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# Exploring a non-existent city via historical GIS systems by the example of the Jewish district 'Podzamcze' in Lublin (Poland)

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# Exploring a non-existent city via historical GIS system by the example of the Jewish district 'Podzamcze' in Lublin (Poland)

The historical geoportal of Lublin created by the "Grodzka Gate – NN Theatre" Centre is probably the first thematic portal using object-oriented spatiotemporal databases for presenting historical data in Poland. Authors discuss the theoretical and methodical basis of historical GIS system function and present the example of executed implementation – the interactive map of the non-existent Jewish district 'Podzamcze' in Lublin (www.teatrnn.pl/miejsca/mapa/lublin-podzamcze-czwartek). The application gives access to archival collection of documents as well as to the catalogue of events, places and people connected with the former Jewish district. Integration of genealogical databases, gazetteers, old maps/city plans and collections of archival documents with API Google Maps allows to discover the city independently and comparing historical events in historically accurate space along with the present one.

JEL classification: C18 Methodological Issues: General; I20 Education and Research Institutions: General; L86 Information and Internet Services: Computer Software; N94 Regional and Urban History: Europe: 1913–; Y91 Pictures and Maps

Keywords: historical GIS, object-oriented programming, interactive maps, multimedia, urban heritage

Graphical abstract:
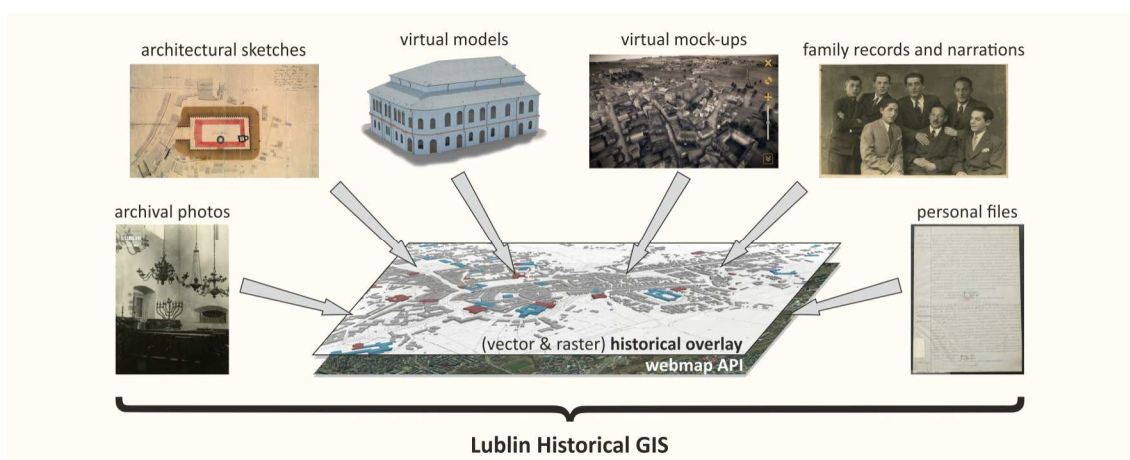
## 1. Introduction.

The versatility of Geographical Information Systems (hereinafter: GIS) for storing and analyzing data has been well recognized in Heritage Studies. So far, the most common approach of presenting data on the Internet is the geoportal form (e.g. https://mapy.zabytek.gov.pl/nid/). However, the functionality of classical 'field-based' geoportal is limited. In this article, the component of hGIS internet application which integrates historical information concerning people, places, events and sources, created by the team of the "Grodzka Gate – NN Theatre" Centre in Lublin, was presented (fig. 1). The Centre is a municipal cultural institution which activity concentrates on the cultural heritage of the city along with its region and the cultural education (www.teatrnn.pl). As a result of the digitalizing actions, creating regional encyclopaedias and developing thematic internet sites connected with different aspects of history and cultural heritage, in 2012 a conception of implementation tools enabling the usage of high-level structurization was formulated. This solution is meant to enable better integration of information, more effective knowledge management and the realization of new projects with the usage of automatic data processing.

Many subjects of different types are conducting projects aiming to create, process and analyse structured data, including international organizations, governments, corporations, non-government organizations and universities. Apart from the positive aspects of the data-role increase, many dangers that are raised in critical data studies (Iliadis, Russo 2016), are connected with this phenomenon. Those deliberations usually concentrate on big data however, methodological reservations can be implemented in the actions on a much smaller scale. One of the goals of this article is the presentation of theoretical assumptions of the implemented solutions and their critical analysis.

