Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering. Vol. XIV, 2025
Print ISSN 2285-6064, CD-ROM ISSN 2285-6072, Online ISSN 2393-5138, ISSN-L 2285-6064

ENGINEERING AN INTERACTIVE MAP OF STATUES AND MONUMENTS FROM CLUJ-NAPOCA

Florica MATEI[1], Tudor SĂLĂGEAN[1, 2, 3], Ioana POP[1], Elemer-Emanuel ŞUBA[1], Mircea-Emil NAP[1], Silvia CHIOREAN[1], Paul SESTRAŞ[1, 2], Simion BRUMĂ[1, 2], Ştefan BORCAN-CONȚEVICI[1], Cristian MĂLINAŞ[1], Lucia-Adina TRUȚĂ[1]

[1]University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca,
Faculty of Forestry and Cadastre, 3-5 Calea Mănăştur Street, 400372, Cluj-Napoca, Romania
[2]Technical University of Civil Engineering of Bucharest, Doctoral School,
122-124 Lacul Tei Blvd, District 2, 020396, Bucharest, Romania
[3]Technical Sciences Academy of Romania, 26 Dacia Blvd, District 2, 030167, Bucharest, Romania

Corresponding author email: lucia-adina.truta@usamvcluj.ro

Abstract

While the technology in Earth observation and Surveying fields advances, it's possible to learn more information in less time. This research aimed to design a web application that provides useful information about the public monuments from Cluj-Napoca near the user's location. Users can fix their position on the map, define the range of interest, and identify the monuments on the web map. Also, they can find the best route to the touristic objectives, pictures of the monuments, and their history. To achieve these, we first retrieved the coordinates of the statues and monuments using the Mobile Topographer application. We included these coordinates and information about the studied objectives' history and type in a geodatabase. Secondly, we used ArcGIS Pro to obtain information based on the collected data, and a map was created. We created customized scalable icons for each studied monument type. Once data was analysed, it was uploaded into ArcGIS Online as a hosted feature layer based on which a web application was built. This application will be publicly accessible, without conditional on software licenses or the device used.

Key words*: ArcGIS, monuments, Satellite Geodesy, web application.*

INTRODUCTION

Romania has more than 50 historic towns (Bucurescu, 2018). Cluj-Napoca is one of the most notable Romanian historic towns due to its rich cultural heritage and architectural significance (Popescu et al., 2018). Its foundation can be traced back to the Napoca village from the Roman province, Dacia, which was elevated to the rank of municipality 1,900 years ago by the Roman emperor Hadrian (Pascu et al., 1974; Ropa & Ropa, 2017). In time, Cluj-Napoca was adapted to different ages and needs, and due to its distinctive structural and functional features, it became a very refined monumental cultural landscape with a strong identity and a space rich in cultural significance (Maroşi et al., 2019). The Ministry of Culture 2015 records listed 1,791 historical monuments in Cluj county (Romania's Ministry of Culture). Part of the cultural heritage, the statues and monuments, generically called in this paper 'monuments', are symbols of cultural identity, power, and remembrance, helping us understand who we are (UNESCO). Understanding the meaning of a place may improve the public perception of the authenticity of urban heritage (Garcia-Esparza & Altaba Tena, 2020).

Europe's economic growth is interconnected with culture and tourism (Dulau & Coros, 2005). Cultural tourism in urban areas represents the most dynamic aspect (Bucurescu, 2015). While in 2015 the tourist inflow to Romania was negligible compared to this country's significant number of UNESCO-listed heritage sites (Lupu C. et al., 2015), an increase in the number of visitors was reported in 2023 compared to 2019 (WTTC, 2024). In 2016, the tourism density recorded for Cluj-Napoca was almost two times higher than at the country level (Popescu et al., 2018). Prior research found that the presence of educational material enhances the experience of visiting a historic site and that the more easily accessible a location is, the more enjoyable it is to see a historical monument or statue (Cameron & Gatewood, 2000). One challenge associated

with this issue is that, while some locations are strongly linked to a specific historical event or period, others may lack such associations or be tied to multiple, overlapping narratives (Ries & Schwan, 2023). Furthermore, to foster public awareness and ensure the preservation of cultural heritage, it is essential to systematically document and visually present relevant information (Horbinski & Smaczynski, 2023). This highlights the growing need to assist potential visitors of Cluj-Napoca in connecting a monument's visual representation with its detailed description and precise geographic location through an interactive map. Recently, the expansion of information technology, especially mobile applications, and web platforms has enhanced tourist experiences by facilitating access to data needed by tourists to know the locations, distance to, and description of the monuments (Markhasi Rupilu et al., 2018). Digital documentation has transformed visitor interaction with heritage sites, enhancing education and surpassing user expectations (Comes et al., 2020). However, even if there exist some web applications for monuments in Romania, including Cluj-Napoca (e.g., Attractive Romania, Cluj Tourism App, Explore Romania - Official App, Monuments Romania, Cluj Now), the problem is that the list of monuments is very brief, hard to find, or no longer contains up-to-date information. Consequently, people who want to find information about the historical, cultural, and religious monuments in Cluj-Napoca will encounter great difficulties.

