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Challenges in use of geographical information systems (GIS) in a research for understanding conservation of cultural heritage in Bursa

Challenges in
use of GIS

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Abstract

Purpose – The purpose of this paper is to present a framework of introducing a proper method to document and to analyze conservation process of cultural heritage in Bursa, known as one of the UNESCO World Heritage Sites in Turkey and to discuss challenges in use of geographical information systems (GIS) for assessment of a complex data collected and analyzed during different phases of the historic researches.

Design/methodology/approach – A systematic approach is used to understand relations between theoretical and practical processes of heritage conservation in Bursa. Due to the complicated structure of input data, GIS was used as the major tool in illustration of cultural heritage in various spatial scales, while providing connection between different timelines of its urban history. Within this concept, at first, conservation history of cultural heritage in Bursa is briefly described. Second, four stages of the method, used to make reliable and convenient assessment, are given. Finally, facilities and challenges in using this system are discussed in relation with the results achieved.

Findings – As a result of this study, both chronological and spatial distribution of all types of conservation practices are described in related with theoretical and legal aspects. There appear both advantages and limitations in use of GIS, during assessment of input data to understand conservation history of Bursa.

Originality/value – Therefore, it would be possible to see if it is adequate to understand the complicated structure of such kind of overlapped sources in a systematic way of information management system.

Keywords Cultural heritage, Urban conservation, Geographical information system, Inventory methodology, Bursa

Paper type Case study

1. Introduction

Architectural and urban planning works influence both formation and transformation of historic character of a city, which can be accepted as an evidence of the past society that gives the guidelines for the future development and prosperity. Revitalization and conservation of historic urban areas include aspects of maintenance and renewal of their physical traditional texture together with economic and social dynamism on their development. Hence, the multi-layered structure of a historic city center is necessary to be understood in unity despite of its complex character, which should be defined in a systematic way of geographical information management.

This study is a part of the Phd thesis (“An Assessment on Conservation Activities in Bursa, Focusing on Conservation Council Decisions from 1955 to 2012”, Department of Architecture, Middle East Technical University, Ankara, 2015) that was financially supported by Bursa Metropolitan Municipality (Bursa, Turkey) to where the authors are grateful for contributions in its archival research.



Historic urban areas are vulnerable to number of stressors such as rapid urbanization, population growth and natural disasters. Management strategies related to historic urban areas aim to provide the use of cultural heritage for sustainable development of cultural landscapes and natural environment. As Agapiou *et al.* (2015) mention, conservation of cultural heritage areas require innovative and cost effective tools for systematic monitoring which require costly and time consuming data and information collection procedures for large areas. The importance of digital photogrammetry and laser scanning during process of a digital documentation for an immovable is also reminded by Yastıklı (2007), while geographical information systems (GIS)-based surface analysis is capable to be done systematically on investigating former status of various sites, from archaeological and natural sites to historic mining areas, as studied by Kovács *et al.* (2011) and Al-kheder *et al.* (2008).

In addition to analyzing the morphological development of a historic city, heritage conservation process is also essential to be assessed and elaborated by digitizing collected input data in different methods. There are several tools, one of which is known as GIS, which is used to manage large data sets for developing sustainable management plans of historic urban areas. The process of urban conservation can be facilitated by making use of spatial database in this system, as already been defined by the scholars (Bilgin Altınöz, 2002; Günay, 2009; Lerotic, 2011). Moreover, He *et al.* (2015) state that the use of GIS systems brings their own challenges for supporting decision-making strategies because of the large scales of their database system despite of the remarkable advances in its field to support management of cultural heritage sites.

As one of the historic cities in Turkey, Bursa, a Nomination File of Bursa as UNESCO World Heritage Site (WHS) since 2014, has followed legal and organizational aspects in conservation issue, which also being witnessed to practices occurred in conservation of historic urban areas since the end of the nineteenth century. It is significant as being the first capital of Ottoman Empire and a developing industrial city in Turkey. Various types of cultural properties have been subjected to different conservation activities, from the public participated symposiums to the restoration applications. These activities have continuously effected to the sustainability of both tangible and intangible cultural heritage in Bursa, which should be studied by searching on historical documents describing faults and successes on the applied projects.

Due to its complicated structure, proper tools and methods need to be used to achieve systematic and clear evaluation on conservation history of Bursa. However, there sometimes has appeared incompatibility in assessment process of the research due to variety of technical equipment in use of collected data in different formats of a basic system. Consequently, in this paper, it is aimed to present both facilities and difficulties in use of GIS as a method to understand conservation history of Bursa, by analyzing and evaluating chronological and spatial distribution of all types of conservation implementations.

In this respect, this paper starts with a brief description of conservation approaches in Bursa, by focusing on the togetherness with national conservation legislations in Turkey. Second, the methods used for making reliable and convenient assessment on these activities are described in detail, while conservation activities in Bursa are being used as input data in accordance with GIS. Afterwards, the contribution of GIS in this study is explained together with gaps occurred during visualization of collected and analyzed data. By this way, the challenges in methodological aspects are discussed to understand the capability and utility of information management systems in such kind of complicated research studies.

2. Conservation of cultural heritage in Bursa

Bursa, as one of the UNESCO WHS in Turkey, contains listed archaeological remains, buildings[1] and sites[2], comprising historical, architectural and cultural value within unity of the city. Apart from the archaeological remains (from the second century BC) and new industrial buildings of Turkish Republican Period (from 1923 till present), most of the

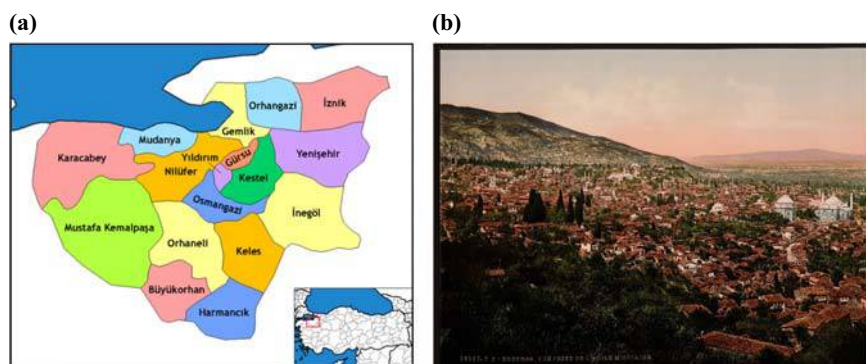
existing historic buildings in Bursa were constructed during the Ottoman Period (between the fourteenth and twentieth centuries) (Figure 1).

