multiform connections between court, city, and territory, offering many details in the complex relationships between sound and space within the urban context. Therefore, our idea has been to fully exploit the potential of digital humanities and to go beyond the simple digitization of sources.

Despite the digitization of a large number of sources, the use that libraries, archives, and museums make of their digital heritage still very often follows the model of the printed catalog, enriched with some interactive functionality. However, digital humanities offer many more opportunities to use cataloging data for research purposes. Unfortunately, digital cataloging projects supported by the libraries themselves often do not include related research projects. To take full advantage of digital resources it is necessary to rethink their ways of use that can allow us to access metadata with a view to *knowledge-sharing*—that is, the means to provide and propose a contextualization of content, documents, and their relationships beyond the simple availability of data and digital objects. In particular, the comparison and cross-referencing of data through new display modes offer the opportunity to highlight the existence of networks and relationships that cannot otherwise be analyzed. Thanks to information technology (IT) tools, we can therefore improve multidisciplinary research and propose different ways of communicating and interacting.¹⁸ In this sense, our project permits users to access the data of musical and cartographic sources and at the same time to discover places, institutions, and events that led Modena to become a center of music production.

Reading and interpreting places and spaces through the sound production that took place in them constitutes a point of confluence between musicology and geography (Giuriati 2015, 115). Sound, indeed, can be interpreted as a form of knowledge of the environment around us. The music itself has

¹⁸ The cataloging promoted by the Estense Library has led to the creation of a digital library, where today the metadata of the cataloged objects are freely accessible. The digitized materials are not downloadable but only viewable. On the other hand, the Este Soundscape project proposes a different reading of these data, allowing the comparison between apparently different sources that belong to the same context.

helped to define the identity of a place, influencing in some cases its architecture (Dell’Agnese and Tabusi 2016; Rocca 2013). Often, sound production has influenced the architectural features of environments (e.g., theaters, churches, and concert halls); conversely, the performance practice of a city has sometimes contributed to the creation of urban spaces (e.g., squares, parks, and public gardens) suitable to host festive occasions. In this sense, sound has been one of the essential components in the development of city spaces.¹⁹ Even in the course of history, musical production has been conditioned by the place for which and in which it was performed (Knighton and Mazuela-Anguita 2018). At the same time, the city represents a privileged environment for musical creation, showing through its history the complex network of institutional relationships that made it possible; the methods of circulation of music, sources, and genres; and the social status and mobility of musicians (Bombi, Carreras, and Marín 2005, 18).

In the Estense context, an analysis of the different types of music production gives us an understanding of how city spaces cannot be considered simple places: they allow us to identify times, ceremonies, and spontaneous practices; perception skills; and a culture of performance and listening. While the Modenese cartographic resources allow us to observe the changes in the territory and in the urban landscape, the Estense musical sources tell us how that same territory produced music. The comparative study of these sources made possible through digital technology help to demonstrate how musical sources can be interpreted as a product of the interaction between court and city, since they are proof of the musical production and practices of some city institutions (e.g., the Oratorio di San Carlo Rotondo, the Accademia de’ Dissonanti, and certain theaters in the city). Musical and cartographic sources also

¹⁹ Music has always had a political and social significance, influencing and enriching the scenarios in which it was produced. Sometimes the construction of music venues has had a symbolic meaning, as illustrated, for example, in Woolf’s (1988) discussion of the pivotal position of the opera house in the reconstruction of nineteenth-century Paris and its role as a locus of diplomatic activity, as analyzed by Everist (2021). Our project aims at analyzing the historical soundscape of Modena from this perspective, considering the music not only as a merely artistic activity but also as a social, political, and cultural activity. Studying the musical activities of the various institutions in Modena has enabled us to understand the extent to which music has been a central part of the city’s culture and has contributed to the development of its sonic identity over the centuries. In this sense, external sounds not strictly related to musical production (i.e., not traceable through scores or historical sources) have not been considered in the reconstruction of the historical soundscape.

tell us about spectacular outdoor events that involved both the court and the city. The open spaces of Modena's squares and streets were often the settings for masquerades, tournaments, and jousting matches, featuring floats and theatrical performances. These occasions were not only intended as a means of celebrating an anniversary, entertaining the court and the people, or organizing cultural events but were also excellent opportunities for dukes to demonstrate the magnificence of the court. In the late seventeenth century, the music of the Este family in Modena thus became a social art designed to be displayed and used as a tool for building consensus and publicly affirming the prince's power.

