ASSESSMENT OF HISTORICAL STRATIFICATION IN MULTI-LAYERED TOWNS AS A SUPPORT FOR CONSERVATION DECISION-MAKING PROCESS; A GEOGRAPHIC INFORMATION SYSTEMS (GIS) BASED APPROACH CASE STUDY: BERGAMA

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ABSTRACT

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This thesis is focused on developing an 'information based' method for structuring, analyzing and evaluating data about historical stratification in multi-layered towns to provide 'utilizable information' which will support conservation decision-making process.

The context of the thesis is defined as 'multi-layered towns' which have been continuously inhabited since early ages onwards and where still inhabitation exists; the majority of the Anatolian towns have such a structure. In order to contribute to the conservation of multi-layeredness of such towns, handling complex and multi-dimensional data about historical stratification becomes the central issue of the thesis.

Therefore, this thesis aims at defining the framework, content and organizational scheme of the 'decision supporting study' through which historical stratification will be assessed; developing an 'information based' assessment method which will provide terminological, syntactic and structural standards; and determining the most compatible tool and medium through which the study will be carried on.

In order to constitute the framework and organizational scheme, conservation decision-making process, role of information and ways of handling this information within this process are discussed by consulting management sciences as these concepts originate from them. Disciplines dealing with multi-layeredness, elements of analysis and information types are referred to, while defining the main procedures and structure of the assessment method. In addition, Geographic Information Systems (GIS) as spatially referenced databases are found to be suitable to handle complex and multi-dimensional spatial data. Hence, GIS contribute to both the definition of the framework and the formation of the assessment method.

Subsequently, the case study on Bergama (Pergamon) is carried on to confirm the proposed method, since it is an outstanding example within multi-layered Anatolian towns.

In conclusion, production of information for conservation of multi-layered towns should be handled as a process that should not based upon personal interpretation but upon scientifically produced accurate information. Due to the differentiation of information on stratification at every point within the town, area-based conservation decisions show deficiencies for those kind of towns; thus, they should be reconsidered. It is demonstrated that GIS are suitable to carry on the proposed method. However, the application of the proposed method is required to continue both to supply feed-back to GIS specialists, and to re-assess and develop the method itself.

Keywords: multi-layered towns, historical stratification, conservation decision-making process, 'decision supporting study', information management, Geographic Information Systems (GIS), Bergama.

ÖZ

KORUMA KARAR VERME SÜRECİNE KATKI OLARAK ÇOK- KATMANLI KENTLERDEKİ TARİHSEL KATMANLAŞMANIN DEĞERLENDİRİLMESİ; COĞRAFİ BİLGİ SİSTEMLERİNİ (CBS) TEMEL ALAN BİR YAKLAŞIM UYGULAMA ÖRNEKLEMESİ: BERGAMA

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Bu tez çok katmanlı kentlerdeki tarihsel katmanlaşmaya ilişkin verilerin yapılandırılması, analizi ve değerlendirilmesi yoluyla koruma karar verme sürecini destekleyecek yararlanılabilir bilgiye dönüşmesi için bilgi bazlı bir metod geliştirmek üzerine odaklanmıştır.

Tezin kapsamı 'çok katmanlı kentler' olarak tanımlanmıştır. Bundan kast edilen; erken dönemlerden başlayan, yerleşim süreçlerini halen sürdürmekte olan yerleşim birimleridir ki bir çok Anadolu kenti böyle bir özelliğe sahiptir. Böyle çok-katmanlı yapısı olan yerleşimlerin korunmasında çok büyük önemi olan tarihsel katmanlaşma hakkındaki çok yönlü bilgi bu tezin ana konusudur.

Bu ana konu doğrultusunda, bu tez tarihsel katmanlaşmanın değerlendirilmesinde kullanılan 'karar destek çalışması'nın çerçevesini, kapsamını ve organizasyon yapısını tanımlamayı; terminoloji oluşumunu ve yapısal standartları sağlayacak bilgi bazlı değerlendirme yöntemi oluşturmayı ve çalışmayı sürdürmek için en

uyumlu araç ve ortamı saptamayı hedefler.

Kapsam ve organizasyon şemasının oluşumu için, koruma karar süreci, bu süreçte bilginin ve bilginin değerlendirilmesinin rolleri, yönetim bilimleri açısından tartışılmaktadır. Değerlendirme yönteminin oluşumu için, ana yöntemler ve yöntemin yapısı tanımlanırken, çok-katmanlılıkla ilgilenen disiplinler ve zaman-mekansal bilgilerin sunuşu, analiz elemanları ve ilgili bilgi tipleri ele alınmıştır.

Mekansal veritabanı olarak değerlendirilen Coğrafi Bilgi Sistemleri (GIS), karmaşık ve çok-boyutlu bilgilerin ele alınması için de uygun bulunmaktadır. Bu nedenle Coğrafi Bilgi Sistemleri hem çalışmanın ana çerçevesini hem de değerlendirme yönteminin oluşmasına katkıda bulunmaktadır.

Bunları takiben, çok katmanlı Anadolu kentleri arasında çarpıcı örneklerden biri olan Bergama üzerinde önerilen yöntemin uygulaması ve sınaması yapılmıştır.

Bu çalışmanın sonunda, çok katmanlı kentlerin korunmasında bilgi üretiminin ve yorumunun kişilere göre değişmeyen bir süreç olarak ele alınması ve karar verme sürecinin bilimsel yöntemlerle işlenmiş hassas bilgiye dayanması gerektiği sonucuna varılmıştır. Çok katmanlı kentlerde katmanlaşmaya ilişkin bilginin kentin her noktasında farklılaştığı dolayısıyla bugün mevcut karar sistemindeki alan bazlı kararların bu tür kentlerle uyumsuzluğu vurgulanmıştır. Buna bağlı olarak uzun vadede koruma mekanizmasının bu anlamda yeniden yapılandırılmasının gerekliliği üzerinde durulmuştur. Bütün bu çalışmaları yürütmede kullanılacak aracın yapısının çok katmanlılıkla uyumlu olması gerektiği ve Coğrafi Bilgi Sistemlerinin (GIS) mevcut özellikleriyle bu uyumu gösterdiği ortaya koyulmuştur. Ancak, önerilen yöntemin diğer çok katmanlı kentlerde de uygulamaya ve sınanmaya devam edilmesi ve Coğrafi Bilgi Sistemleri (GIS) uzmanlarına bu sistemlerin özellikle korumaya yönelik olarak da geliştirilmesi hakkında geri bildirim verilmesinin gerekliliği de önemsenmiştir.

Anahtar Sözcükler: çok katmanlı kentler, tarihsel katmanlaşma, koruma karar verme süreci, 'karar destek çalışması', bilgi yönetimi, Coğrafi Bilgi Sistemleri, Bergama.

To My Dear Mother

Aysın BİLGİN

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CHAPTER 1

INTRODUCTION

Rarely being the product of a single epoch, in the majority of the cases towns are the outgrowth of a continuous habitation beginning from early ages onwards. The contemporary physical structure of the town is the result of the continuity and change of physical existence and use of space through a historical development process. Different time intervals in historical continuity of a town have their own physical and cultural reflections that form up different layers of the town's historical, cultural and physical thickness. The superimposition of these different layers, sometimes coming on top of each other, sometimes side by side, make up the historical stratification of the contemporary town, hence, making possible to call it as a 'multi-layered town'[1].

The multi-layered towns are complex entities that are formed up of different layers along with all the multi-dimensional and dynamic relationship between these layers. Every epoch producing its own physical structure in relation with the previous ones constitutes the web of relations in the physical thickness of the contemporary town.

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[1] The term 'multi-layered' is an archaeology-originated term, synonymous with the term 'multi-stratified', used to mention the stratification of multiple layers. It is also recently used for defining an urban archaeological site (Conti, et al. 2000: 39). The same term appears in Geographic Information Sciences and Systems (McHarg, I. L. 1998: ix), as the main principle of these systems are based on handling spatial data in layers. The term 'multi-layered town' is used to define the towns with historical continuity previously by the author of this thesis (Bilgin Altınöz, A. G., Erder, C. 2000), (Bilgin Altınöz, A. G., Erder, C. 1999), (Bilgin Altınöz, A. G. 1998), (Bilgin, A. G. 1997). All through the thesis, the term 'multi-layered town' will be used to indicate the town, which has been inhabited continuously throughout different eras and where habitation still continues.

It is the network of relationships that makes things meaningful. That is, an object gains its meaning through a web of relations with other things which makes up a context. Just as it is for objects or artifacts, the ways which places are experienced and produced are through a network of relationships (Thomas 1996: 60). The components of different layers formed through historical continuity of the multi-layered town can conform different relationships with each other. This relation can be a mere physical relation in which "the architectural strata produced touch but do not inform each other" (Boyer 1994: 19). In this case, the previous architectural strata solely contribute to the diversity within the town without being an integral part of the structure of the town. While in some other cases, the elements of different layers can have both physical and semantic relations with each other. Consequently, the previous architectural strata become an integral part of the town due to the reuses and transformations through historical continuity.

Whether having only a physical relation or both physical and semantic ones, different layers and their components play an important role in the configuration of the contemporary structure of the multi-layered town as well as in the formation of its urban identity. It is the admixture of these different layers and their relation with each other that form up the identity, which can also be defined as 'diversity' as well as 'specificity' for the multi-layered towns. Consequently, one of the most important value the town acquires becomes its capacity to procure a line of continuity between different periods within the unity of its diversity / specificity (Zanchetti, Jokilehto 1997: 42-44).

Anatolia has been subject to continuous inhabitancy beginning from the early ages onwards. Different parts of Anatolia has been inhabited by different civilizations having different cultural and social structures for different time intervals. These differences are reflected as the variety of the physical environment that has been produced. However, in spite of all these varieties, 'being continuously inhabited' and thus, 'being constituted by layers' appear to be common properties for most of the Anatolian towns. So, even though the definitions, contents and time intervals which make up the layers change from one another, most of the Anatolian towns can be called 'multi-layered towns' due to the same principle of formation through historical continuity.

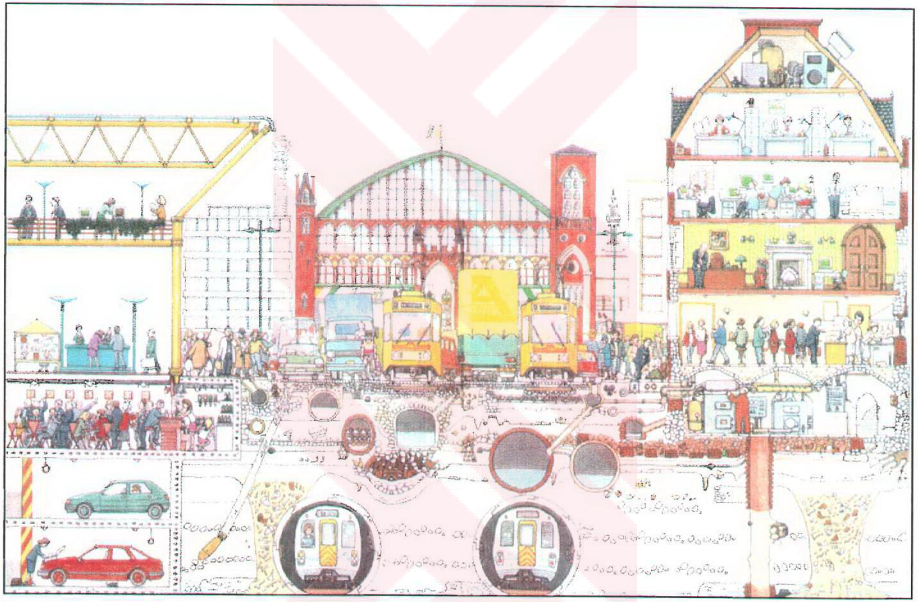

figure 1.1. A slice through a city by Peter Kent (Kent 1995: 28-29). Representation of a 20th century multi-layered town in which the structures and remains of different periods exist within the same context.

Together with different layers they comprise, multi-layered Anatolian towns embody an important part of our cultural heritage. Considering the physical environment formed through historical continuity as the prime value that constitutes the urban identity, planning and conservation studies should aim to conserve the town as a whole together with all the multi-dimensional relations within the dynamics of continuity and change. Hence, multi-layered Anatolian towns become a subject for conservation so as to prevent the annihilation of these layers each of which are equally important as a reflection of their historical continuity while contributing to their urban identity. There upon, multi-layered towns, indicating specifically the Anatolian towns, which have been inhabited continuously through out different eras and where habitation still continues, constitute the context of this thesis.

1.1. Definition of the Problem

In order to achieve a sound conservation, it is essential to obtain comprehensive, correct and utilizable information about the context. Consequently, 'conservation of multi-layered towns' necessitates the integration of various types of information among which information concerning the historical stratification has a vital position due to its direct relation with 'multi-layeredness'. As it is pointed out by Feilden and Jokilehto (1993: 15):

> A historic resource may at different periods of its history, become a part of a new whole through which it is redefined as a part of a new potential unity; such transformations are part of its historical stratigraphy. Treatments aimed at the restoration of a heritage resource should refer to this new potential unity and should therefore be carried out within the framework defined by it.

Hence, comprehensive, correct and utilizable information about the historical stratification of the multi-layered town should be considered prominently during the conservation decision-making process, and consequently, during the conservation interventions in different scales, so as to sustain the town's multi-layered character. Thereupon, production of utilizable information through the collection, structuring and processing of raw data on historical stratification becomes an important issue. This necessitates following up a method compatible with the multi-dimensional, dynamic character of the multi-layered town through an information base on historical stratification as well as using a tool and a medium compatible with the designed method.

As important as having appropriate method and tool to handle the information about the historical stratification, is the appropriate integration of this information to the conservation decision-making process. The assessment of the historical stratification based on proper, correct and sufficient information and the utilization of this information in a correct way during the decision-making process is essential to achieve appropriate conservation decisions and appropriate interventions based on these decisions.

The decisions and regulations imposed by the decision-maker are too powerful as they directly affect the future of the built-up physical environment as long as they are put on the plans or projects. As LeGates and Stout (1996:199) point out, once the lines are drawn, which could have been drawn otherwise, they render the future in the way they propose. Being such an important and powerful process, appropriate decision-making necessitates to be built upon the assessment of historical stratification achieved through an appropriate methodology in handling correct, sufficient, and up-to-date information by utilizing a proper medium and tool compatible with the dynamic and multi-dimensional character of the multi-layered towns besides the integration of all these studies into the conservation decision-making process.

In case the conservation decisions and actions are built upon inappropriate assessment of information concerning the historical stratification, the tool utilized is unable to get along with the multi-dimensional and dynamic character of multi-layered town or the appropriate information handled by appropriate tool exists but is not utilized at the right point in a right way within the process, the incompatibility of the conservation decisions with the historical stratification occurs. This results in losing some layers of the multi-layered towns, and thus the historical stratification, instead of conserving it as a whole. These problems are common to most of the multi-layered towns in different regions or countries including those in Anatolia.

In most of the contemporary Anatolian towns, the physical reflections of different eras and the networks of relations they embrace are unrecognizable or changed, or even totally destroyed. The danger of losing the multi-layered character and resulting in one-dimensional areas is an important problem facing the multi-layered Anatolian towns. The reasons of the problem are manifold due to the multi-faceted character of multi-layered towns and to that of urban conservation. It can emanate from the socio-cultural and economical factors as well as from the political pressures or from the lack of control mechanism owing to the deficiencies in the current administrative and legal system concerning conservation.

Along with all these possible causes, one of the main sources of this problem has been observed as the incompatibility of conservation decisions and interventions based on these decisions with the historical stratification of the town.[2]

In the current conservation process in Turkey, the principle decisions of Higher Council for the Conservation of Cultural and Natural Properties are the major obliging rules, which direct most of the conservation decisions and actions within historic towns. Even though the evaluation criteria are not defined clearly within these principle decisions, still it is possible to extract the importance of the information on the historical development of the town as one of the evaluation criteria in conservation decision-making. Likewise, information on historical

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[2] The conservation and planning problems of the multi-layered towns have been subject of concern for the author of this thesis since the beginning of the Master's studies, which ended up with the thesis entitled 'Urban Archaeology: As the Basis for the Studies on the Future of the Town; Case Study: Bergama' in 1996. In the Master's thesis the aim was to introduce and discuss the concept, content and methodology of 'urban archaeology' as well as to assess its contribution as a base for planning and conservation of historic towns. Bergama was chosen as the case and concepts and methodology proposed in the conceptual part of the thesis were applied on it as a preliminary study, which resulted in a general evaluation of the historical stratification of Bergama depending on the diachronic analysis of the inner organization and the general layout of the town in different eras as well as a comparison of the historical stratification of the town with the previous and the existing conservation and planning decisions. As a result of the Master's thesis, it was observed that area-based conservation decisions were incompatible with the historical stratification of the town. Hence, the areas with similar historical stratification were subject to different regulations, which gave rise to different implementations in similar areas, even sometimes causing the elimination of the remains of some eras. These problems observed in the case of Bergama are, infact, common for most of the Anatolian towns. Departing from the results and observations of the Master's thesis, the reasons of the incompatibility of historical stratification with the conservation decisions as well as the ways to overcome this incompatibility, the process, methodology and tools to be used are found to be the major topics that should be studied further. As a continuation of both the case and the subject to an extent, this thesis should be evaluated keeping the previous study and its results in mind. The Master's thesis (Bilgin 1996) as well as the papers presented in different symposiums on the subject (Bilgin Altınöz, A. G., Erder, C. 2000), (Bilgin Altınöz, A. G., Erder, C.1999), (Bilgin Altınöz, A. G. 1998), (Bilgin, A. G. 1997) can be referred to, so as to have a more detailed background about the subject.

development and stratification is mentioned as an input for the decisions of Provincial Conservation Councils and for the preparation of conservation plans of historic towns, which are the subsequent levels in conservation decision-making process.

One of the major problems is that, all these different groups acting at different levels of the conservation process in historic towns collect, analyze, interpret and evaluate the data concerning the historical development and stratification of the town again and again separately. This information is utilized as a base in determining different types and degrees of registered areas by conservation councils. Concurrently, it is obtained and used by the planning groups while preparing the conservation plan of the town and it is re-collected every time another plan is being prepared by another group of planners. Likewise, different project groups preparing the restoration projects for different structures in the town arrive at and interpret this information partially again for the structure they are dealing with and for its near surrounding.

The information about the historical development and stratification of the town can change due to the production of new data by the specialists through new scientific studies. Other than this, it should not differ from one study to another within the whole process. What can differ is the reflection of the assessment of historical stratification in the decisions, plans and projects produced through the design and choice phases within the conservation decision-making process.

The second major problem is the lack of a definite method as to collect, structure, analyze and evaluate the data to provide information on historical stratification and development of the multi-layered towns. Information on historical development and stratification of the town is an important input for different levels of conservation decision-making process. Thus, it necessitates to be processed through a well-defined method, which provides a common language in storage, representation, analysis and evaluation.

Although the information on historical development and stratification of the town forms up one of the most important evaluation criteria for the conservation decision-making in Turkey, there exists nearly no guidance as to the method pf manipulation, assessment and utilization of it within this process. Within few guiding documents, only the main subject topics are defined, and hence, they are insufficient and far away from describing the process and criteria of assessment in necessary particularization. As a result of the problem of uncertainties concerning the method, conservation decisions, including conservation plans and projects, are built upon insufficient and inappropriate information, or even sometimes they do not use this information at all.

Last but not least is the problem about the incompatibility of the tool and the medium utilized for the storage, analysis and evaluation of the information about the historical stratification including also the existing situation of the town. The information concerning the existing situation as well as the historical development and stratification of the town is dynamic due to the continuous formations and transformations in the existing structure of the town and the continuous production of information as a result of on-going scientific studies, researches and excavations concerning different periods of the town. The current medium used in representation, analysis and evaluation of the historical stratification is two-dimensional paper space which does not support the dynamism and multi-dimensionality of information in multi-layered towns. As a result of this incompatibility, achieving up-to-date information, which is a prerequisite for appropriate decision-making, becomes quite hard. Besides, the information concerning different periods of the town are generally dissolved into the plans showing the existing situation of the town as a result of which a great deal of information is underestimated or neglected during the decision-making process.

As a consequence of all these problems -that is, the insufficiency of the basis, criteria and method of the assessment of historical stratification and its integration to the conservation process as a support for the conservation decisions and actions as well as the incompatibility of the medium and the tool used as a base for the determination and expression of the existing situation of the town and its historical stratification- different parts of the town with similar stratification are faced with different regulations and consequently different types of interventions which result in the rapid destruction and loss of remains belonging to different layers in these areas instead of their conservation.

1.2. Aim and Scope of the Study

> Both massive change and rigid, inflexible preservation tend to result in 'one-dimensional areas', which are lacking in depth and continuity. Thus the city for example, should be so managed that it is layered in 'time-deep areas' of varying intensity, which contain both new stimuli and familiar reassurances (Kain 1981: 12).

In order to sustain the time-deep multi-dimensional character of the multi-layered towns, this study aims at providing a method and tool through which the information on the historical stratification becomes an integral part and a conscious parameter within the conservation decision-making process.

Conservation can be achieved if the decisions and regulations proposed are compatible with the physical structure and the stratification of the town. Conservation of multi-layered historic towns can be regarded as a decision-making process in which the information on the historical stratification has a vital position. Hence, the main principles for the conservation of multi-layered towns should be based upon the information about the town together with all the layers and relations it comprises. The most important condition for that is to manipulate the 'information' as to make it utilizable for the purpose. As also mentioned by Clemente (1994: 8), the studies on cities cannot be built upon total information available, the important thing is to be able to achieve an intelligent selection. Besides the choice of the information to be utilized, it is equally important to define how it will be structured, presented, questioned, and evaluated in order to form the principles for the conservation.

The main objectives of the study are shaped considering the problems of vagueness and inappropriateness as to the definition of the method, process and the tools for assessing the historical stratification for the conservation of multi-layered historic towns in the current conservation decision-making process in Turkey. It is not the aim of this study to re-define the whole conservation decision-making process in Turkey. Nor is to create and develop a system which includes all types of information necessary for the decisions and proposals to achieve urban conservation.

The thesis deals with setting up a 'decision supporting study' on the assessment of historical stratification in multi-layered towns by defining its method and its position within the existing conservation decision-making process and the administrative system in Turkey. Considering the multi-faceted character of multi-layered towns and the necessity for various types of information concerning various aspects of the towns by different groups of specialists to achieve appropriate conservation decisions and proposals, it is aimed to obtain an environment in which all these different studies can integrate with each other. Therefore, the 'decision supporting study' on the assessment of historical stratification of multi-layered towns, which is the main objective of this study, should have such a method and should be produced in such a way that it can be integrated with other types of studies so as to obtain the necessary basis for conservation decisions as a whole.

Both the constitution and structuring of the proper method for the 'decision supporting study' and its proper integration in the decision-making system is inseparable from defining the most relevant tool to obtain the necessary basis and medium for such a study. Therefore, the importance of computer technologies in manipulating complex, multi-faceted and dynamic information within the decision-making process, and especially that of Geographic Information Systems (GIS) in spatial information and spatial decision-making are considered during the determination of the tool.

GIS, as systems designed and developed for handling spatial data, are contemplated to be the main tool to consummate the proposed decision supporting study as they offer a medium compatible with the 3-dimensionality of the multi-layered towns and with the dynamics of the information about the town. Knowing that the GIS are spreading to the municipal uses as well as planning activities, a method taking into account the historical stratification of the town as an integrated part of the system will also contribute to the conservation studies in practice in the future as well.

While carrying on this study, a standard GIS software available in the market is used without making any changes or additions to it. This is due to the fact that, like most of the computer programs, GIS are not developed especially for serving the conservation discipline, and thus, it is very important to assess the software with its existing capabilities, advantages and short-comings so that it can be enhanced accordingly in future studies. Moreover, as mentioned, making additions and changes to the software, which should be based upon a preliminary assessment of it, is a second step that necessitates an interdisciplinary study together with GIS specialists and programmers.

The major contribution of this thesis is construction of the framework and content of a 'decision supporting study' for the assessment of historical stratification in multi-layered towns. The main objective of this study is to acquire an 'information based' approach for the appraisal of the historical stratification of the town as a support for the conservation decision-making process. Accordingly, the main goals of the study can be defined as:

- to define the contextual and organizational framework of the proposed 'decision supporting study' within the current conservation decision-making process in Turkey by answering the questions 'What will be its objectives? At what phases will it integrate and contribute? Who will be using it? How will it be organized?'.
- to constitute an 'information based' assessment method for the proposed 'decision supporting study', which will allow structuring, analyzing and evaluating the data related with the historical stratification in multi-layered towns.
- to achieve a medium by utilizing a tool compatible with the 3-dimensionality of the multi-layered towns, to adapt the proposed method to the proposed medium, and to evaluate the pros and cons of the tool (GIS) in the proposed assessment method for historical stratification in multi-layered towns, as well as in a wider context of conservation of historic towns.

The importance and influence of political and socio-economical factors in the conservation and planning activities cannot be discarded. However this study will be limited to the physical structure of the town and the knowledge about the physical structure. It is well known that the execution of the proposed method will depend on the political and socio-economical influences.

1.3. Methodology of the Study and the Structure of the Thesis

The information era along with the developments in the computer technology brought about a re-consideration of the definition, general framework and methodology of various disciplines, and appraisal of the relevance of terminology, methodology and tools of other disciplinary areas for themselves. Hence, the boundaries of the disciplinary areas have gradually faded out and different disciplines are incorporated with each other with a new wider viewpoint.

The impacts of these developments are reflected in the field of conservation, as the increasing amount and complexity of information utilized for achieving conservation decisions and producing proposals, as well as the emphasis on the managerial aspects and multidimensional, multidisciplinary character of conservation. Yet, the impacts of the prospering computer technology are reflected to the conservation field in a lesser extent. It is not possible to talk about the integration of computer technology within the conservation process competently and thus the production of new programs or enhancement of the computer programs produced for other disciplines according to the needs of conservation, else than a few special programs produced quite lately for dealing with computerized photogrammetry.

As a multidisciplinary field dealing with complex and multidimensional problems, conservation at the point that it has achieved today, requires to benefit from the new technologies, including the computer technology, as well as the terminology, methods and tools produced and utilized by other disciplines. Therefore, this study, which aims at dealing with the assessment of the complex spatial information concerning the historical stratification in multi-layered towns so as to support the decision-making process within urban conservation which is gradually coming closer to the management of the built environment and its integrated planning, necessitates making use of the methods, tools and terminology of many other disciplinary areas. Even the keywords utilized to define the theme of this study reflect this necessity obviously. These keywords are the main concepts of different disciplines, and thus, they require to be comprehended within their own disciplinary framework together with their reflection in conservation.

information, decision-making process, decision supporting and management, which are major concepts defined and enhanced within the disciplinary area of the management sciences are utilized to re-look and re-evaluate the process of the conservation of historic towns and to determine the role of the proposed 'decision supporting study' in the whole process. Complex spatial information calls for the utilization of computer technology and geographic information systems (GIS) in particular, which are not the tools designed according to the specific needs of the conservation discipline actually. Historical stratification and multi-layeredness bring forth the necessity to understand the process of dealing with strata/layers and the methods of representing them within the framework of the major fields dealing with layers, namely archaeology and geology. Likewise, the representation of the spatio-temporal data due to multi-layeredness and stratification justifies the comprehension of models produced for representing such data by means of cartography.

Within this study, all the different concepts, methods and tools originating from different disciplinary areas are utilized to structure the defined problem and to achieve the defined aim of the thesis by reconsidering the current system with a wider viewpoint, extracting input from it and proposing an approach via a new tool to deal with the problem by taking the advantages of the methods used by other disciplines in dealing with stratification but without forgetting the general framework and requirements of urban conservation and the process and procedures of conservation decision-making in Turkey. In that respect, the Geographic Information Systems (GIS), which are spatially referenced databases suitable for handling complex and multi-dimensional spatial data, are utilized as the 'tool', without making any changes or additions to the software due to the defined objectives, in order to perform the proposed methodology for the assessment of historical stratification in multi-layered towns.

Departing from the conceptual base that is formed for building up the methodology for the assessment of the historical stratification in multi-layered towns to support the conservation decision-making process, the case, which is chosen to be Bergama (Pergamon) as an outstanding example of multi-layered Anatolian towns, is studied by means of the defined methodology and the defined tool. The study is detailed for the case of Bergama, so as to evaluate the problems and the advantages of the proposed 'decision supporting study' and proposed tool, that is, GIS, more distinctly.

As mentioned before, this study will not be dealing with the socio-economic and political factors as well as the other ones connected with them, which have a profound influence on urban conservation. Though the importance and effects of these factors are very well known, they do not contribute to the formation of this study due to the limits defined for the thesis.

The thesis is structured according to the defined objectives in the way to reflect the methodology of the study. The first chapter is the introduction of the thesis in which the explanation of 'multi-layered towns' as the context of the thesis is followed by the definition of the problem, the objectives, the methodology and the structure of the thesis.

In the second chapter a brief introduction to the concepts of 'information', 'decision-making', 'decision-making process' and 'decision support systems', which are management sciences-originated concepts, are made. This is followed by the reconsideration of conservation of historic towns as a spatial decision-making process and the delineation of the main properties and role of information and decision supporting studies in conservation decision-making process departing from different examples of studies concerning with different aspects of the conservation of historic towns. Within this framework, the review of the urban conservation process and procedures in Turkey is made with the aim to define the problems in the utilization of information on historical stratification in the current system. In the second part of this chapter, the relation between Geographic Information Systems and the conservation of historic towns are studied. In that respect, the role and contribution of the evolving computer technology within the field of conservation is tried to be defined by reviewing the utilization of different types of computer programs in different stages and scales of conservation studies along with their advantages and problems and potentials. Among the other computer programs, geographic information systems (GIS) are studied in more detail in this chapter. A concise look at the origins and application fields of GIS is followed by a thorough exploration of the utilization of GIS in the field of conservation. Within this chapter, general properties of GIS projects in contextual and organizational framework are determined. This chapter ends with the definition and framework of the proposed GIS based 'Decision Supporting Study' for the assessment of historical stratification in multi-layered towns.

The third chapter contends with the basic concepts and issues for building up the GIS based assessment method. In the first part of this chapter the methods of storing, handling and presenting the information concerning different layers in multi-layered towns are tried to be defined through the study of the approaches of different disciplines towards stratification. 'Layer/strata/stratification' and 'spatio-temporal data' come out to be among the main concepts while dealing with multi-layeredness and historical stratification. Accordingly, the approaches of geology and archaeology, as the major disciplines in which layers and stratification play a fundamental role, towards the process of studying stratification and representing the data concerning different layers are examined. Besides the approaches of geology and archaeology, the different models produced for the representation of the space/time conception in cartography are analyzed as well. In that way, the common points in the methodology while dealing with layers are determined.