The authors have focused on the description of hGIS application subsystem on account of the high degree of implementing advancement of this module in the conducted project and the role of map interfaces in contemporary social communication. P. Celiński (2013: p. 191) shows that 'digital coding of form and content opens this text/picture of culture for all possible database practices, aesthetics and policies – which makes it prone to remix, functional variations and countless overlapping/merging semiotic narratives and interfaces'. This element weighs in favour of broad usage of maps in different types of projects integrating existing initiatives, including spatial narratives (Bodenhamer 2015).

Various models of hGIS systems and methods of spatial data implementation in the title application are shown in this study. Theoretical references to the presented solution are conceptions: the model of three domains (Yuan 1999), deep map (Bodenhamer 2010), parallel leading of source and critical structure (Szady 2013) and spatial narratives (Bodenhamer 2015). Conceptions mentioned above will be discussed in a broader manner further.

According to D.A. Smith 'the use of online mapping and spatial research has become ubiquitous, with hundreds of millions of desktop and Smartphone users regularly accessing mapping services' (Smith 2016: p. 107). It is also confirmed by the data of Polish mobile phones users provided by PBI Gemius survey (2019). Google Maps application reached the third position in the top 20 most used applications on mobile devices in April 2019. The number of Google Maps users in Poland was 16 147 197 and its scope was 57,21%.

## 2. Research aim

The aim of presented research was to develop Internet platform with extensive database backend and versatile CMS for storage, management and publication of spatiotemporal

narrations. The wide range of topics covered by historians and journalists of "Grodzka Gate – NN Theatre" Centre created a serious challenge for developing such a system. So far, the platform had been powered by a number of databases, kept separately for each topic: personal files, graphic and photographic documentation, lexicon of thematic entries. This made it difficult to effectively manage and publish the collected data. In the course of the considerations, it was established that the thematic map interface would be the most concentrated form to present such diverse data sets. Various existing GIS systems and geo-portals had been analyzed, however a new solution was needed to fill up the needs of modern user. The main requirements for the system design were: hierarchical organization of data sets, spatial and temporal scalability, thematic grouping of entities, tagging with keywords and automation of calling up documentary sources for thematic articles in the CMS. A brief overview on the development of historical GIS methodology, our conceptual diagram, implemented ERD and the case study are presented in following sections.

## 3. Methodology

### 3.1. GIS system versus hGIS system.

Towards the end of the 1950s, first attempts of using computers for creating thematic maps were taken. From 1960 to 1969 the first large geographical system with analytic capabilities was created (The Canadian Geographic Information System). One of the authors of Canadian GIS – R. Tomilinson (1968) described it as 'computer-based information system for storage and manipulation of map-based land data'. The spontaneous development of computer technologies has found its reflection in the creation and growing use of more and more sophisticated GIS programmes. Parallel to the technological development analogical progress of scientific fields has come, to list

some of them: spatial analysis, geostatistic, cartographic modelling, and cartographic visualization. The growth of theoretical spheres gave foundations for distinguishing GIS as a new science field – GIScience (Geographical Information Science; Urbański 2008, Kemp 2010).

Between the 1980s and 1990s attempts for implementing GIS systems for presenting spatiotemporal information were taken. Three suggestions for designing spatiotemporal databases were distinguished in the early period. T. Panecki (2015: p.38) points out advantages and disadvantages of these models:

- *Time-slice snapshots* (Langran, Chrisman 1988) – assumes creating several isolated charts for objects of different years. This model is very simple but also extremely exposed to data reduction;

- *Date-stamping* (Vrana 1990) – assumes placing all the objects in one chart along with 'time' as an attribute. Unfortunately, does not allow to construct relations between earlier or later states;

- *Space-time composite* (Langran, Chrisman 1988) – used mainly for surface modeling, e.g.: land usage. Each area is divided into the smallest homogeneous fragments (according to data attributes) and each one of them is ascribed an identifier. The relationship building enables geometrical and attribute data merging. The database does not show any redundancies and potential topological errors can be easily detected. It is labour-intensive.