The Digital Project

The Este Soundscape project will create a digital platform through which to reconstruct and explore the sounds, places, events, and people who contributed to the creation of a city's musical identity. The online platform, which is currently under construction, will enable the user to explore and see the urban landscape of early modern Modena, to hear the sounds and music of this city, to access resources dedicated to different sonic events, to read musical sources, and to have data about the context of their production.²⁰ Thanks to the use of state-of-the-art web development tools and GIS,²¹ the platform will feature an interactive search and navigation environment, plus an interactive map with geo-localized objects and events. The chronological period considered by the project is the seventeenth century; it is in fact in this century that Modena becomes a first-rate cultural center and creates its "sound identity."

The "Este Soundscape" Cartographic System

Among digital tools, cartographic supports can contribute to new data visualizations, thanks to the development of numerous mapping tools and GIS. Territorial information systems allow users to acquire, store, organize, catalog, modify, re-elaborate, integrate, and return data concerning phenomena that take place in the territory. The structure of these systems, based on

²⁰ Initially conceived at the Interdepartmental Research Center on Digital Humanities, University of Modena and Reggio Emilia, the project is currently being developed independently by the authors.

²¹ A geographic information system (GIS) is a computer system that analyzes and displays geographically referenced information. Among the GIS applications currently available for use in this project is QGIS (qgis.org), a free and open-source cross-platform desktop GIS.

a database, is associated with geographic information (i.e., coordinates) for the georeferencing²² of the data. A GIS uses a logical model that subdivides the elements (streets, buildings, rivers, land uses, administrative boundaries, etc.) into superimposed layers with numerous technical and data management benefits, allowing simultaneous queries on the various information levels and extraction of information based on their positioning (e.g., count of elements in a specific area, selection of elements based on the distance to another element) (Fea and Loret 2010).

The use of GIS, which began in the 1960s mainly in public administration or in the field of earth sciences, has progressively spread to numerous sectors, including archaeology, cultural heritage, and marketing. Considerable success can also be found in the application of GIS to historical analysis. In fact, GIS tools are useful not only for the creation of maps but also for the extrapolation and reworking of information relating to a particular territory in various historical phases, allowing one to detect its changes in time (Vagnini 2010).

These tools can also be used in various disciplinary fields interested in urban history, such as musicology. Cartographic tools, facilitating the visualization of places, institutions, urban areas, and paths affected by the musical activities of a city, allow us to investigate, through a wide-ranging perspective, the sound landscape of cities and “place identity” more generally. Constituting the cornerstone of numerous social and cultural activities, with their social and cultural resources, cities have been a prerequisite for the growth of music production.

Digital cartography, with the support of the latest digital tools, such as GIS, enables observation of changes in the local area, for example by superimposing historical maps on satellite images. For musicological research purposes, cartography is very useful for locating music production centers within the urban context, improving knowledge of places and music production and dissemination methods. Above all, it is useful for understanding how geographical areas and musical expression have interacted with and influenced each other. Starting from this assumption, the fulcrum of the Este Sound-scape project is the presence of an interactive map within the platform. The map, as we will see in the following pages, will allow users to identify the musical centers of early modern Modena, to carry out advanced searches, to

²² The term *georeferencing* is commonly used in the field of geographic information systems to describe the process of associating elements represented on a map with spatial coordinates, thus locating digital data in the real world.

filter the data, and to view the insights through pop-ups and hypertext. For the creation of the digital map, the Google satellite web mapping service was used as a basis onto which a historical map of the collection of the Estense Library was superimposed.