The second part of this chapter concerns with defining the major elements of analysis in different levels of geographic space for multi-layered towns and the types of information necessary for the assessment of historical stratification. For this, the main components of the town, which are necessary to understand the structure of the town, are tried to be determined. In determining the main components of the town studies on urban morphology, urban archaeology and urban conservation are made use of. The attributes of different components of town, which should be defined during the conservation decision-making process, are first classified in general. This is followed by the determination of the specific attributes that should be defined for the conservation decision-making process in Turkey. This is achieved by resolving the role of the information on the historical development and stratification of the towns within the current system and by extracting the methodology followed in the analysis and the criteria for the assessment of the historic stratification. The methodology and the criteria for the assessment of the historical stratification are tried to be refined and extracted from the process, methodology, concepts, definitions and criteria delineated in the conservation acts, the principle decisions, the regulations and the specifications concerning conservation and conservation planning. Among all, a special attention is paid to the 'conservation areas', their types, definitions and designation, as they are very effective within the decision-making process for the conservation of historic towns in Turkey.

In the fourth part, the main functions and the basic concepts coming along with GIS are defined so as to be utilized in the constitution of assessment method. The last part of the chapter defines the structure of the proposed GIS based assessment method departing from the issues discussed in the previous parts of this chapter.

Chapter four concerns with the implementation of the proposed assessment method and its evaluation through the case of Bergama in detail and the discussions on the problems, advantages and potentials observed for the case of Bergama departing from the results of the case-study.

Chapter five is the conclusion of the thesis, which ends up with the appraisal of the appropriateness of a study for the assessment of the historical stratification in multi-layered towns to support the conservation decision-making process in Turkey as well as the appraisal of the appropriateness of GIS for such a study. The thesis concludes with further research topics that this study opens way to.

The literature survey carried out for the thesis is parallel with the outline of the study. Accordingly, main topics of literature survey are:

- information, decision-making process, decision support in management sciences and disciplines dealing with spatial decision problems;
- current approaches in conservation of historic towns: concepts, methods, applications, and 'decision supporting studies';
- conservation of historic towns in Turkey: process, procedures and conservation site decisions;
- dealing with multi-layeredness: stratigraphic methods in disciplines dealing with stratification, cartographic models for the representation of spatio-temporal data;
- elements of analysis: main components of towns considered in urban morphological and urban archaeological studies;

- information types for assessment of historical stratification: heritage record systems;
- GIS: fields of utilization in general, examples of utilization in conservation of cultural heritage specifically, concepts, properties, and functions;
- Bergama: conservation and planning studies, historical periods and existing situation.

As also reflected by the main topics of literature survey, due to the multi-dimensional and multi-aspected character of the context and problem of the thesis, it becomes inevitable to refer to subjects originating from different disciplinary fields. While referring to the subjects originating from the disciplinary fields other than conservation, special care is given to keep in mind that the main concern of the thesis is the conservation of multi-layered towns. Accordingly, the subjects originating from other disciplinary fields are not considered in all details and aspects, but instead, the necessary and basic concepts related with the subject of thesis are tried to be achieved and extracted from with a conservation architect's viewpoint.

As a fundamental principle in the utilization of concepts, terminologies and methodologies concerning other disciplines than conservation, only the basic ones commonly mentioned in different references have been utilized.

'Information', 'decision-making' and 'decision support systems', are the main concepts originating from management sciences which also found their reflections in urban and regional planning disciplines with a 'spatial' concern as 'spatial information', 'spatial decision-making' and 'spatial decision support systems'. Concerning these subjects, the sources that are involved with the general description of the basic concepts and processes are referred to. In accordance with the above-mentioned fundamental principle, only the basic concepts, processes and terminologies that are common in all the referred documents are utilized within the thesis.

Dealing with multi-layeredness calls for understanding the methodology of stratigraphical studies in disciplines that are mainly concerned with stratification, those are geology, archaeology, including also urban archaeology and buildings archaeology. For concepts and methods in geological stratification, different sources on basic theoretical and conceptual framework for geological stratification published in different periods beginning from the emergence of the concept in 1960s till today are chosen (Weller 1960; Prothero 1989; Doyle, Bennett 1998). Whereas, the main concepts concerning the archaeological stratification are cited from a contemporary basic document that gives a general view of archaeological studies (Renfrew, Bahn 1991). Besides, articles especially concerned with concepts and methods in archaeological stratification are referred to, among which also exist the articles of two scholars who have designed the most commonly used two different stratigraphic charts (Harris 1992; Carver 1992).

Another issue concerning multi-layeredness, which derives from other disciplines, is recording and representation of spatio-temporal data. Models of space-time conception and temporal GIS are studied all in reference to a publication of Gail Langran (Langran 1993) both as he provides a compact summary of different space-time conception models defined and utilized by different scholars, and as he is a person who has been denoted as an authority on this subject by various scholars.

CHAPTER 2

DECISION SUPPORT AND GEOGRAPHIC INFORMATION SYSTEMS (GIS) WITHIN THE DECISION-MAKING PROCESS FOR CONSERVATION OF MULTI-LAYERED TOWNS

2.1. Information, Decision-Making and Decision Support in Conservation of Historic Towns

At the point that it has achieved today, conservation of historic towns is considered as a continuous process that necessitates to be handled as a management problem. Just like all other management problems, it consists of different decision-making processes in which 'data' about different aspects of the subject of concern and 'data processing' to achieve utilizable 'information' is of utmost importance. 'Information' and 'decision-making' have been fundamental concepts especially for management sciences, and thus, have been conceptually enhanced and shaped mainly within their area of concern. Although they originate from management sciences, these concepts have found their reflections and interpretations in different disciplinary areas involved with any kind of management and decision-making issues including urban and regional planning disciplines.

Thereupon, it is necessary to have brief and general knowledge about the main issues such as role and properties of information in decision-making, the components of the decision-making process, how information, decision problems, decision-making processes, and systems to support decision-making are handled in management sciences.

In order to define the content and framework of the proposed method for the assessment of historical stratification as a support for conservation decision-making in multi-layered towns, it is necessary to re-view the urban conservation process and procedures in Turkey as a spatial decision-making process.

2.1.1. Information, Decision-Making and Decision Support Systems

Information is defined as "the meaningful conclusions drawn from data" (Olson, Courtney, Jr. 1992: 407). As it is indicated commonly (Malczewski 1999; Sauter 1997; Olson, Courtney, Jr. 1992), 'data' are of little value by themselves and they have to be transformed into information so as to be useful. Data are transformed into information that can be utilized for solving specific decision problems through 'data processing', which consists of the main phases of collection, organization, representation, analysis, evaluation and interpretation of data.

The period beginning from 1960s onwards is identified as the 'information age', in which the volume and complexity of information utilized have grown up to a great extent (Bonczek, et al. 1981: 3). Since then, 'information' has been a major resource and 'data processing' has been a major issue for several disciplines, especially for those dealing with management issues. Consequently, 'information resources management' (IRM) is considered as a management philosophy in which 'information' is regarded as 'an asset that should be managed' to contribute the success of any managerial activity (Huxhold, Levinsohn 1995: 33).

As Bonczek, Holsapple and Whinston (1981: 12) state, "All managerial activity revolves around decision-making". Yet, 'good decision-making' depends on the availability of relevant and appropriate information on which the choices are based (Sauter 1997: 3). The quality of the decision-making process as well as the quality and appropriateness of the decisions achieved depend directly on the quality and sufficiency of available information, more than the quantity of it. It is not true to say that the more information is, the better decisions achieved are. Indeed, in achieving proper decisions, what is necessary is the more of the 'appropriate type of information', in other words 'useful information' (Sauter 1997: 3).

V. L. Sauter (1997: 53) defines the characteristics of useful information for decision-making as 'timeliness, sufficiency, level of detail and aggregation, understandability, freedom of bias, decision relevance, comparability, reliability, redundancy, cost efficiency, quantifiability, appropriateness of format'. It is important to assess the sufficiency and the quality of the information according to these properties before using it for decision-making.

Decision-making is defined as a process that encompasses a sequence of activities, which are necessary for achieving decisions on a specific subject (Olson, Courtney, Jr. 1992: 406). Decision-making process is characterized by intelligence, design and choice phases all of which can be decomposed into other sub-phases or stages.

The intelligence phase involves a scanning stage, in which the problem is identified, research is carried on and data is collected, and an interpretation and assessment stage, in which a judgment is applied to the results of the data analysis. In the design phase the experience and values achieved during the intelligence phase are applied to generate different alternatives and to establish criteria for choice. The choice phase covers the evaluation of alternatives and the selection of action. It also includes the ratification stage in which the decided action is accepted and a consensus is obtained. This is followed by the implementation stage, wherein the means and mechanisms for executing the decided action are determined. The final stage is the feedback stage, which involves the monitoring, and assessment of the results of the decision and the quality of the decision-making process (Stohr, Konsynski 1992: 33-34; Olson, Courtney, Jr. 1992: 13-15). The defined decision process cycle does not necessarily follow an orderly sequence. In some cases, the process may involve loops back to previous phases, as well as the ignorance or repetition of some of the phases within this cycle.

The structure, that is, the degree of definition, of the decision problem is an effective factor concerning the decision-making process (Olson, Courtney, Jr. 1992: 410). The decision problems vary within a range between being completely structured to being completely unstructured. The structuredness of a decision problem depends on a variety of factors. The decision problems are structured if they are stable, commonplace, recurrent, programmable, have easy access to information, well understood and focused. The decision problems are unstructured if they have volatile context, are atypical / unique, discrete, intuitive / creative, have problematic access to information, have unclear decision criterion and multiple decision strategies (Marakas 1999: 58). That is to say, the decisions are structured, or in other words programmable[1], if a definite procedure can be applied and if they do not have to be treated all over again whenever the problem occurs. The decisions are unstructured, or unprogrammable if they are complex, unusual and new to necessitate a special treatment and if there is no single method for conducting the problem exists. There are also semi-structured decision problems that are unstructured in one or more of the intelligence, design and choice stages within the decision-making process (Konsynski, Stohr, McGee 1992: 9; Marakas 1999: 58). The degree of structuredness of a decision problem affects the way of approaching and handling the decision-making process.

Information and data processing as important components of the decision-making process have been effected by the progress of the computer technology. Parallel to the development of the 'information age', beginning from 1960s onwards, there have been many advances in the computer technology. As an outcome of the advances in the computer technology as well as a reflection of the necessity of processing large amounts of data rapidly and efficiently, many computerized systems emerged during this period. Taking into account the vital role of 'information', computer systems which mainly focus on data processing, such as the database management systems and information systems, have been built up and utilized extensively since then. These are followed by the development of more advanced and complex systems, which focus on the whole decision-making process. Considering also the degree of structuredness of the decision problem as an important factor in defining the decision-making process, 'decision-making systems' and 'decision support systems', which make use of database management systems and information systems besides the modeling and knowledge-base systems integrated within their body, have been set up in early

[1] H. A. Simon defines the decision problems as programmable and unprogrammable instead of structured and unstructured, in SIMON, H.A. (1960), *The New Science of Management Decision*. Englewood Cliffs, N.J.: Prentice Hall. (cited in Konsynski, Stohr, McGee 1992: 8-9).

1970s and prospered through 1980s[2] with the aim to help the decision-maker during the decision making process by utilizing the computer technology.

'Decision-making systems' (DMS) are computerized systems set up for handling the structured and programmable decision problems, whereas 'decision support systems' (DSS) are computerized systems designed, built and used to assist the decision-makers for dealing with the semi-structured or unstructured problems during the decision-making process (Konsynski, Stohr, McGee 1992: 7-10). Dealing with semi-structured or unstructured problems, DSS assume that there is not a definite solution of the decision problem and therefore allow the decision maker to solve the decision problem through his/her expertise and reasoning (Ayeni 1997: 4). Within the decision-making process, DSS should rather support the choice phase besides the intelligence and design phases (Sauter 1997: 47). Therefore, DSS has an important role in management sciences as computerized systems which do not replace the decision-maker and the judgment, but increase the effectiveness of the decision maker by providing support on the way to make a decision (Marakas 1999: 3; Ayeni 1997: 4).

Concepts of 'information', 'decision-making' and 'decision support' are significant concepts not only for management sciences but also for all the other disciplinary areas dealing with any kind of decision problem. Among them there exist also the disciplines dealing with spatial decision problems, which are the decision problems of special concern to spatial or geographical data, that is data related with a place or a location (Malczewski 1999: 3). Hence, the main concepts concerning decision-making, which have arisen from management sciences, are studied comprehensively and consequently have found their reflections in disciplines dealing with spatial problems such as urban and regional planning.

Being considered as significant issues, 'spatial data', 'spatial information' and 'spatial decision-making' and 'spatial decision support systems' have been comprehensively discussed and redefined by the disciplines dealing with spatial decision problems.

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[2] The origins of DSS can be considered as the concept of 'decision calculus' defined as "model-based set of procedures for processing data and judgments to assist a manager in his decision-making" which was put forth by J. D. C. Little, in LITTLE, J. D. C. (1970), Models and Managers: The Concept of a Decision Calculus, *Management Science* (16), 466-485 (Konsynski, Stohr, McGee 1992: 7).

The spatial decision-making process is defined following the similar major stages with those of the 'aspatial' decision-making process. J. Malczewski (1999: 96) defines the major stages in spatial decision-making process as the intelligence phase which includes the problem definition, evaluation criteria and constraints, the design phase which includes the alternatives and decision matrix, and lastly the choice phase which includes the decision maker's preferences, decision rules, sensitivity analysis and recommendation.

Spatial decision problems are complex problems in which evaluation criteria and alternatives based on the evaluation criteria are multiple just like the decision-makers involved within the process. Multi-criteria nature of spatial decision problems, calling for the combination of quantitative and qualitative information in making up the evaluation criteria on which to base the alternatives, are pointed out by and large (Malczewski 1999; Thill 1999). Hence, spatial decision problems are defined as 'multi-criteria decision problems' which should be evaluated though different criteria determined according to different objectives and preferences of different decision-makers involved within the process.

For the disciplines dealing with spatial problems, the qualified and sufficient spatial information plays a vital role in the spatial decision-making process. The ways to handle spatial information by making use of computer systems are highly searched for within the disciplines dealing with spatial problems. Yet, spatial decision support systems are relatively recent and minor-league with respect to decision support systems utilized in management sciences. Ayeni (1997: 5) defines the spatial decision support systems (SDSS) as the 'off-shots of DSS'.

Geographic Information Systems (GIS) play an important role and extensively utilized for handling spatial problems. Thus, it is widely discussed whether GIS are DSS or not. However, the common approach is to define GIS as important tools that support the spatial decision-making process but not to call them as DSS (Ayeni 1997; Peckham 1997; Engelen et al. 1997; Malczewski 1999). This is because GIS support the intelligence phase of decision-making process which covers the identification of the problem, data collection, analysis and evaluations but they are not sufficient enough to support the design and choice phases in which new alternatives are developed and choice between them is made. GIS require to be integrated with additional modeling system components to support the design and choice phases so as to be called as DSS.

Regardless of dealing with spatial or aspatial decision problems, it is possible to state that, the decision-making process is made up of the main phases of intelligence, design, choice, implementation and control in which comprehensive and qualified information about the subject of concern has a central position. It is also possible to state that, computer science, which has developed parallel to the developments in the information era, has been utilized for handling great amount of aspatial and spatial information as well as for supporting the decision-making process within the management and administration disciplines as well as within the disciplines dealing with spatial problems, such as urban and regional planning.

2.1.2. Conservation of Historic Towns as a Decision-Making Process

'Conservation' is an umbrella term that encompasses a variety of descriptions and interpretations in relation to natural and built environments. Conservation of the built environment has been a long-lasting concern, within which the meaning and content of the concept have enhanced from the conservation of single monuments to that of historical sites, settlements or regions as a whole.[3] At the point that it has achieved today, conservation of historic towns, or in other words urban conservation, is closely related to integrated planning and management of the built environment and cultural landscape (Jokilehto 1992: 112) and functions to direct the physical and functional development of the built environment by taking into account all the man-made and natural components of it along with their various time layers and morphological features (Broner-Bauer 1990: 141). Its aim

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[3] As a constituent of the built environment, the historic towns and their conservation have been a subject of concern beginning from early 20th century onwards, especially following the period of Second World War and its destructions. The conceptual and contextual developments on the conservation of historic towns reached the climax during the 'Architectural Heritage Year' of 1975. Correspondingly, the basis for the contemporary framework of the conservation of historic towns, taken in its broadest sense to encompass the whole urban tissue together with the layers formed through time and together with the cultural and natural environment that surrounds it, were shaped during 1960s and 1970s as an outcome of the discussions held at the international platform as well as the pioneering examples of urban conservation projects prepared for different towns in different countries. Already in those years, the complexity of historic towns together with the integrated relations which exist between their physical and socio-economical structures as well as that with their surrounding territory were comprehended and the concept of 'integrated conservation', which is still a valid issue, was shaped accordingly.

is to 'co-ordinate and regulate' the continuity and change of urban structure and its values as a whole, without making any differentiation about the type or the period of the heritage in concern (Zanchetti, Jokilehto 1997: 44).

Conservation of historic towns, therefore, is not a static study, but a dynamic and a critical process. This process composes of the documentation, description, analysis and evaluation of the historical resource in its historical time-line[4] as well as its condition in the physical, cultural, social and economic context of the present day, so as to attain decisions and proposals. As important constituents of the urban conservation process, conservation plans and conservation projects, which are prepared at a definite section within this continuous process, bring forth decisions and proposals regarding the future of the historic towns.

Urban conservation process can be considered as a spatial decision making process within which there exist other decision-making processes at different levels. The phases defined for the urban conservation process follow a parallel sequence with that of the spatial decision making process. Similarly, the vital role of information within the process of decision-making can be visualized in the urban conservation process as well as all other conservation activities. Hence, 'information' acquires a significant status in all kinds and scales of conservation activities. Obtaining comprehensive information on the subject matter to be conserved is crucial to achieve proper conservation decisions and implementations consequently.

Just like it had been for the management and administration disciplines as well as the planning discipline, the increase in the extent and importance of 'information' for conservation discipline falls within the same period considered as the beginning of the 'information age' and the development of computer technology. This period beginning from 1960s onwards have also been the period in which many of the specialized subjects, dealing with the urban context, such as urban conservation, integrated conservation and urban archaeology, have been extensively discussed and shaped within the conservation discipline. Thereafter, the data collection, analysis and evaluation have been taken as a primary and

[4] Historical time-line is a term utilized by Feilden and Jokilehto to define the sequence of phases that the historical resource has passed through, beginning from its creation till its perception at the present time. See (Feilden, Jokilehto 1993: 16) for further information.

essential step in the conservation process, mainly when dealing with complex problems like historic towns.

The increasing role of information in the urban conservation process was reflected in the increasing importance of inventories and data catalogues since 1960s.[5] The inventories and catalogues providing skeleton information about the architectural heritage have been utilized extensively during the conservation studies as invaluable tools (Feilden, Jokilehto 1993: 25). Since 1970s, as a consequence of the increasing amount of information required and produced, a lot of things have changed in the studies concerning the handling of information. These changes are reflected in the re-shaping of the concept and content of inventories[6], as well as in the enhancement of other approaches, tools and methods which focus on representing, analyzing and assessing data more than the compilation and storage of them. As a consequence, the recognized philosophy of 'information resources management' (IRM) in management sciences found its reflection as the concept of 'heritage information management' which has been introduced as a critical issue for the conservation of historic sites (Feilden, Jokilehto 1993: 27).

Likewise it has been for the decision-making process in management sciences, the quality of information utilized within the conservation decision-making process is of vital importance. The properties defined for useful information in decision-making process is applicable for the case of urban conservation as well. Hence, conservation measures should be based upon 'up-to-date, sufficient, in necessary level of detail and aggregation, in appropriate format, understandable, bias free,

[5] This prerequisite was indicated beginning from the mid 1960s. In the meeting of Council of Europe in 1965 in Barcelona called as 'Palma Recommendation (Recommendation A): The Criteria and Methods of Cataloging Sites, Ancient Buildings and Historical or Artistic Sites for Purposes of Preservation and Enhancement', the impossibility of safeguarding the cultural heritage effectively without identifying the assets comprising it and therefore the necessity of compiling a 'protective inventory' were indicated together with recommended criteria, methods, model index-card and terminology of a protective inventory of the European Cultural Heritage. Following this meeting, also in 'The UNESCO Convention Concerning the Protection of World Cultural and Natural Heritage' formulated in Paris in 1972, one of the major responsibilities of states was defined as the identification of the heritage to be protected. In the following years the importance of cataloging and preparing inventories were mentioned in several meetings and conferences at the international platform.

[6] For further information see the proceedings of European Colloquy organized by Council of Europe and French Ministry for Education and Culture – Direction du Patrimoine in Nantes, 1992 on 'Architectural Heritage: Inventory and Documentation Methods in Europe' (Cultural Heritage, No. 28 - Council of Europe Press 1993)

decision relevant, comparable, reliable, utilizable, efficient, quantifiable'[7] information about the heritage resource.

Conservation of historic towns is a 'multi-criteria decision problem' just like most of the spatial decision problems. Due to the complex and multi-faceted character of historic towns, urban conservation process necessitates to be evaluated through different evaluation criteria deriving from different aspects of the historic towns and different objectives and preferences of different decision-makers included within the process. As a consequence, the extent of quantitative and qualitative information necessary to achieve appropriate decisions and interventions increases. Especially when the concern is multi-layered towns and conservation of their multi-layered character, the information concerning the historical stratification of the town becomes one of the most important information which is necessary for a proper conservation decision-making process, besides the information about the physical properties of the components of the urban tissue or the social and the economic structure of the people living in it.

2.1.3. Decision Support in Conservation of Historic Towns

Departing from the basic feature of conservation studies defined as '*caso per caso*', it will not be wrong to state that the majority of conservation decision problems are the problems with no single, definite solution and each case should be considered specifically within its own context. Therefore, conservation decision problems can be defined as semi-structured or unstructured decision problems. Dealing with unstructured and semi-structured problems, conservation decision-making process involves different studies on different aspects of the historical resource that support the decision-making, but still necessitates the expertise of the decision maker to achieve the final judgment.

Collecting, analyzing and evaluating data so as to obtain utilizable information concerning different aspects of the town have an important place within the urban conservation process including also the urban conservation plans and conservation projects. Information is essential for the preparation of the

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[7] The properties defined for 'information' in conservation decision-making are not different than the properties that contribute to the quality of 'information' in any kind of decision-making process as defined in Chapter 2.1.1.

conservation plans and conservation projects, however, information processing concerning different aspects of the town should not necessarily accompany a conservation plan or a conservation project prepared within a limited period of time defined for them. Instead, dealing with information on different aspects of the historic town should be considered as separate sets of studies, which are carried on independently from the planning or the projecting phases. These studies, through which information on different aspects of historic towns are gathered and handled by the professionals and specialists of different fields, should be united and integrated with each other when necessary in order to form the basis for every kind of conservation activities, including the conservation planning studies and conservation decision-making.

Especially during the last two decades there is an increasing intention to prepare studies, projects and systems which focus handling the data on different aspects of historic towns so as to guide the decision-makers and decision-making processes. With this intention, various studies concerning different aspects of different historic towns are prepared beginning from 1980s onwards. (table 2.1)

These studies have many common aspects one of which is that they all deal with data processing as to one or more aspects of the historic town from conservation viewpoint, which can also be considered as heritage information management. Data processing, as a part of heritage information management, covers different phases as data collection, data storage and structuring, analysis and evaluation phases.

The most common applications concerning information management in conservation field are in the way of collecting and storing data or collecting, storing and structuring data concerning one or more aspects of heritage resource. Inventories and heritage recording systems can be exemplified within this category. These studies generally make use of computer technologies, especially database management systems. More recently the importance of geographical data in connection with attribute data is realized which reflected itself in the utilization of geographic information systems.

table 2.1. Decision supporting studies in conservation of historic towns and regions

	NAME / DATE	DEALERS	AIM	CONCERN	PHASES /TECHNIQUES	PROPERTIES
TURIN / ITALY	Beni Culturali Ambientali nel Comune di Torino - Storia e Architettura della Citta' (1981 - 1984)	Politecnico di Torino & Assessorato all'Urbanistica del Comune di Torino	analysis and evaluations supporting the conservation and planning activities	historical development of cultural environment typological analysis	Data Collection Analysis Evaluations (conventional techniques)	*integrity: integrity of vertical and horizontal development of Turin / natural & man-made features within the town and integratable with other studies by using terminology in current decision making system *continuity: territory / whole city / single structures
ROME / ITALY	Sistema Informativo Territoriale Interdisciplinare per il Comune di Roma (mid 1980s onwards)	USICS - Ufficio Speciale per gli interventi sul Centro Storico di Roma	obtain an information base utilizable for different purposes by Commune of Rome and Superintendency	archaeological analysis data bank for historical center	Data Collection Data Storage & Structuring (computer technology - GIS & DBMS)	*integrity: 'modular' and integratable with other studies carried on by the Commune of Rome *continuity: historical area / single structures *dynamism/flexibility: updatable, reversable, modifiable
GENOA / ITALY	Progetto Civis Ambiente & Progetto per Ripa di Genova (1987 - 1998)	Universita' di Genova Amministrazione Publiche Soprintendenza ai Beni Archaeologici Soprintendenza ai Beni Architettonici e Ambientali	support the conservation and planning decisions and implementations in different scales	historical development typological analysis buildings archaeology physical properties of existing buildings	Data Collection Data Storage & Structuring Analysis Evaluations (computer technology - GIS)	*integrity: integrity of archaeology, physical condition, socio-economic aspects of bldgs and integratable with other studies by using terminology of current decision-making system *continuity: historical area / single structures *dynamism/flexibility: updatable, reversable,
MILAN / ITALY	L'informatizzazione del Censimento dei Beni Architettonici e Ambientali dei Comuni della Provincia di Milano (1987 - 1998)	Politecnico di Milano; Istituto per la Storia dell'Arte Lombardia; Centro per i Beni Culturali e Ambientali della Lombardia; Centro Studi per la Programmazione Intercomunale dell'Area Metropolitana Provincia di Milano	support territorial plan for the Province of Milan (Piano Territoriale di Coordinamento di Milano)	distribution and properties of cultural and environmental properties within the Province of Milan	Data Collection Data Storage & Structuring Analysis (computer technology - GIS, DBMS & Image Processing)	*integrity: natural / architectural / archaeological heritage *continuity: whole territory / single structures / objects *dynamism/flexibility: updatable, reversable, modifiable
EMILIA-ROMAGNA / ITALY	C.A.R.T. - Carta Archeologica del Rischio Territoriale (1995 onwards)	Istituto Beni Culturali Regione Emilia-Romagna Soprintendenza Archaeologica dell'Emilia-Romagna CNR - Centro Nazionale di Ricerca	support town & landscape planing policy support decision-making for archaeological research management obtain an interpretation tool for archaeological researches foster cooperation between state and local agencies	assessment of archaeological evidence within the Emilia-Romagna Region	Data Collection Data Storage & Structuring Analysis Evaluations (computer technology - GIS)	*integrity/integrability: integrity of different aspects and integrability with other studies *continuity: whole region / remains of single structures *dynamism/flexibility: updatable, reversable, modifiable
YORK / ENGLAND	YAA - York Archaeological Assessment & York Environs Project (1991 onwards)	University of York English Heritage York Archaeological Trust North Yorkshire County Council	support the preparation and development of heritage management strategies provide an efficient tool for archeological researches and studies	historical development of York and its Environs, prediction, location, survival and range of archaeological sites within this area	Data Collection Data Storage & Structuring Analysis Evaluations computer technology (GIS & DBMS)	*integrity: different aspects concerning rural and urban area *continuity: whole region / single structures *dynamism/flexibility: updatable, reversable, modifiable
GÖTEBORG / SWEDEN	Save Historic Göteborg (1997 onwards)	Göteborg University, Institute of Conservation Foundation Save Historic Göteborg	provide a 'conservation design model' to support the conservation activities in the historic center of Göteborg	information, marketing and diffusion of knowledge about the historical development and architectural properties and values of the built environment and its components	Data Collection Data Storage & Structuring Analysis (conventional techniques)	*integrity: natural, social and man-made components of built environment *continuity: between different scales
DENMARK	SAVE - Survey of Architectural Values in the Environment (1987 - 1990)	Danish Ministry of Environment and Energy Local Consultative Groups	to provide a system of evaluating buildings and urban *structures from a* preservational view point to obtain municipal preservational atlasses	describing, analysing and evaluating historic buildings and building groups as a part of geographic and urban structure	Data Collection Data Storage & Structuring Analysis Evaluations Presentation and Publishing (conventional techniques and computer technology - DBMS)	*integrity: integrity of different aspects of built environment *continuity: municipal area / single structures *dynamism/flexibility: partially updatable, reversable, modifiable
QUEBEC / CANADA	Étude de Potentiel Archéologique et Analyse des Composantes Architecturales du Vieux-Québec (mid 1990s onwards)	City of Québec & Provincial Culture and Communications Department	to integrate historic-period archaeological sites into the urban planning process to identify potential sites to guide development strategies in daily operations of municipal urban planning department	describing and evaluating the archaeological potential of the town as a part of the city's built heritage database	Data Collection Data Storage & Structuring Analysis Evaluations (computer technology: GIS, DBMS, CAD, Image Correction Software)	*integrity: integratable with other data available on the city's corporate GIS system *continuity: whole city / single structures *dynamism/flexibility: updatable, reversable, modifiable
VIRGINIA / U.S.A.	MAPIT - Mapping and Preservation Inventory Tool	Heritage Preservation Services, Branch of Mapping and Information Technologies, National Park Service	to contribute to Cultural Resource Management to support the decisions and implementations of State and Tribal Historic Preservation Offices (SHPOs and THPOs) to provide a preservation planning platform	identification of cultural resources and their contexts, state-wide distribution patterns and county-wide localized patterns	Data Collection Data Storage & Structuring Analysis computer technology (GIS & database)	*integrity: sharing database with other governmental agencies accross states and regions *continuity: state / county / historical area / single structures *dynamism/flexibility: updatable, reversable, modifiable
PORT PENN / U.S.A.	National Register Historic District Port Penn, New Castle County, Delaware	University of Delaware	obtain a multi-disciplinary forum about the historical and architectural values in Port Penn to be utilized for researches and planning activities	historical development process of the town and the buildings, changes in building functions and styles within this process	Data Collection Data Storage & Structuring computer technology (GIS & database)	*integrity: historical, architectural, artistic aspects of buildings *continuity: historical area / single structures *dynamism/flexibility: updatable, reversable, modifiable

Besides the nation-wide inventories or archaeological and architectural heritage record systems which cover more standardized and general information about the heritage resource, there are studies developed especially for a specific town or a region with more detailed content and configuration which aim at collecting, storing and structuring data concerning one or more aspects of historic town to be utilized for conservation purposes. 'Interdisciplinary Territorial Informative System of Commune of Rome' is one of those studies dealing with obtaining information on the archaeological and historical evidences in Rome as a part of an interdisciplinary territorial system. Similarly, 'National Register Historic District Port Penn' deals with acquiring information about the historical development process and architectural values in Port Penn. These are examples of studies which collect, store and structure the data concerning various aspects of interest.