The key element of building the context of a place is the established time and space conception, which translates into the manner of spatial databases construction. Presented suggestions should be classified to spatial databases of spatial orientation (Field-based or Space-dominant), which is a typical cartographic approach to GIS

(Wachowicz 1999). In the cartographic approach, the reality is divided into homogeneous layers, consisting of graphic objects groups. The layers of a vector graphic (points, lines, polygons) or raster graphic divide space which is constant. All objects in the range of each layer posses a common set of characteristics: location (sequence of coordinates X, Y) and other quantitative attributes (numerical) or qualitative (descriptive). Those elements help to harmonize data in a topological and attribute manner. Time attribute can be considered among object's characteristics as timestamp or valid time reference, however, the form of object notation in a database (one line in a table) causes that each object can be represented only in one place, one geometrical form and in one time range. The presentation of location variability or the shape of one actual object requires the creation of many database records of altered coordination values in a specific time. This kind of process disturbs the homogeneity of objects groups (layers) and leads to data redundancy. To preserve the cohesion of data it is essential to create separate layers of various geometrical and time attributes which increases data redundancy and makes the analysis of groups more difficult. Those are main reasons against the spatial oriented databases usage in historical studies, therefore the preparation of historical geoportal demanded to find different solutions.

### 3.2. The object-oriented approach of hGIS system.

Object-based GIS is founded on a loose relation database building and abstracts from the continuity of time and space (Wachowicz 1999, Richta, Zara, 2005). The object which is the basic link of spatial databases can posses many relations connected with location, geometrical form and time. In other words, one hypothetical real object can be represented in many time ranges, different places and by different types of geometries. Object-based GIS is 'a way of modelling the world that allocates entities to hierarchical classes' (Gregory 2003, p. 107). Crucial element of databases hierarchization (charts)

from more general (parents) to more and more detailed notion classes (children) is the possibility of information inheritance: properties and methods characterizing superior classes are by assumption attributed to inferior classes – although the second ones can contain their own, separate combinations of properties and behaviours. Object orientation is currently acknowledged as appropriate for gathering in processing data for historical studies.

The last three decades allowed further development of the IT foundations of Historical GIS. The contemporary canon forms 10 models of spatiotemporal databases (Reis Ferreira, Camara, Viera Monterio 2010). The most complementary, in B. Szady assessment, are propositions by M. Yuan (1999) – Three Domain Model and R. Fazal (2009) Object Role Modelling. 'The scheme [Three Domain Model, Yuan 1999] consists of four charts, one for each class (time, place, object) and a combining chart and it can be easily implemented in spatial databases like Oracle Spatial or PostGIS' (Szady 2013: p. 24). In spite of terminological differences, the conception of Object Role Modelling (Fazal 2009) is very similar.

B. Szady (2013) proposes the modification of certain models by database division into two parallel structures: source and critical (analytical). In the historian opinion, in case of the ambivalence of sources and variance of accessible interpretations, it is necessary to gather information about the source of data (the information about the historical source) as well as the information concerning existing historical criticism.

Along with the premiere of the project The Great Britain Historical GIS (Gregory, Gilham, Southall 1998), the term Historical GIS supplanted former used expressions (Temporal GIS, Spatiotemporal GIS). Regardless of the established model of gathering and data processing, from the turn of 20th and 21st centuries, many

projects using GIS tools for the historical narration were created. Spontaneous increase in the number of studies concerning time-spatial analysis resulted in naming the decade of 2000-2010 the time of 'spatial turn in humanities', however only in 2010 the theoretical conception of 'deep mapping' was shaped. According to D. Bodenhamer:

> "a deep map is a finely detailed, multimedia depiction of a place and the people, animals and objects that exist within it and are thus inseparable from the contours and rhythms of everyday life [...] A deep map is simultaneously a platform, a process and a product. It is an environment embedded with tools to bring data into an explicit and direct relationship with space and time..." Bodenhamer 2015: p. 3.

Theoretical conceptions of three domain model (Yuan 1999), deep mapping (Bodenhamer 2010), the separation of source and critical structure (Szady 2013) and spatial narration (Bodenhamer 2015), find a great practical reflection in the implementation of historical GIS platform for Lublin (fig. 2).

## 4. Implementation

The "Grodzka Gate – NN Theatre" Centre is a municipal culture institution established in Lublin in 1998. Since its beginning, the Centre gathers historical materials and utilizes new forms of communication for creating narration concerning the history and cultural heritage of the city and its region. The Centre's activity range consists of various forms, from classical publications, through internet technologies, computer modelling and 3D visualizations to culture animation, theatrical activity and the organisation of social events. During twenty years of activity, the Centre gathered vast collection of digital materials consisting of more than 90 thousand objects available in the institution's library including 50 thousand iconographic objects, 27 thousand records of oral history, 19 thousand text publications and multimedia of other kind (audio recordings, films, animations, 3D models etc.). There are 4500 entries concerning

people, places and events in the regional encyclopaedia. The Centre's databases consist of recordings concerning more than 70 thousand people, 12 thousand places, 125 thousand events, 66 thousand active archival sources – those numbers are growing constantly.