Monuments mirror Cluj-Napoca's historical evolution, offering visitors an emotional and enjoyable connection to the past (Ries & Schwan, 2023). Yet, without awareness of their historical significance, the psychological impact on visitors remains minimal (Ries & Schwan, 2023). To address the above-mentioned issues, needs, and problems, we aimed to design an interactive map with updated, detailed information about the monuments in public places of the Cluj-Napoca municipality, a map shareable as a web application and usable as a guide or information resource for all potential users. This agrees with the aim of cultural heritage organizations joining efforts to preserve and share information about our common heritage (Vilceanu et al., 2022).

The importance of our work in environmental engineering is emphasized by: the sustainable integration of cultural heritage in the urban landscape, using interactive mapping as a tool for informed spatial planning; awareness of the built environment like monuments, and improving tourism in Cluj-Napoca.

Some of the unique features that our web application offers to users are:

- precision and accuracy in mapping, by including the rectangular coordinates in our app, hence providing high-precision geographic information to users who need exact geospatial data, whether for academic, governmental, or navigational purposes;
- localized and in-depth focus on Cluj-Napoca, offering more detailed and accurate information about its public monuments;
- customizable user experience. The interactive map with dynamic search and navigation, enables the users i) to visualize monuments within a selectable area, which adds a dynamic, real-time mapping; ii) to choose their starting location, and the application automatically generates a route to the monument they selected; iii) to search a monument by its name;
- historical and contextual information about monuments, providing users with a richer educational experience that might help them learn about the cultural significance of each monument;
- friendly, with no special accounts required, making it more accessible and convenient for the users.

These features generate certain benefits of our web application, for example:

- serves tourists who want to navigate the city and learn about its historical context;
- facilitates public cultural awareness, giving users the possibility to understand the significance of the monuments in their urban environment and contributing to a sense of pride and deeper connection to local heritage;
- offers potential for future expansion, as the structure we created could turn into a scalable model for other places;
- it is free and open to the public, so tourists, locals, and anyone interested can access it without worrying about hidden costs, subscriptions, premium features, or login requirements.

The unique features and benefits emphasize the novel contributions of our web application compared to the existing solutions in the field.

MATERIALS AND METHODS

The list of monuments per county, issued in 2015 encompasses 33 historical monuments in the Cluj-Napoca municipality (Romania's Ministry of Culture). However, our study is based on the most comprehensive source relevant to this topic, which describes over 150 monuments (Ciorca, 2020). A study from 2015 indicated that 75% of existing monuments in Cluj-Napoca are concentrated in its historic centre, particularly in the Fortress of Cluj (Orban & Puiu, 2015). Monument selection followed the criteria in Figure 1, and the methodology involved six steps, as shown in Figure 2.

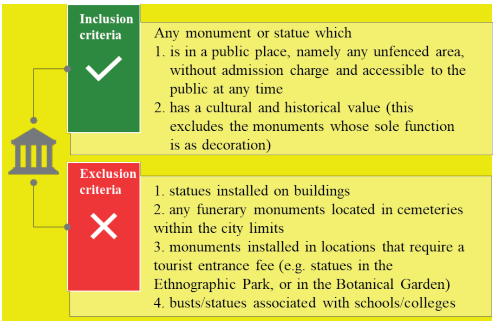


Figure 1. Monuments' selection criteria

Figure 2. Flow of the study steps
(Icons used in this diagram were freely downloadable from Freepik.com)

1. Collecting data on the monuments. These data fall into two categories: data on the location and data on the significance of the monuments. We obtained the data on the position of monuments using the procedures detailed in the next sub-section. The information on the monuments' significance was gathered from the main source document (Ciorca, 2020) and was entered into the database. The information conceptualization consisted of identifying information that could be represented as a map. Data on the monuments' chronology were also collected. For many of them, the information on the monument installation was incomplete, and often, only the year of origin was identified.

2. Determining the position of monuments. Given that monuments are located in urban environments, in areas with constant vehicular or pedestrian traffic, the conditions for determining rectangular coordinates by the resection method are not favorable, as often the sights from the station to the monument may be blocked by buildings, cars, or pedestrians. Thus, we decided to use satellite geodetics, specifically GPS determination of point coordinates using the Mobile Topographer application, running version 9.3.2., from a Samsung smartphone, model Galaxy A54 5G. In this application, we selected the Projection System Stereo 70 from the settings. Coordinate determination was performed by connecting to GPS constellations, Glonass, Beidou and Galileo, with access to an average of 25 satellites for each measurement. We stationed as close as possible to each monument for approximately 5 minutes to increase the accuracy of the measurements. The position determination procedure was repeated for each monument, on different days, due to weather and time factors. The coordinates were recorded in a database and organized in a Microsoft Excel file to facilitate the project's next steps.