More advanced approach in such studies include not only storing and structuring the related data but also their analysis so as to guide the local and governmental decision-makers as well as the preparation of plans and projects. For example, 'Informationing on the Census of Architectural and Environmental Properties of Communes within the Province of Milan' concerns with the distribution, quality and quantity of cultural, architectural, archaeological and environmental properties in the Province of Milan to support the territorial planning studies. 'Save Historic Göteborg', concerning about the architectural values and properties of Göteborg, and 'MAPIT' (Mapping and Preservation Inventory Tool) for Virginia, dealing with the identification and distribution of cultural resources in Virginia region, are studies and systems which analyze the related data besides collecting, storing and structuring them.

The most sophisticated and complex group of studies covers the phases of data collection, storage, structuring, analysis and evaluations with the aim to obtain comprehensive knowledge on one or more aspects of historic towns. These studies aim at providing utilizable information on a specific aspect or aspects of the historic town or region obtained by processing the raw data through different evaluation criteria so as to be utilized in different scales and types of decisions, projects and implementations concerning the conservation of historic towns.

The early examples of these projects are realized by utilizing conventional methods and tools whereas all the recent ones use computer technology and specifically geographic information systems in association with database management systems. 'History and Architecture of the City – Environmental Cultural Properties of Commune of Turin' is one of the most important examples of such studies, which is realized by conventional techniques in 1980s. The concern of this study is to define the values of built up and natural components of Turin obtained through historical development process of the cultural environment. As this study is realized with conventional techniques, it is not possible to visualize data storing and structuring phases that are more common to computerized systems.

'YAA - York Archaeological Assessment and York Environs Project' investigating the origins of City of York and the relationship of different periods in York, 'Civis Environment Project and Project for Bank of Genoa' for the survey of historic city center of Genoa as a part of a European Project 'Civis Environment', 'SAVE - Survey of Architectural Values in the Environment' as an evaluation system of buildings and urban tissue in Denmark, 'C.A.R.T. - Document on Territorial Archaeological Risk of Québec' for describing and evaluating the archaeological potential of Québec as a art of the city's built heritage database, are important examples of such studies which utilize computer technology.

The above-mentioned studies can be classified into groups according to the point of departure of the study and the contextual framework defined for them. Some of these, such as the studies for Rome, York, Milan, Göteborg and Québec have departed from the case in concern and developed a scheme special for that case. There are also studies which are prepared for a specific site concerning a specific aspect similar to the previous ones, but constitute a part of nation-wide or world-wide projects, like the project for Genoa as part of a European Project 'Civis Environment'. Whereas, some others, like 'SAVE' in Denmark, 'C.A.R.T.' for Emilia Romagna region in Italy and 'MAPIT' for Virginia region in U.S.A. aim at obtaining a methodology, which can be utilized throughout the nation. Last but not least are the studies, like 'InterSAVE' as the international version of 'SAVE' project, which try to develop worldwide applicable methodologies for the survey, analysis and assessment of information on different aspects of historic towns.

Most of the above-mentioned studies focus on the survival, state and identification of archaeological, architectural and historical evidences and values in a historic town or a region which should be considered during conservation and development plans, projects, implementations. There is a common aim in all those studies as to guide plans, projects as well as to support decisions and policy-making concerning the historic town or region with a conservation view point, and specialization by providing results of the analysis and evaluations on the historical resource or at least the necessary raw or semi-processed data concerning the subject.

Besides supporting different types of decisions and implementations, these studies always aim at obtaining a platform or a document for researchers in directing academic researches and for the inhabitants in obtaining conservation consciousness. It is important to note that these studies neither embrace the entire information necessary for urban conservation planning or decision-making, nor they are the conservation plans themselves, as they do not include decisions about the historic resource. Yet, they cover the documentation, survey, analysis and / or evaluations of one or more aspects of the town, which are important for decision-making, in other words, supporting the decision-making process.

Such studies aim to help the decision-maker during the conservation decision-making process. However, they cannot be defined as 'decision support systems' (DSS), which exist as important tools for the management and administration disciplines as well as for planning and other disciplines having managerial and decision-making activities. DSS is a stereotyped term indicating a set of procedures to be followed to support the decision-making process by utilizing computer technology and specific system components both in management sciences and in urban and regional planning disciplines.[8]

The above-mentioned studies either utilize database management systems and geographic information systems but do not include all the system components as to be defined as a DSS or do not utilize computer technology at all. Therefore, it is not possible to define these studies as 'decision support systems', which appear in disciplines dealing with management issues and spatial or aspatial decision-

[8] DSS are defined in detail in Chapter 2.1.1.

making. However, in any case, it is possible to consider them all, whether prepared by utilizing computer technology or by the conventional techniques, as 'decision supporting studies' depending on their common role and contribution to the conservation decision-making process.[9]

The 'decision supporting studies' are prepared rarely by a single group or institution but in most of the cases there are different groups involved in the preparation of these studies. In the majority of cases there is an academic component of the dealer group as one or more universities and institutes or at least some supervising academicians specialized on the subject. Generally, there is also a local administration component of the dealer group either as employer of the study or as the producer of it through their specialized offices and borough councils dealing with conservation and urbanization issues. Besides, the existence of a central governmental component as ministries and their local executive and control offices such as councils and superintendences responsible from conservation of cultural heritage is in common. In some cases there are also local civil organizations incorporated to the study.

In most of the 'decision supporting studies', just like in other recent studies on conservation plans, projects and discussions about the conservation of historic towns, some common properties can be observed. These properties are basically dynamism / flexibility, integrity and continuity.

Historic towns are dynamic entities. They are subject to a continuous change resulting from the formations, transformations and disappearances occurring in urban fabric. Correspondingly, the information concerning a historic town is dynamic as well. The dynamism of the information is due to both the dynamism in urban structure and the dynamism in production and renewal of the information as a result of ongoing studies, researches and excavations in historic town. The information on the existing situation of the town changes due to the changes occurring in the existing fabric, whereas the information concerning the historical background of it changes and increases with the continuing scientific studies

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[9] Departing from the aim and role of such studies which deal with the compilation, systematization, analysis and evaluation of information concerning one or more aspects of historic towns, such studies will be named as 'decision supporting studies' throughout the thesis.

which reveal new information about different periods of the town and the elements making up that town.

Conservation decisions, conservation plans and projects should be built upon correct and up-to-date information. Therefore, in order to be able to 'co-ordinate and regulate' the continuity and change within the historic towns, the conservation studies need to be able to cope with their dynamism. Accordingly, 'dynamism' becomes a key issue in the 'decision supporting studies' as well as the conservation plans and projects. This property of 'decision supporting studies' come forth especially as a result of utilization of computer technology. Computerized systems give the possibility of easy renewal and updating of information, which is crucial for decision-making and implementations in conservation of historic towns. This property exists and even is indicated specifically in the 'decision supporting studies' of Rome, Genoa, Milan, Emilia-Romagna region, York, SAVE – Denmark, Québec, Virginia region and Port Penn.

Historic towns are complex entities. It is not possible to isolate the historic town from the new town, the existing tissue from the archaeological remains beneath it, the man-made environment from the natural one, the settlement area from its territory and from the network formed with other settlements, the physical structure of the town from its social, economic and cultural aspects since the formations and transformations within the historic town, which are aimed to be directed and managed by urban conservation process, are the outcome of all these integral relations. Therefore, the studies for the conservation of historic towns should take into consideration all the man-made and natural components that make up the physical structure of the town as well as the social, economic, cultural and political factors, which have important impacts on the formation and transformation of the urban tissue.

As a result of the complex and multi-faceted character of historic towns, the planning of historic towns necessitates expertise and specialization in various fields and their contribution to the process like it is also mentioned in the International Charter for the Protection of Historic Towns adopted by ICOMOS in

1987[10]. Consequently, the information that conservation decisions in historic towns necessitate is produced by different expert groups specialized on different aspects of the town and come from a variety of sources all in different formats and details. It is possible to achieve proper conservation decisions and interventions only if the information concerning all these different aspects of historic towns are considered and evaluated within an 'integrity'. Nearly all of the decision supporting studies which focus on one or more aspects concerning the decision problem aim at 'being integratable' with other studies focusing on other aspects of the historic town so that they can become a whole. For this reason, the choice of tool and terminology is generally made according to the tools utilized by other complementary projects and studies considering that they can be integrated with each other.

The properties of integrity and/or integrability can be observed nearly in all the 'decision supporting studies'. In the study for Turin, integrity appears as a striking feature, which is obtained through the utilization of a similar terminology with that of the current decision-making system. Whereas in Rome and Virginia projects, integrity is achieved by choosing GIS as the tool so as to make the results of the study sharable with other data available in a larger corporate GIS system for municipal or governmental applications.

'Continuity' is another keyword within the 'decision supporting studies' as well as the conservation plans and projects built upon them. The historic town is composed of different man-made and natural elements of different scales. The physical structure of the historic town is made up of all these different elements and the web of relations between them. For the towns with historical continuity, every single element, part or layer of the town is in relation with each other and with the whole. (figure 2.1)

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[10] 'Planning for historic towns and districts must be a multidisciplinary effort involving a wide range of professionals and specialists, including archaeologists, art historians, architects, town planners, restorers, photogrammetricians, civil, structural, traffic and soil mechanics engineers, jurists, sociologists, economists, etc.' is stated in the International Charter for the Protection of Historic Towns adopted by ICOMOS in 1987 (Larkham; 1996: 291).

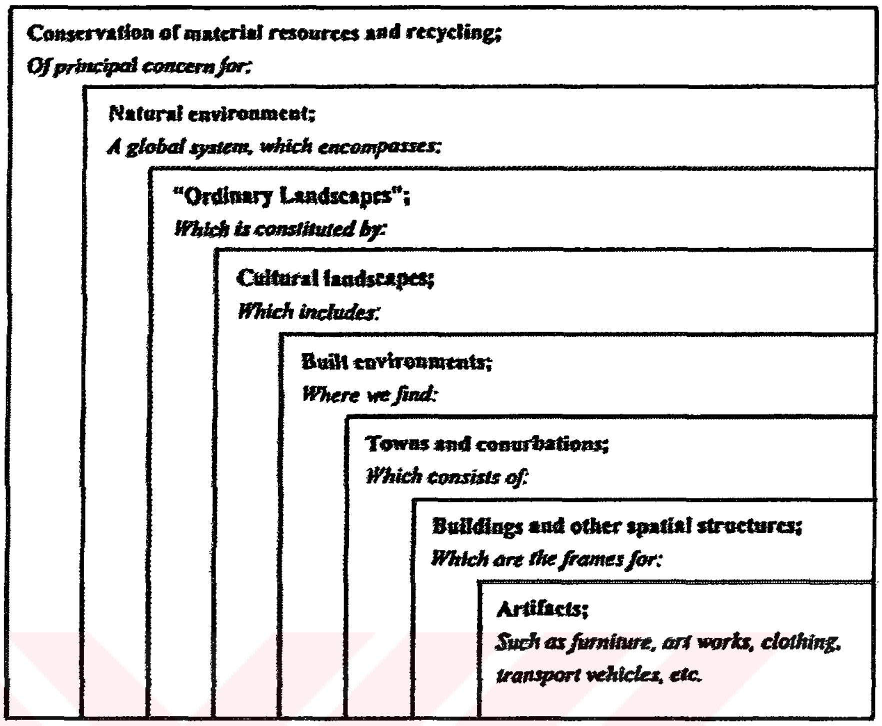

figure 2.1. Jan Rosvall's definition of conservation hierarchy levels and their relations (1999: 6).

It is not possible to give decisions and define proposals about a single element in the town solely without considering its relation with the other elements and with the whole. Owing to this integrated relationship of the components with the whole in a multi-layered town, each decision in the smallest scale effects the whole, and respectively the decisions related with the whole effect the smallest part of the whole. Thus, it is essential to obtain continuity between different scales and details and to allow the flow of information between them.

The property of 'continuity' can be observed in all of the 'decision supporting studies' whether utilizing computer technology or conventional techniques. As an early and pioneering example, Turin is a very successful study in this respect. In the study of Turin, it is possible to observe the architectural, archaeological and environmental values in a sequence of territorial level, settlement layout level, settlement's inner organization level, building block's inner organization level and single edifices level. In each of those different levels the values coming from the upper levels are indicated which allows to follow the continuity between different scales and types of information and their integrated evaluation.

Together with all these properties, the 'decision supporting studies' gain an important role in conservation of historic towns. When considered as a continuous spatial decision-making process of intelligence, design, choice phases, 'decision supporting studies' contribute to the conservation of historic towns by supporting especially the intelligence phase of the decision-making process which comprises data collection, storage and structuring, analysis and evaluations.

2.1.4. Conservation of Historic Towns in Turkey; Re-viewing the Current System as a Conservation Decision-making Process

As it had been all around the world, the demand for conservation of historic sites entered into the agenda of the conservation field in Turkey in 1970s[11] partially due to the impacts of increasing urbanization and tourism[12] but also as a reflection of the developments in the international platform.[13] Conservation in site scale was legalized in 1973 with the acceptance of Law for Ancient Monuments (Act No: 1710) as the first conservation act of the Turkish Republic. This act contributed to site scale conservation activities by defining the concept of 'site' and its different types and by introducing the right to intervene with the development plans according to the requirements of conservation when necessary (Madran 2000: 234). Law for the Conservation of Cultural and Natural Properties (Act No: 2863) replaced Law for Ancient Monuments (Act No: 1710) in 1983 and has been in

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[11] There were site scale conservation attempts before 1970s but they were in the form of indirect conservation activities: either by determining some streets, squares and facades as 'to be conserved' and some areas as 'protocol areas' in the development plans, such as Erzurum, Sivas, Kastamonu and Urfa (Madran 2000: 234) or by registering single buildings side by side to obtain a site scale conservation like it had been for the riverbank of Amasya in 1958 (Kuban 2000: 163).

[12] E. Madran (2000: 234) defines tourism as an important factor causing and shaping the site scale conservation activities after 1970s and points out the planning studies for Bodrum prepared in those years as an example of this approach.

[13] The first 'site' definition and types are translated from 'Palma Recommendation (Recommendation A): The Criteria and Methods of Cataloging Sites, Ancient Buildings and Historical or Artistic Sites for Purposes of Preservation and Enhancement' which is was produced in the meeting of Council of Europe in 1965 in Barcelona. The impacts of international decisions and developments continued by the international agreements that Turkey has accepted by laws. These are 'Convention Concerning the Protection of the World Cultural and Natural Heritage, Paris, 1972, UNESCO' accepted in 1982 and 'Convention for the Protection of the Architectural Heritage of Europe, Granada, 1985, Council of Europe' accepted in 1989.

force since then[14]. Other than redefining the concept of 'site' and using the new concept of 'conservation area'[15], the ultimate contribution of Act No: 2863 concerning site scale conservation has been introducing the concept of 'conservation development plans' for the first time by stating the conservation of historic sites as a problem of planning (Madran 2000: 236). Together with Act No: 2863, Higher Council of Ancient Real Estates and Monuments (GEEAYK) which had been the only authority in all the phases of determination of principles, decision-making concerning different cases and control within the conservation process since 1951, left its place to two different councils acting at different levels of the conservation decision-making process with the aim of decentralization. As a result, the determination of principle decisions has been left to the responsibility of Higher Council for the Conservation of Cultural and Natural Properties, and decision-making and control in local scale to that of Provincial Conservation Councils.[16]

Assigning the 'site' decisions and 'conservation development plans' the major role for the conservation of historic towns, Act No: 2863 defines the procedures to be followed in urban conservation activities as follows[17]:

- Designation and registration of an area as a 'site'; (by the Conservation Council depending on the principles defined by the Higher Council)
- The interruption of the implementations within the 'site' and the cancellation of the existing development plan concerning the 'site'; (by the Conservation Council)

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[14] Act No: 2863 was revised in some details by another Act No: 3386 accepted in 1987, and took its final form that has been in force since then.

[15] In the Act No: 2863 which is in force today, 'site' is defined as the towns or the remains of the towns which are the products of various civilizations from prehistoric eras till today and which reflect the social, economical, architectural and similar properties of their eras, the places of important historic events and the areas of conservation necessity with registered natural properties (1983a: 1) Whereas 'conservation areas' are defined as the areas that are obliged to be conserved in order to protect the immovable cultural and natural properties or achieve their effective conservation within a historical environment. It is important to point out that, 'site' and 'conservation area' in Turkish conservation legislation terminology are used differently than they are used in common international terminology in which 'conservation area' is used instead of 'site' of Turkish legislative terminology and 'buffer zone' is used instead of 'conservation area' of Turkish legislative terminology. This complication and difference is due to the direct translation of international documents during their first utilization in Act No: 1710 and they have been used in this way since then. In this thesis, the terminology in Turkish conservation legislation will be used.

[16] Thereupon Higher Council for the Conservation of Cultural and Natural Properties will be called as 'Higher Council' and the Provincial Conservation Councils will be called as 'Conservation Councils'.

[17] These procedures are defined in Act No: 2863, Article 17 (1996a: 9).

- Determination of the building conditions, which will be valid during the transition period, within 1 month; (by the Conservation Council)
- Preparation of the Conservation Plan for the 'site' within 1 year after its registration as a 'site'; (by the planning group employed by the authorized Municipality or the Governorship)
- Approval of the plan; (by the Conservation Council)
- Approval of the plan or statement of the oppositions to the plan; (by the Municipal Council)
- The new Conservation Plan's coming into force.

Through these procedures defined in the act, Higher Council, Conservation Councils, local authorities and plan / project groups have become the major actors during different levels within the whole process of conservation of historic towns. The principle decisions concerning the 'sites' made by the Higher Council, 'site' designation decisions concerning the cases made by the Conservation Councils, the plan and project decisions concerning the detailed conservation plans and projects of the designated 'sites' developed by planning and project group, proceed as separate decision-making processes at different levels. Altogether, they contribute to the formation of the whole urban conservation decision-making process in a hierarchical way by providing data to the succeeding level as well as by feeding back the preceding one. Therefore, conservation of historic towns can well be defined as a conservation decision-making process, which is the convergence of different decision-making processes at different levels. Accordingly, the current conservation decision-making process in Turkey can be re-viewed departing from the framework offered for any spatial decision-making process. (figure 2.2)

The decisions made by Conservation Councils aught to be based on the 'principle decisions' formulated by the Higher Council. Hence, the formulation of principle conservation decisions by the Higher Council can be identified as the first level of decision-making process. This level constitutes 'intelligence phase', in which principle objectives and principle evaluation criteria are established upon the definition of the problematic, 'design phase' in which principle decision rules are determined and 'control phase' which comprises control and approval of decisions made at the following level depending on determined principle decision rules.

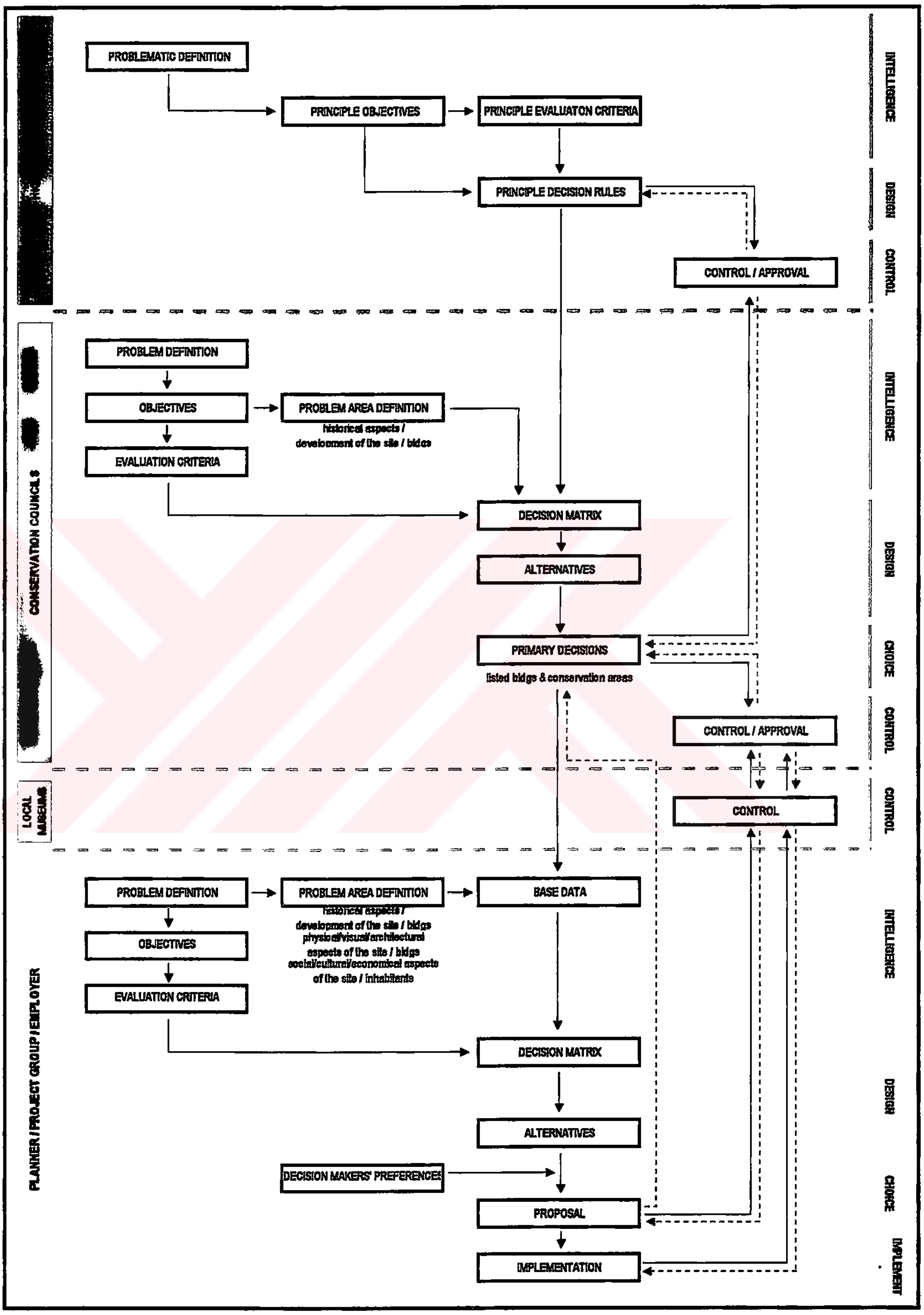

figure 2.2. Conservation decision-making process in Turkey.

The second level is accomplished by the Conservation Councils. This level covers four main phases of the decision-making process as intelligence, design, choice and control phases. In the intelligence phase, problem definition in connection with objectives are made which altogether lead to the determination of evaluation criteria. Parallel to them, the problem area definition is made by collecting data on historical development of the site and the buildings during the intelligence phase. It is followed by the design phase, in which problem area definition and evaluation criteria achieved during the intelligence phase are integrated with the principle decision rules coming from the upper level, so as to form up the decision matrix and alternatives consequently. In the choice phase, primary decisions concerning the listed buildings and conservation areas are obtained through the alternatives produced in the design phase of this level. Then comes the control phase, which includes the control and approval of the developed alternatives in the next levels. The primary decisions formulated at this level are controlled and approved by the upper level when necessary. This level has a sub-level in which local museum authority controls the actions carried on in the following level, departing from the decisions of the Conservation Councils.

Planners / project groups, local authorities and property owners are the main actors involved in the last level of conservation decision-making process. These groups together with the employer of the project, that can be private and public property owners, local authorities and others, make their problem definition, decide upon the objectives and derive evaluation criteria. Concurrently problem area definition is achieved through the collection and evaluation of data so as to provide information concerning the historical aspects and development of the site and the buildings, information concerning the physical, visual, architectural aspects of the site and the buildings and information concerning social, cultural, economic aspects of the site and the inhabitants. All of these, together with primary decisions coming from the upper level, contribute to the formation of base data during the intelligence phase of this level. This phase is followed by the design phase in which alternatives are proposed according to the decision matrix which is formed through the combination of the base data and the evaluation criteria. Then comes the choice phase in which a proposal is chosen within the alternatives produced according to the decision makers' preferences. Control and approval of the proposal by the upper level is followed by the implementation phase in which the approved proposal is implemented under the control of the upper level. The defined conservation decision-making process in Turkey, which constitutes of different decision-making processes at different levels, does not necessarily follow the same order in each case. There can be changes, ignorances or repetitions in some of the phases within this cycle just like there can be in any decision-making process defined in management sciences.[18]

As a result, it can be observed that conservation of historic towns in Turkey depends mainly on the 'case free' principles formulated by the Higher Council, which direct all the other decisions, the 'site' decisions made by the Conservation Councils and the conservation plan and project decisions made by the planning groups and project teams. Whether concerning single structures or areas, the primary step for all kinds and scales of conservation activities is their determination, definition and classification followed by the registration as a cultural heritage. The procedures defined in the conservation act also reveal the importance of the stages of determination and registration of 'sites' as a primary stage within the procedures to be followed for the conservation of historic towns.

As also pointed out by Zeren (1990: 2) the results of the determination and registration of cultural heritage is taken as a definite input during the research, preparation and approval phases of all kinds and scales of conservation and planning activities in historic towns. Yet, it is a repeatedly stated problem that the boundaries and types of designated 'sites' are not compatible with the historical evidences and properties of the area as these decisions are not generally built upon comprehensive scientific information evaluated through clear, definite designation criteria and as a consequence they change frequently in many of the cases.

In the conservation decision-making process in Turkey, the decisions concerning directly the 'site' or the buildings at the 'site' are built upon different types of information. The information about the physical, visual and architectural aspects as well as the information about the social, cultural and economic aspects of the area and the inhabitants are utilized in the formation of the conservation planning and project decisions. Whereas, the information about the historical aspects of the

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[18] These are defined in detail in Chapter 2.1.1.

area is utilized in both levels of the conservation decision-making process and therefore is of utmost importance for the formation of proper decisions that will help for the conservation of the site and the buildings. However, in the current system, this common information is produced separately by separate groups acting in two different levels of the conservation decision-making process. As a consequence, a variety concerning the information on the same subject occurs due to the differences in the data collection, processing and interpretation carried on by seperate groups, although it is a basic information which can change only if new findings occur or new aspects are discovered by the specialists studying the different historical layers constituting the area and the buildings.

One of the major reasons of this, is the lack of a definite document which informs about the properties and guides the processing procedures of the data on historical development, which should be utilized as the basic information by Conservation Councils in delineation of the boundaries and types of 'sites' as the most important and primary step in conservation of historic towns. Concerning the preparation of conservation plans, the situation is slightly better. In order to define the process of preparing a conservation plan and its context, 'Technical Terms of References for the Preparation of Urban Conservation Plans' was set up in 1990 in accordance with the conservation Acts 2863 and 3386 and the related regulations which were indicating urban conservation as a planning problem. This document contains the definitions, aims, objectives related with urban conservation planning as well as the processes of data collection, evaluation, synthesis, forming the plan decisions, examination and acceptance together with their sub processes. The aim of the document was stated especially as to define the main topics adaptable and enhancable according to different cases during the preparation of a conservation plan so as to provide a common language for conservation plans, instead of providing a detailed model of plan preparation that can fit all the different types of sites in different parts of Turkey.

In the 'Technical Terms of References for the Preparation of Urban Conservation Plans', researches on different aspect of the town, such as the survey and documentation of the existing physical, social and economic structure as well as the historical formation of the town, are defined as important studies in order to achieve appropriate decisions. Being specifically produced for conservation planning process, this document is quite general, and thus, not sufficient enough in defining properties and procedures of processing the data on historical development.

In all the main levels of conservation decision-making process in Turkey, it is possible to realize the common importance of information on historical development and stratification of the site, together with the common problem of divergences in production and interpretation of the same information between different levels of decision-making and vagueness and ambiguities as to the properties and procedures of processing this information so as to be utilizable in decision-making processes. Especially for the case of multi-layered towns, these divergences and indefinities resulting from the incompatibilities between decisions about 'site' boundaries, types, and the properties and historical stratification of area cause the destruction of many layers of the town.

Inconsistent with the increasing importance of 'decision supporting studies' in conservation of historic towns in different countries, in Turkey no 'decision supporting studies' concerning different aspects of heritage information management can be distinguished. Data is processed only as part of a project or a plan, and reprocessed every time when necessary.

Hence there is a necessity to define a 'decision supporting study' for the assessment of historical stratification in historic towns, specifically for the case of multi-layered towns which will provide a standard language and method to structure, analyze and evaluate data on historical stratification in order to support and guide the conservation decisions and implementations in different levels.

2.2. Geographic Information Systems and Conservation of Historic Towns

As important as constructing an assessment method for historical stratification in multi-layered towns, is defining the most compatible tools for such a study. Geographic Information Systems (GIS) appear as an important and powerful tool and component of most of the SDSS that deal with spatial information and spatial decision-making. Besides, most of the 'decision supporting studies' for the conservation of historic towns have been utilizing GIS as the main tool. It is obvious that the utilization of GIS in all these studies is not a coincidence.

The major properties and the extensive utilization areas concerning spatial information management and conservation information management calls for a tool which allows integrity, continuity, dynamism and flexibility while dealing with spatial data and spatial decision problems. GIS is a compatible tool with the nature of the 'decision supporting study' as well as the nature of multi-layered towns as the context of the study. Hence, GIS is regarded as an integral component during the constitution of the proposed assessment method for the historical stratification in multi-layered towns.

While defining the role of GIS in a 'decision supporting study', the origins, development, applications of GIS in different fields and specifically in conservation of historic towns, and features and organization of GIS based projects should be considered in relation to the developing computer technology.

2.2.1. A Retrospective View of the Utilization of Computer Technology in the Field of Conservation

Utilizing computers in different scales and phases of conservation studies has been rejected for a long time due to a 'believed incompatibility' between the nature of the historic resource and that of the computer systems that produce mechanical outputs, as they are more advanced in accuracy than artistic quality[19] (Ashton 1995: 42-43). Therefore, the use of computer technology is relatively recent in the conservation field, and thus many of the computer programs developed for different disciplines could not be adapted to conservation studies as they did in the other fields. Recently, although quite limited, it is possible to observe the exploitation of computer technology in conservation studies as well. Especially the utilization of database management systems, computer aided design programs, three-dimensional modeling programs and, more recently, geographic information systems are observed in various studies in the field of conservation.

[19] Robert Ashton defines the relation of computer systems and conservation field, especially that of architectural conservation. He discusses the reasons why computer technology is not being utilized in the conservation field and consequently the reasons why computer systems are not being enough developed to be utilized more extensively in this field. For further information see (Ashton, R. 1995: 42-54).

Conservation decisions and actions necessitate the utilization of a considerable amount of data concerning different aspects of the historical resource. Therefore, most common computer programs utilized in conservation studies are database management systems (DBMS). DBMS provide efficient access and storage of data. They also allow making queries on the data according to the criteria defined by the user. The more advanced type of DBMS are relational database management systems (RDBMS) which allow dividing the data into subgroups according to different aspects of the subject, and defining common features in different databases as key feature to obtain a relation in order to make a connection between separate databases.