In 2016 The Centre started the realization of internet application (hGIS Lublin) integrating information concerning people, places, events and sources. Its conception was created in 2012. The aim of the project is creating a networking system that will allow setting a narration concerning former events and happenings of people's lives in the historical adequate context of a place. hGIS Lublin places itself in the contemporary developing conception of deep mapping as well as in more and more popular direction of spatial narratives (Bodenhamer, Corrigan, Harris 2015). The historical geoportal of Lublin is something more than adding a map interface to the existing functionality of the Centre's websites. The historical GIS is supposed to function as an umbrella system that integrates programmes, tools and databases used by the employees of the Centre to discover, analyze and narrate historical events for a broader audience.

The basic unit of hGIS platform for Lublin is the 'content' chart, in which one object of the chart corresponds to one of the website content (it is an equivalent to one www subpage, i.e. One entry/article displayed from the level of CMS). Objects of the 'content' chart are classified to categories (events, places, people, sources) and tagged with adequate text attribute 'type' (fig. 3). The chart consists of obligatory elements like title entry, creation/update date, language or object ID. Simultaneously, depending on the type, an object can contain relation with other charts (authors, taxonomies, geometries, sources among other things from the digital library). Individual sets of separate objects relations with other objects are stored in 'content connections' intermediary chart. It is possible to search through different categories (events, places,

people, sources) and narrow searching to certain hierarchical levels. The module takes into account Soundex usage for words with similar phonetic sounds. Interactive web-map windows are based on the most popular API Google Maps, which were adapted for showing historical spatial data. The website project, the structure of MySQL database, content management system, (based on PHP) and the scaling of historical cartographic visualization are original implementations made by the project team and people associated with The Centre 'Grodzka gate – NN Theatre' in Lublin.

## 5.   Results and discussion

In 2018 a breakthrough in the development of the application, especially in historical GIS for Lublin, came – project team managed to effectively integrate databases of people, sources and events with a vector city map for the interwar period (www.teatrnn.pl/places/map/lublin-1928). The biggest factual challenge (so far) has been the reconstruction of buildings, street network and historical address numbering for the former 'Podzamcze' district (www.teatrnn.pl/miejsca/mapa/lublin-podzamcze-czwartek, fig. 1, fig. 4). Before the Second World War, the district was mainly inhabited by the Jewish community. During the war, German occupation authorities created a ghetto for the Jews of Lublin in 'Podzamcze'. In the years 1942 – 1943 the Jews of Lublin were exterminated in death camps (*KL Bełżec*, *KL Majdanek*). 'Podzamcze' was the area of intense Soviet bombing in 1944, that is why damaged buildings were finally torn down in 1954 (www.kurierlubelski.pl). At that time, in 'Podzamcze' area, a spacious Castle Square ('Plac Zamkowy', fig. 1, fig. 4) was arranged along with a bus station and a market place. The current of the Bystrzyca river was conducted by the underground canal and in the axis of the valley, a wide line of communication was built. The reconstruction of pre-war buildings in Lublin demanded many-months work of an interdisciplinary research team. In result, a fully interactive thematic web-map has been

prepared. It presents scientifically verified and documented events of peoples' lives in a historically adequate context of place. The integration of spatial data (more than 2000 geometries of geodetic precision) with biographical archives of 43 000 Jewish citizens of Lublin (fig. 5) was the first serious test of the application.

Anytime user searching for a particular information – i.e. personal record of his/her great-, great grandmother – enter the teatrnn.pl web-page, the platform would automatically generate the article page with all features related to that particular entity: maps, photos, documents, narrations, etc. Database connections allow further surfing and discovering additional information (fig. 6). Maps present where the person lived, with multiple locations if moved, studied, worked and eventually died (if recorded). Family trees show relatives: parents, children, spouses, other family members. Lists of events related to people start from two simple entries: 'was born' and 'died', but tend to grow anytime additional information is found. Archival records, scanned files and photographs justify the information presented. The functionality of the system can be compared to Google Maps, ArcGIS StoryMaps and Wikipedia to present spatiotemporal narrations.

## 6. Conclusion

The application, created by the team of the "Grodzka Gate – NN Theatre" Centre in which an important part is historical geoportal of Lublin was based on theoretical assumptions described in this article (Wachowicz 1999, Yuan 1999, Fazal 2009, Szady 2013). The object-oriented design allowed to introduce several methodological approaches: archivist, genealogical, geographical, historical – all combined created a multidimensional encyclopaedia for the history of the city, its space and inhabitants. The authors believe this is what D. Bodenhamer (2010) meant by the term 'deep map' and T. Harris (2015) draw as 'A geospatial web framework for deep mapping and

spatial stories'.