3. Designing the icons. The icons we created represent in a very suggestive, visual way the type of monuments to which they correspond in the interactive maps and web application. We chose to generate these icons in the Inkscape software version 1.3.2. because the outcome is vector images, which maintain their resolution at different zooming levels. In the case of the icon for the monuments, the Carolina Obelisk was taken as a model. For the group of statues

icon, the Transylvanian School group of statues was taken as a model. The icons were drawn in such a way as to be recognizable and distinct from any distance. The created icons have a minimalist style so that their meaning is immediately apparent to any user without the need for written information.

4. Creating the monuments map in ArcGIS Pro. The geographic information system (GIS) was implemented using ArcGIS Pro version 3.3.0., projection system Pulkovo 1942 Adj 1958 Stereo 70. The Excel file with the monument's coordinates was added in the ArcGIS Pro, and using the XY table to point function, the points representing the monuments were materialized on the map. We then performed a visual classification by unique values and used the created icons to show each monument's location on the map and its type, symbolized by these icons. Due to the project's complexity, we used ArcGIS Pro to build the map layers that will constitute the hosted feature layer in the web map.

5. Creating the web map. We created a web map, using ArcGIS Online and based on the designed GIS. First, we exported the map layers from the project created in ArcGIS Pro. These map layers contain coordinate data for monuments. Exporting these layers as shape files greatly shortened the work that had to be done in the ArcGIS Online platform. Shapefiles exported from ArcGIS Pro were imported into ArcGIS Online as hosted feature layers. This web map and the project in ArcGIS Pro are intended for geodesy and cartography specialists.

6. Creating and publishing the web application. The web map created in ArcGIS Online platform was used to develop the web application, based on pre-established templates that can be accessed by selecting the 'create web app' option when inspecting a map. We illustrated the nearby function, generated a route to a monument, and searched a monument by its name. This last step of the process will use all the previous operations, with the final goal of creating a map that will serve as a guide for the monuments found in public places in Cluj-Napoca. The web application is for any user, regardless of the level of expertise or software available, and will run on any device without requiring an ArcGIS account or license.

RESULTS AND DISCUSSIONS

Based on the inclusion and exclusion criteria, 76 monuments were included in our study. Of these, 53 monuments (70%) were considered of great interest to future users of the interactive map and the web application, therefore, these were called 'main monuments', while the other 23 monuments were called 'secondary monuments'.

After performing the survey, the determined rectangular coordinates were organized in tabular form to facilitate input into ArcGIS Pro, along with other details like the location, the classification by type of monument, the date when it was installed, and the monument's author.

Table 1 summarizes the main monuments included in the study, with the related available details.

Table 1. Main monuments database

ID	Monument	X coordinate	Y coordinate	Location	Type	Installation date	Authors
1	Lupa Capitolina	586524.993	392629.182	on Eroilor Blvd, vis-a-vis of Greek Catholic Cathedral	M	29.11.2008	Ettore Ferrari
2	Statue of Cardinal Iuliu Hossu	586539.517	392652.688	on Eroilor Blvd, at crossing with Bolyai Janos street	RS	30.11.2018	Ilarion Voinea
3	Memorandists Monument	586492.936	392534.342	on Eroilor Blvd, near Unirii Square	M	1994	Eugen Paul
4	Matthias Corvinus Statuary Group	586500.951	392439.574	on Unirii Square, near the Saint Michael's Church	SG	12.10.1902	Fadrusz Janos, Pakey Lajos
5	Shot Pillars Monument	586428.226	392410.92	at the crossing between Unirii Square and Napoca street	M	10.2003	Liviu Mocan
6	Statue of Bishop Marton Aron	586563.964	392366.061	Garden of Saint Michael's Church	RS	03.2009	Bocskay Vincze
7	Monument of glory of the Romanian Soldier	586813.542	392917.373	behind the Orthodox Metropolitan Cathedral	M	1996	Radu Aftene
8	Statue of Bishop Nicolae Ivan	586736.827	392955.374	in front of the steps of the Orthodox Cathedral	RS	30.11.2018	Alexandru Păsat