DBMS and RDBMS are generally utilized to store and structure the information about historical resources of different scales, which can be the whole historical site or a single historic building or even objects found at the site. It is also possible to attach documents, images and drawings to each of these records within the database, which makes possible to use these programs for building up inventories concerning the historical resources. When the advantages of computer environment about the storage of documents without being deformed or deteriorated as well as viewing them as scale-independent are considered, production of inventories and catalogues by utilizing DBMS becomes more attractive, and thus, have been widely utilized after 1990s as a relevant tool.

In addition to the DBMS, computer aided design (CAD) softwares are also made use of in the conservation studies in different scales so as to produce measured drawings as well as analysis and evaluations through these drawings. As mentioned previously, the majority of people dealing with historical resources reject to utilize computer technology in documenting the historical resource because of the mechanic character of the output drawings that are found to be incompatible with the time-deep irregular character of the historical resource. With these programs, it is quite hard to produce 'picture like' drawings that reflect the desired effect of the historical resource, as these softwares are developed for engineering disciplines, which necessitate accuracy of the precise mechanical drawings. Although it is not easy to produce 'hand-drawn like' drawings by CAD softwares the high level of accuracy provided by these programs is still very important for conservation studies.

Most of the CAD programs also allocate the insertion of scaled images and photographs as a background to the drawing, which can be utilized in making drawings and renderings over them or making presentations by overlaying the images with the drawings. The most important advantage of CAD drawings is their flexibility in making corrections and additions rapidly.

The CAD programs also allow dividing a drawing into different layers in order to make easier to draw by defining different line types, colors and thicknesses within a drawing file. Considering the analysis and evaluations which are to succeed the preparation of measured drawings, this feature of CAD softwares can be utilized to classify the components of the historical resource, either in site scale or a single building scale, in different layers as a result of which analysis can be carried on. However 'analysis' is not an enhanced property of CAD programs. The files, which include analysis provided by hatches in different layers, colors and textures, become quite bulky. In this respect, CAD softwares do not provide additional advantages over the conventional paper space other than the superiority in rapid correction during the analyses and evaluations phases of the conservation studies. Besides all these properties, CAD softwares allow the production of 3-dimensional drawings that can be converted into 3-dimensional models by utilizing additional modeling programs. The 3-dimensional models of the historical resource are utilized in producing virtual reconstructions. Virtual reconstructions prepared for buildings and sites allow the tryout of different possibilities about the origins of the historical resource as well as about its future condition after different interventions. Just like the drawings produced by CAD programs, the virtual reconstructions are criticisized for being too much artificial. However the paramount advantage of visualizing and presenting the historical resource as it had existed before and as it will exist in the future after the restoration or conservation work proposed without giving any damage to the original structure should not be underestimated.

The utilization of geographic information systems (GIS) in conservation field is relatively recent with respect to the utilization of the abovementioned systems and softwares. As a consequence of being a new issue as well as being originated and shaped in another discipline, GIS are not utilized with their full potential in conservation issues and call for detailed examinations and experimentations.

2.2.2. Geographic Information Systems (GIS)

There exist many different descriptions of GIS more or less similar with each other. All the different descriptions indicate the same aspects that make up the GIS: geographic – information – system. 'Geographic' indicates that the concern is of spatial objects with geographically - or spatially - referenced data, 'information' indicates the extraction of meaningful conclusions from the data through different processes, and 'system' indicates the integrated set of procedures - mostly automated or computerized - through which the data are managed (Martin 1996: 3). Departing from these main aspects, GIS can be defined simply as computer-based systems for dealing with spatial data.

GIS are spatially referenced databases that provide the link between spatial inputs and database. They consist of a standard relational database and a graphic or mapping database connected with each other as a result of which every feature in the GIS environment carries their attribute data sets together with the graphical ones. The link between the graphic and attribute data sets of a spatial object is obtained within the GIS environment upon which the system becomes ready for different querying and modeling purposes.

GIS allow the capture, storage, retrieval, analysis and display of spatial data. Different than the CAD systems in which the spatial data are stored as merely graphic information, in GIS the spatial data are stored as graphic information associated with non-graphic attribute information. This allows highly enhanced analysis capabilities for GIS, which are superior to CAD systems. GIS are also superior to DBMS as they provide an additional capability of spatial querying and analysis besides the capabilities of storing, structuring and querying of non-spatial data in DBMS.

GIS provide an integrated environment in which the different facilities of DBMS, CAD and modeling programs and systems are united so as to enhance their capacity for spatial analysis and evaluations. GIS alone are less advanced in drawing capabilities than CAD systems, in querying capabilities than DBMS and in the 3-dimensional representation capabilities than 3D Modeling programs. Nevertheless, GIS allow the integration of data produced in these different systems as a result of which a better-quality drawing prepared in a CAD environment as well as its 3-dimensional model prepared in a modeling program can be transferred into the GIS environment subsequently so as to be integrated with a well-organized database produced in an advanced DBMS.

All these integrated capabilities of GIS, which provide the input, storage, analysis and output of spatial data so as to obtain spatial information, makes GIS a very powerful tool in handling spatial problems. Therefore they are widely utilized in supporting the spatial decision-making processes. Despite of the support they provide, GIS cannot be defined as SDSS as they need to be integrated with additional modeling facilities to turn out to be SDSS. Nevertheless, due to their capabilities and advantages in handling spatial data, GIS become indispensable tools and major components for the formation of SDSS.

2.2.2.1. Origins and Application Fields of GIS

Understanding and representing the space together with its spatial components and relations have ever since kept its significance. For this reason, 'maps' have been utilized as important instruments as the representer of the real world. Maps have been produced and utilized in representing and describing the natural or man-made geographic features through an abstraction. They represent, describe and analyze using the geometric language that signifies the elements of the real world. The different aspects of the real world, the 'content plane', are reflected in the maps, which are 2-dimensional graphic representations of the real world, by using the geometric language. Geometric elements are used to be the visual occurrences / marks, which are linked with geographic occurrences / features in the set of sign functions determined (Wood 1993: 133). Due to the abstraction they make, maps include interpretation in themselves. The map is a 'highly complex supersign', which is a synthesis of lesser signs (Wood 1993: 132).

Maps have been utilized not only for representing the real world but also for analyzing the different components of it. 'Map analysis' is known to be a prevalent concept for analyzing environmental and human settlement issues in 1960s. However, different themes coming from different maps, which indeed share the common geographical space, were not easily integrable in 2-dimensional map space while performing map analysis. This problem was tried to be defeated by overlaying transparent maps each containing a theme on a light table[20] (Huxhold, Levinsohn 1995: 6).

Multiple map overlay technique has been an early, effective and common technique for carrying out spatial analysis. The hand-drawn overlay maps have always been significant in analyzing the relationship between different components of the landscape (Foresman 1998: 4). The overlay maps and cartographic analysis, which are prepared either for analyzing separate components forming up a space or separate phases in the formation of a space, are the fundamental and foremost basis for geographic theory and spatial analysis which have been effective in the formation and development of Geographic Information Systems (GIS).

The advances in computer technology, beginning especially from 1960s onwards, forced new studies and applications about incorporated solutions to handle spatial data. The computer-based version of map overlay analysis technique was first applied by Howard T. Fisher with SYMAP, which can be noted as a significant computer program for the birth of GIS technology (Huxhold, Levinsohn 1995: 7).

Besides the developments in the computer technology, the changes in political thinking and social transition from an industrial society to an information society during the same period, had been influential over the governmental activities. This played an important role in the formation of GIS (Foresman 1998:10-11). The international recognition of land use policy for environmental protection initiated a variety of global programs that relied on GIS technology.

Especially in North America, Canada, in the 1950s and early 1960s, the government started to be more effective in land use management which resulted in the necessity for a tool to handle the spatial data for Canada Land Inventory (Marble 1990: 12). This was followed by the design of the first operational industry-scale computer-based GIS, called Canadian Geographic Information

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[20] Ian McHarg (1969) is known to be a leading name in utilizing this technique (Huxhold, Levinsohn 1999: 6).

System (CGIS)[21] (Foresman 1998: 4). Following the first applications beginning with CGIS, Geographic Information Systems (GIS) have grown up as an important sub-field of Information Systems (IS) which consist of other sub-fields such as Land Information Systems (LIS), Management Information Systems (MIS), Database Management Systems (DBMS), Expert Systems, and Decision Support Systems (DSS).

GIS based studies in various disciplinary areas follow more or less similar lines of research with those described by S. H. Savage[22] for the case of archaeology (1990: 22). In fact it is possible to enhance Savage's description by relating them with the enhancing role of GIS in a disciplinary field. Departing from several examples of GIS applications and enhancing the grouping made by Savage for the case of archaeology four major areas of GIS based applications, which also refer to stages of enhancing role of GIS, can be defined:

- Utilization of GIS as a storage, drawing and representation tool: This is the primary stage of applications in which GIS is utilized no more than any other drawing, representation and storage tool. The existing methodology is applied just as it would be without utilizing GIS. In this case GIS has no methodological contributions.
- Utilization of GIS as an analytical tool: In this second stage, GIS is not only utilized just as a drawing, representation and storage tool, but also as an analytical tool. In this case, the spatial and attribute data are structured and simple queries are realized. This phase utilizes GIS more efficiently with respect to the previous one, however there still does not exist any methodological contributions of GIS.
- Studies following GIS procedures: In this stage, all the GIS capabilities and procedures are utilized by adapting the existing methodology of a discipline. Hence, the existing methodology is revised in consideration with georeferenced spatial and attribute data storage, structuring and manipulation as well as complex analysis and evaluation functions of GIS. In this stage, the

[21] Canadian Geographic Information System (CGIS) under the leadership of Dr. Roger Tomlinson in early 1960s (Foresman 1998: 4).

[22] Savage defines three main lines of research with GIS methods in archaeology as: site location models for cultural resource management; 'GIS procedure related studies'; studies addressing larger theoretical concerns about landscape archaeology.

methodological contribution of GIS to the existing method utilized by the discipline can be realized more with respect to the previous ones.

- Studies of larger theoretical and methodological concern through GIS: Being the last stage in GIS based studies, in this final stage departing from the technological and methodological advances provided by GIS, new theoretical and methodological contributions are made to the disciplinary field. In this stage theory, method and tool are regarded as interconnected with each other. This stage necessitates interdisciplinary studies in which GIS applications are also enhanced according to the requirements of the discipline in concern. That is, not only a methodological contribution to the discipline but also a methodological contribution to GIS exists all together in this final stage.

These major stages of enhancing role of GIS in a discipline ranging from a simple tool to support old methods towards integrated methodological and theoretical contribution of GIS depends not only on the objectives and strategy of a disciplines approach towards this new technology, but also on the 'time' spent for GIS Implementations. In any GIS application, time is required to built the necessary platform. W. E. Huxhold and A. G. Levinsohn (1995: 107) summarize "the role of time required for GIS implementation (*T*)" with the following formula:

T	=	time to build the platform
	+	time to build the applications
	+	time to develop and learn new procedures

Hence, the more 'time' is spent for the utilization of GIS and experience is gained in a disciplinary field, the more enhanced becomes the role and contribution of GIS.

GIS have been used by many disciplines dealing with different kinds of spatial problems. D. Martin (1996: 31) classifies the application fields of GIS as those related with the physical environment, which can be divided into two basic sub-groups as natural environment and built environment, and those related with socio-economic data.

Within the GIS applications related with the physical environment, applications concerning the natural environment are perhaps the most advanced and popular field of application. This is probably due to the fact that the emergence of GIS has been through an application concerning natural environment, that is CGIS. GIS have been extensively utilized for applications concerning natural environment since CGIS till today. GIS applications concerning natural environment vary within a wide range including environmental monitoring and management, land use and management, agriculture, forestry, hydrology, geology, metallurgy, meteorology, wild-life and zoology.

Applications concerning the built environment also spread a wide range of disciplines. Within these, the most common application fields are municipal applications, and urban, regional planning and management applications. These include infrastructure management, transportation and network analysis and management, utility services management.

Another common application field concerning the built environment is archaeology. Various archaeological applications of GIS with differing concerns can be visualized. Site location and identification studies for classification and characterization of archaeological sites using complex high dimensional groupings and the patterning of site characteristics for the purposes of management, 'predictive site modeling' for projecting known patterns or relationships into unknown times or places for site and non-site locations identification purposes, form up the main GIS based study types in archaeology. There are also more recent studies that refer to larger theoretical discussions and methodological concerns related to landscape archaeology through GIS methods (Savage 1990: 22). The military applications of GIS also appear as a common application field, which both concerns with natural and built environment.

Apart from the applications of GIS concerning built and natural environment which all deal with physical data, there are also applications of GIS which deal with socio-economic data. However, socio-economic applications of GIS are not as advanced and widespread as the applications related with the physical environment. Besides other factors, an important factor is socio-economic applications of GIS's being more recent and thus less improved when compared with the former.[23]

[23] See (D. Martin 1996) for further information on socio-economic applications of GIS.

2.2.2.2. Utilization of GIS in Conservation of Cultural Heritage

Utilization of GIS in conservation of cultural heritage is a relatively recent application field with respect to other applications concerning the natural and built environment.

Conservation of 'cultural heritage' covers a wide range of subjects, including the conservation of architectural edifices, historic towns, archaeological heritage and the like, each of which have different approaches towards the utilization of GIS, and consequently, each of which have reached different stages of development in GIS based studies. However, in any case, regardless of the subject, similar stages of enhancing role of GIS can be visualized in different fields within cultural heritage conservation in accordance with the objectives and strategy of the field in concern and with the time spent for the GIS implementations.

Various examples of GIS based projects on conservation of cultural heritage, realized since the beginning of 1990s, majorly cover archaeological heritage as well as urban and architectural heritage, which includes single edifices and historic sites. At the intersection of these two main subject groups is the urban archaeological heritage, which can be considered as a sub-group of both archaeological heritage and urban heritage applications.

Crain and MacDonald (cited in Savage 1990: 23) note the progressive stages of GIS, concerning their utilization in the field of archaeology, as evolving from 'inventory systems to analysis systems to decision support systems'. This classification, which is also valid for other fields within cultural heritage conservation, is actually parallel to the stages of enhancing role of GIS in any disciplinary field. Departing from the various examples, progressive stages of utilization of GIS in conservation of cultural heritage can be grouped as heritage record systems, analysis, evaluations, cultural resource management (CRM) and predictive modeling (table 2.2).

Within these groups, 'heritage recording systems', which make up the widest area of utilization of GIS in conservation of cultural heritage, coincide with the primary application stage of GIS, in which GIS is utilized just as a storage, drawing and representation tool with no methodological contributions. Whereas, 'analysis' is the second stage in which GIS is not only utilized just like a drawing, representation and storage tool, but also as an analytical tool by structuring spatial and attribute data and by realizing simple queries through them.

The third stage of GIS applications in conservation of cultural heritage is concerned with 'evaluations', for which spatial and attribute data storage, structuring and manipulation as well as analysis and evaluation functions of GIS are realized. In this stage, all the GIS capabilities and procedures are utilized to their full extent with the aim to adapt the existing methodology to GIS data management procedures. CRM and predictive modeling coincide with the fourth stage wherein theory, method and tool are regarded interconnected with each other. Hence, new theoretical and methodological contributions are made both to the field of utilization, departing from the technological and methodological advances provided by GIS, and to GIS, departing from feedbacks coming from this utilization process.

Various projects on cultural heritage conservation realized with GIS reveal that the utilization of GIS as heritage record and analysis tools is very common in all scales and types of cultural heritage conservation issues. Respectively their utilization as an evaluation tool is less common and even do not exist at all concerning single historical structures. Cultural resource management (CRM) and predictive modeling applications of GIS can be seen concerning only the archaeological heritage (table 2.2).

Departing from the examples as well as the theoretical discussions, it will not be wrong to say that the most advanced GIS applications in conservation of cultural heritage are those involved with archaeological heritage, in most of which integrated methodological and theoretical contribution of GIS can be recognized. Apart from archaeological heritage, it is not possible to mention a well integration of GIS in methodological and theoretical configuration of studies on conservation of cultural heritage.

table 2.2. GIS applications concerning cultural heritage issues.

		PROJECT NAME / COUNTRY (REFERENCES)	HERITAGE RECORD	ANALYSIS	EVALUATION	CRM	PREDICTIVE MODELLING
ARCHAEOLOGICAL HERITAGE		Gardermoen Project / Norway	■				
		JADIS - Jordan Antiquities Database / Jordan	■				
		The British Archaeological Database / UK	■				
		ICRD-Integrated Cultural Resources Databank / USA	■				
		Shenandoah Project / USA	■				
		Caere Project / Italy	■	■			
		PerseusGIS / Greece	■	■			
		Shepton Mallet Project / UK	■	■	■		
		Iowa Project / USA	■	■	■		
		ArcheoDATA System	■	■	■		
		C.A.R.T. System / Italy	■	■	■	■	
		SCALA Project / France	■	■	■	■	
		Midwest Project / USA	■	■	■		■
		Montana Project / USA	■	■	■		■
		MANX National Heritage Information System / UK	■	■	■	■	■
		The MountTrumbull Red Flag Model / USA	■	■	■	■	■
		Fort Drum Project / USA	■	■	■	■	■
URBAN AND ARCHITECTURAL HERITAGE	URBAN ARCHAEOLOGY	Informativo Territoriale Interdisciplinare per il Comune di Roma / Italy	■	■			
		Étude de Potentiel Archéologique et Analyse des Composantes Architecturales du Vieux-Québec / Canada	■	■	■		
		York Environs and Archaeological Assessment Project / UK	■	■	■		
	HISTORIC SITES	Port Penn Project / USA	■				
		SIRIS Project - Informative System for the Reconstruction of Historic Settlements / Italy	■				
		MAPIT-Mapping and Preservation Inventory Tool / USA	■	■			
		Management of Data Regarding Environmental Impact on Historic Materials and Structures / Greece	■	■			
		L'informalizzazione del Censimento dei Beni Architettonici e Ambientali dei Comuni della Provincia di Milano/Italy	■	■	■		
		Progetto Civis Ambiente & Progetto per Ripa di Genova / Italy	■	■			
		Evaluation of Vernecular Architecture - Earthen Cob Buildings / UK	■	■	■		
	SINGLE STRUCTURE	Chateau de Vincennes Project / France	■	■			
		Stone Conservation at Jefferson and Lincoln Memorials / USA	■	■			

Even though there can be seen various examples concerning urban and urban archaeological heritage, they are generally in the form of heritage recording and basic analysis operations and they rarely reach the stage of evaluations. Due to the lack of enough experience about the utilization of GIS for the conservation of urban and urban archaeological heritage, GIS neither have established adequate methodological and theoretical contribution to the studies on the conservation of urban and urban archaeological heritages, nor have had the opportunity to be restructured and enhanced according to the requirements of those studies. Applications concerning conservation of single edifices are rather in a primary stage and there have not yet produced enough studies to enhance the role of GIS.

Utilization of GIS in conservation of cultural heritage in Turkey is more recent, and consequently, at an initial stage of enhancement with respect to those in most of the other countries. Nevertheless, the utilization GIS on different subject areas of cultural heritage go parallel with the general situation. That is, studies on archaeological heritage are the most enhanced ones with respect to others also in Turkey[24], although they are not as advanced as to provide methodological and theoretical contributions.

Utilization of GIS in urban conservation is more recent than that of archaeological heritage, and respectively less enhanced. In fact, the studies do not go further than heritage record and simple analysis[25]. Concerning the architectural edifices, it is not even possible to mention about any application. Due to these facts, GIS have not yet been considered as efficient tools for the studies on conservation of cultural heritage in Turkey.

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[24] Kerkenes Project, which is carried on under the direction of Françoise and Geoffrey Summers from METU Faculty of Architecture, is one of the most important GIS based projects dealing with the non-destructive research techniques in an archaeological site prior to excavation.

[25] An example of utilization of GIS for conservation of urban heritage in Turkey is the project of 'Inventory of Cultural Assets in Historical Peninsula of İstanbul' by I.T.U. Faculty of Architecture, Major Program in Restoration, which aims to provide a computer based inventory of cultural assets, based on the information in registration forms. There is another project, 'Urban Information System Project in Historical Peninsula of İstanbul' carried by <BOAT> Laboratory of YTU Faculty of Architecture since 1995. Within the context of this project a model is developed for urban information systems in which conservation is taken as an issue.

2.3. Definition and Framework of the Proposed 'Decision Supporting Study': A GIS Based Method for the Assessment of Historical Stratification in Multi-Layered Towns

'Conservation of multi-layered town' is a multi-criteria spatial decision-making problem. As a spatial multi-criteria decision-making problem, it necessitates the utilization of different types of information according to different criteria among which information on historical development and stratification has a primary role. Identical to decision supporting systems (DSS) utilized in decision-making processes in management sciences and spatial decision supporting systems (SDSS) utilized in decision-making processes in urban and regional planning disciplines, urban conservation process requires to be supported by different 'decision supporting studies'. For the case of multi-layered towns, assessment of historical stratification appears to be an important topic, which should be handled as a 'decision supporting study'.

'Decision supporting study' for the conservation of multi-layered town aims at providing conscious integration of information on historical stratification to the conservation decisions and interventions with the intention of contributing to conservation of its 'multi-layered character'. In order to achieve this aim, the 'decision supporting study' deals with the management and assessment of information on historical stratification in a multi-layered town through scientific data and their systematic and scientific processing and evaluation.

Hence, the 'decision supporting study' can be considered as an information management process, which goes parallel with the urban conservation management process, while feeding each other back. Although 'decision supporting studies' should be set up and performed separately from the conservation decisions and planning phases, at certain points when a conservation decision is to be given, a conservation / development plan or a project is to be prepared within the urban conservation management process, they should integrate with other 'decision supporting studies' on various aspects of the town and with other necessary information groups so as to contribute to their preparation. (figure 2.3)

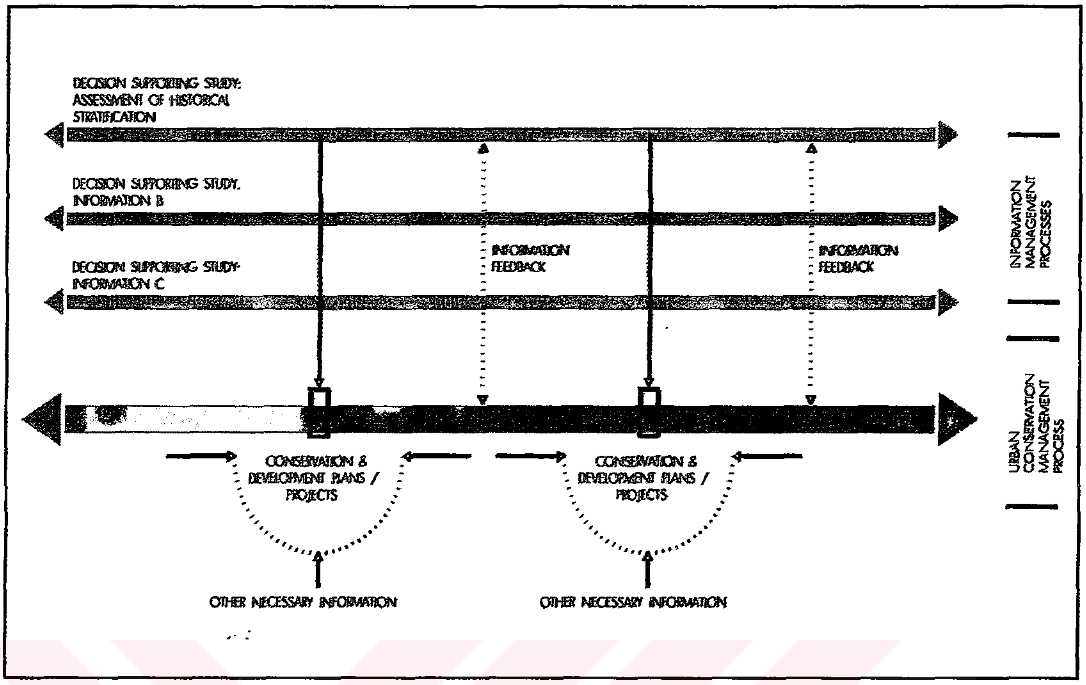

figure 2.3. The viewpoint of this thesis towards urban conservation process indicating the relation of proposed 'decision supporting study' on assessment of historical stratification with other 'decision supporting studies' as well as with urban conservation management process and conservation plans / projects.

Another objective of the 'decision supporting study' on the assessment of historical stratification is to unify the function of information gathering and assessing in a single process. Hence, the same subject studied by different groups through different data processing methods and evaluation criteria at different levels of conservation decision-making process in the current system should be handled as a single study realized by a single group which provides information to all the concerning groups of decision-makers, operators and researchers.

The 'decision supporting study' provides information for different user groups such as decision-making groups, researching and informing groups, and the operating groups within the multi-layered town (figure 2.4). The decision-makers are Conservation Councils which are responsible from making the decisions concerning the determination, classification and registration of sites as well as controlling the new interventions in association with local museums. Planners who determine the development and conservation plan decisions, architects who decide upon the projects of new buildings in the historic settings, conservation architects who decide upon the interventions concerning the restoration and conservation of single structures or groups of buildings, archaeologists who decide and plan archaeological excavations and researches, and the local authorities which decide upon the interventions concerning the infrastructure of the town while controlling and guiding the developments and interventions within the town, can be defined as both decision-making and operating groups. There are also researching and informing groups which include the academic researchers, archaeologists and inhabitants.

This study is structured so as to be utilized by all these different groups. Accordingly, the 'decision supporting study' for the assessment of historical stratification will *support* the Conservation Councils in determining the 'site' decisions and in controlling the restorations and new interventions as well as will function as a *guide* to the planners in plan decisions, architects in designing new structures, conservation architects in restorations, archaeologists in planning the archaeological researches and excavations and local authorities in controlling the interventions. Besides it will provide *a databank and a discussion platform* for researchers concerned with the historical development and stratification of the town and as a reference to the property owners and inhabitants of the town in informing about their buildings, parcels and the town in general.

While providing utilizable information for different purposes and by different groups, 'decision supporting study' on the assessment of historical stratification should present the major properties of dynamism / flexibility, integrity / integrability and continuity which are commonly observable in any 'decision supporting study'. It should be dynamic and flexible to cope with the dynamism of information concerning the dynamic urban structure of the multi-layered town as well as its renewal, correction, enhancement and updating. It should provide integrity of different types and formats of information coming from different sources that can contribute to the assessment of historical stratification. It should be integratable with other 'decision supporting studies' and information concerning different aspects of the multi-layered town other than historical stratification so as to be utilized in conservation and development plans and projects when necessary. Last but not least, it should provide continuity of information concerning historical stratification by allowing the flow of information between different components of the multi-layered town in different scales and details.

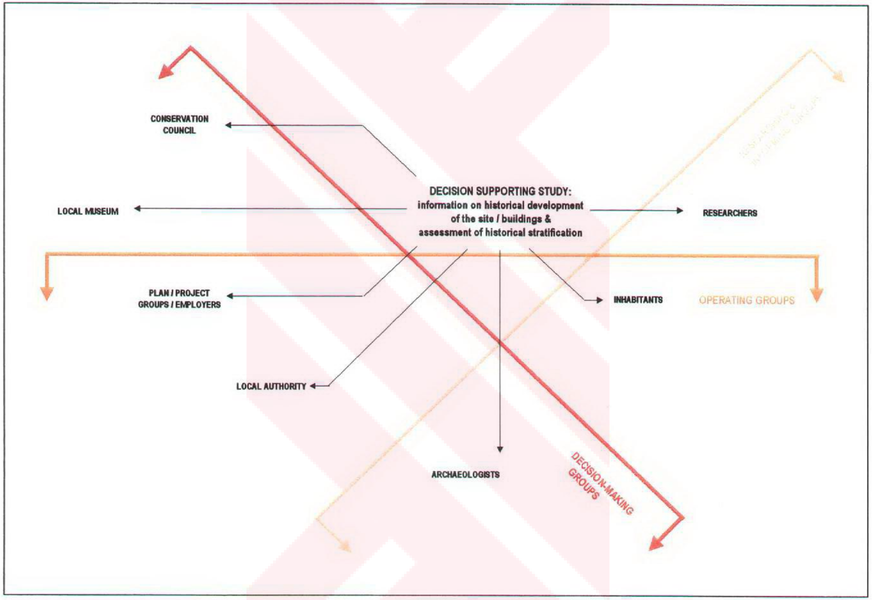

figure 2.4. The position of the proposed 'decision supporting study' in relation to different groups involved within the multi-layered town.

In order to afford all these basic properties, it becomes important to utilize a tool that will acquire the most compatible medium with the provisions of the 'decision supporting study'. The properties and functions of 'decision supporting study' involve many correspondences with the properties and functions GIS, which have been considered as the basic tool of many 'decision supporting studies'. Consequently, GIS are considered to be the most compatible tool for a 'decision supporting study' on assessment of historical stratification in multi-layered towns.

Being defined as the major tool, GIS have considerable impact not only on the methodological formation, but also on the organizational framework of the proposed study. Hence, in defining the organizational and contextual framework of the proposed 'decision supporting study', a two-fold approach should be carried on. The construction of the organizational and contextual framework is both related with the requirements of 'urban conservation management' and with that of 'GIS based project management'.

In any kind of management action based on GIS application it is possible to define common basic groups, which should be involved within the project. Huxhold and Levinsohn (1995: 95) categorize these major groups of participants as sponsors, end users / clients, project management, system designers, system implementers and data providers and define their roles as follows:

- *Sponsors*, which can include senior management of the participating agency(s), and outside agencies that may provide additional funding (e.g., another level of government or a venture)
- *End users / clients* of the new system, the people currently performing the business functions that will be served by the GIS
- *Project management,* who have been the responsibility for managing planning and implementation
- *System designers,* who determine and translate end-user and organization needs into technical specifications
- *System implementers,* from participating agencies identified to participate in the implementation and outside specialists retained to perform special implementation tasks
- *Data providers*, which may include the end users of the GIS, existing computerized systems, outside agencies, data companies, and contracted services

Departing from this basic categorization and GIS based management framework applicable to any kind of management action, in accordance with the requirements for the urban conservation management process, the main groups involved within the 'decision supporting study' for the assessment of historical stratification in multi-layered towns within an organization, distribution of responsibilities and flow of actions can be determined. Accordingly, the organizational framework of the proposed GIS based 'decision supporting study' comprises of two main organizational levels, which necessitate to be handled by two different groups of actors with different responsibilities and flow of actions. The first one is the primary level, which deals with the management and constitution of the main framework of the study within the organization, whereas the second one is the level of implementation of the defined main framework to different cases under the control and guidance of the previous level (figure 2.5).