The platform is an original PHP framework dedicated specifically for spatial narrations. It's an online CMS solution that allows to create, manage and publish spatiotemporal data from the perspective of individuality (person, place, event, document). It's scalable, user-friendly and fast. It's multidimensional – automatically searches for related features, archives, photos, audio and allows to embed Youtube, Sketchfab, etc. Finally, it's visually attractive and it's broad; it already consists of thousands of records, relations and multimedia.

The interactive map of the former Jewish district 'Podzamcze' was a challenging but successful case study for the interdisciplinary research of hGIS Lublin project. With several thematic maps already working ('Lublin-1928', '19$^{th}$- and 20$^{th}$-century brickyards', 'Unia Lubelska', 'Shtetl Routes') the system's versatility had been tested – with positive results – both on a local and regional scale. Later development works will verify established assumptions and the manners of methodology implementation from different fields along with those connected with hGIS systems. The authors assume that established solutions will allow creating and integrating many interactive maps of different thematic and time aspects. Thanks to that the system users will be able to thoroughly learn the history of the city and the cultural heritage of the region.

## 7.   Future works

Currently, the hGIS project team for Lublin deals with realization of other parts of interactive thematic maps, among other things, remaining districts of interwar Lublin, Lublin of 19th and 18th centuries, the industry of Lublin (brickyards in 19th and 20th centuries), Lublin and its surroundings connected with the commemoration of The Union Of Lublin in 1659 (teatrnn.pl/unia-lubelska/), the maps of Jewish culture heritage from Shtetl Routes project (Kuna 2016, www.shtetlroutes.eu). All features of the

historical geoportal of Lublin are already available at teatrnn.pl.

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## Disclosure statement

No potential conflict of interest was reported by the authors.
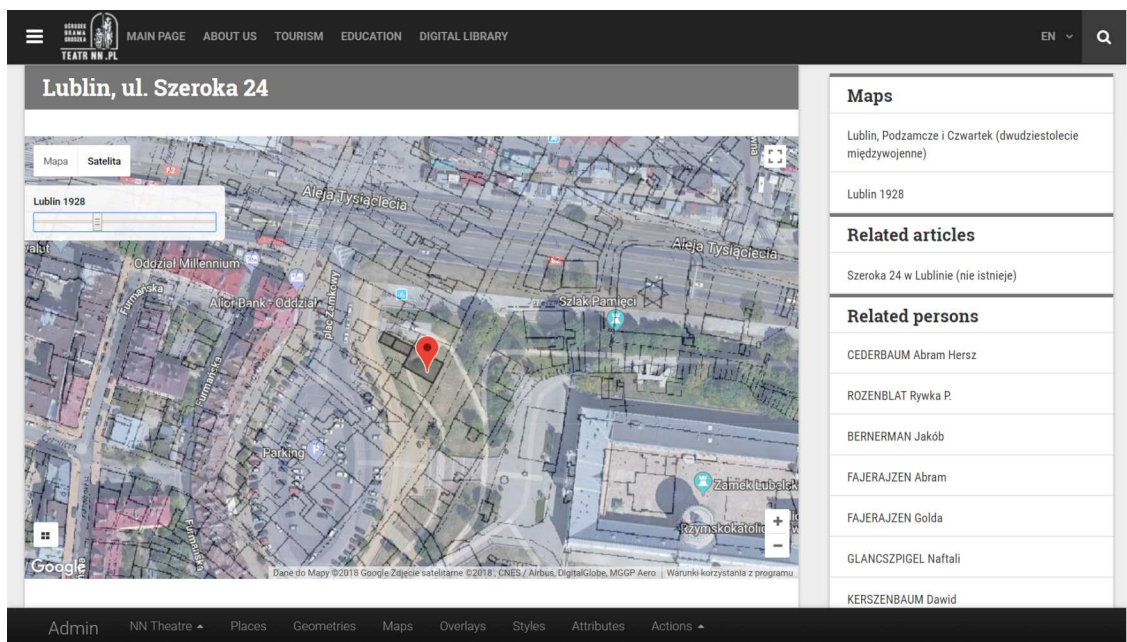
## Funding