ID	Monument	X coordinate	Y coordinate	Location	Type	Installation date	Authors
9	Statue of the Mitropolitul Bartolomeu Anania	586730.25	392944.015	in front of the steps of the Orthodox Cathedral	RS	30.11.2018	Septimiu Jugrestan
10	Statue of Avram Iancu	586688.742	392968.99	in Avram Iancu Square, between the Orthodox Cathedral and the National Theatre	S	1993	Ilie Berindei
11	Statue of Lucian Blaga	586629.843	393010.028	in front of National Theatre	S	1986	Romul Ladea
12	Statue of Mihai Eminescu	586620.47	392989.221	in front of National Theatre	S	1976	Ovidiu Maitec
13	Bust of Alexandru Vaida Voevod	586579.082	392979.331	on West side of National Theatre	B	16.03.2012	Ilarion Voinea
14	Statue of Iuliu Maniu	586382.839	393016.956	in front of the wall of Tailor's Bastion	S	8.02.2019	Ioan Marchiș
15	Statue of Baba Novac	586325.309	393021.148	in front of Tailors' Bastion	S	1975	Virgil Fulicea
16	Statue of Andrei Mureșan	586247.98	393209.714	at the crossing between Andrei Mureșan str. with Cipariu Square	S	2019	Ilarion Voinea
17	Statue of St. George (the Dragon Slayer)	586340.742	392840.777	Mihail Kogălniceanu str., in front of Calvinist Reformed Church	RS	1960	Rona Jozsef, Kalman Lux
18	Statuary group the Ardelean School	586300.011	392608.623	close to the main entrance of Babeș-Bolyai University	SG	30.06.1973	Romulus Ladea
19	Statue of the Virgin Mary	586270.014	392472.095	in front of Piarists' Church	RS	11.2023	Anton Schuchbauer
20	Bust of Octavian Goga (Students' Culture House)	586237.649	392156.759	in front of Students' Culture House	B	1988	Info not available
21	Bust of George Coșbuc (Students' Culture House)	586232.154	392135.787	in front of Students' Culture House	B	1988	Info not available
22	Bustul lui Lucian Blaga	586240.039	392090.04	in front of Central Universitary Library	B	1970	Eugen Gogan
23	Statue of Francisc David	586761.946	392606.419	On 21 Decembrie Boulevard, near the Unitarian Cathedral	RS	08.2019	
24	Carolina Obelisk	586759.919	392237.872	in Museum Square, in front of Mikes Palace	M	1831	Mihaly și Antal Schindler, Anton Csuros, Samuel Nagy, Josef Klieber
25	Statue of Constantin Daicoviciu	586750.028	392202.931	in Museum Square, in front of the National History Museum of Transylvania	S	NA	NA
26	Monument to anti-communist resistance	586747.307	392012.929	at crossing between Iuliu Hossu and George Barițiu streets	M	12.06.2006	Virgil Salvanu
27	Statue of Antonin Ciolan	586704.3	391824.764	in the Central Park	S	NA	NA
28	Statue of Nicolae Bretan	586697.91	391746.925	in the Central Park	S	2013	Ana Rus
29	Bust of Sigismund Toduță	586655.82	391758.898	in the Central Park	B	NA	NA
30	Bust of George Coșbuc	586632.156	391715.782	in the Central Park	B	NA	Vetro Artur
31	Bust of Octavian Goga	586580.211	391544.008	in the Central Park	B	NA	NA
32	Statue of Liviu Rebreanu	586564.944	391499.166	in the Central Park	S	NA	NA
33	In memoriam 1956 (Hungarian revolution monument)	586677.175	391710.431	in the Central Park	M	2009	NA
34	Statue of Mircea Luca	586398.124	390979.666	behind Cluj Arena Stadium	S	NA	NA
35	Statuary group Horea, Cloșca and Crișan	586769.785	391463.852	near Napoca Hotel	SG	1974	Ion Vasiliu
36	The Monument to the Salvation of the Nation	587001.165	391915.552	on the Citadel (Cetățuie) Hill	M	01.12.1997	Virgil Salvanu
37	Statue of Mihai Viteazul	587047.343	392410.101	Mihai Viteazul Square	S	1976	Marius Butonoiu
38	The eternal flame	587005.512	392341.481	Mihai Viteazul Square	M	23.04.2003	Paul Eugen
39	Bust of Alexandru Ioan Cuza	586869.267	392827.959	vis-a-vis of Prefect's Palace in front of CEC Bank	B	NA	Marcel Voinea
40	Bust of Emil Racoviță	586323.519	392764.12	Mihail Kogălniceanu str., in front of National College Emil Racoviță	B	NA	NA
41	Bronze model of the old town	586936.076	392529.621	on top of the former Fire Tower	M		NA
42	Statue of Saint George (Regele Ferdinand str.)	586701.415	392457.505	Regele Ferdinand str., no. 1	RS	1941	Kende Ferenc, Rahman Maria

ID	Monument	X coordinate	Y coordinate	Location	Type	Installation date	Authors
43	Bust of Woodrow Wilson	585730.461	391981.403	Louis Pasteur str., no. 4	B	2002	NA
44	Bust of Florian Ştefănescu Goangă	585817.667	392340.48	in front of Psychology Institute	B	NA	David Şandor
45	Bust of Ion Chiricuţă	585835.672	392278.313	in front of the Oncologic Institute 'Ion Chiricuţă'	B	2008	Alexandru Lupu
46	Bust of Alexandru Lapedatu	585834.755	393331.799	Dimitrie Bolintineanu str., no. 16, at the street corner	B	NA	NA
47	Bust of Ion Agârbiceanu	585888.921	393393.103	at the crossing of Andrei Muresan and Brasov streets	B	NA	Romul Ladea
48	Statue of Gheorghe D. Mărdărescu	586911.563	394883.525	in front of Faculty of Economics and Business Administration	S	08.2019	Valentin Tănase
49	Troiţa (Mărăşti)	587509.23	394364.209	at the crossing of Fabricii and Aurel Vlaicu streets	M	1990	NA
50	Column from Expo Transilvania	587778.062	395536.276	near Expo Transilvania	M	1974	Virgil Salvanu
51	Whistlers at Expo Transilvania	587770.719	395506.434	near Expo Transilvania	M	1974	Târnovan Vid
52	Bust of General Nicolae I. Dăscălescu	586457.724	393133.71	in front of the Infantry Division	B	NA	Anton Tănase
53	Bust of General Gheorghe V. Avramescu	586486.637	393122.765	in front of the Infantry Division	B	NA	Anton Tănase

M = monument; RS = religious statue; SG = statuary group; B = bust; S = statue; NA = information not available.