The map chosen is an eighteenth-century reproduction of the famous 1684 map by Giovan Battista Boccabadati,²³ made by Domenico Vandelli.²⁴ The representation shows both the above-ground Modena, with plan drawings of buildings and streets, as well as the underground Modena, with its canals and drains already partially buried. This detailed map points out the *forma urbis* of the city after changes that occurred in the sixteenth and seventeenth centuries, including the Herculean addition, the Citadel of Castellamonte and the Palazzo Ducale.²⁵ Modena maintained this structure until the end of the eighteenth century, when various interventions, promoted by both Francesco III and his son Ercole III, completely modified the urban aspect (Bertuzzi 2001). Therefore, Vandelli's map describes the city in detail, and it is particularly suitable for our project because it permits us to identify

²³ Giovan Battista Boccabadati (1635–96) was a lawyer who was also involved in mathematical and scientific studies. In 1671 he was appointed court librarian by Duke Francesco II, and in 1681 the duke appointed him court engineer. In 1684 he was commissioned by the Municipality of Modena to create a map of the city. The original map of Giovan Battista Boccabadati is today preserved in the Archivio Storico del Comune di Modena.

²⁴ Domenico Vandelli (1691–1754) studied with the Jesuits (later becoming an abbot) and at the University of Modena, applying himself in philosophy, mathematics, and theology. Thanks to his studies, he became professor of mathematics and engineering at the University of Modena. He was also a geographer of the Este court and an antiquarian, as well as an inspector of rivers and drainage.

²⁵ With the investiture of Modena as the capital of the Este duchy, a process of urban renewal began to give the city an aspect more suited to its new function. In the second half of the sixteenth century, the Herculean addition had expanded the urban area to the north, although the city still preserved a medieval-type layout. During the seventeenth century, numerous construction sites were opened (for the construction of churches and the embellishment of noble palaces). The most important projects carried out in this period were the construction of the military citadel between 1635 and 1642, and the Ducal Palace to replace the old castle. Afterwards, in the second half of the eighteenth century, the city was partially renovated through the revision of the urban plan implemented by Francesco III. The project, inspired by the ideals of rationality and regularity typical of the Enlightenment, aimed at improving the services and demolishing the unhealthy houses.

buildings, streets, squares, and main infrastructures thanks to its numerous labels. Finally, Vandelli's map constitutes a significant testimony for the city of Modena, created to pay homage to the city itself. The map, commissioned by the Municipality of Modena in 1684, was displayed in the Council Room "in the service of the city," with the order never to remove it from that place (Quaderni dell'Archivio Storico di Modena 2009, 4).

Structure and Function

The platform is based on a relational database system, containing data derived from the analysis and study of musical, cartographic, historical, and archival sources. The interface is currently provided in Italian.

The database created in Django framework is divided into interrelated entities called "Sources" (*Fonti*), "People" (*Persone*), "Genres" (*Generi*), "Events" (*Eventi*), and "Institutions" (*Istituzioni*). The database offers various possibilities for accessing the data including the free text search and browse resources, search indices, and a time slider.

The Sources entity represents the main core of the database and contains records of musical sources examined. The People entity stores data related to musicians and composers. In the Genres entity, musical sources are divided according to their musical form. In Events, one can find all spectacular and musical events realized in the public spaces of the city. Finally, the Institutions entity holds records related to the center of music production in Modena. The Institutions are the connecting element between the relational database system and the virtual map, called EsteWebGIS; each institution is georeferenced through the OpenStreetMap plug-in present in the database, showing the location of each institution on the map. The virtual map provides an interactive city navigation environment through the Google satellite web mapping service. Thanks to the features of the QGIS software, the historical map of Domenico Vandelli has been georeferenced, matching it with the satellite image of modern Modena. By simply ticking or deselecting the layer of the historical map, this overlap allows the user to compare the historic city structure to the present day (Fig. 1). Furthermore, centers of music production in the city can be identified on the map using polygons (Fig. 2). They have been divided in four categories: "Theaters" (*Teatri*), "Squares" (*Piazze*), "Palaces" (*Palazzi*), and "Churches" (*Chiese*).



Figure 1. Screenshot of EsteWebGIS showing Vandelli’s map. The interactive map will permit users to compare Vandelli’s map (A) and the historical center of Modena as it appears today in the Google satellite web mapping service (B).