**Figure captions**



Figure 1. Window with the interactive map of a place (Lublin, 24 Szeroka street – the address of the former Jewish district 'Podzamcze', non-existent today) and elements connected with it: maps, articles, database of people, etc. (teatrnn.pl).
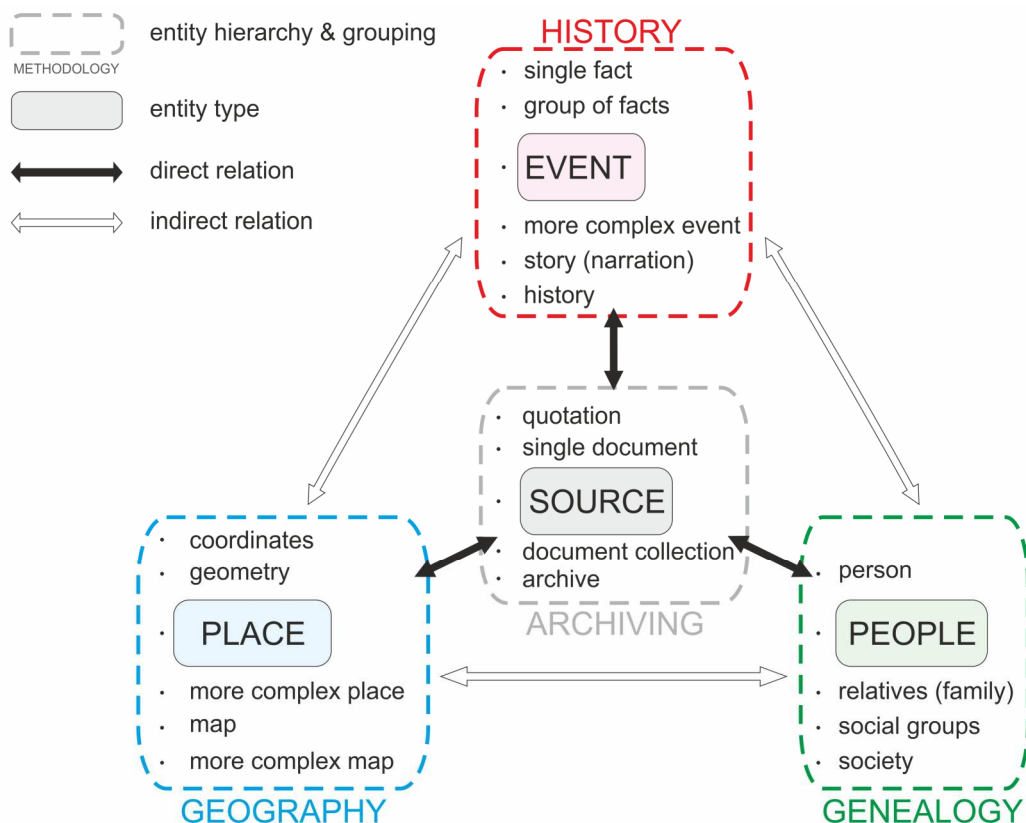
Figure 2. Relation concept model in the application. Archival source contains the description of event (what?, when?) taking place in a certain area (where?), with the participation of certain people (who?). The platform enables searching databases according to any given category (events, places, people, sources).
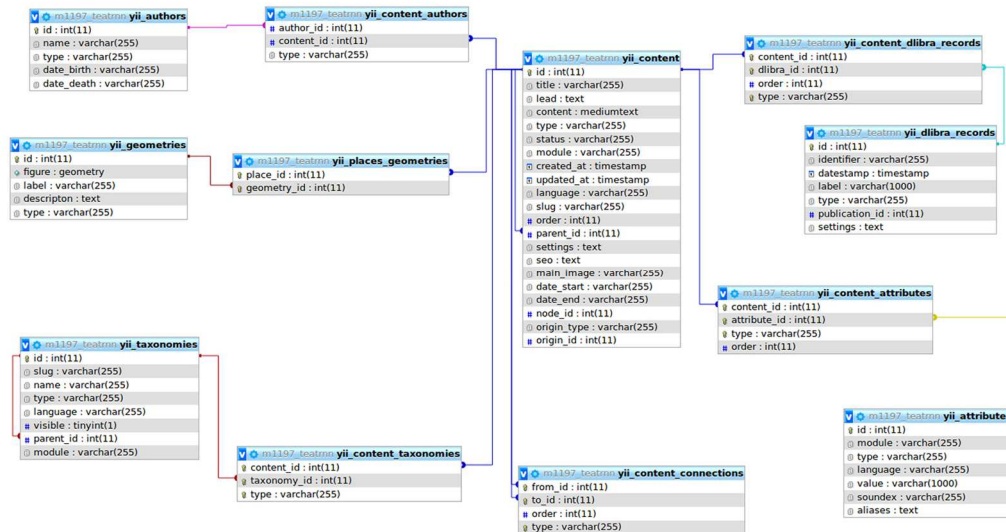