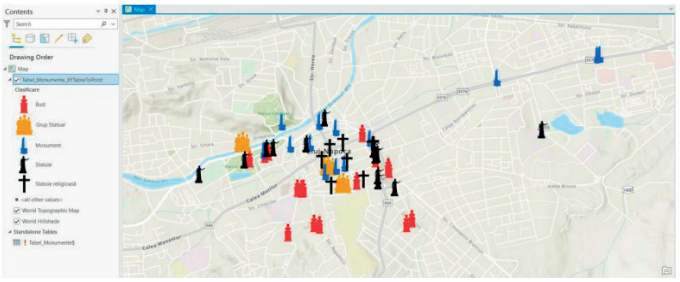


Figure 3. The map with the monuments' classification by type, symbolized by the icons we designed

After including the monuments' coordinates, we classified the monuments based on their types and added their visual symbols. The unique values representation mode from the Symbology section was used to create the point layer. Unique values were designated based on the Classification field in the Attribute Table, which had five values: bust, statue, statuary group, monument, and religious statue.

Figure 3 illustrates the map created in ArcGIS Pro and monuments classified by type, and visually represented by the icons we created in Inkscape. Monuments' classification by type was done according to the criteria specified in Table 2, which also shows the corresponding icon we created for each monument type. Once created, the icons were introduced into the project folder, where they could be accessed from the properties page of the Symbology tab.

Table 2. Monuments' classification criteria and the icons created for each monument type

Type	Classification criteria	Icon
Bust	any monumental installation depicting only the shoulders and head of the personality represented	
Statue	any monumental installation that reproduces in whole or in part, the body of the person represented	
Statuary group	any monumental installation representing several distinct personalities	
Monument	any monumental installation not representing any personality	
Religious statue	any monumental installation representing an ecclesiastical personality or Saints	

The purpose of these icons is to visually and concisely communicate the monument's type while enhancing the map's appearance.
After visual classification by unique values, the created layer was saved as a layer file in the Share ribbon.
Following the classification by unique values, we made a chart with the number and proportion of each monument type (Figure 4).

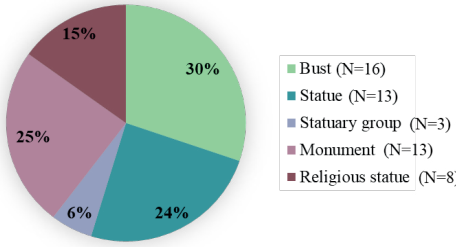


Figure 4. The proportions of various types of monuments out of the overall number of main monuments (N = 53)

The age of the monuments or the installation date, for some of the monuments in our study, is unknown. Since the analyses we performed required such information, we assigned a date, in the following way:

- for monuments with missing information about the day, but with data about the month and year of installation, we indicated the last day of the installation month;
- for monuments with data only on the year of installation, the day and month used in subsequent analyses is the 31st of December;
- for the monuments with no precise information on the installation or building date, we considered them to have been installed within the last three decades because of the available data suggesting this period. Consequently, they were not considered for the following analyses.

Two criteria were taken into account for this determination, i.e., the date of monument installation on its original site and the actual age of the monument, meaning from the day it was built until the present.
Based on the criteria considered, we concluded that the Carolina Obelisk (Figure 5), installed in Museum's Square in 1898, is the oldest monument in Cluj-Napoca. This monument honours the stay of the royal couple Emperor Francis I and Caroline Augusta in Cluj, in 1817. It was built south of the city's Central Square in 1831.
The monument classified as the newest one based on the same criteria, is the Statue of the Virgin Mary (Figure 6), in front of the Piarists' Church. This monument was considered the newest because the present statue is new, created in response to the excessive deterioration of the old statue, which is no longer displayed in public places, but is preserved in museum conditions, together with the original angels. The old statue, erected in 1774 as a sign of gratitude for the protection given to Cluj during the last great plague epidemic between 1738 and 1742, was also named the "Plague Column". The new statue, a faithful copy of the old statue, was installed in 2023, in front of the Piarists' Church, in the place formerly occupied by the old statue.