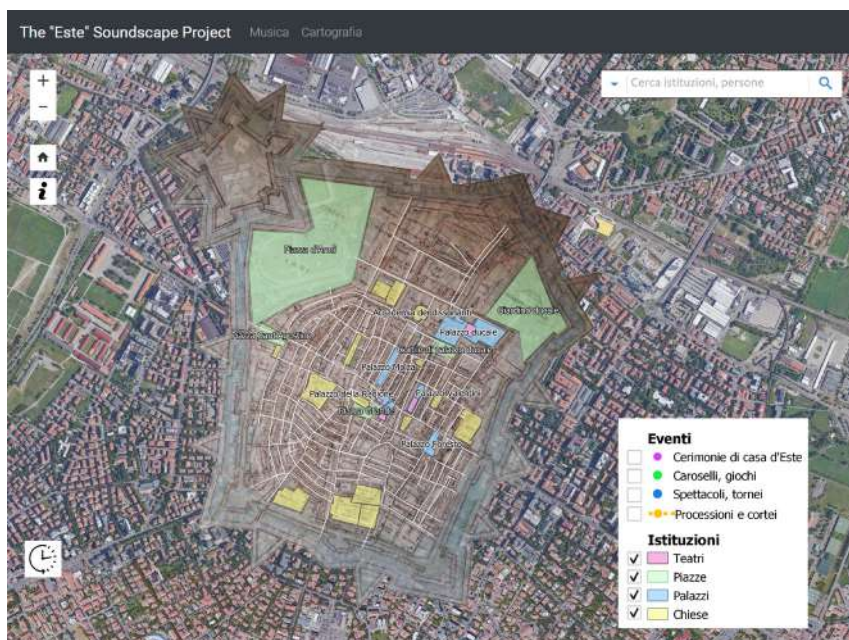


Figure 2. Screenshot of EsteWebGIS showing centers of music production.

Thanks to the map layers, the EsteWebGIS offers different views: it is possible to select a specific category (Theaters, Squares, Palaces, or Churches) or view all categories from the menu. For example, theaters can be highlighted rather than churches or squares (Fig. 3). In addition, informative pop-ups display information regarding institutions and their musical activities and give direct access to the related musical sources. Moreover, using queries, it will be possible to filter and to cross-reference data to obtain re-elaborations of the base map according to specific criteria (e.g., to discover which places in Modena hosted events linked to the anniversary of the House of Este).



Figure 3. Screenshot of EsteWebGIS showing theaters.

During the seventeenth century, several theaters in the city began to host opera performances, offering a busy calendar of high-quality events supported by various dukes. The city's first theatrical activity was carried out at the Teatro della Spelta, built at the behest of duke Francesco I, who was keen to provide the duchy's new capital with a theater that met the needs of the court. Instead, the first court theater, housed in the Palazzo Ducale, dates back to 1669. It was a small theater exclusively intended for the court's private use. The most interesting theater, which managed to combine the

needs of the court with those of the city, was the Teatro Valentini. Initially, it was a large “show room” located in the noble Palazzo Valentini, which was built around 1542 by Giovanni Andrea Valentini. In 1683, the theater was bought by another Modenese nobleman, Marquis Decio Fontanelli, who made it the most important theater in the Este duchy, directly linked to the duke’s cultural policy. The theater, renamed Teatro Fontanelli, was chosen by Francesco II as the place to host theatrical performances that were sponsored by the court but open to a paying audience.²⁶ The auditorium contained 136 boxes arranged in five rows with a gallery, with a total capacity of around 1,000 seats (Martinelli Braglia 1985). The Estense Library now preserves nine opera scores and the Fontanelli family’s collection of librettos.²⁷ The presence and correspondence of archival documentation, musical sources, and libretti allows us to reconstruct the whole operatic activity of the Teatro Fontanelli, providing at the same time an accurate portrait of the court opera in Modena.

The Teatro Fontanelli does not exist today. Its location remains visible only in some historical maps of Modena, like the Vandelli one. A pop-up displays brief explanatory notes, the number of sources and people associated with the theater, and a hyperlink to the corresponding institution record (Fig. 4). The record contains data about the history of the institution and bibliographic and archival sources connected to it so that the user can visualize the list of musical sources linked to the institution and access the specific entry for every source (Fig. 5).