This multi-layered character of the city was subjected to permanent changes between the late nineteenth century and the early twentieth century, by the application of Beneficial (Tanzimat) Reforms in urban planning (Dostoğlu and Vural, 2002). Meanwhile, many immovable cultural properties, especially the monumental ones, were repaired and restored according to new regulations[3] issued during the final years of the Ottoman Empire (Çakıcı, 2015, pp. 67-74).

The transformation movements have continued to influence decisions on city planning, after the proclamation of Turkish Republic in 1923. The listing and conservation implementations were approved to be applied on site, by the establishment of the High Council for Immovable Old Properties and Monuments (GEEAYK) in 1951, as the central decision maker governmental institute. Meanwhile, reconstruction was inevitable instead of simple repair and conservation of monumental historic buildings, which were destroyed and collapsed as a result of disasters, such as earthquakes and fires occurred within city center of Bursa (Çakıcı, 2015, pp. 92-98).

Following the new acts[4] on conservation, issued in between 1973 and 2003, not only monumental but also historic houses in old neighborhoods of Bursa started to be restored and rehabilitated together with their surroundings. Especially by the Conservation Act accepted in 1983, conservation development plans were prepared to preserve the historic areas in city center of Bursa, by providing public awareness and municipal participation into the sub-projects of the plans (Çakıcı, 2015, pp. 124-203).

After the acceptance of the new acts in between 2003 and 2005[5], the local authorities have taken the power of design, application and control of conservation implementations, which concerns mostly regeneration and renovation of historic areas instead of conservation and continuation, which resulted in “transformation” and “metamorphoses” (Şahin Güçhan, 2015). Meanwhile Bursa started to follow the new approaches in conservation come out during this “Era of Change” (Şahin Güçhan and Kurul, 2009, pp. 33-34) in Turkey. Rebuilding of traditional texture was common to be applied under title of “street rehabilitation projects,” proposed during the projects of transformation and regeneration within abandoned or emptied neighborhoods in its historic city center (Çakıcı, 2015, pp. 203-289).



Notes: (a) Location and districts of Bursa ([https://tr.wikipedia.org/index.php?q=aHR0cHM6Ly90ci53aWtpcGVkaWEub3JnL3dpa2kvRG9zeWE6QnVyc2FfZGlzdHJpY3RzLnBuZw](https://tr.wikipedia.org/index.php?q=aHR0cHM6Ly90ci53aWtpcGVkaWEub3JnL3dpa2kvRG9zeWE6QnVyc2FfZGlzdHJpY3RzLnBuZw;)); (b) historic view of Bursa in 1890s (<https://en.wikipedia.org/index.php?q=aHR0cHM6Ly91bi53aWtpcGVkaWEub3JnL3dpa2kvRmlsZTpWaWV3X29mX3RoZV9jaXR5LF9CdXJzYSxfVHVya2V5LUxDQ04yMDAxNjk5NDUwLmpwZw>); (accessed August 3, 2017)

Figure 1.
Current location and
historic view of Bursa

As a result of the meetings and on site investigations of the International Council of Monuments and Sites (ICOMOS), the sites of “Bursa Hanlar District, Sultan Complexes and Cumalıkızık Village” were decided to be managed in respect to their identity and conservation status, which resulted in the membership of Bursa as one of Nomination File of Bursa as UNESCO WHS (2014)[6] (Figure 2). This membership was accepted as a breakpoint in conservation history of Bursa since contributing to development and revival of its conservation policy.

In brief, Bursa is a pioneering city in terms of both building and site conservation, in relation with national conservation legislations for more than a century. In order to present this pilot role, all collected data comprising written (the Councils’ conservation decisions, literature sources, etc.) and visual (maps, plans and photographs, etc.) documents need to be reorganized as input data to be used in an information management system.

3. Methodology and data sources

Since the major topic of this research is to assess various types of conservation activities in Bursa, a combination of interpretive-historical and case-study research methods is preferred to be used. Historical researches include both visual and written archival sources, which should be overlapped with the recent ones in a systematic method by using geographical features. In order to evaluate that match of collected data together with geographical features, it was required to study in a holistic methodology, which is composed of four phases (Figure 3). The first phase is composed of documenting data gathered from both literature and archival surveys. After classifying the data to have a chronological order together with typological distribution of conservation activities and cultural heritage, an attribute list is prepared to be used in digitization phase of the study. The grouped input data is introduced into GIS in order to reveal clear results on a basic map. Finally, it is able to discuss the analysis via the compared maps including both spatial and temporal information. This contributes to understand dominant implementations, mostly conserved cultural heritage and breakpoints in conservation history of Bursa, which describes evaluation phase of the method.