In the first organizational level, the main framework of the 'decision supporting study' is constructed by considering and reviewing the defined assessment method[25]. The main actors of this level are 'project manager' and 'system administrator'. 'Project manager' is the person who takes the responsibility of managing and controlling the project within the organization. The project manager has to have expertise on management, conservation and restoration of historic structures and sites, besides having adequate knowledge on utilization of GIS. 'System administrator' is the person who takes the responsibility of designing and managing the system according to the requirements of the 'decision supporting study' within the organization. The system administrator should have expertise on information systems and especially on theoretical and technical background and requirements of GIS softwares and necessary hardwares, besides having a general knowledge on the definition, aim, contents and objectives of the 'decision supporting study'.

In GIS data management process there are two basic data models as *mental model* (perception structure) and *logical data model* (Huxhold, Levinsohn 1995: 8). Mental model is the way real world features and events are perceived, together with the relation between these features and events, from the standpoint and requirements of the person or organization that designs and utilizes the

[25] The proposed assessment method for the 'decision supporting study' is defined in Chapter 3.

application. In other words, it is a structured perception of the real world features, events and relations. The mental model has to be converted into a logical data model so as to be applicable in GIS environment. Logical data model is the reflection of mental model in terms of GIS structure. Hence, the features of mental model are represented geographically as spatial entities and descriptive data concerned with them as attributes together with their relations with each other and processes of data management in a logical data model.

Considering and revising the main framework and method defined for 'decision supporting study' on assessment of historical stratification in multi-layered towns, project manager constitutes the mental model, which is then converted into a logical data model in collaboration with the system administrator. GIS implementation can be realized by converting the logical data model into physical data structure. Subsequently, *data management strategy*, which "provides a set of guidelines for structuring, collection, management and storage of data," (Huxhold, Levinsohn 1995: 9) is constructed by the system administrator. The determination of data management strategy leads to the system design, which consists of the determination of technological requirements as to the hardwares and softwares by the system administrator on one hand, as well as to the formation of data processes by both the project manager and system administrator on the other hand. Thereupon, the project becomes ready to be considered by different groups for different cases as the second organizational level.

The second organizational level focuses on the implementation of the main framework and method of the 'decision supporting study' defined in the previous organizational level on different multi-layered towns. The main actors of this level are 'project coordinator', 'scientific supervisor', 'data entry and analysis supervisor', 'data providers', 'data entry clerks' and finally the 'end users'.

The project coordinator is responsible from managing and controlling the 'decision supporting study' on a specific multi-layered town. Hence, project coordinator should have comprehensive knowledge on conservation and restoration of historic structures and sites, and on the structure, aim, scope and content of the 'decision supporting study', in addition to knowledge on utilization of GIS as much as the 'decision supporting study' necessitates.

The 'scientific supervisor' is a person who has comprehensive knowledge on that specific multi-layered town, on the historical development processes and current situation of the urban form and edifices and who has wide-ranging acquaintance of the literature on that specific multi-layered town and with the specialists studying different periods of the town. The scientific supervisor is not a person inside the organization but instead should be an academic who will take the scientific responsibility of the study and who will consult the project coordinator in that respect.

As mentioned previously, the essential data for the constitution of the 'decision supporting study' on the assessment of historical stratification in multi-layered towns come from various sources and necessitates the knowledge of specialists of different periods. Therefore, 'data providers' for such a 'decision supporting study' are mainly the academics and experts, who can be historians, archaeologists, architects, urbanists, and the like, specialized on different periods and aspects of the town. Besides this major group, local authorities are also among the data providers as they conduct the basic data concerning the contemporary situation of the town. Identical to the position of scientific and data entry, analysis supervisors, the data providers of the study are not among the constant staff of the organization, instead each specialist provides and prepares the essential information in the defined format as a project from outside, and consult the project coordinator and scientific supervisor on the subjects concerned with his/her specialization period or periods. The scientific supervisor can be one of the data providers concerning one or more periods as well, whereas, he/she can also be just a coordinator and conductor of the data providers.

Data entry and analysis supervisors are GIS analysts and programmers who are specialized on GIS besides other related programs, such as CAD, DBMS, image processing softwares and the like, and who has thorough knowledge on the specific GIS software that is found to be the most appropriate to be utilized for the project by the system administrator. Just like the scientific supervisor, data entry and analysis supervisors are not constant members of the organization but instead they are either academics or professionals who will take the technical responsibility of the study and who will consult the project coordinator in that respect.

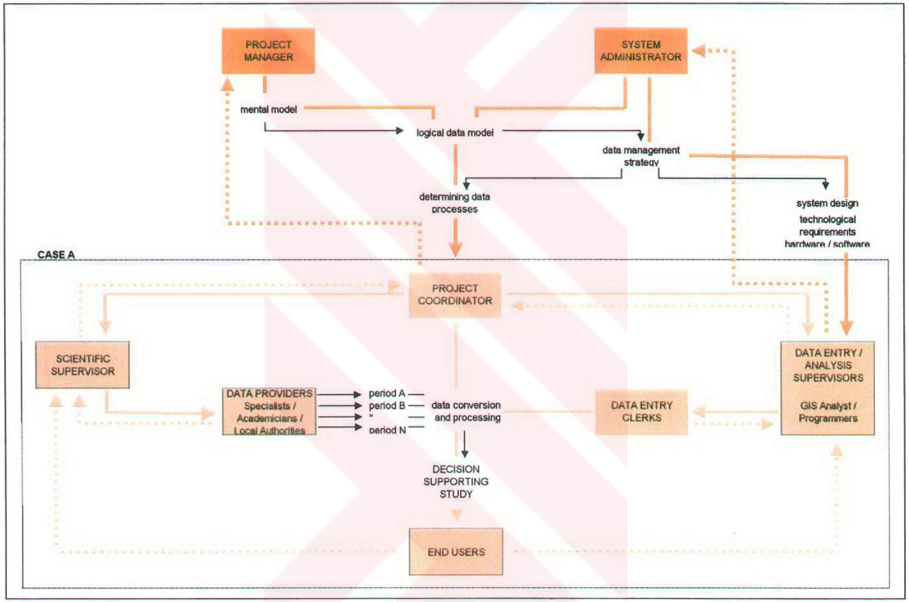

figure 2.5. Organizational framework of the proposed GIS based 'decision supporting study'. The colored boxes show the actors among which those from outside the organization are indicated with a dotted border. The colored arrows represent the flow of actions and the feedbacks. The rest notify the responsibilities of different actors and their succession .

Data entry clerks are among the constant staff who should be trained on the computer programs, particularly on GIS, CAD, DBMS and image processing softwares in addition to basic computer programs which are decided to be utilized, prior to the constitution and execution of the 'decision supporting study'.

In the second organizational level, the data processes determined in the previous level by the project manager and system administrator are transferred to the project coordinator. Project coordinator, in collaboration with scientific supervisor and data entry and analysis supervisors, review the determined data processes according to the special requirements of the town in concern, and in consequence, finalize the data structures and processes. Subsequently, the scientific supervisor determines the layers and units of the study through the main periods within the historical development process of the town, as well as the specialists to be contacted in order to provide the necessary information concerning the urban form in those different periods. Scientific supervisor informs the specialists of determined periods, who are the major data providers, about the data structure, elements of analysis and information types required from them. Consequently, each specialist, or group of specialists, having expertise on one or more periods within the historical development process of the town, collect and structure the required data concerning each period separately. The resultant data coming from the data providers are put together and controlled under the coordination of the scientific supervisor for the last time and then they are transferred to the data entry clerks so as to be converted into the digital environment and consequently to the GIS environment. Meanwhile, the data entry and analysis supervisors look over the system design and technological requirements determined by the system administrator in the previous level. Departing from the provisions settled on together with the scientific supervisor and the project coordinator, the data entry and analysis supervisors establish the system for the case in concern. Under the supervision of the data entry and analysis supervisors, the data entry clerks convert the data coming from the data providers into the digital environment and into the GIS data structure. Hence, under the coordination of the project coordinator and the supervision of the scientific and data entry and analysis supervisors, the 'decision supporting study' becomes ready to be utilized by the end users. The defined organization scheme involves feedbacks to previous phases in both of the organizational levels.

From the descriptions of roles of actors and flows of functions it can be observed that the organizational scheme composes of constant staff of the organization as well as members outside the organization. The primary organizational level is composed of 'project manager' and 'system administrator' who should be permanent members of the organization. In the second organizational level, 'project coordinator' and 'data entry clerks' are the permanent staff, Whereas 'scientific supervisor', 'data entry and analysis supervisors' and 'data providers' are the partakers who should not necessarily be among the constant staff but instead should participate and contribute the study from outside the organization (figure 2.5).

As mentioned previously, the proposed 'decision supporting system' should be integratable with other studies necessary for urban conservation management process. The above-defined organizational scheme allows such an integrated structure as a result of which an 'urban conservation information and decision support system' can be constituted for different multi-layered towns. Such a system can be achieved under the coordinative and integrative role of the 'project coordinator' for each case. Hence, in the establishment of a more extensive information system, the project coordinator should undertake the central role of management and coordination of different 'decision supporting studies' necessary for urban conservation management process.

Although the organizational framework defined here can be accomplished under various public and private bodies, the examples from different countries reveal that most of the similar 'decision supporting studies' are realized under the administration of either the related ministry or the local authority and in collaboration with various academic institutions. The major aim of such a study is to support the conservation decision-making process concerning multi-layered towns. Hence, the determination of the main body under which the study should be carried on depends on the main actors of the conservation decision-making process of the country in concern. As mentioned previously, the major authorities efficient in conservation decision-making process in Turkey are the Higher Council and Conservation Councils, which take place under the Ministry of Culture, General Directorate for Preservation of Cultural and Natural Assets. Hence, General Directorate for Preservation of Cultural and Natural Assets is the main body responsible of controlling and managing survey and registration of historic buildings and sites, designation of different degrees and types of 'sites', as well as the approval of both restoration projects of historic buildings and conservation plans of historic sites. Therefore, for the case of Turkey, the most proper solution seems to be the establishment of the proposed organizational scheme under the Ministry of Culture, General Directorate for Preservation of Cultural and Natural Assets. Under this main administrative body, the 'decision supporting study' should benefit the contribution and participation of the local authority as well as the necessary academic institutions.

In Turkey, GIS have already began to be accepted and utilized as a developing tool for the municipal uses as well as planning activities. If the proposed 'decision supporting study' on the assessment of historical stratification in multi-layered towns can be realized within the above-defined organizational framework under Ministry of Culture, General Directorate for Preservation of Cultural and Natural Assets and in collaboration and participation of local authorities and academic institutions, it can turn out to be an integrated part of the conservation decision-making process in Turkey, and consequently, can contribute to the conservation decisions and implementations as well as other municipal and planning activities realized with GIS more efficiently.

CHAPTER 3

CONSTITUTION AND STRUCTURE OF THE PROPOSED ASSESSMENT METHOD

Following a scientific and a systematic method is a prerequisite in achieving a proper assessment of historical stratification, which will support the conservation decision-making process and interventions in a multi-layered town. Therefore, constitution of the method that is to be followed during the 'decision supporting study' is of utmost importance.

Constitution of the method embraces the configuration of the elemental phases of the 'decision supporting study' together with common terminology and format in defining the data, means of providing, documenting and presenting the data and system of rules in relating and questioning different kinds of data. Along with the definition of all these, 'basic standards' in assessment of information on historical stratification in multi-layered towns can be achieved in any 'decision supporting study' following the same method. The 'basic standards', which a 'decision supporting study' on the assessment of historical stratification in multi-layered towns should perform, are not different than the 'basic standards' expected from any heritage information management system. The 'basic standards' of heritage information management systems are defined by Institute for Records and Documentation of Italian Ministry for Cultural and Environmental Properties (ICCD[1]) as follows (Poggi 1993: 49 – 50):

- terminological standard: formation of normalized dictionaries
- syntactic standard: definition of rules for the recording of particular information

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[1] ICCD - Istituto Centrale per il Catalogo e la Documentazione (Poggi 1993: 47)

- structural standard: application of a structural scheme ruling the relations amongst homogeneous information and amongst the different kinds of information concurring to the description of the asset

While setting up the basic terminological, syntactic and structural standards in a heritage information management system, the medium and tools to be utilized need to be considered integrally. GIS are compatible with the 'basic standards' required for heritage information management systems due to the properties of their data model. W. E. Huxhold and A. G. Levinsohn (1995: 10) define the common GIS data model as:

- Shared geopositioning
- Standard data definitions
- Explicit entity relationships
- Planned data distribution
- Standards for data communication
- Data maintenance processes

In accordance with the compatibility of GIS data models and processes with 'basic standards' required for heritage information management systems, GIS support the formation of the terminological, syntactic and structural standards of the 'decision supporting study' on assessment of historical stratification in multi-layered towns. The method of assessment, that provides the basic terminological, syntactic and structural standards of the 'decision supporting study', requires to be configured with regard to the specifications of the context, the objectives of the study, and the competency of the tool. Therefore, 'multi-layeredness', as the basic specification of the context, play an important role in the configuration of the elemental phases of the study and the means of providing, documenting and presenting the data of 'spatiotemporal' character. Assessment of historical stratification in multi-layered towns, as the major objective of the study, helps to comprise the basic elements of analysis and information types to be considered as well as the terminology and format in defining them. GIS, as the major tool, becomes one of the basic components in setting up the content and methodology of the proposed study by supporting the formation of the data models and system of rules in relating and questioning different kinds of data.

3.1. Dealing with 'Multi-Layeredness'

> It is clear enough, space and time, however conceived, are the great framework within which we order our experience. We live in time-places (Lynch 1972: 241).

Time has significant consequences on the formations and transformations of the physical structures of towns with historical continuity. The contemporary structure of a multi-layered town is the outcome of the continuous multi-dimensional and dynamic relationship of space and time through a long formation process.

As a result of the close relation between space and time, the data concerning the historical stratification in a multi-layered town acquire a spatiotemporal character. In the formation of a methodology for the analysis and assessment of historical stratification in multi-layered towns, dealing with multi-layeredness and consequently handling spatiotemporal data gains a vital position. During the formation of the method of assessment of historical stratification in multi-layered towns, 'multi-layeredness' in connection with 'spatiotemporality' brings forth two basic questions:

- Which phases should be followed in a study dealing with 'multi-layeredness'?
- How should spatiotemporal data, as the major input of such a study dealing with 'multi-layeredness', be represented and handled?

In order to be able to answer these basic questions, two major issues should be studied in detail. First one concerns with the models generated for the representation of spatiotemporality by the disciplines basically dealing with the representation of space. Second one concerns, the methods and processes in dealing with multi-layeredness and the ways of handling and representing spatiotemporal data in connection with multi-layeredness by the disciplines in which layer and stratification is of central importance.

3.1.1. Models for the Conception of Time / Space Relationship

Time / space relation has been a subject of interest for a long period. The discussions on how to analyze, evaluate and represent the effects of time on spatial features had been in the agenda of different disciplines. Especially cartography, as a discipline dealing with the representation of three-dimensional space on a two-dimensional representation medium by extracting the main elements composing it and by utilizing symbols in representing them, had been included in the debates on how to represent the fourth dimension, time, and its spatial effects.

Cartography defines space by boundaries between different objects or entities. Cartographic space cannot be well structured without its time component. Therefore, cartographic time should be contended in connection with cartographic space. Cartographic time is defined through boundaries between events that cause the formation of different versions of an object or a map state. Spatial boundaries are formed with the difference between adjacent locations, while temporal boundaries are formed with the difference between the adjacent states of the modeled system, that is, the changes (Langran 1993: 29). As a result, 'change', 'event', 'version' and 'state' turn out to be the fundamental concepts necessary for understanding and representing the spatiotemporal data. (figure 3.1)

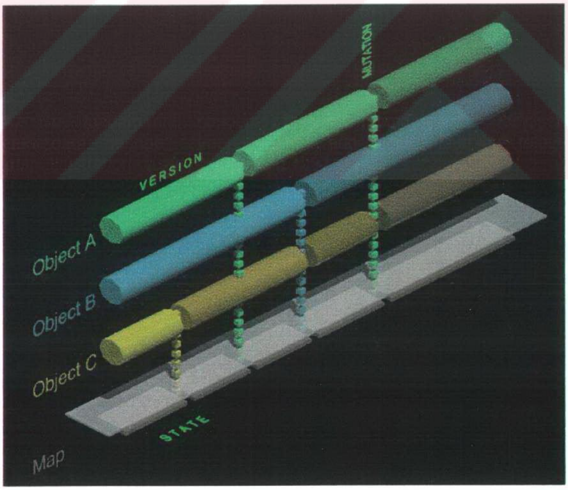

figure 3.1. The fundamental concepts for understanding and representing the spatiotemporal data: 'change', 'event', 'version' and 'state' within the relationship of objects to map. Illustration based on (Langran 1993: 33).

A 'version' represents the condition of an object for a duration, a 'change' or a 'mutation' represents the points where the modification of an object version to another object version occurs, an 'event' represents the cause that produces a new object version or a map state and a 'map state' defines the all together condition of different objects forming up the context.

Based on these main concepts, different models are developed for the conception of time / space relationship, each of which highlights different aspects and thus offers a different vision of spatiotemporality. Gail Langran (1993: 37-43) defines the most common models for conception of time as the 'space-time cube model', 'sequent snapshots model', 'base state amendments model', and 'space-time composite model'.

The 'space–time cube model' represents the relation between space and time as a three-dimensional cube with two space dimensions, x and y, and one time dimension, z. This model has been utilized by many scholars[2] in achieving a general understanding of the process of the development of a two-dimensional space through time. (figure 3.2a)

The other models depart from the 'space-time cube model', but aim at giving more specific information about the space in different time slices. The initial step in all is to define the critical time intervals in which 'mutation' occurs between different 'versions' due to 'events' causing 'changes' in the 'map state'. (figure 3.2b)

'Sequent snapshots model' has its roots in traditional mapping and has been used by different disciplines as a common representation model. In the 'sequent snapshots model' the state of space in different time slices, which are not necessarily equal intervals, is represented 2-dimensionally following a sequential order. In this model, what is represented is the state of the space in selected time slices, but not the events that cause the changes. (figure 3.2c)

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[2] Langran defines this as the space-time model of Hagerstrand (1970), Rucker (1977), Szego (1987) and others (Langran 1993: 37).

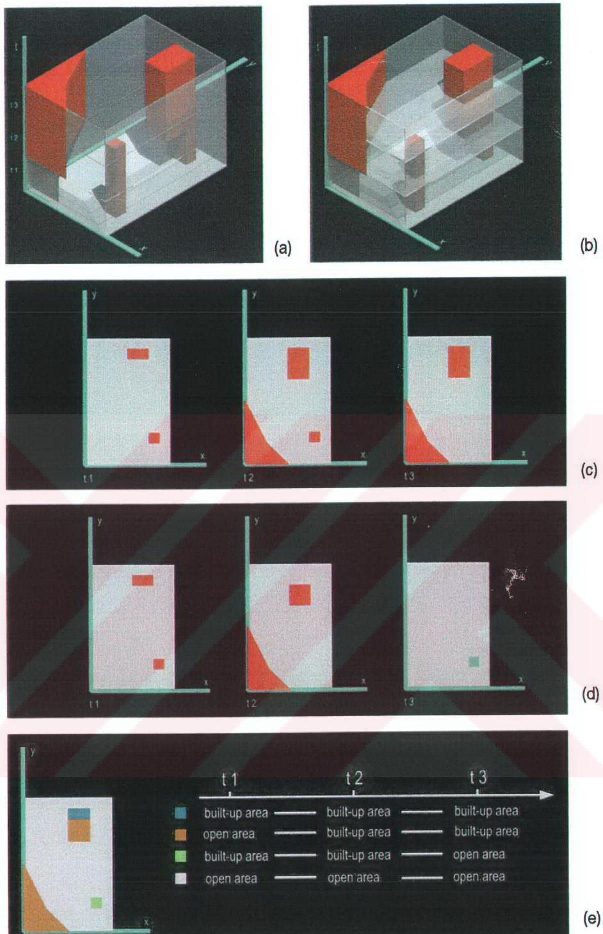

figure 3.2. Models for representing space/time conception based on Langran (1993: 30, 39-41). Illustration of changing built-up/open area relation in time in an imaginary example through different space/time conception models. (a) 'space-time cube model' in which the red objects represent the built-up areas and the rest as open areas. (b) 'space-time cube model' with horizontal layers dividing it at critical time intervals. (c) 'Sequence snapshots model': Grey represents open areas and red the built-ups. (d) 'Base state amendments model': Grey represents open areas, red represent changing state of open areas to built-up areas, blue represents changing state of built-up areas to open areas. (e) 'Space-time composite model': Each color represents a combination of different map states.

‘Base state amendments model’, which is another common model for representing spatiotemporal data, emanetes from the fact that ‘change’ is a fundamental component of cartographic time (Langran 1993: 40). In this model, the state of the space at a determined base time is followed by the snapshots showing only the changing objects. Hence, only the changes are given beginning from a defined base state as a result of which an object version is stored only once. (figure 3.2d)

The ‘space-time composite model’ derives from the fact that, the part of an object which have been subject to a change in time, disaffiliates from the initial ‘parent’ object and turns out to be a separate object with its own history dissimilar from the other parts. This model represents spatiotemporal units with different temporal attribute sets and defines each unit as a separate object with a separate history. The ‘space-time composite model’ is, in a sense, the end result of the overlay by using the intersection of sequence snapshots or the union of base state amendments. (figure 3.2e) derived from

Each of these models developed for representing space / time relation has advantages and disadvantages over each other in different aspects. The ‘space-time cube model’ gives a good view of a processual formation and continuity. However, it is quite hard to extract the spatial properties at a specific time, which is also very important for the analysis and evaluation of the spatiotemporal data. ‘Sequent snapshots model’ is generally criticized for not reflecting directly the changes between two states of a space and the events causing these changes. This model necessitates an extensive comparison on two different states of the space in order to extract the changes. Besides the temporal boundaries, indicating the moment of change between a state of the space and the previous and the next versions of it, are hard to be located in such a model. ‘Sequent snapshots model’ is also criticized as they cause redundant storage of data in recording and representing the spatiotemporality. In this model, the state of the space is given completely for each of the different time slices, which results in the replication of all the unchanged data for each of the snapshots. ‘Base state amendments model’, as a ‘change-only’ or ‘event-based’ representation, is superior to ‘snapshots model’ concerning the well presentation of changes and mutations, the observability of temporal structure and temporal neighbors, and the negligence of redundant data storage. However, 'base state amendments model' can be utilized if the space-time relations of the objects within the selected period for representation are very well known. In other words, this model can be utilized as an end result of analysis and evaluations. The 'space-time composite model' is found to be the most proper model to be enhanced for spatiotemporal data analysis and evaluation by some of the scholars[3]. The reason for this is its being conceptually the most straightforward model in which the end result of the effects of time over space can be visualized. However, contrary to the 'sequence snapshots model', this time the state of space in different time slices necessitates an extensive study on the history of each object. Besides, this model has also some shortcomings, like decomposing into many smaller objects in the final representation and the difficulty of active change of the identifier of an object into identifiers of two new objects each time a mutation occurs.

Due to these various advantages and disadvantages, it is not possible to define any one of the above-mentioned models for representing the space / time relation as the best or the most enhanced model. The choice of model to be utilized can differ regarding to the purpose and subject of concern. According to a purpose one model can be more advantageous over the others whereas for another purpose another one can be more beneficial. Yet, the discussions and studies on 'spatiotemporal data representation' and consequently 'temporal GIS' continue as important, recent and rising issues and they do not seem to end up in the near future.

3.1.2. Learning from Other Disciplines: Geology and Archaeology

> Layer: one thickness of matter or substance (Hornby, Gatenby, Wakefield 1958: 708).
>
> Stratum: a layer, a distinct horizontal division (Hornby, Gatenby, Wakefield 1958: 1269).

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[3] Despite some of the few problems, Langran defines this model, which was first proposed by N. R.Chrisman to be utilized for temporal GIS, more advantageous over the other in reflecting spatio-temporal data. (Langran 1993: 41-42)

The concepts of 'layer', 'stratum' and 'stratification' have a central role in the formation of conceptual and methodological framework of the disciplines dealing with obtaining the 'related history' departing from the material remains of historical continuity. Geology, dealing with obtaining related natural history of earth, and archaeology, dealing with obtaining related natural and cultural history of humankind, are the major disciplinary fields in which layer / stratum and stratification are of utmost importance.

In both geology and archaeology each layer is known to represent an interval of time, short or long, defined according to different criteria. Different time intervals result in the formation of different horizontal homogeneous -in some aspects- thicknesses of cultural or natural debris, each of which can be called as a layer or stratum.

Not much different than for geology or archaeology, strata or layers in multi-layered towns signify homogeneous thicknesses or divisions that are formed up in different time intervals. As Christine Boyer (1994: 19) mentions:

> In the City of Collective Memory, we find that different layers of historical time superimposed on each other or different architectural strata (touching but not necessarily informing each other) no longer generate a structural form to the city but merely culminate in an experience of diversity.

Therefore, it becomes essential to understand different viewpoints of different disciplines towards stratification and historical continuity as well as different approaches in theories and methodologies.

From the geological point of view, strata or layers are formed through the progressive movements in sedimentation, horizontal and vertical distribution of plants and animals during the geologic history and existence of earth (Weller 1960: 3). These strata follow an orderly succession in below upward, sometimes continuous, sometimes interrupted forming up stratification.

The superimposition of strata –stratification- is the principle basis for the studies in geology, especially in stratigraphy, which is defined as the branch of geology that is concerned with order and relative position of the strata of the earth's crust.[4] The aim of stratigrapher is defined as to relate the events that have occurred during the existence of the earth in the order which they have taken place and to restore the physical geography of each given time in the past and this way to write a connected history (Weller 1960: 3). While doing this, the stratigrapher identifies, sorts and interprets 'units' forming up the layers in terms of 'events' and establishes their relation in time (Doyle, Bennett 1998: 1).

The principle of superimposition has always been mentioned as the most important one of the basic stratigraphic principles and played an important role in the formation of the methodology of the stratigraphic studies. According to this principle, the lower layers must have been formed before the upper ones. Each layer within this formation indicates a time interval and they should be recorded in an orderly sequence from below upward so as to be able to achieve a comprehensive interpretation (Weller 1960: 20).

The main tools in establishing stratigraphical order are defined by Doyle and Bennett (1998: 4-6) as the sequencing tools, which include the observation, description and distinction of units in order to determine their relative chronology through the principle of superimposition and way-up criteria, the time tools, which define the geographical time in which the units were formed in a regional and a global correlation, and lastly the interpretation tools, which form the basis for the identification of the global environment through time.

An overall review of geological stratigraphy helps to understand the main steps common to all stratigraphical studies in geology (Weller 1960; Prothero 1989; Doyle, Bennett 1998). Accordingly, the geological survey is the first phase of the stratigraphical analysis. During the geological survey, the distinction of the stratigraphic units is the preliminary step in which the identification of units are

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[4] The studies on stratification and strata have been a basic concern for geology from very early periods onwards. The guiding principles of geological stratification were already accepted in 1830s as the principles of superimposition, uniformitarianism and relative chronology (Doyle, Bennett 1998: 2). The advances achieved in stratigraphy during the 19th century, gradually lost its importance and stratigraphy degenerated into a simple catalogue of units and names. Stratigraphy regained its central position after mid 20th century and turned out to be more sophisticated together with the development of many specialized branches (Doyle, Bennett 1998: 2-5).

made according to the distinguishing features[5]. Following the determination of the units, the data related with each of these units are collected by notifying the name, lithology, type and reference sections, the lower and the upper boundaries, subdivisions, thickness, distribution and age of the related unit. The interfacial changes, indicating the differentiation in the content of the deposits, are the basis of determining the 'units' each of which represents an interval of time. Therefore, the recognition of boundaries between adjoining geologic units, both horizontally and vertically are of paramount importance. The distinction of stratigraphical units is followed by the determination of stratigraphic sequences and chronology. Firstly, the chronology of the units are defined relatively utilizing the sequencing tools, then the geographical time in which the units were formed are determined within a regional and a global correlation utilizing the time tools. The last phase in the studies of stratigraphy embraces the analysis and evaluation of the stratification. Through the analysis of the superimposition of stratigraphic units and their relation with each other, the stratigraphic correlation is achieved. The evaluation of the stratigraphic correlation lead to the interpretation of the stratigraphy and the identification of the global environment through time, which is the final goal of the stratigraphic studies.

During all the different phases of stratigraphical studies, beginning from the geographic survey until the end of the stratigraphic interpretation, representation of the stratigraphical data is of prime importance. There are common stratigraphic representation methods[6] developed to handle the stratigraphical data most efficiently in accordance with the objectives of the discipline of geology which are indicated commonly in the literature (Weller 1960; Prothero 1989; Doyle, Bennett 1998). The most common way to represent stratigraphical data is drawing cross-sections. Data can be represented by stratigraphical cross sections that are two-dimensional diagrammatic representation of the earth. This type of representation does not include the topographical information. It is also common to utilize geological cross sections, which also includes topography and structural

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[5] The distinguishing features that help the identification of units, are defined in 'North American Stratigraphic Code' as composition, texture, primary structures, structural attitudes, biological remains, apparent mineral composition, geochemistry, geophysical properties, geomorphic expression, unconformable or cross-cutting relations and age (Prothero 1989: 353).

[6] Examples of stratigraphic recording and representation methods commonly utilized in Geology are given in Appendix A, figures A.1 and A.2.

deformations (Prothero 1989: 213). The problems arising from the two-dimensionality of cross sections are tried to be overcame by drawing a series of cross sections on an isometric map in a way to form a three-dimensional cross sections of an area is called as fence or panel diagrams[7]. The fence diagrams can obtain a better understanding of the relations and patterns however they carry the risk of being too complex (Prothero 1989: 213). Another important representation method is drawing block diagrams, which are perspective or isometric drawings of solid bodies representing portions of earth showing both the surface topography and the subsurface geology (Weller 1960: 651-653). Although the block diagrams are not realistic and precise diagrams, they are quite helpful to achieve a global understanding of the stratification as they show a generalized relation of stratigraphy with surface geology and topography (Weller 1960: 651). Last but not least are the stratigraphic maps, which are two-dimensional representations of the three-dimensional space and show the areal distribution of a stratigraphical unit as well as different aspects of it (Prothero 1989: 215). There are different types of stratigraphic maps produced according to different purposes each showing different aspects of the stratification[8].

The geologic mapping process has three main phases. First of all, just as it is made in geological survey, the decision is to be given as to what strata should be grouped as 'units'. Then, the vertical sequence of the units as well as the units' relations to the surface in two dimensions and their sub-surface relations in three dimensions should be determined together with the boundaries between different units. Generally, geological maps represent a single selected phase of the stratification or the overlay or combination of different phases making up the existing structure and stratification. However, especially when the purpose is to understand and represent a process of formation and change of the stratification, map series showing the situation in different time intervals are utilized[9].

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[7] These diagrams have different types as normal, isometric or stereographic panel diagrams according to projections used (Weller 1960: 649-650).