Another useful example is the drama *Flavio Cuniberto* by Domenico Gabrielli, staged in 1688 at the Teatro Fontanelli. Like a catalog entry, the record contains several fields related to the bibliographic, physical, and analytical description of the source including its proper title, dimensions, paper type, shelf marks, watermarks, composer, and so on. It also includes archival and

²⁶ In 1705, the son of Decio Fontanelli, the Marquis Giulio, sold “the public theatre of comedies” to Count Teodoro Rangoni. In the nineteenth century, the theater was expanded in various ways; in 1816 it was renamed the Teatro Comunale di Via Emilia, and in 1842 the new, present-day Teatro Comunale was opened (see Martinelli Braglia 2007, 20).

²⁷ The Fontanelli family collection consists of 1,352 music librettos, all printed and dated from the early seventeenth century to around 1760. Many of them relate to Modenese performances of musical dramas that took place at the Teatro Fontanelli during the reign of Francesco II.

historical information about the context of the production of this drama, and a link to the Estense Digital Library gives access to the digital scores and libretto. In the same way, from the record of the musical source it is possible to access information about the composer and genre (Fig. 6), and, where possible, an audio track can be accessed.

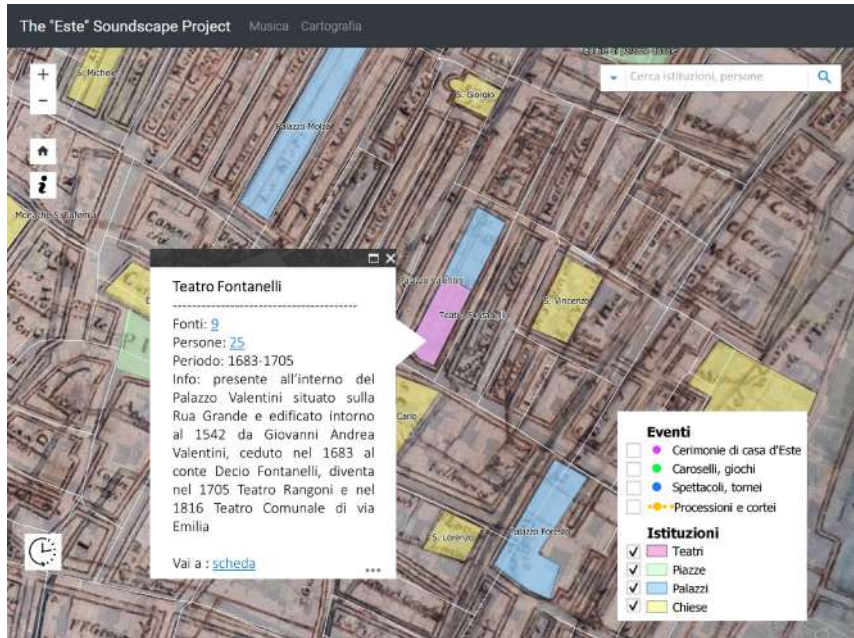


Figure 4. Screenshot of EsteWebGIS showing the Teatro Fontaneli.

The "Este" Soundscape Project Musica CartografiaIstituzione: **Note:**

Inizialmente era un camerone "da spettacolo" presente all'interno di un palazzo nobiliare chiamato Palazzo Valentini, fu edificato intorno al 1542 da Giovanni Andrea Valentini. In seguito prenderà il nome di Teatro Fontanelli. Era conosciuto per essere "il teatro pubblico delle commedie" perché adibito alle recite dei comici al servizio della corte. Probabilmente la sua realizzazione venne affidata sempre a Gaspare Vigarani. Nel 1681 il Valentini fu interamente distrutto da un incendio. Riprenderà la sua attività qualche anno più tardi, nel 1685 grazie al marchese Decio Fontanelli che lo rilevò e gli donò nuova vita consacrandolo al melodramma. Il teatro, ribattezzato col nome di Teatro Fontanelli, fu infatti scelto da Francesco II come luogo dove ospitare le rappresentazioni teatrali patrocinata dalla corte ma aperte ad un pubblico pagante e divenne in breve tempo il teatro più importante degli Stati estensi, direttamente legato alla politica culturale del duca.