3.1 Documentation phase, including literature and archival research

Accurate spatial information and detail documentation is initially needed for the development of restoration programs and management of historic areas. A detail and

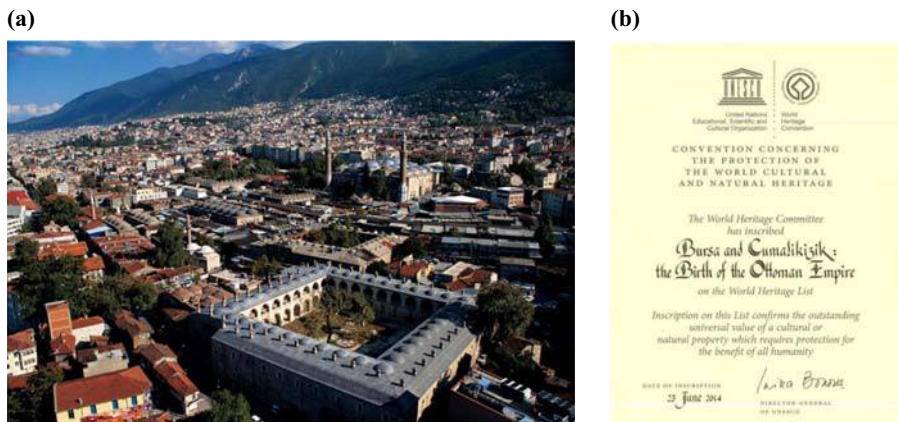
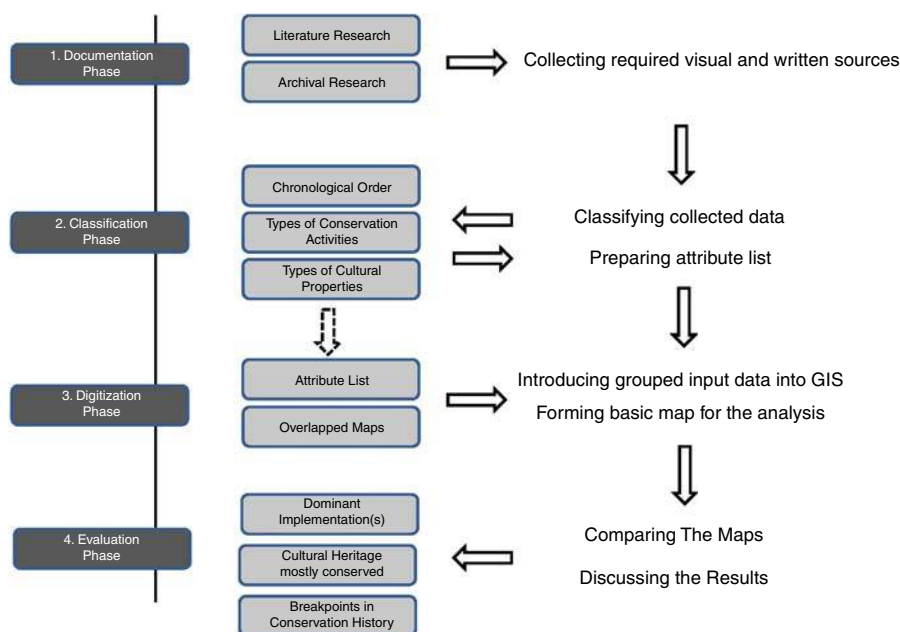


Figure 2.
Bursa; as one of the UNESCO World Heritage Sites in Turkey

Notes: (a) Current view of Bursa (www.bursa.gov.tr; accessed November 18, 2016); (b) Membership Document of Bursa as one of the UNESCO World Heritage Sites in Turkey (<http://alanbaskanligi.bursa.bel.tr/en/>); accessed February 18, 2017)



Challenges in use of GIS

Figure 3. Flowchart revealing four phases in methodological process of the study

precise documentation is the first phase that requires realistic representation of the condition and location of cultural heritage, which enables to develop plans and strategies for its protection and future sustainable development. Hence, a comprehensive literature review (Çakıcı, 2015, pp. 22-26), including both written and visual documents in terms of urban history and conservation history of Bursa, should be done at first.

The primary written information was gathered from the books, the articles published in periodical journals, the proceedings printed in the symposium books, and thesis works. Historic texts, including logbooks of travelers and researchers, were also investigated and evaluated as the secondary sources of the historical research. Due to the lack of accuracy of the literature on the conservation history of Bursa, it was required to gather virgin original data from the local sources in the archives of Local Authorities, the General Directorate of Pious Foundations, the Regional Conservation Council of Bursa (BKVKBK)[7] and Bursa Provincial Administration and the Special Provincial Administration.

As a result of the archival research, printed historic maps, aerial photos, sketches and drawings of master plans and conservation development plans were collected and scanned to be used as in GIS, which also helped in revealing the morphological development in multi-layered character of Bursa. Consequently, an inventory for documentation of conservation decisions and implementations, concerning cultural heritage in Bursa, were aimed to be prepared, in order to be used on a base map via GIS.

3.2 Classification phase, preparing tables and attribute lists of GIS database

Before passing through introducing process, it was required to classify the input data into distinctive subtypes, in order to present collected information in a more understanding way. The information gathered from literature survey was classified under the titles of “urban history” and “conservation history.” Dates of conservation events were put into order chronologically in relation with urban development activities, in order to discover if there has been any common relation between these two types of historic data. For instance, 1855

earthquake and 1958 fire were both two significant events causing not only structural damages but also reconstructions of collapsed historic buildings within historic commercial center of Bursa, while influencing conservation approaches in its urban planning policy. Hence, that matching helps us to observe similarities and discrepancies in between results of these two disasters that happened hundred years apart from each other.

Afterwards, the conservation implementations were reorganized according to the information given in the conservation decisions approved by BKKKBK. Those decisions were put in order according to their “date” and “ID number” together with “aim(s)/reason(s),” “effect(s)/result(s),” “owner(s)” and “the stakeholder(s)” of conservation implementations (Table I). Moreover, the information about cultural properties, which were mostly repaired and restored, were also given systematically, in order to identify the spatial distribution of conservation activities in Bursa and its hinterland.

After this pre-understanding process for all types of conservation activities, a matrix table (Table II) was prepared to describe the relation between conservation activities and related cultural heritage, accepted as the input data to be entered later into GIS systematically. In this table, cultural properties were grouped under the titles of “historic area (HA),” “historic building (HBldg)” and “archaeological remains (AR),” while conservation activities were categorized as “Research,” “Approval” and “Application.” Accordingly, “symposiums” and “documentation studies” about conservation of local heritage were grouped under title of “Research,” together with “the expert reports attached to the Councils’ decisions.” This “Research” process is significant as including demands and proposals required to be defined and understood before “Approval” and “Application” processes of conservation implementations.