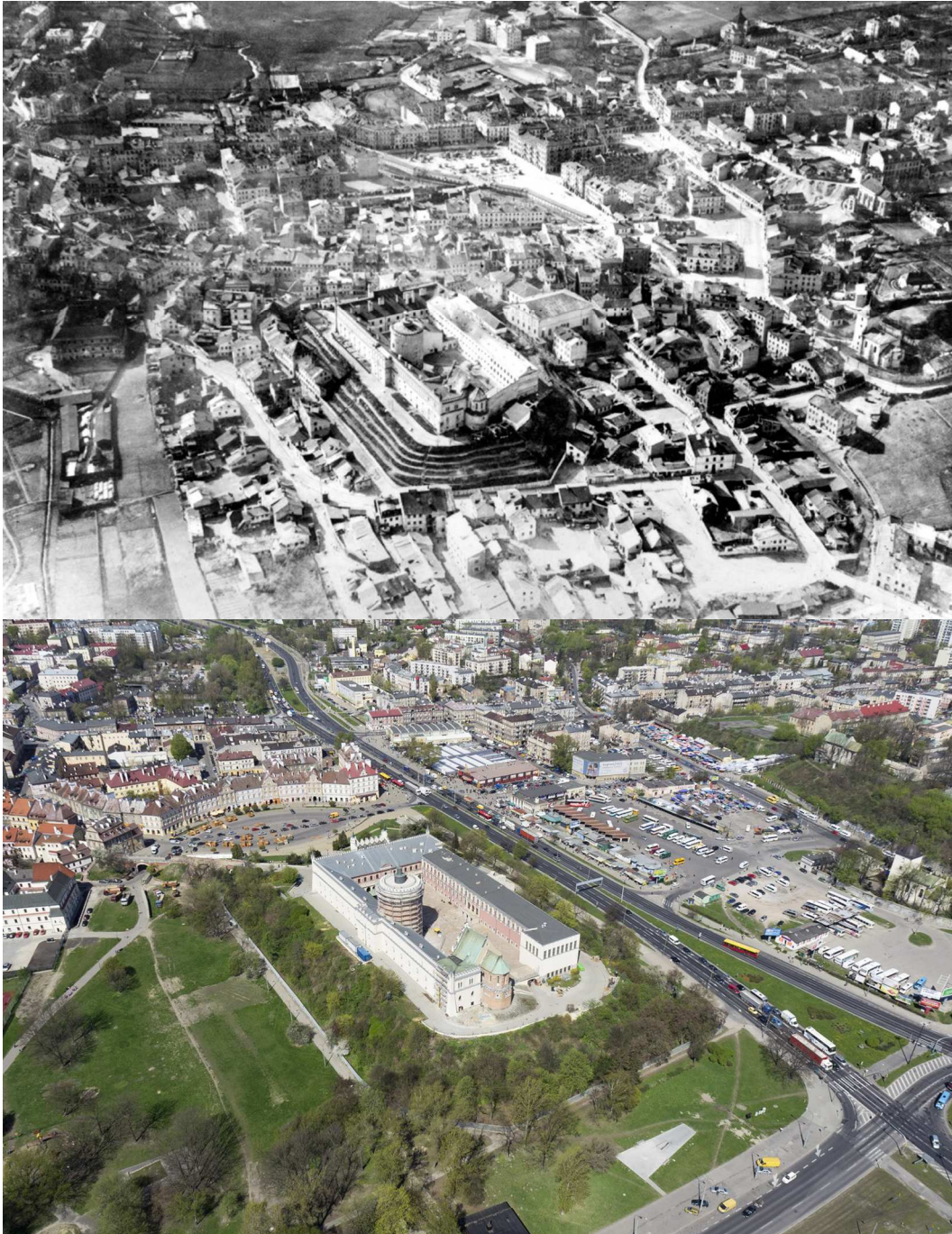Figure 3. Entity relationship diagram (ERD) for the teatrnn.pl portal.