Fonti d'archivio: Bibliografia: **Fonti collegate:**

TITOLO	AUTORE
<i>Non dà freno all'amor disuguaglianza</i>	Autore incerto
<i>Il trespolo tutore</i>	Stradella, Alessandro
<i>Il Vespasiano</i>	Pallavicini, Carlo
<i>Li due germani rivalli</i>	[Lonati, Carlo Ambrogio]
<i>Eteocle e Polinice</i>	Legrenzi, Giovanni
<i>L'ingresso alla gioventù di Claudio Nerone</i>	Giannettini, Antonio
<i>Flavio Cuniberto</i>	Gabrielli, Domenico
<i>Il Maurizio</i>	Gabrielli, Domenico
<i>L'inganno scoperto</i>	Perti, Giacomo Antonio

Posizione:

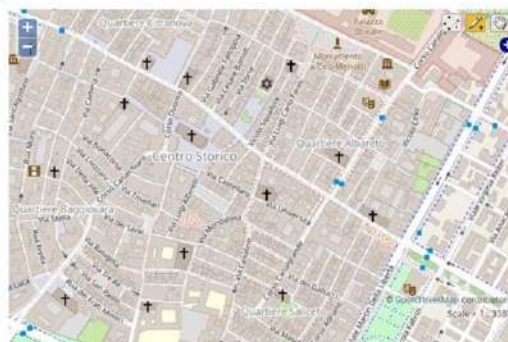


Figure 5. Screenshot of the record for the Teatro Fontanelli showing information about the history of the theater and archival, bibliographic, and musical sources related to it.

The "Este" Soundscape Project Musica Cartografia

Titolo	Flavio Cuniberto
Titolo uniforme	Flavio Cuniberto
Livello bibliografico	Monografia
Tipo documento	Manoscritto
Presentazione	Partitura
Lingua	Italiano
Collocazione	I-MOe - MUS. F. 421
Data	1682
Compositore	Gabrielli, Domenico
Categoria	Vocale
Genere	Dramma per Musica
Organico	5555AAATBB; orch.
Descrizione fisica	Ms. in 4o obl. 3 vol cc. 53/106/135 dim. 330x217mm Legatura in cartone povero
Contenuto	Antiche segnature: vol I piatto ant. C.65; K.15; dorso F; fascetta allegata A. risg. post. G.20.; vol II. piatto ant. K. 16; C.65; dorso F; risg.post. G. 22; vol III. piatto ant. K.; dorso F; risg. post. G. 24 Filigrane: cc. 3-4 giglio fiorentino cerchiato Melodramma in tre atti, senza sinfonia introduttiva, ma con 2 brevi sinfonie strumentali in apertura del II e del III atto. Due intermezzi
Ruoli	Flavio Cuniberto-A; Ernelinda-S; Lotario-T; Ugone-B; Emilia-S; Teodata-A; Guido-A; Vitige-S; Bleso-B; Cirillo-S.
Testo	Libretto (Sartori 1990 10717)
Librettista	Noris, Matteo
Collocazione Libretto	83.D.19 (3) [1688];70. E.01 (4) [1682]
Rappresentazione	10/1688.Modena. Teatro Fontanelli
Dedica	Decio Fontanelli a Francesco II
Luoghi	Teatro Fontanelli
Legami con gli Este	Dedica a Francesco II
Fonti d'archivio	ASMO Archivio per Materie. Compositori.
Bibliografia	Cipollone 2000; Chiarelli 1996
Discografia	Concerto Classic. Cello Tales. Roberta Invernizzi-Ensemble Chiaroscuro 2015.
Note	Il dramma per musica Flavio Cuniberto fu composto da Domenico Gabrielli su libretto di Matteo Noris. La prima rappresentazione ebbe luogo presso il Teatro San Giovanni Grisostomo di Venezia nel 1682, successivamente venne rappresentato a Modena presso il Fontanelli nel 1688 grazie a Francesco II d'Este.

Manoscritto

Libretto

Figure 6. A screenshot showing the record dedicated to the *Flavio Cuniberto* by Domenico Gabrielli, an opera in three acts, on a libretto by Matteo Noris, represented at Teatro San Giovanni Grisostomo in Venice in 1682. Today, the Estense Library preserves the manuscript of the second representation that took place in Modena at the Teatro Fontanelli in 1688.

Our virtual map will also be able to display a series of external events—“Carousels” (*Caroselli e giochi*), “Shows” (*Spettacoli e tornei*), “Ceremonies” (*Cerimonie di casa d’Este*), and “Processions” (*Processioni*)—through which the court interacted with the city (Fig. 7).