It is also essential to form an attribute list (Table III), including the content of the attributes, which are planned to be used in introducing whole conservation history of Bursa into GIS. Accordingly, the cultural properties were identified according to their “Name,” “Location,” “Function,” and “Registration Statue.” On the other hand, “type,” “date,” and “reason” of the related conservation activities have contributed to find out if there has been any destructive or conservative approaches on them. For instance, the functional distribution of historic buildings and sites were also observed as a result of grouping the utility that was proposed in various restoration and rehabilitation projects, according to that attribute list. Most importantly, the codification, shortly referencing different types of conservation activities in this attribute list, should be given in all tables commonly, in order to use these classified information systematically.

While the documents gathered from archival research were confirmed in detail by this categorization, the historic attributes of the city were identified together with contemporary city elements, which also have influenced transformation of historical texture. For instance, the “road(s)” were confirmed since they have been continuously opening and widening since the end of the nineteenth century, which also contributes to identify and reshape morphological character of the historic city center of Bursa. Besides, geographical objects, such as “river(s)” and “plain” of Bursa, were also identified according to their dimensions, locations and conditions while the interventions applied their surrounding were also confirmed.

3.3 Digitization phase, introducing classified data into GIS

Following classification phase, all types of cultural properties and related conservation activities were needed to be digitally visualized on geographical aspects. A holistic digital database, composed of written and visual documents together with geographical features on recent plans, was prepared. Meanwhile, GIS was preferred to be used instead of the variety of methods in digitizing such a complicated data. Since it has ability to present collected and categorized data via geographical documents[8].

Conservation activities in Bursa, according to the conservation decisions gathered from the archive of BKTVKK Participants for the conservation activities, mentioned in the council decisions						
Number and date of conservation decision	Name of conservation council	Type/name/parcel number of related cultural property	Type of conservation implementation	Prepared by	Decided to be applied by	Aim/reason for the activity
371/April 23, 1955	GEEAYK	Yıldırım Bayezid Bezzestan	Approval of Restoration Project	Removal of previous additions	Directorate General of Foundations and its major architect: Ali Saim Ülgen	Directorate General of Foundations To make the cells of Bezzestan visible, together with its inner courtyard
387/May 27, 1955	GEEAYK		Approval of Restoration Project	Construction of new building Removal of additions	Directorate General of Foundations	To remove the attached shops on the outside of the Bezzestan To reconstruct the added shops by using compatible material (except reinforced concrete) To remove the shops filling the spaces between the colonades To add new shops surrounding
970/July 7, 1958	GEEAYK		Approval of Restoration Project	Construction of new buildings Maintenance Reconstruction	Directorate General of Foundations	To repair brick wall inside for its stability To reconstruct the collapsed part of the Bedesten by using reinforced concrete and to recover the reconstructed columns, vaults, and arc with brick, for a traditional view

(continued)

Challenges in use of GIS

Table I.
A part of table identifying types of conservation activities in Bursa

Table I.

Conservation activities in Bursa, according to the conservation decisions gathered from the archive of BKTVKK Participants for the conservation activities, mentioned in the council decisions					
Number and date of conservation decision	Name of conservation council	Type/name/parcel number of related cultural property	Type of conservation implementation	Prepared by	Decided to be applied by
7763/April 19, 1974	GEEAYK	Tophane Neighborhood and its surrounding and East Part of Maksem Neighborhood	Approval of Citadel Walls Registration	The architect of High Conservation Council (GEEAYK): Besim Çeçener	Decided to be applied by
		Public and religious buildings Dwellings			To establish historic areas as "site," while registering historic buildings within Hisar District
		Hisariçi ve çevresi için "Sit Anlayışlı Koruma Planı" çalışması	Preparation of Conservation Plan		To start related implementations in historic urban site, according to the conservation principles mentioned in the Urban Development Plan
		Studies on preparation of Development Plan for Muradiye District	Studies on Implementary Development Plan (imar tabiiyat planı)	Ministry of Public Works and Housing	To prepare a conservation plan (SIT anlayışlı İmar Planı) for defined urban site within Cıtaşel District
A-625/July 9, 1977	GEEAYK	Natural Monuments; Religious and Cultural Monuments; Dwellings	Approval of Registration	General Directorate of Ancient Arts and Museums	To register the historic buildings within city center of Bursa

Source: Çakıcı (2015)

Challenges in use of GIS

	Research (R)		Type of conservation activities		Application (A)	
			Approval (App)			
Historic area (HA)	Symposium	SYMP	Street rehabilitation project	SRP	Street rehabilitation project	SRP
	Documentation	DOC	Rehabilitation project	RP	Rehabilitation project	RP
	Report on the current state	REP	Conservation development plan	CDP	Conservation development plan	CDP
Demand on registration	Proposal demand on conservation	PD	Infill within the historic area	INFILL	Infill within the historic area	INFILL
		DREG	Environmental regulation project	ERP	Environmental regulation project	ERP
			Urban regeneration project	URP	Urban regeneration project	URP
			Urban design project	UDP	Urban design project	UDP
			Registration decision	REG		
Historic building (HB)	Symposium	SYMP	Restoration	REST	Restoration	REST
	Documentation	DOC	Simple repair	SR	Simple repair	SR
	Report on the current state	REP	Partial reconstruction	PRConst	Partial reconstruction	PRConst
	Proposal demand on conservation	PD	Reconstruction	RConst	Reconstruction	RConst
	Demand on registration	DREG	Registration decision	REG		
Archeological remains (AR)	Symposium	SYMP	Restoration	REST	Restoration	REST
	Documentation	DOC	Simple repair	SR	Simple repair	SR
	Report on the current state	REP	Partial reconstruction	PRConst	Partial reconstruction	PRConst
	Proposal demand on conservation	PD	Reconstruction	RConst	Reconstruction	RConst
	Demand on registration	DREG	Organized excavation	EXC	Organized excavation	EXC
			Transportation Registration decision	TRANS REG	Transportation	TRANS

Table II.
Matrix showing classification of cultural properties and conservation activities

Source: Çakıcı (2015, p. 39)

As explained by Parker and Asencio (2009, p. xiv), it is a system for storing, analyzing and displaying geographically based data while managing digitized maps and any other electronic representations of geographic spaces as the data about geographic locations. In addition to this spatial use, this system is also preferred to prepare chronological order of conservation activities in a timeline, which would also contribute to understand if there is any temporal relation in between them.