[8] Structure contour maps, isopach maps, facies maps, paleogeologic maps, and paleogeographic maps are different types of stratigraphic maps each focusing on different aspects of stratification (Prothero 1989: 215-219).

[9] An example is the series of paleogeographic maps of Ohio and nearby surrounding prepared to show the changing relation of land and sea in time (Weller 1960: 579).

As Colin Renfrew and Paul Bahn (1991: 90) state, "Archaeological strata or layers accumulate over much shorter periods of time than geological ones, but nevertheless conform to the same law of superimposition". It is again the relation of time and space that produces different strata. The superimposition of different strata form up the stratification in which contemporary activities take place horizontally in space whereas changes in those activities occur vertically through time. Stratigraphy has an important role for archaeology, as it is a discipline dealing with strata and stratification.[10] Stratigraphy, from the point of view of archaeology, is defined as the study and validating of stratification - the analysis in the vertical, time dimension of a series of layers in the horizontal, space dimension (Renfrew, Bahn 1991: 90). Stratigraphy is based on the difference between the units of superimposed context. As a result, 'interface', which is defined by Harris (1992: 127) as "the lines of demarcation between the units", have been the common concern in all the different methods of studying stratification in archaeology.

Due to the major role of stratigraphy and stratigraphical studies in archaeology, stratigraphic recording and representation methods[11] have been of primary concern since the first development of stratigraphic studies onwards. The first significant method on archaeological stratigraphy mentioned commonly in related literature is 'Wheeler-Kenyon method'[12], which had two important aspects as, stratigraphic excavation and stratigraphic recording. The stratigraphic excavation was "the idea that sites should be excavated in the reverse order to that in which they were laid down" (Harris 1992: 114). Following the stratigraphic excavation, stratigraphic recording was made through the assignment of a unique layer number to the deposits as they were discovered. In the stratigraphic recording, the interfaces between stratigraphic layers were of utmost importance, which caused the development of section drawings with interfacial lines (Carver 1992:213). According to Harris (1992:114), the emphasis of Wheeler-Kenyon

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[10] The development of archaeological stratigraphy dates back to 2nd World War years, when stratigraphic content of European towns were revealed, and partially destroyed, due to the aerial bombardment. Following the war years, the two most important books, as the preliminaries, were published on archaeological stratigraphy by Kathleen Kenyon (1952) and Mortimer Wheeler (1954). Thereupon, different methods have been developed in order to study stratigraphy.

[11] Most common stratigraphic recording and representation methods utilized in archaeology are exemplified in Appendix A, figures A.3 and A.4.

[12] 'Wheeler-Kenyon method had been effective till 1970s.

method was on the vertical aspects and relations whereas less importance was given to the horizontal aspects. Hence, beginning from 1970s Wheeler-Kenyon method is found to be insufficient due to so called 'deficiency' in dealing with complex sites with thousands of layers. It became impossible to express the stratigraphic sequence through section drawings, which were basic elements of the method.

The emphasis on vertical aspects began to leave its place to horizontality as a result of the insufficiency of stratigraphic sections. Consequently, the stratigraphic excavation and recording methods, which emphasize horizontal dimension so as to reveal the spatial relationships in a particular layer, started to be indicated and searched for more often (Renfrew, Bahn 1991: 92). The new emphasis in horizontal relations reflected itself in a new method of representing stratigraphy as 'single-context plan'. Carver (1992: 212) defines single-context plans as records of each stratigraphic unit separately. It is the extent of the upper interface of each stratigraphic unit, which is recorded in the single-context plan (Harris 1992: 127). One of the main features of 'single-context planning' was determining the horizontal extension of each context by recording its boundaries. Overlaying the plans drawn on transparent sheets that show the boundaries of each context in the stratigraphic order allowed to visualize the relation of the areas covered by different context (Carver 1992: 212). Through the overlay of the single context plans, 'composite period plans' can be obtained. The 'composite period plans', contemplated in a sequence, help to understand the development of the site. Harris (1992: 121-124) defines the preparation of 'composite period plans' as:

> Every unit of stratification was drawn on his own, separate plan, prior to its removal by excavation. At the time of phasing, these individual plans could be combined on a light-table and a 'period plan' drawn, leaving out details which would not have appeared at the surface at that period.

Due to the insufficiency of sequential sections in stratigraphic recording, in 1970s another method came forth as stratigraphic sequence diagrams. As Carver states, "these diagrams also give new meaning to the idea of 'phasing', particularly in multi-stratified sequences" (Carver 1992: 213). With this purpose different stratigraphic sequence diagrams were constructed for the stratigraphic excavations with interfacial analysis. The commonly mentioned two important examples of stratigraphic sequence diagrams are 'Harris Matrix', as a foremost of its type, and 'Carver System', as a successive one built upon Harris Matrix with the aim to enhance it.[13] Stratigraphic sequence diagrams are not used alone but used in association with other representation methods mainly the sections, facades, trench plans as well as composite plans.

Stratigraphic representation methods developed especially for archaeological sites are made use of for the analysis of other subjects where stratification is central. As Martin Davies (cited in Harris 1992: 133) states;

> ...notions of stratigraphic deposition, disturbance and relationships, although central to excavation theory and practice on archaeological sites, can be equally applied to standing structures. Fabric can be overlaid by later fabric, and fabric can be cut and later fabric introduced.

Stratigraphy is an important issue for 'urban archaeology' and 'buildings archaeology' dealing with the historical development processes of 'still living towns' or 'still standing buildings', which are the sub-disciplines derived from archaeology after 1980s onwards but have turned out to be considered as separate disciplines in time[14]. Whether considered as separate disciplines or sub-disciplines of archaeology, urban archaeology and buildings archaeology deals with stratification of different layers and their consequences as a central issue.

Urban archaeology aims at obtaining comprehensive understanding of horizontal and vertical development of the still living towns beginning from the earliest settlement stage until today. Similar to urban archaeology, buildings archaeology intends to acquire comprehensive understanding of the development of the still

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[13] Harris Matrix was first shaped in 1973. Edward Harris (1992: 128) defines the matrix that he has developed as a diagram of relative time and of "the four dimensions of the stratigraphic accumulation of a site", which was more than a two-dimensional image that could be provided by a section. The most important aspect of Harris Matrix was its reflecting the relationships between the units. The other stratification diagram was developed by Martin O. H. Carver, which was, in fact, built upon the Harris Matrix. Carver System groups the sets of contexts by emphasizing the duration they have within a sequence after a Harris Matrix is prepared. According to Carver (1992: 213), Harris Matrix is a model of how the stratigraphic units are disposed in the ground, where as Carver System is a model of what happened through time, and therefore a more advanced system for stratigraphical studies. On the other hand, Harris does not agree that Carver System is more enhanced and advantageous over Harris Matrix (Harris: 1992).

[14] See Bilgin (1996: 9-20) for further information on concepts and definitions of urban archaeology.

standing historic buildings beginning from the earliest construction stage until today.

Departing from the fact that managing 'still living towns' or 'still standing buildings' necessitates understanding, representing and evaluating the continuities, discontinuities and changes during the historical development process not much different than the case of buried stratigraphy. Therefore the representation methods utilized for urban archaeology and buildings archaeology are quite similar with those utilized by archaeology and geology[15].

There are different recording and representation methods utilized in studying stratification in still-living towns.[16] In the studies of urban archaeology the most common way of representing the stratification is provided by the utilization of diachronic plans, which are the plans of the town in different periods revealing the major elements of the urban structure. The diachronic plans are overlaid in order to obtain a plano-volumetric view of the town to evaluate the continuities and discontinuities in the urban structure as a basis for the future archaeological researches as well as conservation and planning activities.

Besides the diachronic plans and plano-volumetric representation methods, 'composite period plan', which reflects the information concerning different periods together with the existing situation of the historic town, appear as a common representation method in urban archaeology. There are also altimetric plans, which provide information about the location, position and altitude of remains belonging to different periods, and sequence diagrams in association with diachronic plans and schematic sections for representing the stratigraphic correlation between different layers reflecting different periods as other methods utilized in the studies of urban archaeology.

In the studies of buildings archaeology, the most common stratigraphic recording and representation method is the 'stratigraphic sequence diagram' in association

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[15] Some of the common recording and representation methods of stratification in buildings archaeology and urban archaeology are given in Appendix A, figure A.5 and A.6.

[16] See Bilgin (1996: 33-47, 170-182) for further information on recording and representation methods of stratification in urban archaeology.

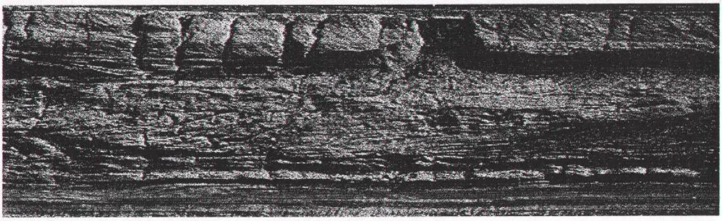
with sections, facades and plans. Stratigraphic sequence diagrams are not only used for the archaeological sites, but also for the analysis of still-standing buildings, since a building is a stratigraphic entity as well. Although not as common as stratigraphic sequence diagrams in association with sections, facades and plans, there are also cases in which diachronic plans and composite period plans are utilized without stratigraphic sequence diagrams.

3.1.3. Appraisal of the Main Concepts, Phases and Data Recording and Representation Methods in Dealing with 'Multi-Layeredness'

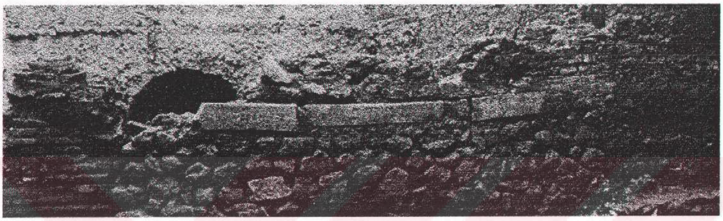
'Stratification' – that is, the superimposition of layers / strata – is a principle issue for the disciplines dealing with 'layers', namely geology, archaeology, urban archaeology, and buildings archaeology. An overall survey on stratification in these disciplines reveals many common points in their ways of dealing with 'multi-layeredness'. These common aspects are directly reflected in the aim, basic concepts and definitions, principles and methodologies concerning stratigraphic studies in all these different disciplines.

It does not matter whether the concern is the stratification of natural debris related with earth's crust, the stratification of natural and cultural debris related with humankind, stratification of urban tissue and its components in a 'still living' town, or the stratification of construction and finishing materials in a 'still standing' single structure (figure 3.3), the aim is always to relate the events in the sequence they have occurred in order to understand the subject of concern in a better way together with the formations, transformations and disappearances.

The basic concepts and principles forming up the theoretical framework of stratigraphical studies in different disciplines follow a parallel and more or less similar approach. 'Layer' / 'stratum', 'stratification', 'interface' appear to be the basic concepts which are defined in a similar way in all of the disciplines dealing with 'multi-layeredness'. Even though dimensions and contents may change according to subject of concern, 'layer' / 'stratum' correspond to the distinct divisions which refer to different time intervals, 'stratification' represents the superimposition of different strata in a historical development process, and 'interface' indicates the demarcation lines between the layers.



(a)



(b)

(c)

(d)

figure 3.3. Stratification in different disciplines. (a) Geological stratification (Prothero 1989: 61). (b) Archaeological stratification (S.A.R. 1985b: 560). (c) Stratification in Urban Archaeology (Insolera, Perego 1983: 314). (d) Stratification in Buildings Archaeology (Poleggi 1993: 114).

Besides the above-mentioned common basic concepts, for all the disciplines dealing with layers, the 'principle of superimposition', emphasizing that each layer indicates sequential time intervals in which the lower layers must have been formed before the upper ones, has always been mentioned as one of the most important stratigraphic principles. This principle affects the way that the stratigraphic studies are held as another important similarity. That is, in stratigraphic studies, the excavation or research is carried on from above downward - from the last phase towards the beginning - but represented and analyzed from below upward - first phase towards the last.

In addition to these main common aspects, in all of the disciplines dealing with multi-layeredness, the studies related with stratigraphy follow the similar phases:

- identification of layers and stratigraphic units,
- determination of stratigraphic sequence and relative chronology of layers and stratigraphic units,
- stratigraphic recording and representation,
- stratigraphic correlation,
- stratigraphic interpretation.

It is observed that, the preliminary step in any kind of stratigraphical study is the determination and identification of layers as units. Different layers, each representing an interval of time, are identified with reference to the distinguishing features and the interfacial changes indicating the differentiation in the content. What comes after the identification of layers is the determination of the 'units' based on these layers so as to be utilized during the stratigraphical study. It is not essential to consider each layer as a 'unit'. According to the subject of concern, either each single layer, or two or more layers forming a group, can be assigned as 'units' of the stratigraphical study.

Along with this, the stratigraphic sequences and relative chronologies of layers are to be determined as the second step. During this phase, the exact periods that the layers belong to or cover, their relative chronologies and sequences are decided upon.

Stratigraphic recording and representation turn out to be one of the principal phases of stratigraphic studies, which is common to all disciplines dealing with layers. Its importance is due to its being the stage in which the most proper medium essential for the continuance of the study is provided in accordance with the objectives and the concern of the study.

Following stratigraphic recording and representation, the stratigraphic correlation and analysis are made. Through the superimposition and overlay of layers, the stratigraphic correlation is achieved. Correlating the layers, with each other and with the whole in the vertical time dimension and the horizontal space dimension, forms the basis of stratigraphic analysis. During the correlation phase, the principle of superimposition plays an important role. Hence each layer indicating a time interval is recorded and correlated in the reverse order of occurrence, that is in an orderly sequence from below upward so as to be able to achieve comprehensive interpretation of the stratification. Deriving from the stratigraphic correlation, formations, transformations, continuities and discontinuities of different aspects and constituents of layers are analyzed according to the objectives of the discipline and subject of concern of the stratigraphic study. Stratigraphic studies end up with the stratigraphic interpretation achieved through the evaluations of the stratification in all the disciplines dealing with layers.

Stratigraphic recording and representation methods utilized to handle stratigraphic data are imperative during any stratigraphic study as they provide the essential basis for the execution of all the stages that constitute the whole study. As stratification is formed through the interrelation of time and space, the concern of all the stratigraphic recording and representation methods utilized in disciplines dealing with multi-layeredness are data of 'spatiotemporal' character. Hence, both the models developed for the conception of time / space relationship and the stratigraphic record and representation methods utilized in different disciplines dealing with layers are based on similar concepts and follow similar attitudes. In any of them, 'interface' is a common concept, central in the formations of models and methods. Plan based representations are used to represent the situation at interface of two adjacent layers, while, section and block based representations are used to indicate interfacial lines between different layers.

table 3.1. Role of stratigraphic studies, representation and recording methods in different disciplines.

DISCIPLINE	GEOLOGY	ARCHAEOLOGY		
			BUILDINGS ARCHAEOLOGY	URBAN ARCHAEOLOGY
SUBJECT OF CONCERN	stratification of natural debris related with the sedimentation of earth's crust	stratification of cultural and natural debris related with humankind	stratification of the architectural elements, structural components and materials in a 'still standing' historical building	stratification of urban tissue and its components of a 'still living' historical town
AIM AND FOCUS	obtain related global natural history of earth	obtain knowledge about the physical, social, economical and natural aspects of human past within the natural and built-up environment	obtain knowledge about the historical construction process of a building through technological, typological and relational analysis of architectural elements, structural components and materials	obtain knowledge about the historical development process of a town through the formations, transformations and disappearences in the urban tissue and its components in different periods
RECORDING AND REPRESENTATION METHODS	cross sections	stratigraphic sections	sequence diagrams in association with sections, facades and plans	diachronic plans
	fence diagrams	sequence diagrams in association with stratigraphic sections and plans	sections and facades	composite plans
	blocks	single-context plans	diachronic plans	altimetric plans
	thematic maps	composite plans	composite plans	sequence diagrams in association with diachronic and composite plans
	map overlay	blocks		schematic sections

Furthermore, the models for the conception of time / space relationship are similar with the stratigraphic recording and representation methods enhanced by the disciplines dealing with multi-layeredness. That is to say, 'space-time cube' model is similar to the 'block representation', 'sequence snapshots' and 'base state amendments' models are two different ways of producing 'single context' or 'diachronic plans', and 'space-time composite model' is identical to 'composite period plans'.

These methods or models, named differently, are similarly utilized in different disciplines dealing with 'multi-layeredness' or with the representation of 'spatiotemporal data'. What differs is the order of preferences in their utilization. According to the objectives and subject of concern of different disciplines, content, scale and dimensions of layers differ from each other. As a consequence, the aspects to be emphasized as well as the accuracy and detail required in their recording and representation change as well.

If a global view of the stratification is considered necessary, 'block representations', or in other words 'space-time cube' model are utilized. They are drawn as axonometric, isometric or perspective views indicating the interfacial lines between the layers so as to give a general impression about the stratification. In the cases when vertical relations between the layers are of primary interest, sections are drawn by showing the interfacial lines. Whereas, if the horizontal relations as well as horizontal extents of different strata are more important, then plans, which are drawn to pass through the interfaces between the layers, are utilized. Among different types of plans, as composite period plans, otherwise wording 'space-time composite' models, are used to demonstrate the final situation of stratification and the extent of various combinations of layers. Whereas, period plans, single context plans, or diachronic plans are produced commonly through 'sequence snapshots' models and also through 'base state amendments' models. These types of plans are used to show the extent and contents of a layer at a definite period and the transformations of them through the sequential periods. The sequence diagrams are utilized especially when the stratification is complex and does not follow an orderly sequence, that is when different elements or layers belonging to different periods exist side by side and when their stratigraphic sequence is of foremost concern.

Stratification in geology deals with the sedimentation of earth's crust in a region, a continent or even intercontinental zones. Due to subject of concern, dimensions of layers are quite big and the interest is global devoid of minor details. Hence, importance is given to vertical relation of different sedimentation types and their sequences in relation to each other. Therefore, the most common methods are cross-sections and fence diagrams as 3-dimensional cross-sections, which are followed by block representations. Plan based representation and recording methods are less common in geology as the main concern is vertical relation of layers across very large distances more than horizontal extent, content and changes. Hence, usage of thematic maps, map overlays and sequential period maps, which represent existing situation, extent and content of stratification as well as formations / transformations of layers through a historical process, are less frequent with respect to sections, fence diagrams and blocks. Stratification in archaeology deals with cultural and natural debris related with humankind, as a result of which the layers of concern are smaller with respect to geological ones and necessitates a more detailed study about the vertical relations as well as the horizontal ones.

Consequently, stratigraphic recording and representation methods involve stratigraphic sections and sequence diagrams in association with sections and plans in the first place. They are followed by the single context plans and composite period plans. The utilization of blocks only occurs is a general schematic view of the stratification is aimed to be given. In the case of urban archaeology, due to its subject of concern, which is the stratification of urban tissue, the relation of every urban element with each other horizontally at the same period and vertically through different periods are to be studied in detail. In the stratigraphic studies in urban archaeology, the most common method is the diachronic plans and plano-volumetric view of the town obtained through them. There are also composite plans showing the existing state of stratification and altimetric plans showing the altitude of remains belonging to different periods. Sometimes, when the stratification is too complex, sequence diagrams are utilized in association with diachronic and composite plans. Section based recording and representation is quite rare in urban archaeology, as the stratification of each component of urban tissue is impossible to be recorded through sections. Yet, partial sections drawn from the critical spots are used to demonstrate the vertical relations of different layers representing different periods in a schematic way. In buildings archaeology the stratigraphical study requires a very detailed research on each architectural component of a still-standing historic structure. In that case, formations and transformations concerning different architectural elements as the constituents of different layers and the sequential relations between them are the major issues of interest. Accordingly, sequence diagrams in association with sections, façades and plans are at the first rank as a record and representation method. The utilization of diachronic plans and composite plans alone are not as common as the above-mentioned record method in buildings archaeology.

For the disciplines and studies in which the representation of spatiotemporal data is the major concern, such as cartography or temporal GIS based studies, this time the concern becomes the representation of information as much as possible with the most direct way which contains the lesser amount of data. Therefore the 'space-time composite' model which reflects the final condition of spatiotemporal data becomes the most preferred model with respect to the models which represent every stage separately.

To sum up, it is possible to state that the main concepts and main phases in all the studies dealing with multi-layeredness are similar with each other. There are various methods and models produced and enhanced by different disciplines to deal with 'multi-layeredness' and to represent 'spatiotemporality'. These recording and representation methods or models, although named differently, are in fact similar with each other, but they are found to be more beneficial or less beneficial according to the objectives and subject of concern of the study.

3.2. Elements of Analysis and Information Types for the Assessment of Historical Stratification in Multi-Layered Towns

The town is made up of built-up and open areas encompassing natural and man-made features within an urban web. As Nahoum Cohen (1999: 41) points out, "An in-depth understanding of the city structure is a prerequisite for determining conservation potential and hierarchy". It is necessary to comprehend the urban structure along with its components, in order to resolve the conservation decisions and actions within a historic town.

Comprehension of the urban structure can be achieved through the comprehension of the basic components of the town together with their properties, position and distribution within the town as well as their relation with each other and with the whole they make up[17]. Especially for the case of multi-layered historic towns in which the urban form and web of relations are very complex and multi-dimensional, conservation decisions and actions necessitate to

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[17] The study of urban form falls into the disciplinary area of urban morphology as well as historical and urban geography, and to some extent urban and architectural history. The studies on urban form date back to the beginning of 20th century, but they have been intensified since mid 20th century (Larkham 1996: 27). There have been different scholars belonging to different research traditions (see Larkham 1998:161) who have been effectual in the theoretical and practical development of the concepts and methods in urban morphology. Marcel Poéte is one of those scholars, whose ideas have been considered by many people and whose studies on ancient cities (Poéte 1958), and especially those on Paris are considered among the most important modern studies on the city (Rossi 1986: 50). In the analysis of urban form, Poète concerns with continuity which can be derived from persistence of plan departing from the fact that, even though the attributes are differentiated and deformed in time, it is, by no means, displaced substantially (Rossi 1986: 59). Within this framework, Poète defines the major elements of persistence as monuments, which are physical signs of past (Rossi 1986: 59), and streets, as the generating element of urban growth (Poéte 1958: 46). He states that the cities are born at a fixed place and the streets give them life (Poéte 1958: 57). Streets are defined as elements of persistence, departing from the tendencies of cities to remain on their axes of development. Hence the analysis of the streets and the street system, considering their form, function, and intensity, becomes the fundamentals of the method (Poéte 1958: 58-59). Also Pierre Lavedan is another forefronting scholar whose studies are considered among the most complete analyses on urban form (Rossi 1986: 51). Following the ideas of Poète, he also defines persistence as a generator of plan. According to him, the persistence is reflected in the city's physical structures, streets and monuments (Rossi 1986: 51). M. R. G. Conzen, as the introducer of urban research tradition in UK, has contributed to both theoretical discussions on urban morphology as well as practical planning experience with his surveys on Alnwick and Whitby (Lilley 2000: 5; Larkham 1996: 28). Conzen also considers conservation as a major theme in analyzing the urban form. He introduces 'management' identified as 'historicity' as a key attribute, and defines the principle factors of historicity of townscape as town plan, building fabric and land use (Larkham 1996: 28). Conzen's plan analysis is based on three major plan elements: streets, plots and buildings (Lilley 2000: 8). The study of Pierre Couperie (1968) on the urban form of Paris within a historical development process, is worth mentioning among the studies on urban form. He has analyzed the growth of Paris, through its area of construction, main arteries, monuments, city walls and installations, by succession of constant scale maps (Couperie 1968).

The methods and elements of analysis proposed and utilized in such studies can be followed in understanding the urban form of different periods by the specialists of these periods, who are to prepare the necessary data for the assessment of historical stratification for the proposed 'decision supporting study'. However, being the methods and elements of analysis for understanding the urban form more than for assessing the historical stratification with the aim to contribute the conservation decisions and actions, they cannot be utilized conclusively for the proposed 'decision supporting study'. Therefore, neither urban morphology nor urban and historical geography are the direct concerns of this thesis but they had been referred to according to the objectives of the thesis in the determination of the basic components of the town which should be analyzed to assess the historical stratification. Within this framework, the approaches of forefronting scholars and their studies in these disciplines have contributed to the determination the elements of analysis. Besides those disciplines in which understanding the urban form is the major concern, there are many studies carried on by other disciplines in which conservation becomes a more important concern. Studies on urban archaeology dealing with the structure of the town and its components within a historical development process and 'decision supporting studies' on the assessment of historical development of the town, such as the study on Turin, mentioned in Chapter 2, are in that respect more directly related and hence, have been utilized in determining the elements of analysis for the proposed 'decision supporting study'.

be built upon the assessment of historical stratification regarding continuities, discontinuities and changes in the urban structure and in the main components forming the urban structure of the town through historical continuity. Thus, the assessment of historical stratification in multi-layered towns demands for an extensive study of the main elements of the town, their relation with each other and with the whole, both 'horizontally', within the same period, and 'vertically', through the successive phases within historical continuity of the town.

3.2.1. Elements of Analysis

Comprehensive understanding of the urban structure can be achieved by breaking down the town into its basic components. Hence, while assessing the historical stratification in multi-layered towns, the main elements, common to the settlement patterns of different periods, should be determined as the basic components making up the urban structure. The type, form, content, details and specific names given to these main elements of the town can differ from one era to another, whereas their fundamental roles in the formation of the urban structure remain the same.

In determining the basic components of the town the integral relation between different scales of analysis should be considered. Urban form necessitates to be analyzed through different spatial elements and relations in different scales, which correspond with different levels of geographical space varying from territorial level to the level of a single structure. Information concerning the spatial elements and relations in different levels of geographical space have been considered in the studies of urban form and heritage information systems, as well as in 'decision supporting studies' for the conservation of historic towns as an important property in providing 'continuity' between different scales, details and aspects[18].

Different elements making up the urban form are hierarchically interrelated with each other so that "smaller-scale elements combine to form larger-scale elements which in turn are parts of still larger elements" (Kropf 1998: 131). This does not mean that the components of town change according to scale or geographical

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[18] Refer to Chapter 2.

level. What differ, are the elements for analyzing the urban form in type and detail for different levels of geographic space, also called different levels of resolution.

Such a hierarchical order also reflects itself in the detail of representation of these elements. That is, a building is represented with building partitions in a larger scale whereas the same building is represented with a simple rectangle in a smaller scale. A. Kostarczyk (1993: 67) defines 'levels of geographical space' in determining the content and detail of information related with a historic town while building heritage record systems. A similar approach of representing the urban tissue through hierarchically related urban elements of typo-morphological analysis is defined as 'levels of resolution' by K. S. Kropf (1998: 130-131) [19]. (figure 3.5)

Like in many of the studies on understanding, analyzing and recording the urban form and its components[20], it is necessary to consider an integrated system based on differing scales of analysis, from territorial level till the level of a single edifice, in determining the elements of analysis for the assessment of historical stratification in multi-layered towns.

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[19] A. Kostarczyk (1993: 67) groups the levels of geographical space as "level of the territorial organization, the level of the settlement network organization, the level of an inner structure of towns and villages, the level of an inner structure of particular urban lot or rural farm". K. S. Kropf (1998: 131) defines hierarchically related elements of typo-morphological analysis by the term 'levels of resolution'. Accordingly, he defines the elements of urban tissue of different levels of analysis, departing from M. R. G. Conzen's and G. Caniggia's conceptions, as " (a) streets and blocks (or plot series); (b) plots; (c) buildings; (d) rooms or spaces; (e) structures, such as walls or roofs (encompassing details of construction); and (f) materials". Not only A. Kostarczyk (1993) and K. S. Kropf (1998), but also other scholars considered different orders or scales in analyzing the urban form such as Jean Tricart who mentioned three scales of analysis: the scale of street, the scale of district and the scale of entire city (Rossi 1986: 48). However there are also objections towards the approach of explaining the urban form on the basis of differing scales like Aldo Rossi does (Rossi 1986: 49). Rossi accepts the benefits of this approach didactically and in practical use, however he finds it unacceptable as such an approach implies that the city and the urban artifacts are modified as the sizes and extends change. Within this thesis, it is accepted that the elements of the urban form do not change but the elements of analysis change according to different geographical levels of space.

[20] Besides the 'decision supporting studies' mentioned in Chapter 2, this kind of a hierarchical approach is also relevant for the studies of urban archaeology in understanding and analyzing the historical development of towns. In the studies of urban archaeology, the basic scales of analysis of urban form in a historical development process can be defined as the analysis of the general layout of the town and the analysis of the inner organization of the town. To these two basic scales, territorial analysis as well as the analysis of smaller regions within the town and the analysis of single structures, in other words studies on building's archaeology, can also be integrated according to the purpose of the study and the availability of information. For further information see Chapter 3 in (Bilgin 1996).

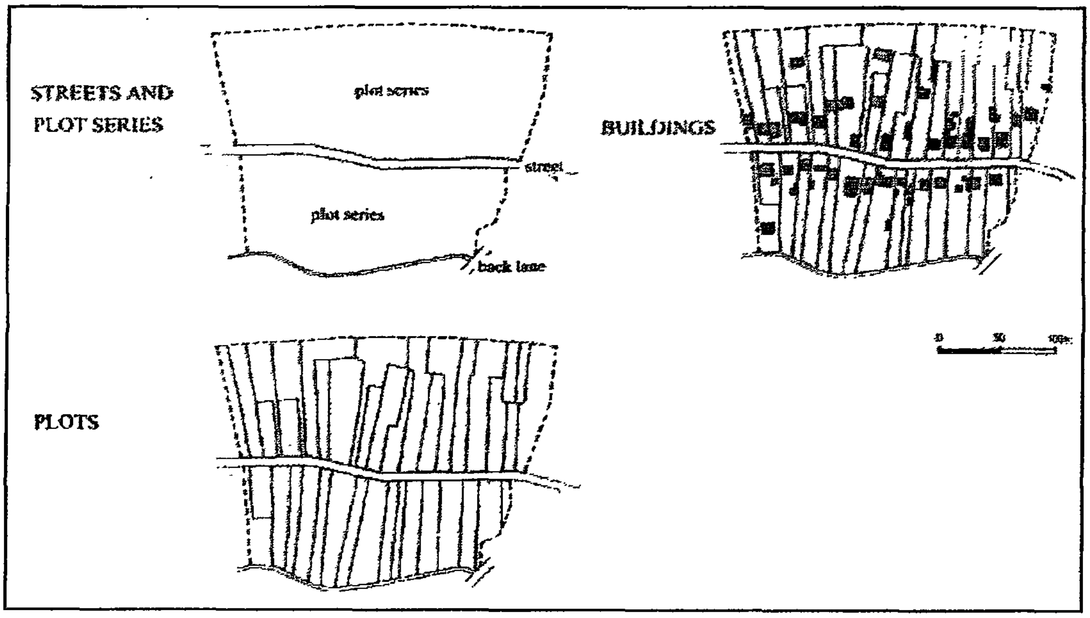

figure 3.5. Karl S. Kropf's representation of 'levels of resolution' (from Kropf 1998: 130)

Accordingly, the major levels of geographic space in analyzing and assessing historical stratification in a multi-layered town can be delineated as:

- the level of territorial organization
- the level of settlement layout organization
- the level of intra-settlement organization
- the level of building block organization

The level of territorial organization comprises the relation of the town with the other settlements within the territory and the network between them. The level of settlement layout organization concerns with the settled areas of the town, their extent and boundaries. The level of intra-settlement organization embraces the major components making up the urban tissue. In the level of building block organization, the components of a building block are considered. The defined levels of geographical space for analysis can be enhanced to cover the level of a single edifice, which consists of the structures and spaces making up a single edifice, and even the detail of building components and materials, as Kropf (1998: 131) points out, according to the aim and content of the study as well as according to the availability of information. In view of the above-mentioned levels of geographical space the major elements of analysis for the assessment of the historical stratification in a multi-layered town can be determined.