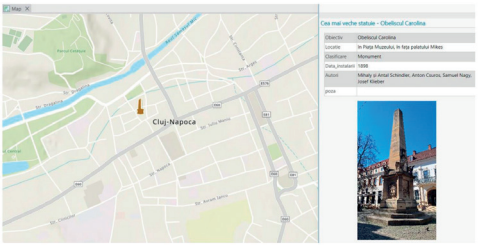


Figure 5. The oldest monument in Cluj-Napoca

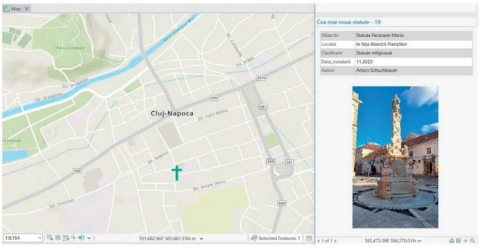
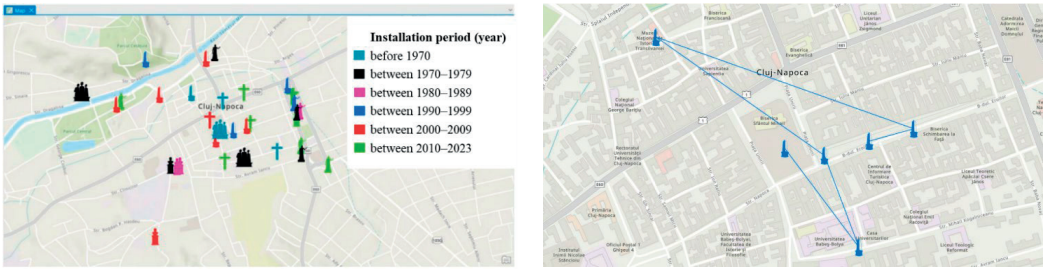


Figure 6. The newest monument in Cluj-Napoca

Another interesting analysis was on the number of monuments installed in the last decades and, of course, visualizing them on the interactive map. Monuments were grouped into ten-year periods according to the date of installation, with two exceptions: i) monuments installed before 1970 were grouped in the same category, because the quantity of these monuments is small and the periods between their installation are too long to justify creating separate categories; ii) monuments after 2010, which also includes statues installed until now. In Figure

7A we have overlaid the layers containing monuments from each defined period. The monuments in each layer have been colored according to the period in which they were installed.

Another analysis performed on the location of the monuments consisted in representing on the map the previous locations for the monuments if it was relocated over time. In Cluj-Napoca, infrastructure changes or construction and renovation of various buildings or parks occur frequently. These works may require moving monuments to facilitate the access of workers and machinery. Depending on the nature and form of the works, the site previously occupied by the monument may become unavailable and as such, it will be allocated a new site. In the case of very old monuments, the reason for their relocation may be war protection. Of the statues and monuments included in this paper, four have been relocated from their original installation site. These are the Statue of the Virgin Mary, Lupa Capitolina, the Carolina Obelisk and the statue of Saint George. Although previous analysis has revealed statues that have been relocated from their original installation site, the exact coordinates of previous monuments' locations are lacking. The only existing information verbally describes the previous locations, but this is not sufficient to represent the previous locations correctly on the map. As a compromise, the monuments' previous locations were marked manually, by placing nodes, which approximate the locations described verbally. The route of the monument's relocations was also marked on the map (Figure 7B).



A B

Figure 7. A. Analysis based on the time in which monuments were installed; B. Illustration of viewing on the interactive map the route of previous locations for the Lupa Capitolina monument

The web map development is an important step towards the project's aim, i.e., to create the web application.

With the shapefiles imported from ArcGIS Pro a map was created, containing two layers named 'Main Monuments' and 'Secondary Monuments'. The 'Main Monuments' layer (Figure 8) contains the monuments considered of major interest to future users.

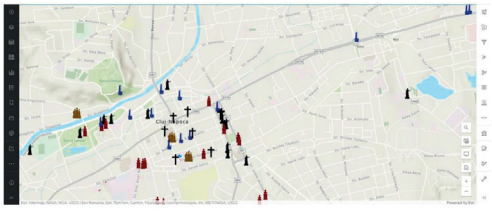


Figure 8. The layer with the main monuments

Monuments in the map layer called 'Secondary Monuments' are monuments that have a lower cultural and historical value. The criterion for classifying monuments as secondary was that their location was within the premises of higher education institutions. The secondary monuments' classification was done by creating a new field in the Attribute Table of the map layer. This field combined the values from the classification and membership fields to facilitate the use of unique value styles to represent them. Based on the unique values, the monuments were symbolized using the icons previously created and colored according to the institution they belong to. For example, in Figure 9, green is for the University of Agricultural Sciences and Veterinary Medicine, red for the University of Medicine and Pharmacy, and blue for Babes-Bolyai University. The web map is then ready to be transformed into a web application. In this

form, the map can be distributed and accessed by anyone wishing to enrich their knowledge of the monuments of Cluj-Napoca.