In this respect, a “base map” was required to be prepared in order to determine where to place particular attributes based upon specific geographic criteria. Meanwhile, historic maps and plans, mostly in hardcopy format, were used together with the digital format of conservation development plans and master plans of Bursa, in order to reveal the enlarged boundary of historic city center[9].

After that rectification process, the input data, composed of information visual and written sources, were started to be introduced into GIS software process systematically (Figure 4).

Attribute(s) list	Spatial objects			Geographical objects		
	Historic Area(s)	Historic Building(s)	Archeological Remain(s)	Road(s)	River(s)	Bursa Plain
<i>Identifying information</i>						
Name	✓	✓	✓	✓	✓	✓
Location	✓	✓	✓	✓	✓	✓
Construction date		✓				
Period		✓	✓			
Original function		✓		✓		
Current function	✓	✓		✓		
Dimension	✓	✓	✓	✓	✓	✓
Current condition	✓	✓	✓	✓	✓	✓
Registration status	✓	✓	✓		✓	✓
Registration type	✓	✓				
<i>Intervention information</i>						
Name	✓	✓	✓	✓	✓	✓
Date	✓	✓	✓	✓	✓	✓
Proposed function	✓	✓	✓	✓	✓	✓
Type of intervention	✓	✓	✓	✓	✓	✓
Current status of intervention	✓	✓	✓	✓	✓	✓
Reasons of intervention	✓	✓	✓	✓	✓	✓
Results of intervention	✓	✓	✓	✓	✓	✓
Owner/stakeholder	✓	✓	✓	✓	✓	✓

Table III. Table including attributes for spatial and geographical objects in Bursa

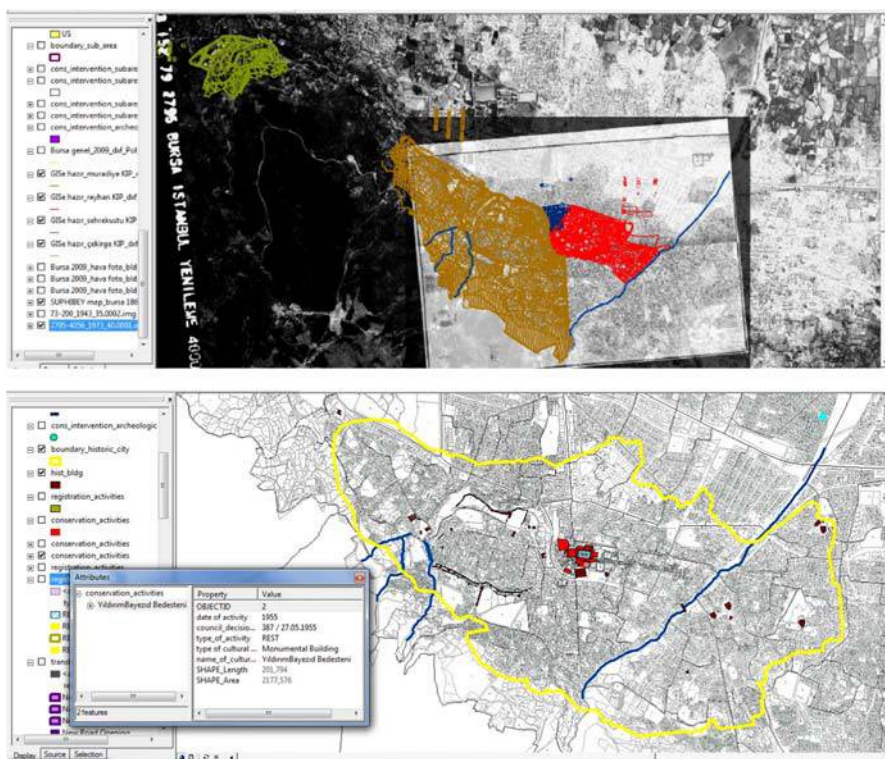
During this digitization phase, spatial objects and the Plain of Bursa were displayed in GIS mapping by being drawn in “polygon geometry”[10], whereas its geographical features, such as “River,” “Contour Lines of Mt. Uludağ,” and “Boundaries of Towns and Villages” were drawn in “line geometry.” Besides, each types of conservation activities was also drawn in “polygon geometry,” since they were confirmed according to the boundaries of building blocks and parcels.

Consequently, all data introduced on a systematically formed database was digitized, which made it easier to understand the distribution of the conservation activities on related historic neighborhoods. Besides, it helped to identify periods identifying conservation history of Bursa in relation with morphological movement of this multi-layered characterized historic city.

3.4 Evaluation phase, comparing the maps prepared in GIS to discuss on the results

In order to make a clear evaluation for collected and classified implementations on the maps, it is essential to find out the right titles or keywords within the framework of normative explanations used in both national and international regulations. There was a linguistic gap between English and Turkish titles used for architectural conservation attitudes, which require a technical dictionary defining different types of implementations in common between these two languages (Bilgin Altınöz *et al.*, 2011). Hence, a dictionary was prepared in this thesis in order to bring consistency to various official terms used in legislations and related institutions about conservation issue in Bursa (Çakıcı, 2015, pp. 437-444). This dictionary would also be a contribution for the following studies related to international approach in conservation of cultural heritage in Bursa.