During analyzing and understanding the urban form, the natural background of the built environment is of prime importance as a major contributor to the configuration of the urban form all through the different eras during the historical development process[21]. Therefore, the town should be analyzed and evaluated within its natural context formed by the topographical features of the site. Accordingly, the *topographical features* of the site on which the urban form resides come out to be the elements for analysis, which should be considered in all the different levels of geographical space. Topographical features, such as sea, lake, river, hill, mountain, plain, woods, break in the terrain and contours and inclination of the terrain, affect the formation and development of the built environment. These natural features are integral constituents of the built up environment in every phase of its historical development process.

Besides the natural context, a historic town, in any phase of its historical development process, should be considered within its territorial context constituting of other built up areas and web of relations between them. In analyzing a multi-layered town at the level of territorial organization, the main elements of analysis are the other urban and rural *settlements* within the territory of the town and the *territorial network*, constituting of roads, railways, paths, etc., between them.

Knowledge on the area covered by the town during different periods within the historical development process is essential not only for understanding the town but also for assessing the historical stratification as a conservation decision support in multi-layered towns. Therefore, in the level of settlement layout organization, the *settled area* covered by the town becomes an element of analysis itself. The *extent* of the settled area, *boundary* of the settled area and the *entrances* to the settled area are important elements, which need to be considered for the analysis in settlement layout organization level.

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[21] Marcel Poète defines the geographic environment as one of the major constant themes, which provides a background to the differing historical periods (Poète 1958: 57, 105-118). Besides Poète, it is possible to observe the importance of natural background in the configuration of urban form in other studies on urban morphology as well as urban archaeology. The study of Pierre Couperie (1968) on Paris is a good example in which the geographical features have accompanied the analysis of urban form of Paris in different eras.

The boundaries define the extent of the settled area. In any phase of historical development process the boundary defining the settled area appears as an important element of analysis in understanding the town. The boundary of the settled area is necessarily a solid boundary like a city wall. It can be a natural boundary formed by a topographical feature. Even the settled area can have an 'open or soft edge' as Kostof (1991: 38) calls it, which is only defined by a legal boundary delimiting the restrictions and privileges instead of any physical circumscription. The boundaries of the settled area of the town are not rigid elements as they are an integral part of an organic entity and they may change from one era to another both in the way they are defined and in their location and extent. While defining the extent of the settled area, differentiation of tissue character within the settled area appears to be an effective factor that should be considered. There are different divisions within the settled area of the town, defined as urban divisions or as characteristic parts of the town, which point to different tissue character than one another. Those parts of the settled area are distinguished from each other by differentiation of use, which is also reflected as differentiation in their spatial and architectural characters[22]. Knowledge on the extent and characteristic of the settled areas concerning different periods within the multi-layered town is important in determining potential and characteristic of the stratification that is to be expected within that area. Therefore, defining the extent of the settled area by differentiating the characteristic parts come out to be an important element of analysis

Just like in the case of the boundaries, each town has entrances. These entrance do not necessarily exist as physical objects. They may be in the form of city gates as the openings in the solid boundaries surrounding the town. Whereas, they can also be freestanding city gates with a symbolic value or just as main streets, providing the territorial connection, in the case of open edged towns.

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[22] S. Kostof (1992: 72) defines urban divisions as "districts of specialized use, distinguished spatially and architecturally from their teeming surrounds". He mentions four basic specialized partitions of urban territory as the administrative district; where the ruling authority resides, the religious district; as a reflection of God in the city, the district of business and commerce, the residential component of the urban structure. He also mentions other types of divisions such as the temporal distinction between old town-modern town, cultural segregation of religious and ethnic, economic segregation and so on. A. Rossi (1986: 69) calls those parts of the town, which are distinguishable from formal and historical standpoint, as characteristic parts of the town.

The entrances to the settled area are important in understanding the layout and organization of multi-layered town as well as the changes in urban / rural relation. Whereas, the extent and boundary of the settled area are not only necessary for understanding the urban form but also for conservation and management of the multi-layered town. Defining the extent and boundaries of the settled area is a primary step in determining the conservation and management decisions concerning archaeological sites and historic towns. The importance of flexible definition of the boundaries and maximum extent of archaeological sites and historic towns, based on the historical and archaeological knowledge, have been mentioned in many of the national and international documents as well as by the scholars concerned with area-based conservation and management issues[23].

Following the analysis at the level of settlement layout organization, is the analysis at the level of intra-settlement organization. In analyzing and understanding the town's intra-settlement organization, the major elements of analysis, which are commonly used in almost all the disciplines dealing with the understanding of the urban form, are *streets* and *blocks*[24].

The street is one of the most important constituents defining the tissue of the town. As Kostof states (1992: 220), the street is "more than a mere traffic channel ensconced within the city's solid mesh...". Besides their economic and social significance as well as their architectural identities, streets are effective on the formation and development of the urban form. Consequently, the street system, as a web, due to its crucial role in the formation and development of the town, is considered as a major element in analyzing and understanding the town's historical development process in different studies on urban form.

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[23] In 1984 Ø. Lunde, in the unpublished paper titled 'The Planning of Archaeological Investigations and the Establishment of Priorities', points that determining the maximum extent of the settlement is an information during the mapping of archaeological data in development areas. R. Klok (1984: 12) mentions the importance of knowledge of the exact size of the site for the protection and management of archaeological sites. Also in the unpublished report on 'Mediterranean Action Plan - Priority Actions Programme - Guidelines for the Rehabilitation of Mediterranean Historic Settlements' prepared by Jokilehto and Marasović in 1994 definition of the area covered by the town, its historical limits and boundaries are stated as one of the principal phases in conservation and management of historic towns.

[24] The *street system* and *building blocks* are considered as the major components of town in various studies concerned with the analysis of urban form in urban morphology, historical and urban geography as well as in urban archaeology. Refer to footnote 14 on page 89.

The streets have two major aspects considerable in the configuration of the urban form. First one is the axis of the street, which defines an orientation, and the second one is its physical subsistence as an open public area having a form defined by the surrounding blocks. The street, with its form, is recognized as an element of analysis in most of the studies on urban form. In that case, all the contractions and enlargements in the form of the street, including the squares, are regarded as an integral component of the street system, as they altogether form the public open areas for circulation within the urban form (figure 3.6). As important as the area and form of the street, is the axis of development[25] defined by the street in the studies with concerned with understanding the urban form as well as in those engaged with conservation as the central issue[26] (figure 3.8, 3.9 and 3.10).

In the assessment of historical stratification in multi-layered towns, the continuity of axis defined by the street is as important as the continuity of its physical subsistence. Therefore, while assessing the historical stratification in multi-layered towns both of the axis and the area defined by the street should be studied as important aspects of the analysis of street system, which point out different information on historical continuity and stratification.

Building blocks are also very important components of urban tissue. Kostof (1991: 147) defines the 'block' as a basic unit of orthogonal planning which contributes to the 3-dimensional character of urban grid. Blocks have been important constituents of the urban form with differing names, such as insulae, ilots and so on, since the early ages. The blocks are reverse indications of the streets within the urban form. The block borders are at the same time the borders defining the streets. (figure 3.6 and 3.7)

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[25] Poéte, points out the importance of streets as the axes of development and their continuous role in the urban form. Refer to footnote 14 on page 89.

[26] In most of the studies on urban archaeology, the main axes are considered among the most important elements of analysis in determining the continuities and changes within the historical development process of the town. Axis in urban composition appears as an important element of analysis also in different 'decision supporting studies' on urban conservation. In the 'decision supporting study' on the assessment of historical development of Turin the axes are analyzed in two different topics as 'rectorial axes in urban composition' and 'directrices of historical development' (Viglino 1986: 86).

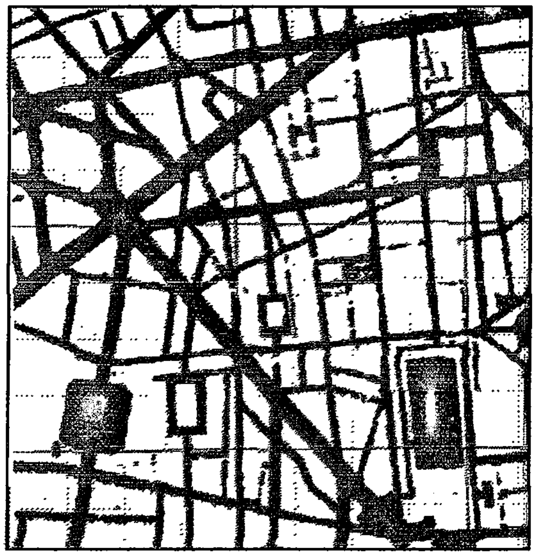

figure 3.6. Analysis of street system of a region in Paris (from Cohen 1999: 44). The analysis covers all the contractions and enlargements, such as squares, as constituents of the street system.

figure 3.7. Analysis of the blocks of the same region in Paris (from Cohen 1999: 44). It is possible to visualize the inverted relation between the street system and blocks in the urban form.

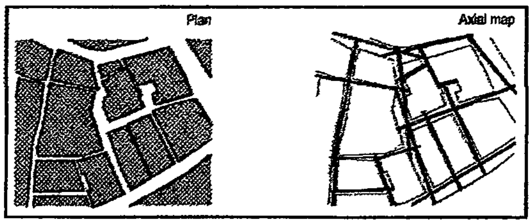

figure 3.8. Representation of the construction of an axial map (from Teklenburg et. al 1997: 264). It is also possible to distinguish the relations between blocks, street area and street axis from this representation.

figure 3.9. Analysis of the main axes in urban composition and the directing axes of historical development in the 'decision supporting study' on the assessment of historical development of Turin (Viglino 1986: 86).

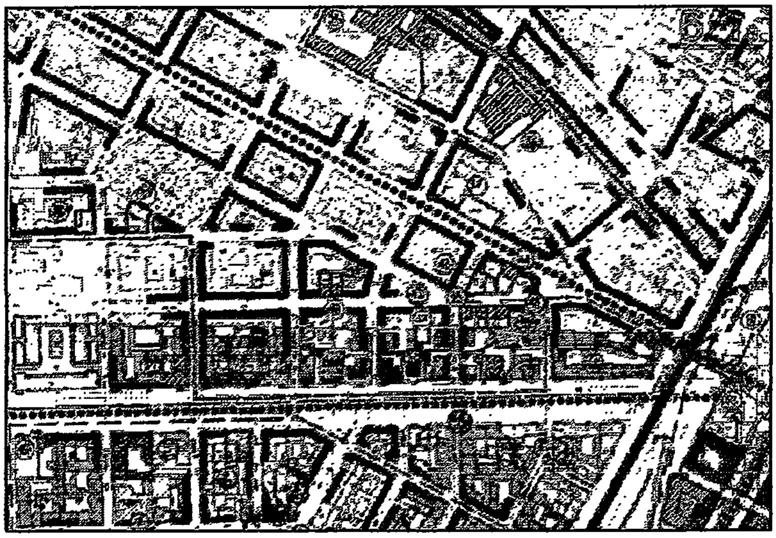

figure 3.10. A closer view of the study on Turin (Viglino 1986: 86). It is possible to visualize the various elements of analysis such as the street system, both with its form and with the axes it indicates, the blocks, with their extent and outline, and the edifices.

Blocks have been considered among the most important elements of analysis in various studies concerning the physical structure of the town, including the studies on urban morphology as well as those concerned with urban conservation and urban archaeology[27].

While analyzing the block, both its extent and its borders, also called outline of block, are important aspects to be considered. The blocks are important, as their tendency to change is less than those of buildings and plots. Especially the outline of the blocks remains almost fixed with respect to their internal arrangement (Kropf 1998: 137-138). Hence, the border, or in other words the outline, of the block as important as its extent in the conservation focused studies[28] (figure 3.10) as well as studies on urban archaeology. Thereby, block, together with its outline and extent, becomes an element of analysis for the proposed 'decision supporting study' on the assessment of historical stratification in multi-layered towns.

The next level of analysis is the level of building block organization, which covers the constituents of building blocks. Hence, *plots*, as important constituents influencing the internal arrangement of blocks, and *edifices*, as the constituents influencing the internal arrangement of plots, appear to be the major elements of analysis at this level. Plot is considered as an important element of analysis especially in the studies on analyzing and understanding the urban form[29], as boundaries of plots are defining elements in the configuration of the built-up and open areas within a block. Even though they are not as rigid as the block outlines, the original plot boundaries and sizes are still legible to an extent in the contemporary urban form, as the changes in plots are in the form of combination

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[27] Block appears among the three major plan elements in Conzen's plan analysis. Similar to the Conzen's approach is the classification of, who also considers plot series, in other words blocks, among the major components of 'urban tissue' (Kropf 1998: 131). Following the ideas of Conzen and Caniggia, other studies on urban morphology have been carried on in which block is considered as an important element of analysis. Keith D. Lilley's on Conventry, England is one of the most recent examples of such studies (Lilley 2000: 5-30). Besides the studies on urban morphology, block appears as a vital element of analysis in nearly all of the studies on urban archaeology (see Bilgin 1996 for more detail and examples), as well as those on urban conservation

[28] 'Decision supporting study' on the assessment of historical development of Turin (Viglino 1986) and the study on 'Birmingham City Centre Design Strategy' mentioned in (Tiesdell et. al. 1996: 57) are examples of such studies.

[29] Plot is considered among the major elements of plan analysis by Conzen as mentioned in footnote 14 on page 89.

or division of original plot units in time (Kropf 1998:138). Knowledge on the plot sizes and boundaries in different periods helps to obtain better understanding and interpretation of the urban form.

Different than the studies on urban morphology, plots are not considered among the common elements of analysis in the studies on urban archaeology as well as in 'decision supporting studies' on the historical development of physical structures of the towns in which conservation is the central issue. Within the framework of this 'decision supporting study', plot, as an element of analysis, is not a compulsory determinant of historical stratification in multi-layered towns. However, plot still appears as a utilizable element of analysis for the reasons that both the plot system in different periods, in so far as they are known, will contribute to understand and interpret the urban form and its components in those periods, and current plot system acts as a legal determinant in the implementation of conservation decisions.

In most of the studies on the analysis of urban form, buildings, mainly the monumental buildings are considered as important elements of analysis, since the monuments are regarded as one of the major elements of persistence[30]. A similar approach can be observed also in urban archaeological studies. Whereas, in the studies concerned with urban conservation, the scope is not only limited with monumental buildings but also covers all sorts of buildings as well as other constructions such as bridges, fountains and the like. Accordingly, within the framework of this study *edifice* is considered as an important element of analysis for it covers all sorts of buildings and constructions.

As mentioned previously such a study on historical stratification can be extended to cover analysis at the level of a single edifice, in which the components of an edifice, such as spaces, walls, columns, floors, are considered as the elements of analysis, as long as the detailed information is available and the system capabilities are compatible to work with huge amount of data. Hence, it is possible to consider this scale of analysis at smaller sites in which the number of edifices

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[30] Poète points out the importance of monuments, which are the physical signs of past, as the major elements of persistence (Rossi 1986: 59). Not only Poète, but also other scholars studying on the analysis of urban form consider main buildings and monuments among the major elements of analysis as mentioned in footnote 14 on page 89.

are limited as well as in which the information on stratification of components of edifices are available. The examples of studies covering analysis at the level of a single edifice are observed especially at 'non-urban' archaeological sites or at a small selected region within urban areas[31] (figure 3.11).

Above-defined are the major elements of analysis, which are essential to be considered for each of the historical periods within the development process of a multi-layered town, including also the existing situation, in order to achieve comprehensive understanding of the formations and transformations in the urban form, and consequently, to accomplish the proper assessment of historical stratification. Apart from these major elements of analysis, there are other elements that the 'decision supporting study' should cover. It has been previously mentioned that the proposed 'decision supporting study' aims to support the conservation decision-making process and to form up a basis for various decisions, projects and implementations, while at the same time intends to provide integrity with other existing studies as well as the forthcoming ones[32]. In accordance with those major aims, the 'decision supporting study' necessitates to cover elements, which are mainly concerned with the existing physical, legal and administrative situation of the town, in addition to the above-mentioned major elements of analysis.

Such elements help for relating the analysis and evaluations on historical stratification with the existing town, allow the comparison and compatibility of existing situation and current conservation decisions with the historical stratification of the town, while at the same time provide a basis utilizable in legal and operational purposes as well as in integration with other related studies.

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[31] An important example of analysis at the level of single edifice is ArchéoDATA project, which has been realized at Château Vincennes (figure 3.11). Château Vincennes was situated outside the city at the period of construction, but now has been within the 'Greater Paris Area' and at the end of one of the main metro lines (Arroyo-Bishop, Lantada Zarzosa 1993: 195-196). It is a relatively small archaeological excavation site, situated within the urban area but still on which no present-day settlement exists. ArchéoDATA project focuses on the analysis of the archaeological entities at the site, considering object-space-time relationship. For further information, see (Arroyo-Bishop, Lantada Zarzosa 1993: 195-203) and (Arroyo-Bishop, Lantada Zarzosa 1995: 43-53). ArchéoDATA project was also mentioned previously among the GIS applications concerning cultural heritage issues. Refer to Chapter 2.2.2.2., p. 57, figure 2.3.

[32] The aims and framework of the proposed 'decision supporting study' are discussed in detail in Chapter 2.3.

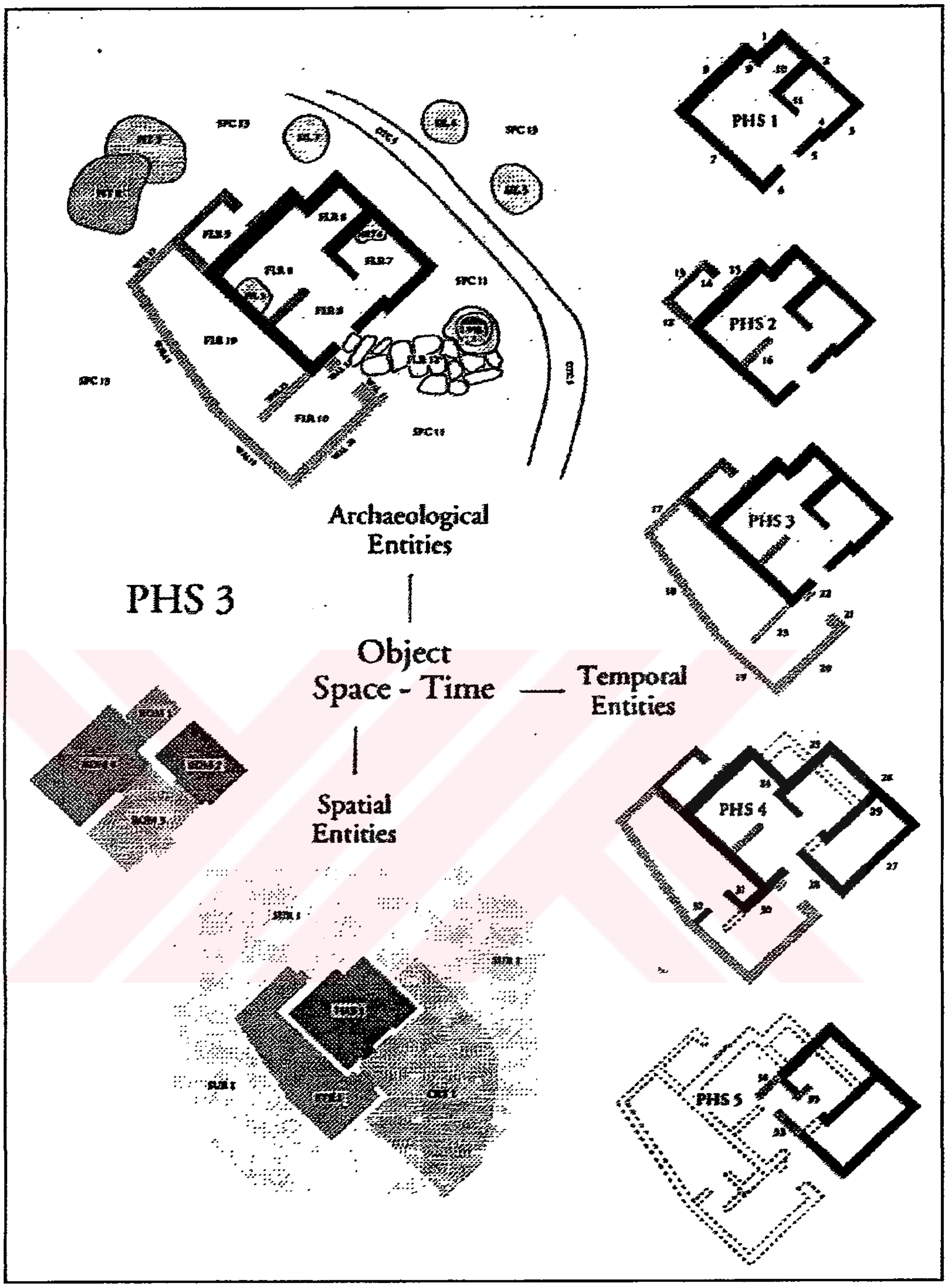

figure 3.11. Representation of the main framework and content of ArchéoDATA project realized for Château Vincennes, which is one of the important examples of analysis at the level of single edifice (from Arroyo-Bishop, Lantada Zarzosa 1995: 48). The project focuses on object-space-time relationship within the site. Accordingly, the main elements of analysis are architectural entities as *silo, wall, floor*; structured archaeological and architectural entities as *house, stable*; spatial entities as *rooms, corridor*; structured spatial entities as *habitat, courtyard*; temporal entities as *phase, sequence*; structured temporal entities as *Roman, Vaccean*, etc.; and interpretative groups as *village, valley, region*, etc. (Arroyo-Bishop, Lantada Zarzosa 1995: 53).

Among them are the elements pertaining to the existing remains, elements relating to current legal conservation decisions and the elements regarding the provision of legal and operational basis for conservation decisions and implementations.

One of the mostly encountered entities in multi-layered towns are the *remains*, which can be defined as the edifices constructed in previous periods and lost their physical substantiality as well as their meaning and integrity with the contemporary urban tissue. Therefore, *remains* and *remain zones* should also be considered in defining the existing situation of the multi-layered town within the framework of this 'decision supporting study'.

Area-based conservation decisions previously made for different parts of the town are important to be considered both for conservation decisions, projects and implementations, and for the appraisal of their compatibility with the information coming from the assessment of historical stratification. Therefore, areas designated for different types and degrees of *'sites'*, appear to be remarkable elements, which should be embraced by the 'decision supporting study'.

Considering the necessity to provide a basis, which can be used in legal and operational purposes as well as in their integration with other related studies, the 'decision supporting study' should cover the elements contained by the documents utilized as legal and operational basis. Such a legal and operational basis commonly used for urban conservation decisions and implementations in Turkey are 1/1000 maps depicting the existing configuration. Along with 1/1000 maps, 1/5000 and 1/25000 maps are also used as basis for decisions and interventions in territorial scale. With regards to the need of providing the same language with those basic documents, the 'decision supporting study' should cover all the elements represented in 1/1000, 1/5000 and 1/25000 maps. Therefore, elements related with references used in these maps (coordinate system, topographical measurement points, texts etc.), administrative boundaries (municipal boundary, contiguous area boundary, etc.), built-up areas, separators, walls, sidewalks and the like, should also be indicated in the 'decision supporting study'.

3.2.2. Information Types

Information needs to be decision and purpose relevant in order to be able to support decision-making process, as also stated previously while defining the properties of useful information[33]. Thereby, the determination of information types concerning different elements of analysis for the assessment of historical stratification in multi-layered towns depends on clarifying what is aimed to be extracted and achieved out of this study.

As mentioned previously, historical continuity, together with the material remains and traces reflecting this continuity, is a significant and distinguishing value for multi-layered towns. Therefore, the material existence, remain or trace of any component of the urban tissue belonging to any of the historical periods within historical continuity of a multi-layered town are to be considered exclusive of their function, physical condition and any subjective evaluation about their relative importance.

The proposed 'decision supporting study' aims at providing necessary 'scientific' information as a supporting mechanism for the conservation councils as decision-makers for the conservation site decisions as well as a warning mechanism for the operating groups within the multi-layered town so as to obstruct the destruction of remains and traces of historical continuity. In addition to these, it also aims at providing a databank as a scientific research platform for researchers dealing with different aspects of historical stratification in multi-layered towns[34]. Hence, the end product of the 'decision supporting study' should allow:

- informing 'identity'
- revealing 'sensitivity'
- resolving 'continuity'

Informing on 'identity' of existing historic features and areas comprises descriptive information about chronology, type and denomination as well as qualitative information utilized as evaluation criteria in conservation decisions. That is, the

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[33] For the properties effecting the quality of 'information' in any kind of decision-making process and similarly in conservation decision-making see Chapter 2.1.1. and 2.1.2.

[34] Refer to Chapter 2.3.

proposed 'decision supporting study' should obtain the information that is necessary for area based conservation decisions in that country, while at the same time it should provide a databank, which compiles different types, formats and scales of 'scientific' data about the urban tissue and its components in different periods so as to be utilized for various researches. Revealing 'sensitivity' aims to warn about the features and areas which may contain material remains of different historical periods that are not visible in the contemporary urban tissue but known or assumed to exist. Resolving 'continuity' of features or areas aims to provide information about continuities and historical stratifications in the existing urban tissue so as to contribute to their sustainability. Continuity in the urban tissue can be in two different ways. In the first one, any component of the urban fabric belonging to any of the historical periods sustains its existence as a whole or a remain materially in the contemporary town, which can be named as 'material continuity'. While, in the second one, the historic feature no longer exists but sustains its line as a trace in the contemporary urban tissue, which can be named as 'trace continuity'. 'Trace continuity' is important also as it can point out a 'sensitivity'. That is, if the trace of an urban component can be visualized within the contemporary town, it can be still existing beneath the contemporary urban component, which carries the same lines of the non-visible historic one. Hence, both the 'material continuity' and the 'trace continuity' are important for decision-making, operating, researching and informing groups within the multi-layered towns[35].

In order to achieve the above-mentioned objectives of the 'decision supporting study', information utilized can be in three different formats according to its relation with the original source. First one is provided by enabling direct access to the original source or document, which can be named as *archival information*. This information is not utilizable for analysis and evaluations, but it functions as additional information concerning the subject, such as photographs, original drawings, details, inventory cards and so on. In the second one the data derived from one or more sources are reflected by classifying and structuring according to the aim and objectives of the study. By this way the *basic information*, which will be utilized for different analysis and evaluations, is provided. Last but not least is

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[35] These are explained in detail previously in Chapter 2.3.

the information obtained through the analysis based upon basic information. This information, which is not available at the beginning of the study but provided as a result of various analysis, can be defined as *processed information.*

According to these above-mentioned objectives and framework, it is possible to define the information types concerning various elements of analysis and that the proposed 'assessment method' should embrace. In any heritage information record and management system different types of information concerning the heritage resource are defined[36]. The first one of these information types is 'information for identifying' the heritage resource. The second one generally aims at characterizing the historical resource and its values. Lastly, there also exists information necessary for managerial and legal purposes, which can be called as 'information for decision-making'.

'Information for identification' consists of *basic information* for defining the element of analysis. First of all, there should be a unique record number given for each element of analysis considering that a unique key value is necessary in case that new datasets are combined to the feature as a relational database. Other information necessary for identification is type, name, address information, current legal status and the sources of information concerning the element of analysis. Besides, there can be *archival information* such as photographs, drawings, legal documents like registration and record forms concerning the element of analysis, which supplement additional information for identification.

'Information for characterizing the historical stratification', assists to comprehend the stratification of different periods together with their material remains and traces. It encompasses *basic information* for defining the period and possible position of the elements of analysis such as period of settlement / construction, more specifically date of construction, provisional / known minimum and maximum altitudes with respect to current ground level. However, most of the

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[36] Grouping the information types according to the needs can be observed in various architectural and archaeological heritage record and management systems in different countries. An example is Record of Scheduled Monuments (RSM), which is a comprehensive archaeological database utilized in England. It contains four data categories: Location and identification; Descriptive; Management; Administration (Fraser 1997: 21-22). David Fraser (1986: 21-23) groups the information provided by Scheduled Ancient Monuments Record System utilized in England in three major categories as: for identifying and locating the archaeological site; for characterizing its known archaeological significance; for assessment and management purposes.

information for characterizing the historical stratification is in the form of *processed information*, which comes from the analysis of spatial aspects of the element of analysis such as the geometric information.

The geometric information concerning the element of analysis is also important historical stratification characterizing information. Especially, 'angles' concerning the feature is very important in assessing historical stratification. It does not matter whether a building, a block or an urban axis is in concern, the angles of the historic resource is traceable within the contemporary urban tissue in a more or less deformed form, and thus, gives an important clue about the historical stratification[37]. This can be exemplified with the representative drawings of S. Kostof (1991: 49) showing the transformation of Roman grid tissue to Islamic organic tissue (figure 3.12).

From the final stage of the tissue, the primary grid tissue is traceable even though the straight lines and angles are deformed to an extent. The streets and building blocks, which more or less follow the pattern of the grid tissue, should be handled and searched with great care, as they can be the reflections of existing remains from the Roman period upon which new constructions are built in the successive periods.

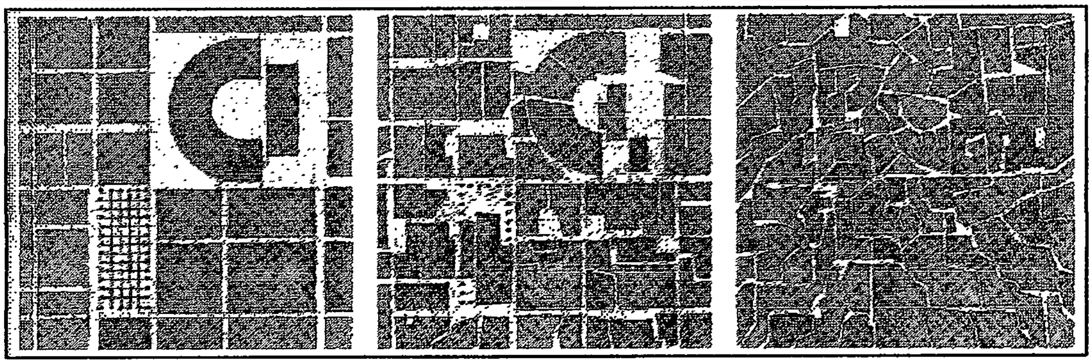

figure 3.12. Representation of the gradual transformation of a Roman town with grid tissue into an Islamic city with organic tissue (from Kostof 1991: 49)

[37] For comprehensive information on the formation and transformation of Islamic Towns and their relation with the urban structure of previous periods, refer to (Msefer 1984).