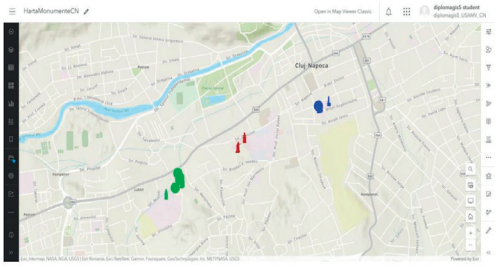


Figure 9. The layer with secondary monuments

Using the models made available through the Instant Apps function of the ArcGIS Online platform, a nearby application was created (Figure 10). This application allows the user to select his/her position on the map by tapping the screen or with a click, and the application will highlight all targets within a selectable radius. The nearby model was chosen because it fits with one of the project's aims, namely to help users discover statues they did not know about. After selecting the application type, we used the express configuration mode.

We set the minimum (100 m) and maximum (2 km) values of the selection area, designated the search sources (Main Monuments and Secondary Monuments layers in the web map), and left the theme-related settings as in the original configuration. We then added the legend and share button because, after configuration, the web application can be published and shared.

The first function of the application, conferred by the template used, is to highlight the monuments located in the selected area (Figure 10). We selected the maximum radius of the coverage area to cover several statues regardless of the point selected by the user.

Another useful feature of the created application is the ability to suggest a navigation route to a monument of interest (Figure 11).

To generate a route, the user chooses a starting position on the map surface. Then, the destination monument is chosen from the list and the route will be generated automatically. At this point, one can choose the traveling method and see an estimate of the time needed to cover the route (Figure 11).

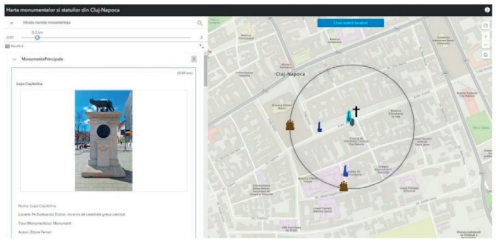


Figure 10. Illustration of the 'nearby' function in the web application

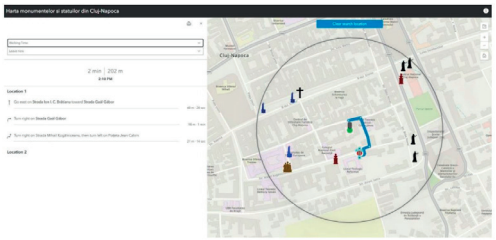


Figure 11. Example of a navigation route generated in the web application

There is also the possibility to search for a specific monument by its name. To do this, one should use the search box, which will present autocompleting suggestions for the name of the monument (Figure 12).

Figure 12. Illustration of the function that searches by monument's name

Selecting a monument on the map will display a list of the monuments in the selection area, where one can see the pop-up windows on the web map. These windows contain the monument's photo, location, type of monument, and information about its significance. The pop-up information has been selected according to its relevance to potential users (Figure 12).

For each monument in the defined proximity area, one can determine the route according to the traveling mode, by using the options included in the pop-up (Figure 13).

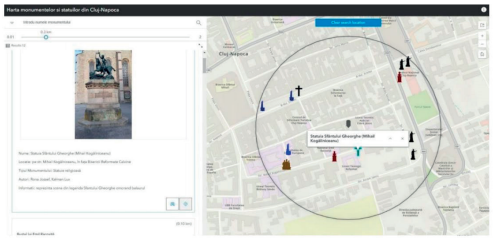


Figure 13. Example of a pop-up list, with information on the monuments

This application can be shared as a link, namely https://usamv-cn.maps.arcgis.com/apps/instant/nearby/index.html?appid=2db1f35fda164895bc87a534b321f9ab&center=23.6815;46.7911&level=13&hiddenLayers=1903b181a0a-layer-4

CONCLUSIONS

The monuments of Cluj-Napoca are numerous and indicate an abundant history, but most are unknown. We classified (as completely as possible) the monuments found in public spaces in Cluj-Napoca, more precisely, their location, type, history, and significance. Using our web application, it is possible to visualize the monuments within a selected area (with a selectable radius of the coverage area, ranging between 100 m and 2 km). In addition, users could also search for a monument by its name, and it is also possible to select the destination monument from the list, choose a starting position on the map surface, and the route will be generated automatically.

Gathering and integrating this data into a web application facilitated the dissemination of information about the monuments. The methods used in our study were effective. Determining the coordinates of the monuments by GPS with the Mobile Topographer application considerably shortened the measurement time. The ArcGIS software ecosystem also proved to be a powerful tool in processing the data needed to create the web application that may be a guide to the Cluj-Napoca statues and monuments.

The personalized route generation is a standout feature of our web app, particularly useful for visitors or those exploring the city.

Our interactive map (and the related web app) is similar to other web applications in that it provides non-experts without extensive training in GIS applications (Kydonakis et al., 2012). It represents a basic toolset to add value to the cultural heritage record and supplies topographic and cartographic information to show the monument's precise location and address (Kydonakis et al., 2012) being the most localized, user-centric, and comprehensive tool for exploring the historical monuments of Cluj-Napoca. Moreover, the costs implied to develop it are incomparably lower than for advanced measurement techniques and processing of the measurement data (e.g., laser scanning technology and low-altitude photogrammetry) (Horbinski & Smaczynski, 2023). Compared to the more general or broader apps available, our web app focuses on the city, interactive map features, ease of access, and detailed historical information. It is particularly valuable for anyone looking to navigate Cluj-Napoca's rich history, whether visiting or exploring their hometown in more depth, to enjoy the diversified offer of historical and cultural patrimony (Popescu et al., 2018).