For example, throughout the sixteenth century, Piazza Grande was one of the city’s key locations. The main buildings of civic and religious power stood on either side of the square: the Cathedral with its bell tower, known as the Ghirlandina, the Palazzo Comunale, and the Palazzo della Ragione. The main religious ceremonies were also held in this square in the seventeenth century, especially liturgies related to the liturgical year, the Cathedral, and the rites of San Geminiano, patron saint of Modena. Piazza Grande was also the setting for masquerades during the Carnival and representations organized for birthday celebrations, illustrious visits, or political events. Historical

chronicles provide some information on how these events unfolded, testifying to their splendor and the number of citizens involved.²⁸

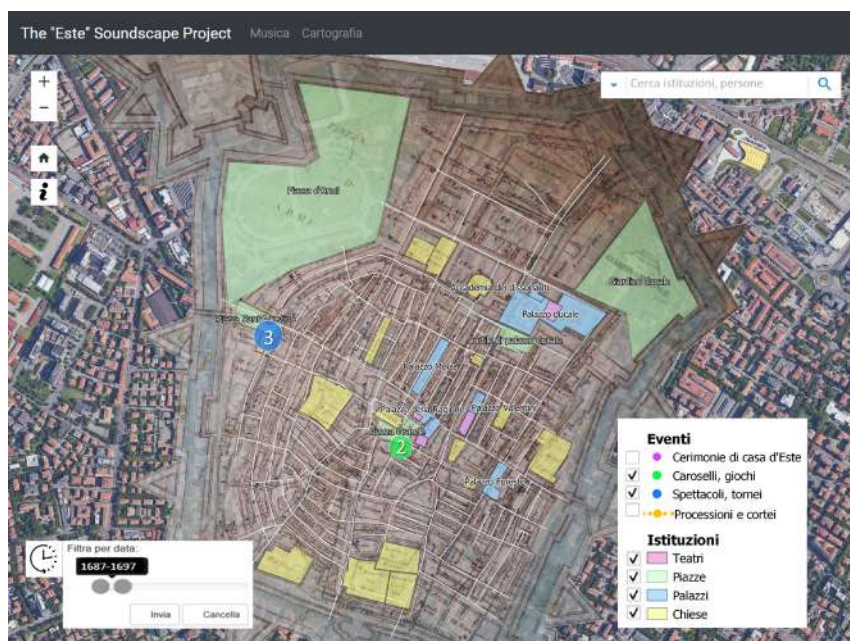


Figure 7. Screenshot of EsteWebGIS showing “Events.”

In 1654, Francesco I married Lucrezia Barberini. The wedding was celebrated by proxy at the Santa Casa in Loreto on 15 April 1654, followed by celebrations in Modena organized with great pomp: lights, music, tournaments, and floats. The chronicler Leone Allacci describes this event: Francesco I’s third bride entered Modena on the night of 24 April 1654, greeted by the sound of the city’s bells. The festivities enlivened the city for several days. An oval-shaped theater was constructed by Gaspare Vigarani in Piazza Grande with platforms for spectators and spaces for musicians. Several ephemeral machines, created for a play entitled *Gli Amori d’Alessandro con Rossane*, were introduced by the sound of fifes and a chorus of trumpets. The chronicler

²⁸ For instance, Giovanni Battista Spaccini’s chronicle is a valuable account that offers vivid insight into the most important events in the city of Modena. Spaccini produced nine volumes of chronicles: the first two rework the diaries of Iacopino and Tommasino Lancellotti, while the rest report the episodes that Spaccini witnessed between 1588 and 1636 (see Spaccini 1993–2008).

reports that about 40 different instruments were assembled for the occasion in order to produce particular harmonic effects (Allacci 1654, 93–94). Although the musical source of this event has been lost, the virtual map shows the place and space of performance (Fig. 8).