During this evaluation phase, the complicated data of the study were visualized by using GIS that is accepted as a convenient tool to make both chronological and spatial analysis. The digitized maps were compared to make proper assessment on definition of different conservation approaches in periods, forming the whole historical background of



Source: Çakıcı (2015)

Challenges in
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Figure 4.
Overlapping all types
of visual documents
and attribute
introducing into a
basic map

architectural and urban conservation of Bursa. In order to make this comparison, the questions to be answered were accepted as the criteria for a proper assessment on conservation history of Bursa. Accordingly, it was wondered that:

- (1) What are the breakpoint events or dates as forming the conservation history of Bursa?
- (2) What are the most popular or common conservation activities approved and applied in Bursa? Or, is there any kind of implementation dominantly active within the historic city center of Bursa?
- (3) Is there any historic area subjected to a combination of different types of conservation approaches? What are the major types of cultural properties mostly subjected to conservation activities? And where are they located within the historic city center of Bursa?

While trying to respond these questions, the data introduced into the rectified maps were put in order chronologically according to the dates of Council's Conservation Decisions. Besides, the results of this mapping process also differentiated according to organization of all types conservation implementations, informed from these decisions. Hence, this evaluation phase has helped to understand that:

- (1) The aggregation in dates of registration and designation decisions revealed the breakpoints of listing activities in Bursa. Moreover, the breakpoints in restoration applications, conservation development plans and new planning

activities were also confirmed as a result of this mapping. Consequently, it would be easy to understand if there is any connection and intersection in between different types of implementations along the timeline of conservation history of Bursa (Figure 5).

- (2) The digitized data were overlapped on the maps according to all types of conservation activities, which were classified in previous phase. By this way,

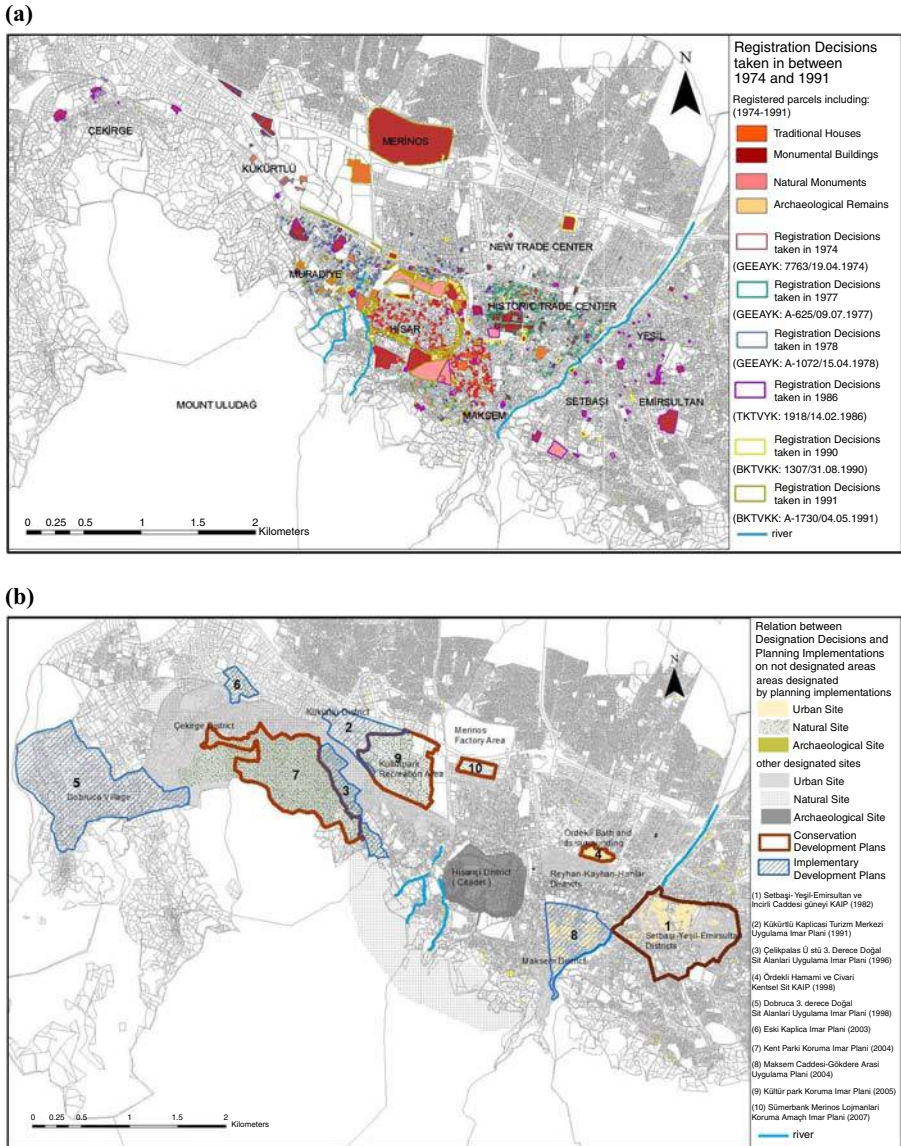
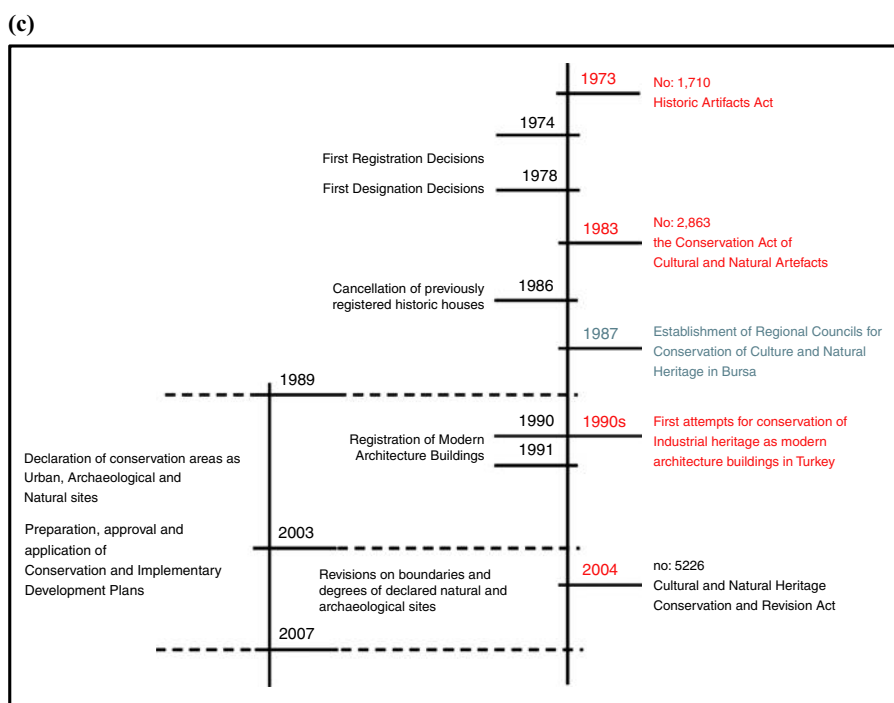