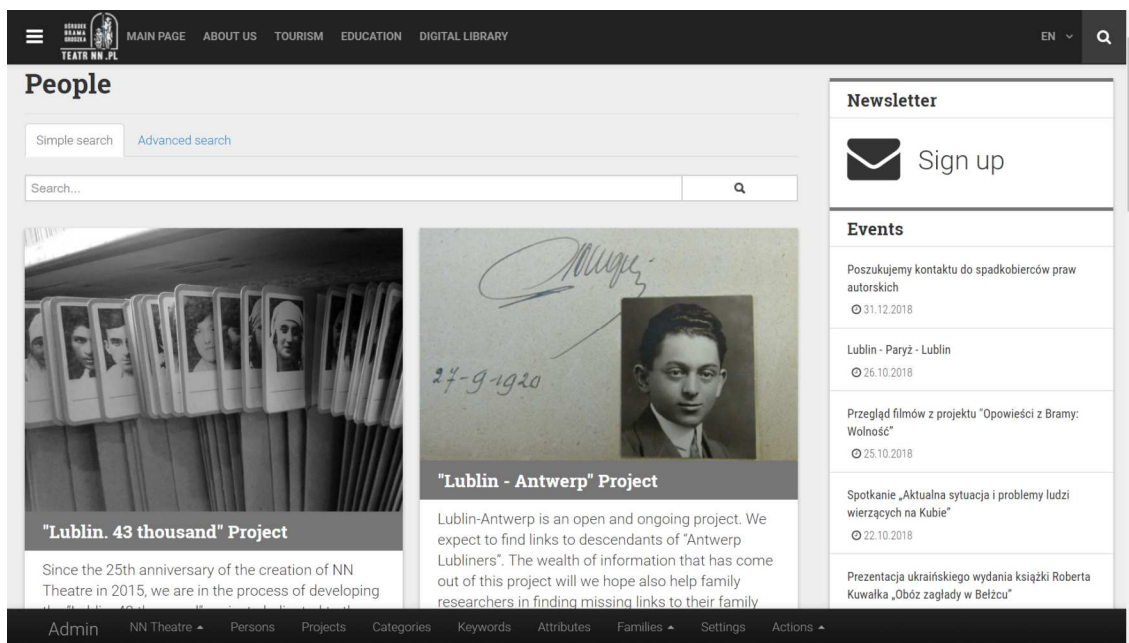Figure 4. Lublin castle and the former Jewish district 'Podzamcze' before 1939 and today (teatrnn.pl).

Figure 5. People database search engine – exemplary theme finds concerning people of Jewish origin, presented as 'Lublin. 43 thousand' and 'Lublin – Antwerp' projects (teatrnn.pl).
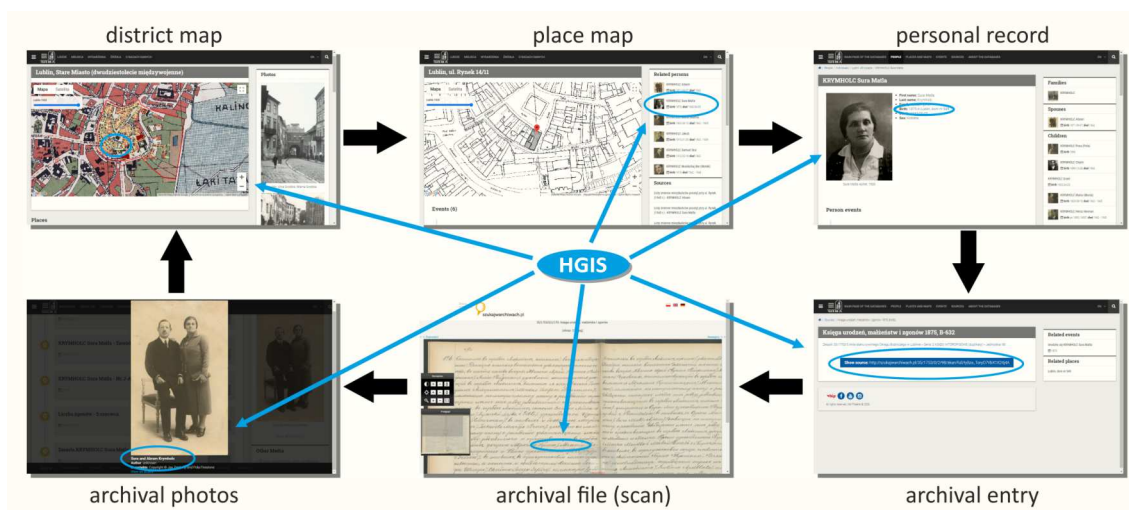


Figure 6. Case study example presenting functionality of the system. Sufring from district map, through place map, personal record, archival entry, scanned files to person's photograph and back to the map (teatrnn.pl).

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