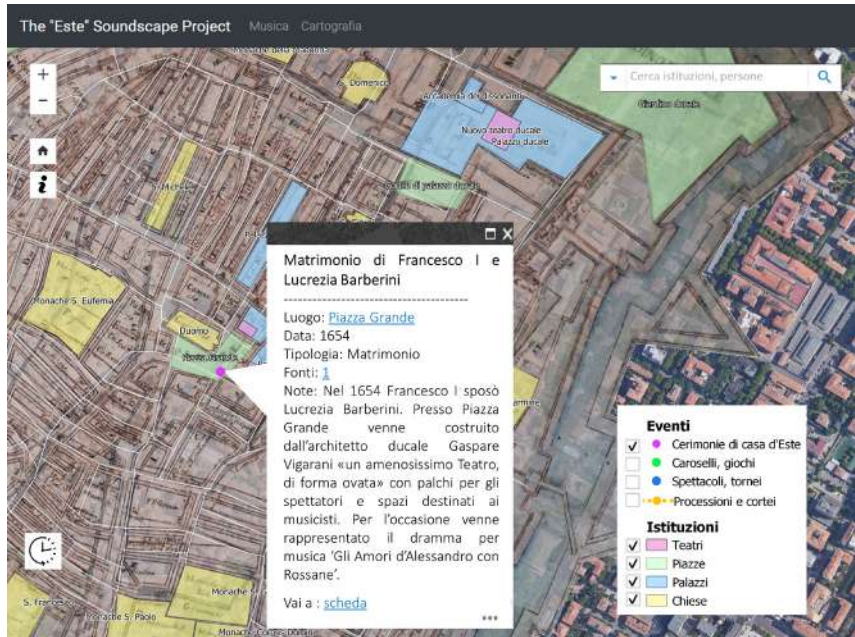


Figure 8. Screenshot of EsteWebGIS showing the Piazza Grande. The pop-up briefly explains the wedding of Francesco I d’Este in 1654. On this occasion, an oval-shaped theater was constructed by Gaspare Vigarani in Piazza Grande with platforms for spectators and spaces for musicians.

A concise pop-up links to a specific record describing the event and offers access to related historical and bibliographic sources and image galleries. Furthermore, if several events have been carried out in the same place, a cluster will indicate the total number (see Fig. 7). Through the search function it will also be possible to filter results. A time slider will allow users to discover the chronological evolution of the spectacular events and will also be useful for obtaining information on the period of activity of an institution present on the map. For example, by superimposing the institutions and time grids, one can learn how many performances were represented in an institution in a certain period. In this way, aggregating data by institution

and year, the identification of the important centers of musical production in the city is possible.

Conclusions

In conclusion, this innovative approach demonstrates the utility of using digital tools and many different types of sources to bring to life a historical soundscape, allowing users to discover the musical culture of an early modern city with an online interactive map. The possibility of cross-references between several types of documents gives users an impression of the multifaceted network of musicians and musical activities realized both in and by the Este court. Moreover, the map provides users with new points of view from which to study a city and its historical and spectacular development. In this sense, the EsteWebGIS can be a valid tool for analyzing the artistic and spatial context of a city in a more general sense.

In fact, the project aims to fill several fundamental gaps in the global reconstruction of the musical and cultural view of a city. The development of a digital project dedicated to a city's soundscape can open a discussion in geographical fields on music and landscape in the early modern era, also providing a useful tool for the representation of the city. Because of the key role that the House of Este played in the development of European musical culture, the knowledge obtained will allow a more balanced historiographical view of the overall social history of music in seventeenth-century Italy.

Finally, the project wants to propose a collaborative and multidisciplinary model for historical research and provide new ideas for the enhancement of cultural heritage. In particular, the interactive map can be used to query the database, but it also offers a starting point for the development of teaching tools for scholars dealing with early modern cities in several respects. To foster reuse, reproducibility, and further adoption by other scholars, the source code of the platform will be made publicly available. The Este Soundscape project offers new opportunities to animate academic teaching according to the methodologies related to "action research" (Elliott, Giordan, and Scurati 1993). In particular, EsteWebGIS will be an interdisciplinary digital tool that connects social aspects, landscape perception, and musical sources with urban spaces.²⁹

²⁹ Authors' contributions: A. F. paragraphs: The Este Heritage; The Music Collection and Its Urban Meanings; Investigating the Historical Soundscape; Structure and Function. S. B. paragraphs: The Cartographic Collection; The Digital Project; The "Este Soundscape" Cartographic System; Conclusions.

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