Figure 5. Analysis and results of evaluation via compared maps prepared in GIS format

continued



Notes: (a) Breakpoints of registration decisions taken by the high conservation council (GEEAYK) and regional conservation council (BKVKBK) in Turkey; (b) relation between different conservation implementations on defined historic urban areas in Bursa; (c) relation between different conservation activities within timeline of conservation history of Bursa (Çakıcı, 2015)

Figure 5.

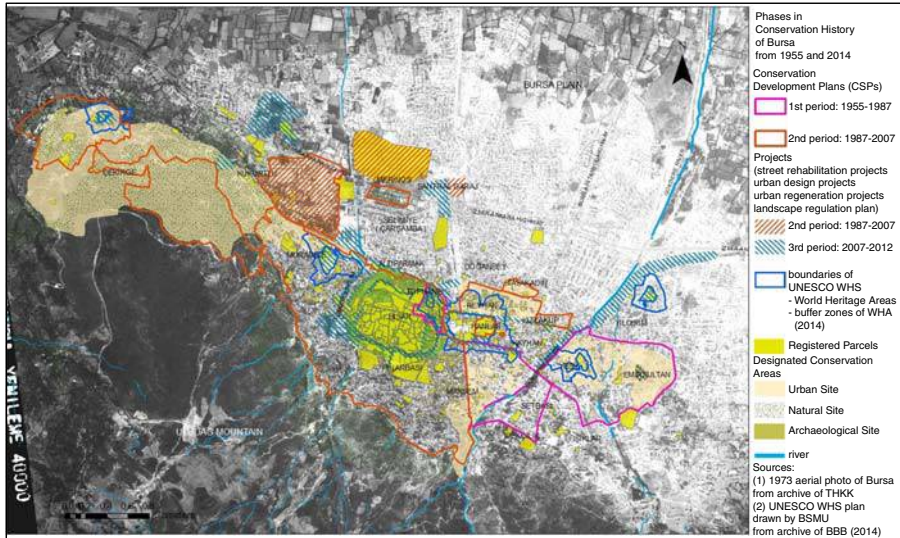
restoration projects were defined as the most popular implementations required for sustainability of historic buildings in Bursa. Besides, preparation and application processes of conservation development plans were observed as dominant attempts to rehabilitate historic areas.

- (3) The mostly conserved and transformed historic areas and buildings, as the immovable cultural properties in Bursa, were revealed by collecting all types of implementations on a common base map. Accordingly, the conservation of both monumental buildings and dwellings constructed in Ottoman Period was frequently mentioned in Council's decisions. Besides, the names of preserved regions or neighborhoods were identified according to togetherness of different conservation applications.

Consequently, conservation applications were assessed in chronological and spatial aspects, which were visualized as a result of this mapping process (Çakıcı, 2015, pp. 385-390). Accordingly, there are three phases forming conservation history of Bursa, which was defined as a result of comparison in between analysis maps (Figure 6). However, since this paper aims to define the methodological aspects of this historical research, the results of this evaluation phase are not required to be discussed in detail here.

4. Discussion on challenges in use of GIS methodology

Within the framework of this study, GIS has initially enabled to decide what would be the convenient strategy to assess chronological and spatial distribution of conservation



Source: Çakıcı (2015, p. 298)

Figure 6. Distribution of conservation implementations in Bursa according to spatial and chronological aspects; three phases in conservation history of Bursa

activities, in both building and site scales, in Bursa. However, there sometimes have occurred challenges in technical use of input data in different formats of GIS, which resulted in incompatibility in assessment process of this study.

During data entry process of this study, it was not easy to select and access to the right tool, which should be used commonly by various institutions related to cultural heritage conservation. For instance, the municipality, in which the archival documents were gathered from, has used NetAcad instead of AutoCAD in preparation of city plans, which has caused lack of harmony in technical use of different drawing programs in relation with GIS. This prevented to achieve clear results in analysis, occasionally.

Moreover, the lack of archival documents has also caused a gap in resulting analytical findings during digitization phase. The matching process of parcel numbers in between old and current cadastral maps were hardly completed due to the loss of required files in the archive of BKVKBK. Due to this lackness, it was also hard to correlate information gathered from Council's decisions and visual documents (sketches, photographs, plan drawings) attached to them. Accordingly, listing decisions could not be evaluated in detail since there was some undefined parcels and building blocks to be drawn on base map.

Especially during inventory documentation of this study, such kind of missing parts might have risks on evaluation of analytical results. However, these risks were manipulated mostly while the missing parts are not so effective on making analytical evaluation on the results of the study. Moreover, it was discovered that there have been recently new studies regulated by Ministry of Culture and Tourism, which is currently known as National Immovable Cultural Heritage Inventory System (TUES in Turkish)[11]. This system is expected to aid local authorities in making meticulous decisions for future planning of similar historic cities, while preserving their cultural heritage. Accordingly, it would contribute into inventorying immovable cultural properties together with their surrounding historic areas in Bursa, via a web-based GIS for any other national governmental agencies. Besides, it would make possible to share identity information of cultural heritage in this historic city, as one of the UNESCO WHS, with international associations, if required.