In summary, we provide a tool that may educate and make the city more accessible and engaging for a wider audience, from history enthusiasts to casual explorers. By leveraging advanced mapping technology with comprehensive cultural insights, our study's results advance tourists' interaction with Romania's monuments, enriching the travel experience and contributing to the appreciation of Romania's vast heritage.

REFERENCES

Bucurescu, I. (2015) Managing tourism and cultural heritage in historic towns: examples from Romania. *Journal of Heritage Tourism, 10*(3), 248–262.

Comes, R., Neamțu, C., Buna, Z., Bodi, S., Popescu, D., Tompa, V., Ghinea, R., & Mateescu-Suciu, L. D. (2020). Enhancing accessibility to cultural heritage through digital content and virtual reality: a case study of the Sarmizegetusa Regia UNESCO site. *Journal of Ancient History and Archaeology*, *7*(3), 124–139.

Ciorca, I. (2020). *Monumente si statui clujene*. Cluj-Napoca, RO: Casa Cărții de Știință.

Dulău, A. V., & Coroș, M. M. (2009). Investigating Cultural Tourism Development and Attractiveness in Transylvania, Romania. A Focus on the Counties of Cluj and Sibiu. Conference Paper. DOI: 10.13140/2.1.1443.3606. Retrieved from https://www.researchgate.net/publication/271442875_Investigating_Cultural_Tourism_Development_and_Attractiveness_in_Transylvania_Romania_A_Focus_on_the_Counties_of_Cluj_and_Sibiu

Garcia-Esparza, J. A. & Altaba Tena, P. (2020). A GIS-based methodology for the appraisal of historical, architectural, and social values in historic urban cores. *Frontiers of Architectural Research*, *9*(4), 900–913.

Horbinski, T. & Smaczynski, M. (2023). Interactive thematic map as a means of documenting and visualizing information about cultural heritage objects. *ISPRS International Journal of Geo-Information, 12*(17), 257.

Kydonakis, A., Chliaoutakis, A., & Sarris, A. (2012). A GIS based application for the management of monuments and antiquities of Cyprus. *In 32nd EARSeL Annual Symposium "Advances in Geosciences", Mykonos, Greece*.

Lupu, C., Padhi, S. S, Pati, R. K., & Stoleriu, O. M. (2021). Tourist choice of heritage sites in Romania: a conjoint choice model of site attributes and variety seeking behavior. *Journal of Heritage Tourism, 16(*6), 646–668.

Maroşi, Z., Adorean, E.-C., Ilovan, O.-R., Gligor, V., Voicu, C.-G., Nicula, A.-S., & Dulamă M. E. (2019). Living the urban cultural landscapes in the city centre of Cluj-Napoca / Kolozsvár / Klausenburg, Romania. *Annals of the Austrian Geographical Society*, *161*, 117–160.

Orban, M., & Puiu, V. (2015). Studies and research on cultural built heritage in Cluj-Napoca fortress and its tourist valorification. *Studii şi cercetări, Geology-Geography, 20*, 109–117. Museum of Bistriţa-Năsăud, RO: Ecou Transilvan Publishing House.

Pascu, Ş., Marica, V., Ţoca, M., & Wagner, R. (1974). *1850 Clujul istorico-artistic*. Cluj-Napoca, RO: Consiliul Popular al Municipiului Cluj.

Popescu, A, Grigoras, M. A., & Pleşoianu, D. (2018). The city of Cluj-Napoca and the Cluj county, important tourist attractions in Romania. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, *18*(1), 401–416.

Ries, M., & Schwan, S. (2023). Experiencing places of historical significance: A psychological framework and empirical overview. *Journal of Environmental Psychology*, *92*, 102179.

Romania's Ministry of Culture (2024). List of historical monuments by county, 2015. Retrieved February 8, 2025, from https://www.cultura.ro/lista-monumentelor-istorice

Ropa, L., & Ropa, M. (2017). Schimbarea denumirii oraşelor Cluj şi Turnu Severin (1974): o manifestare a megalomaniei protocronist-naţionaliste. *Annals of Oradea University. Fasciola History-Archaeology, 27*, 171.

UNESCO, https://www.unesco.org/en/cultural-heritage-7-successes-unes https://www.unesco.org/en/cultural-heritage-7-successes-unescos-preservation-work cos-preservation-work

Vilceanu, C. B., Herban, S., Pescari, S., & Budău, L. I. (2022). Comparative study of 3D modeling by short-range photogrammetry. *Scientific Bulletin of Politehnica University Timisoara*, 67(1), 45–49.

WTTC. (2024). Tourism Satellite accounting: *Romania Travel & Tourism Economic Impact Factsheet 2024*. London: World Travel and Tourism Council. Retrieved February 6, 2025, from https://researchhub.wttc.org/factsheets/romania