GIS-related methods can provide acceptable solutions if landscape metrics are suggested for more detailed information. Overlapping a series of maps performs well if there is not any error in geo-rectification and pixels' matching process. Accordingly, the comparison in between the maps might be not completely correct, although it surely could reveal geometric accuracy as a result.

The hardcopy format of the historic maps, which was collected from the archives, was not in good quality to be scanned, which was a time consuming in rectifying and digitizing the visual data in GIS. This situation makes the base map inscrutable due to the lack of quality in printing.

Hence, it is primarily preferred to find out digital maps instead of hardcopy ones. If there is not any, numerical information, such as the coordinate points shown on the maps, are important for overlapping correctly. Therefore, there was a weakness of technological facilities in transferring historic hardcopy document to current digital ones.

Despite all these difficulties, there are also contributions by using GIS on assessment of spatial and temporal analysis on conservation activities in Bursa. It helped to achieve timeline of conservation history of Bursa, along a long period of time since 1955, which is discovered as the date of the Council's first conservation decision[12]. Instead of petty deviations occurred during introducing process of the input data, it was possible to understand the appearance of reasons and results of breakpoint events in temporal development of conservation issue in Bursa.

That kind of studies are conducted not only from building or site scales, but also investigated from their contexts in setting as well as regional scales. Besides, authenticity and integrity of a heritage can be interpreted from broader spatial and temporal contexts, in which GIS would contribute through database, spatial analysis, and visualization. It improves understanding of heritage's authenticity to support heritage conservation planning, design and management. Moreover, the distribution of conservation activities could be followed on spatial aspects, which also defined the cultural properties and the historic urban areas mostly exposed to conservation and rehabilitation interventions. Hence, it is also capable to identify the scale(s) of the heritage conserved or not conserved within that limited time of conservation history in this historic city.

5. Conclusion

It is clear that there is a wide range of use of GIS in the field of heritage conservation and urban revitalization. This system is a tool to understand distinctive characteristics in data collected, classified and mapped systematically. However, there sometimes has appeared incompatibility in assessment process of the input data due to the differentiation of technical formats in such a basic system. Hence, this study concerns the challenges in use of GIS, selected as a tool to assess the historical background of cultural heritage conservation in Bursa, one of UNESCO WHS in Turkey.

Conservation Decisions, approved by the Regional Council of Conservation in Bursa (BKVKBK), were used as the major source of this study, in identification of the mobility of conservation activities in a historic city. By managing collected and classified input data on GIS, it was capable to reveal both chronological and spatial distribution of these activities. The methodological aspects in use of that tool could describe both architectural and urban conservation approaches in Bursa, by introducing systematically categorized data into GIS. By this way, it was easy to understand success and failure of various scaled conservation implementations approved and applied by the Council.

Moreover, the spatial GIS tools and the methodological flowcharts that were used in this study are flexible to be modified for different environments and regions observing historic character of a city, like Bursa, in the future. These technological tools would provide non-destructive, cost effective and systematic method for management and monitoring cultural heritage in similar Ottoman cities, which makes this study a guide to find out specific actions regarding sustainability of their traditional texture. The input data including all types of conservation practices in chronological order forming conservation history of

Bursa, which is also essential for the urban historians and archeologists studying on this city. Besides, as being financially supported by Bursa Metropolitan Municipality, from 2012 to 2015, which would result in local network in between the public and the scholars, in understanding of conservation history in Bursa.

In conclusion, due to the complicated character of such kind of studies, GIS is a proper tool to achieve systematic and clear results, which provides a basic system to understand, present and evaluate the conservation history of Bursa, which is almost a century old.

Notes

1. Historic buildings in Bursa are being listed as “monumental building,” “religious monument,” and “dwelling/traditional house,” since 1974.
2. Historic sites within city center of Bursa are being listed as “historic urban site,” “archaeological site” and “natural site,” since 1978.
3. The first regulations on conservation were: Ancient Monuments Regulations (*Asar-ı Atika Nizamnameleri*) (1869-1906) and Building and Roads Codes/Regulations (*Ebniye Nizamnameleri*) (1848-1882).
4. These acts are: “Historic Artefacts Act” No.: 1710 (1973), “Law of Conservation of Cultural and Natural Properties” No.: 2863 (1983).
5. Some major of these acts are: “Law for Amendment in the Law for Conservation of Cultural and Natural Properties” No.: 5226 (2004), the Law for Metropolitan Municipalities No.: 5216 (2004), “Law for Regeneration, Conservation and Reuse of Deteriorated Historic and Cultural Immovable Properties” No.: 5366 (2005), the Law of Municipalities No.: 5393 (2005).
6. For detailed information about nomination process, please see (<http://whc.unesco.org/uploads/nominations/1452.pdf>); accessed February 18, 2017).
7. This Regional Council was established in 1987, in order to take decisions on conservation of cultural heritage in Bursa.
8. ArcGIS – ArcMap 10 software – was used as the main digital tool, with supported by AutoCAD, Microsoft Office, and Adobe Photoshop Elements 8.0, during the creation of a digital database.
9. At last, the boundary of the current historic city center of Bursa was enlarged from Çekirge District at west to Yıldırım District at east, while limited by Mount Uludağ at south and by Bursa Plain or İzmir-Ankara highway (former Mudanya-Bursa Railway route) at north.
10. In case of the differentiation in dimension of archeological remains, “point geometry” was selected as another option besides “polygon geometry.”
11. It is a centralized web-based GIS, which is capable of cross-querying 10,000 protected areas (archaeological, urban or historical), 100,000 monuments and registered historical buildings, more than 500,000 Conservation Council decisions and nearly 20 million pages of archival documents for all provinces of Turkey (Boz *et al.*, 2014).
12. That decision (GEEAYK: 371/April 23, 1955) was concerning the approval to restore Bezestan building, constructed at the hearth of historic commercial center of Bursa , and to repair the bazaar and one storey shop buildings surrounding it (Çakıcı, 2015, p. 92).

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