'Information for decision-making' consists of the information, which is defined as the basis for conservation decisions described within the legal structure of the country in concern. It is also *basic information*, which can be supplemented by *archival information* when necessary. In any 'decision supporting study' or heritage information management system, it is important to provide the information, which is defined as the basis and criteria for decision-making in the legal documents, by utilizing a similar terminology in defining and assessing the subject of concern[38]. Therefore, this information should be derived from the existing acts, regulations and legislations of the country in concern.

It is possible to claim that the information for identification and information for characterizing historical stratification should not differ from one country to another, whereas information for decision-making may change according to the urban conservation decision-making processes and procedures defined in the legislations of different countries.

3.2.3. 'Information for Decision-Making' within the Urban Conservation Decision-Making Process in Turkey

The 'site' decisions and 'conservation development plans' play the major role for the conservation of historic towns in Turkey[39]. In order to define 'information for decision-making' for the case of Turkey, it becomes a requisite to confer with the references, criteria and procedures defined for 'site' decisions and 'conservation development plans'. Therefore, acts, principle decisions, regulations, instructions and technical terms of references as the obliging legal documents concerning 'site' decisions and 'conservation development plans', should be referred to in defining information for decision-making in Turkey.

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[38] The 'decision supporting study' on the assessment of historical development of Turin, mentioned in Chapter 2, is a remarkable example in which the utilization and integration of the legal terminology of Italian conservation decision-making system can be observed evidently in the definition of the elements of analysis, their properties and assessment. For further information see (Viglino 1986).

[39] Refer to Chapter 2.1.4.

The principle document for conservation decision-making in Turkey is the conservation act. The act in force today is 'Law for Conservation of Cultural and Natural Properties (Act No: 2863)' enhanced with some minor changes by the Act No: 3386. In Article 3 of the law, the definition of 'site' is given, which covers different 'site' types implicitly[40]. Besides the 'site' definition, the procedures of registration are defined very concisely and the criteria for designation are mentioned only by giving reference to the related regulations (1996: 5).

Another important document which is related with the area-based conservation decisions and activities is 'Regulation on Determination and Registration of Immovable Cultural and Natural Properties to be Conserved' which has been referred to within Act No. 2863, was prepared first in 1987 and took its final configuration in 1989. Article 4 of the Regulation concerns with the criteria for determination and evaluation (1996: 210-211). Within this article the criteria for determination of urban sites are defined as density, architectural and historical integrity. The same article defines the criteria for determination of archaeological sites as existence of qualifications concerning written information, material remains, scientific researches, environmental and ecological observations, scientific assumptions, and topographical properties.

'Instruction on the Principles of the Functioning of Cultural and Natural Properties Conservation Councils' Head Offices', which has been in force since 1996, contains information as to the designation process and criteria. In this document the information that should be provided by the reports concerning the subjects on site scale are delineated. Accordingly, the report should provide information on the general description of the area and its archaeological, urban, natural and historic properties, together with its state of destruction, indicating as if the properties are lost or not. Besides, it should also inform about the current legal state of the area, the decision date number and the 'site' degree if a previous

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[40] In the previous act, Act No. 1710, site types were defined explicitly as archaeological, historic, and natural sites. Accordingly, the places where important historical events had happened were called historical sites, the places where the remains of an ancient settlement or a civilization located underwater or ground is found out or known to be exist are called archaeological sites, the natural beauties or the oddnesses that should be conserved and the beautiful scenes that are formed through the natural and geological events, trees of centuries old and groves are called as the natural sites. The implicit definition of site types in Act No. 2863 points to an additional site type, that is urban site (1996: 3).

decision exists, as well as the status of the area with respect to other conservation laws. Last but not least, the report should also cover information on the existence and type of constructions within the area, land-use of the area and the state of area within the current development plan (1996: 344).

The 'Principle Decisions of Higher Council' are among the most important legal documents concerning 'sites' and their types. The four major 'site' types, as urban, archaeological, historic and natural sites, which are indicated in the act implicitly, are defined explicitly by the Principle Decisions of Higher Council. The most important 'site' types in relation to 'information for decision-making' in multi-layered towns are urban and archaeological sites.

The final configuration of urban site as well as the conditions of conservation / utilization are defined by the Principle Decisions of Higher Council in 1996/419 (1999: 2-5). In this principle decision, the definition of urban site is given as the areas, which present urban and regional characteristics, physical features concerning architecture and art history and the environment generated altogether by these features, reflect the socio-economical and the socio-cultural structures as well as the way of living of their periods and reveal an integrity of tissue.

The final configuration of archaeological site as well as the conditions of conservation / utilization are defined in Principle Decisions of Higher Council in 1999/658 (1999: 23-27). Accordingly, archaeological sites are defined as the settlements and areas in which there exist the products of the ancient civilizations located underground, over ground and underwater that have survived since the existence of humankind and all kinds of cultural properties that reflect the social, economical and cultural properties of the periods they belong to. Among the archaeological sites, the sites that will be conserved exactly the same by prohibiting every kind of activity with the exception of the scientific studies for conservation purposes, are called 1st degree archaeological sites; the sites that are to be conserved but the conditions for conservation and utilization will be determined by the Conservation Councils, that will be conserved exactly the same, other than the scientific studies for conservation purposes, are called 2nd degree archaeological sites; the archaeological areas in which new arrangements can be permitted according to the conservation-utilization decisions are called 3rd degree archaeological sites, and the areas where the archaeological sites; the immovable cultural properties that are defined in the 6th article of Act No: 2863 and the urban tissues that are to be conserved according to the same article of the same act coexist, are called as the urban archaeological sites[41].

In the above-mentioned principle decision of Higher Council, besides the definition of different degrees of archaeological sites, the restrictions that should be obeyed are delineated. Accordingly, in the 1st degree archaeological sites, every kind of building activity and excavations, except the scientific ones, are forbidden. Besides, afforestation and agricultural activities are limited. The already existing buildings in these areas, except the registered buildings, are to be demolished or gradually carried away from the site.

In the 2nd degree archaeological sites all kinds of excavations, except the scientific ones, and the new constructions are forbidden. Different than the 1st degree archaeological sites, simple repairs of the existing buildings, registered or not, and seasonal agricultural activities can continue under the control of Local Museum authorities. In the 3rd degree archaeological sites new building activities can be permitted after the foundation excavations under the control of the specialists from the Local Museum. The construction should stop and Conservation Council should be informed only if remains are found during the foundation excavations. Last but not least are the urban archaeological sites in which planning studies should urgently be prepared. During the preparation of the plans scientific methods for bringing out the archaeological values as well as their repair and exposition should be defined. Besides, extensive archaeological inventories should be taken as basis. Before the approval of the plan no application can be carried on in plot scale. During the planning studies care should be given to the appropriateness of the functions of the area, conservation of the cultural strata in the construction of necessary public services and the

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[41] In 1993, by a principle decision of the Higher Council, the concept of 'urban archaeological site' was introduced as a new type of 'archaeological site' together with which the 3rd degree archaeological sites were redefined. The urban archaeological sites were withdrawn with another principle decision of the Higher Council in 1996 as a result of which the 3rd degree archaeological sites regained their previous definition. However this did not last long as well, the decision of 1996 which withdrew the urban archeological sites was withdrawn with a principle decision of Higher Council on 5.11.1999 in which the definitions and the conditions of conservation/utilization of different 'site' types have taken their final form which are valid today.

consistency of the new buildings with the traditional ones in facade, construction technique and material. The projects of registered buildings should be under the control of the Conservation Councils, whereas the simple repairs of the others continue under the control of the specialists from the Local Museum.

Another important document is 'Technical Terms of References for the Preparation of Urban Conservation Plans' ,which was set up by the specialists of Ministry of Culture in 1990 in accordance with the Act No. 2863 with the aim to define the process of preparing a conservation plan and its context. Due to its aim, this document neither provides detailed information as to the procedures, standards and tools that should be utilized in urban conservation plans nor as to the references and criteria for 'site' designation. Instead, it tries to define a method of 'conservation plan preparation' that can be adapted to all the different types of designated 'sites' in different parts of Turkey.

The most important parts of the document, which can contribute to the determination of the information for decision-making for the proposed assessment method of 'decision supporting study' on historical stratification in multi-layered towns, are the parts concerning the aim, content and procedures of historical research and their evaluation within the conservation plan preparation process.

The research is defined in two different scales as the one concerning the whole town and the one concerning the planning area constituting of the designated 'sites' and their interaction areas. Within the different research topics relating to the whole town, historical research is defined in two steps as historical development and historical zoning. The research about historical development is defined to contain historical development process of the monumental and civil architectural examples in the town, historical development of the settlement beginning from prehistoric ages till today, together with their spatial reflections. The research on historical zoning constitutes of the development of different periods and their spatial expansion, the spatial structure of different periods as far as known and hence the transformation of the town scheme, and lastly providing the old development plans of the town (1990: 10).

The historical research, concerning the planning area that covers the designated 'sites' and their interaction areas, is defined in a more detailed way encompassing both the aim of the research and the methodology to be followed. Accordingly, the aims of the historical research are listed as:

- Defining the changes in the spatial organizations of different periods and their reflections in the contemporary town,
- Defining the historical development process in the site scale as well as the construction processes in the building scale,
- Obtaining the sufficient and correct information concerning the values to be conserved and defining the factors which cause the formation of these values,
- Defining the authentic design principles of the urban heritage together with the original functions and their organization, and through them defining the principles that can be utilized the planning studies (1990: 11).

Following the explanation of the aims of the historical research concerning the planning area and its interaction zone, the basic features of the methodology to be followed are defined. It is stated that, the historical research should cover all the historical stratification of the site, the special interest of the researcher on a period within this stratification should not be an identifying factor and thus, all the different periods within the historical stratification should be handled equally during the historical research. Besides, the necessity for a common language in defining the spatial and historical development of the site is highlighted. The properties of the information concerning the source, authenticity and the degree of reliability should be defined in a report accompanying the historical research. It is also mentioned that all the old town plans and maps should be transferred to the same scale so as to provide a comparison between them. Last but not least the reasons of the transformations in the building blocks, plots and buildings should be searched for during the historical research (1990: 11). Related with the evaluations of researches made in town and the planning area scale, the evaluation of the historical research is mentioned as the evaluation of the existing historical potential by interpreting the effects of the historical development of the town on the existing urban space (1990: 19).

To sum up, it is possible to state that, 'Law for the Conservation of Cultural and Natural Properties, Act No: 2863' provides only the definition of 'site' and the basic properties as to be defined as 'site'. 'Regulation on Determination and Registration of Immovable Cultural and Natural Properties to be Conserved' is perhaps the most straightforward document that gives information about the criteria for area-based conservation decisions. However, this document outlines the general criteria for only the basic 'site' types. Although 'Instruction on the Principles of the Functioning of Cultural and Natural Properties Conservation Councils' Head Offices' can be considered as an indirect document related with 'site' decisions, the designation criteria can be derived from the contents of the reports which are to be prepared for area-based conservation decisions defined within this document. 'Principle Decisions of Higher Council' provides the explicit description of the basic 'site' types, but they do not clarify the definition of their sub-types and degrees. Concerning different sub-types and degrees of sites, a decisive and regulative attribute about the future interventions are provided more than a descriptive attribute about their properties. Besides, references and criteria for the designation of neither basic 'site' types, those are urban and archaeological sites, nor their sub-types and degrees, those are 1st, 2nd, 3rd degree archaeological sites and urban archaeological sites, are defined by the 'Principle Decisions of Higher Council'. The criteria for designation of types of 'sites' and their sub-types and degrees can be resolved from the differentiation between the restrictions concerning different 'site' types and their sub-types defined by 'Principle Decisions of Higher Council' and the decisions given by the Conservation Councils with regard to them. Last but not least, is the 'Technical Terms of References for the Preparation of Urban Conservation Plans', which provides information with regard to the approach and the processes in preparing the conservation plans for historic towns, more than references and criteria for conservation decision-making.

Although the references and major criteria for area-based conservation decision-making concerning multi-layered towns in Turkey are not defined explicitly in neither of those above-mentioned documents, they can be extracted or resolved from the review of those documents directing the decision-making process as well as the decisions made for different cases[42]. Accordingly, the major criteria for designation of urban sites are existence of a tissue character, density, homogeneity, architectural and historical integrity. The major criteria for designation of archaeological sites are existence and quality of material remains, their density and homogeneity as well as the presence of scientific information, observations and assumptions. The differentiation between different sub-types and degrees of archaeological sites depend upon the quality of above mentioned properties as well as the type and quality of existing structures and tissue above them.

Hence, for 1st degree archaeological sites presence of highly dense and qualified movable and immovable surface remains, covering a homogeneous wide area, being under a man-made threat in short and middle term, taking an important place in scientific literature, and not having an existing tissue above, or a regrettable tissue which can be transferred or totally demolished else than the registered structures, are major criteria. For 2nd degree archaeological sites, the quality and density of existing archaeological remains and scientific references are not much different than those in 1st degree archaeological sites, but in that case there is a tissue above, in which no additional structures can be built but the simple repairs of existing structures, registered or not, can continue. 3rd degree archaeological sites can be analyzed in two groups as the ones in rural areas and those in urban areas. For 3rd degree archaeological sites in rural areas, the density, quality, homogeneity of movable and immovable surface remains and scientific references are rather inferior with respect to 1st and 2nd degree archaeological sites. However, either as it is close to a 1st or 2nd degree archaeological site, or in order not to leave it totally uncontrolled in case of facing with something noteworthy in the future, the area can be designated as 3rd degree archaeological site. For 3rd degree archaeological sites in urban areas, the

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[42] As it is mentioned above, the documents concerning the decision-making process neither provide direct information as to the references and criteria in designation of 'sites' nor to the differentiation between different 'site' types and degrees. However, there is a silent agreement on the criteria for designation of different 'site' types and degrees in practice, which does not take place in any of the written documents explicitly. This information is referred to an interview made with Assoc. Prof. Dr. Emre Madran, who is currently instructing 'Legal and Administrative Aspects of Conservation in Turkey' in METU Faculty of Architecture, Graduate Program in Restoration and Conservation of Monuments and Sites, and who has both been the member of various Conservation Councils as well as working for Ministry of Culture formerly.

density, quality, homogeneity of movable and immovable surface remains and scientific references are slightly less significant with respect to those of 1st and 2nd degree archaeological sites. However, there is a considerable tissue above, which should continue its life by repairing the existing structures and building new ones under the control of the Local Museum. The criteria for designation of urban archaeological sites are very similar with those of 3rd degree archaeological sites in urban areas, with the only major difference that the existing tissue above is a tissue that fulfill the similar criteria as to be considered as urban site in case of urban archaeological sites.

In addition to the above-mentioned criteria for determining different degrees and sub-types of archaeological sites, the type of the settlement appears to be an important information as it effects the quality of remains. This can be exemplified in the case of 'mounds' and 'tumuli', which are directly assigned as 1st degree archaeological sites. Besides all these differing criteria for designation of basic site types, as well as their sub-types and degrees, existing archaeological and architectural properties of the area, the state of destruction of these properties and the existing conservation decisions concerning the area are indicated among the major information for conservation decision-making common to all different site types and degrees. The sources, authenticity and the degree of reliability of the information are also indicated among major information just like it is in any decision-making process[43]. With regard to all these legal documents and their consequential implementations, it will not be wrong to state that, type of the settled area, period of settlement, degree of knowledge on existence, state of survival assessed through presenting a tissue character, intensity and homogeneity, and position and perception of the tissue or remaining tissue are the necessary information for area-based conservation decision-making in multi-layered towns in Turkey.

Considering the importance of the quality of each single edifice in making the area-based conservation decisions, similar information is essential to be provided for single edifices as well. That is, type of the edifice, period of construction, degree of knowledge on existence, state of survival and position and perception

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[43] Refer to Chapter 2.1.1. and 2.1.2. for the properties effecting the quality of 'information' in decision-making process.

of the single edifices are also important in defining the 'site' types and degrees in multi-layered towns in Turkey. Among the defined necessary information for decision-making, type and period are also defined among the information for identification and for characterizing historical stratification. Hence, position and perception, knowledge on existence and state of survival are among the major information necessary especially for conservation decision-making.

Position and perception of the edifices or archaeological and architectural properties at a site are directly related with each other. That is to say, if the current position of an edifice is under the ground level then it is not visible, if the current position of an edifice is over the ground level then it is visible. In between these two cases is the case in which the edifice is partially buried, that is situated partially above the ground level and partially below it, then it is partially visible. This criteria is valid not only for single edifices but also for wider areas. In that case the concern is the urban or archaeological tissue's position and perception in general departing from the whole or major part of it. Thereby, three main groups can be defined for the position and perception of the edifices and tissues:

1. over ground / visible
2. over and underground / partially visible
3. underground / not visible

Degree of knowledge on existence of a settled area or an edifice can vary in between being totally known, that is factual, and being totally assumed, that is hypothetical. The situation in between these two cases can be grouped in different degrees according to the exactness or inexactness of the knowledge about the existence, location, and dimensions and form of the subject of concern (table 3.2). Last but not least is the state of survival of the archaeological and architectural subsistence of sites and edifices. D. Fraser (1986: 23) defines the term 'survival' which is also used in 'Ancient Monuments Record Form'[44] as "how much survives of the archaeological monument compared with what is presumed, to the best of our professional knowledge, to have existed originally".

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[44] 'Ancient Monuments Record Form' is the form utilized to compile data for Scheduled Ancient Monuments Record System in England, which was also mentioned previously on page 105 footnote 32.

table 3.2. Matrix showing the differentiation between knowledge on existence.

	EXISTENCE	LOCATION	DIMENSIONS & FORM	
1.	exactly known	exactly known	exactly known	→ *factual*
2.	exactly known	exactly known	not exactly known	
3.	exactly known	not exactly known	exactly known	
4.	exactly known	not exactly known	not exactly known	
5.	not exactly known	not exactly known	not exactly known	→ *hypothetica*

Within the framework of the proposed 'decision supporting study' on the assessment of historical stratification in multi-layered towns, state of survival indicates what survives from the urban form or edifices of different periods of settlement. In defining the state of survival of sites presenting a tissue character, intensity and homogeneity are considered as the major criteria, which are drawn out from the conservation decision-making system of Turkey. Correspondingly, states of survival of single edifices are defined through what survives materially of the edifice and its intactness (table 3.3).

table 3.3. State of survival for sites and edifices.

	FOR SITES:	FOR SINGLE EDIFICES:
1.	intense remains reflecting a homogeneous tissue	whole, intact
2.	moderate remains reflecting a heterogeneous tissue	part of a whole
3.	sparse remains with no tissue character	remain
4.	gap	gap
5.	unknown state of survival	unknown state of survival

3.3. Main Concepts, Properties and Functions of GIS in Constitution of the Assessment Method

GIS are considered as integral tools in constitution of the assessment method. Therefore, the basic terminology and functions associated with GIS environment, which are to be utilized in the assessment of historical stratification, should be understood prior to the constitution of the assessment method[45].

3.3.1. Basic Concepts and Definitions Concerning GIS

GIS environment is a simplified representation of complex real-world geographical space in a digital format. Any spatial location on the earth's surface is referred through coordinate systems. Each location on the spherical surface of the earth is assigned to a unique location on 2-dimensional representation space through a mathematical transformation, which is called *map projection*. There are different coordinate systems and various map projections which are utilized to represent any location on the real-world spherical surface on 2-dimensional representation surface. Hence GIS environment acts as a *spatially referenced data model* of the real world (Malczewski 1999: 25), prior to any operation in GIS environment a common coordinate and map projection system should be selected.

Geographical entities, which refer to elements contained in real-world geographical space, are represented as *geographical objects* in a GIS environment. Geographical objects in GIS environment are associated with *spatial data*, which describes their location in geographical space, and *attribute data*, which identifies their characteristics other than location.

Geographical objects are sub-divided into three major *spatial object classes* each of which are represented through the basic geometry of differing dimensionalities:

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[45] GIS is a very wide-ranging subject. Explaining all the aspects of GIS is not the concern of this thesis. The aim is only to make familiar with the basic concepts, terminology and properties that will be utilized in the following parts. There are a great number of sources which aim to explain all the aspects of utilization of GIS and the other related subjects such as database design, spatial analysis and the like as well as the handbooks for utilization of GIS for different softwares (Aronoff, S. 1991; Batini, C., Ceri, S., Navathe, S. B. 1992; Fotheringham, S., Rogerson, P. 1995; Laurini, R. and Thompson D. 1992; Malczewski, J. 1999; Martin, D. 1996; Peverieri, G. 1995; Worrall, L. 1990; etc.). For more comprehensive information on GIS these sources should be referred to.

points, lines, and *areas*[46]. Since Euclid, in 300 BC, had defined the 'basic terms in geometry' in his masterpiece *Elementi*, points, lines and areas have been considered as the basic elements of geometry that form up the geometric language (Boffito; 1989: 165). "The point is the proto-element of graphic..." (Olsson; 1991: 6). It is the simplest element in geometry through which other elements can be obtained. A line can be defined as the connection between minimum two points. It can also be defined as "the track made by the moving point" as Wassily Kandinsky calls it (Olsson; 1991: 6). In GIS, real-world geographical entities are represented by these basic elements of geometry: points, lines, and areas.

There are two major formats for representing spatial data in GIS, namely *vector format* and *raster format*. Data in raster format are stored in pixels, which are uniform grid cells. In raster format a point is a single pixel, a line have single pixel width and more than one pixels length, whereas an area is made up of adjoining pixels of more than one pixel in both length and width. The data sources of raster format GIS applications are scanned images obtained from remote sensing, satellite imagery, aerial photos, and other image sources. The precision of raster format is directly dependent upon the resolution of the image and consequently the capacity of the software. The higher resolution is, the more precise and detailed and distinguishable geographical objects are.

In vector format spatial objects are indicated with coordinates. Accordingly, a point is identified by a single coordinate, a line by a string of coordinates with different starting and ending coordinates and an area by three or more coordinates with the same starting and ending coordinate so as to form a closed polygon. Contrary to raster format vector format provides a high level of precision, which is only effected by the precision of the original data source from which the coordinates are derived and the storage capacity of the hardware utilized (Malczewski 1999: 26)

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[46] Some of the scholars adds a fourth one to these three major spatial object classes as *surfaces* (Martin 1996: 52-53).

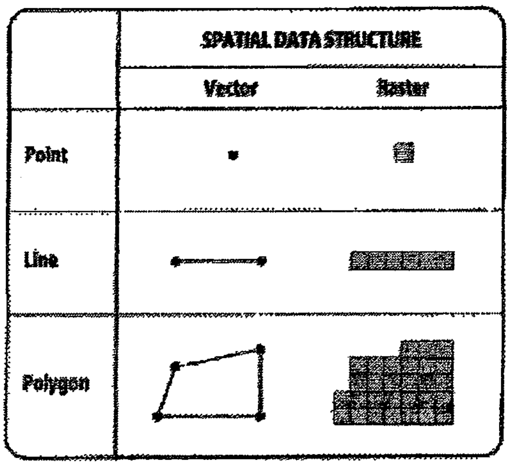

figure 3.13. Basic geographical objects (from Malczewski 1999: 26).

In vector format the geographical objects have definite spatial relations with each other. The information concerning these spatial relations is stored as a part of the spatial data concerning the geographical object, which is called *topology*. Topological data structure provides GIS to define spatial relations between the spatial objects. The basic spatial relations between different spatial objects are *connectivity, adjacency,* and *containment*.

Advantages and disadvantages of these two different formats over each other have been considered vastly (Martin 1996; Malczewski 1999; Aronoff 1991). It is possible to state that vector format allows more precision in data manipulation and analysis although it is hard to reproduce it for following up the changes in frequent intervals. Whereas raster format, which utilizes images obtained from satellites, aerial photos, remote sensing and other sources provides easy comparison of state of space in different time intervals, although its precision depends upon the resolution of the images utilized which never reaches the precision of vector format. There are some GIS softwares, which uses only raster or vector format, but in the majority of contemporary softwares both of these formats are allowed.

Fundamentally, GIS are comprised of *layers* similar to the transparent sheets used in the early multiple map overlay technique for analyzing separate components forming up a space[47]. In GIS environment, different themes are represented in different layers each of which is composed of a single geographic object with a single definite geometry and format. Some of the softwares allow assigning more that one geometry to a geographical object represented in a single layer by defining the layers geometry as *composite*[48]. However, this is not a common case. Besides, it should be taken into account that composite geometry for a single object causes some problems at the spatial analysis stage.

Layers in GIS can be handled and viewed separately as well as in different combinations. Different layers are geographically referenced to each other, that is called georeferencing, as a result of which they share a common geographical space with the same coordinate and projection system.

The display properties of each layer, containing a geographical object, are defined while assigning the layer. These display properties include the legend properties as to the symbol, color, hatching, line type and thickness and so on, as well as minimum and maximum scales of display. When the minimum and maximum scales of displays are defined, the geographical object can be viewed in between those scales, even though it always exists. If no minimum and maximum scales of displays are defined, then the object can be viewed every time without considering the scale of display.

Attribute data or in other words tabular data, is another basic component of GIS data structure, other than spatial data. Attribute data, which defines the characteristics of the each geographical object in GIS environment, are structured in database files. These database files contain tables, which are composed of *records* and *fields*. Each record refers to an entry of a spatial object and is defined by rows in a table. Whereas, each field refers to an aspect of that spatial object and is defined in columns.

In order to provide attribute data, which are stored and structured in tables, the tabular data structure is to be defined. Hence, fields, according to the aspects of the object necessary to be defined, are added to the table concerning each

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[47] Refer to Chapter 2.2.2.1. in which the origins and development of GIS are explained in detail.

[48] GeoMedia produced by Intergraph is an example of such softwares allowing composite data entry to a single geographical object, which corresponds to a single layer.

geographical object type. While adding each field, field properties are to be defined, which include the name of the field, data type of the field, width of the field, and the like.

Concerning the management of attribute data, there are various data models, such as flat data model, relational data model, hybrid data model, hierarchical data model, network data model[49]. Relational database model is the most common one used in GIS, also due to the fact that they allow easy integration of new data sets concerning the geographical objects. In a relational data model the attributes of geographical objects are grouped in different tables and they are related with each other with at least one common field. The relations between different tables can be in the form of one-to-one, many-to-one or one-to-many relations.

Knowing these main concepts and terms concerning a GIS environment, the main properties and functions of GIS can be better understood and utilized.

3.3.2. Main Properties and Functions of GIS

GIS have four main components / sub-systems[50] through which the collection, structuring, analysis, interpretation and presentation of spatially referenced data are provided:

- Data collection, entry and correction: the translation of raw or partially processed spatial data.
- Data storage, structuring and retrieval: the input of spatial data and structuring the database for efficient retrieval by the users
- Data manipulation and analysis: the data transformations for spatial analysis functions and queries internally while also by providing an interface between GIS and specialized spatial modeling systems.

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[49] For comprehensive definitions of these data models, the previously mentioned sources on GIS and database management and design mentioned in footnote 41 of this chapter should be referred to.

[50] There are different approaches to define GIS. One of the most common approaches is the 'systems approach' that defines GIS as a system composed of four main sub-systems (Marble 1990: 12). While others, who do not use the systems approach in describing GIS functions, also point out the similar four basic groups as features or components of GIS (Martin 1996: 57-58).

- Data visualization, output and reporting: the provision of views and outputs of processed, analyzed and queried data in different textual or graphical forms.

The main components / sub-systems of GIS are in accordance with the basic stages of GIS operations (figure 3.14). In a GIS operation the first stage is the data collection as a result of which raw data is provided. Then comes the data input stage. This stage can be the direct input of raw data into GIS. However, considering that GIS allow the utilization of data formed in other softwares, such as CAD softwares for spatial data or other DBMS for attribute data which are in some cases more advanced than GIS, the data input stage can be in two phases as the conversion of raw data into digital data followed by the conversion of digital data into GIS data model. After the data input stage as a result of which GIS data model is produced, the data manipulation stage comes in which various analysis through spatial and attribute data are achieved. The final stage in a GIS operation is the data output stage as a result of which the output data are provided for the end users.

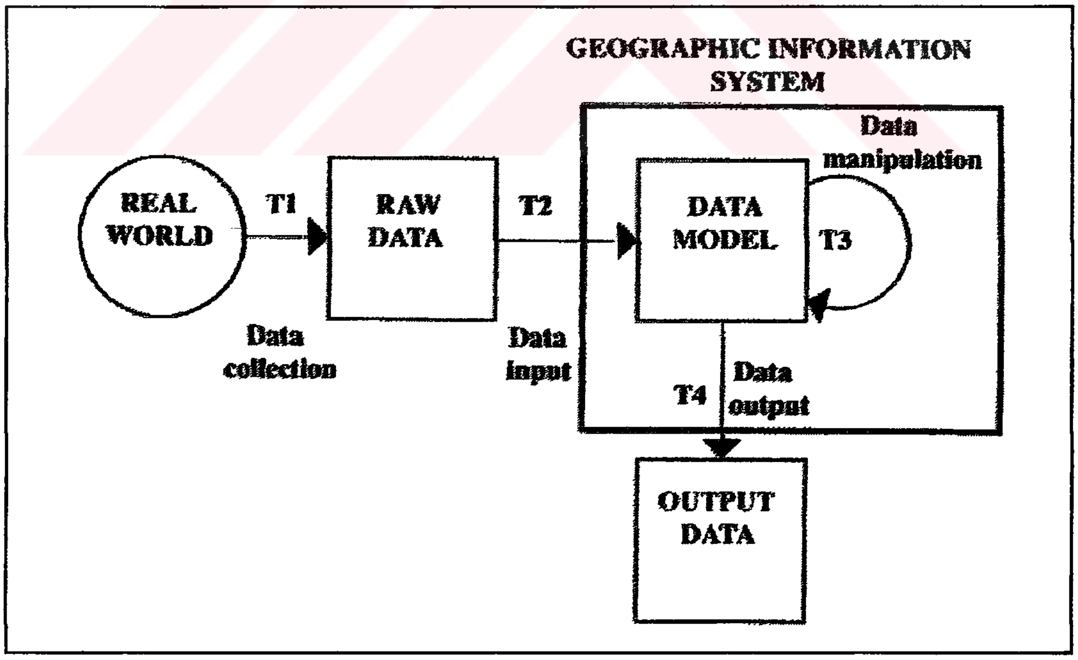

figure 3.14. David Martin's representation of the basic stages of GIS operations from a transformation-based view (from Martin 1996: 61).

Associated with the above-mentioned components of GIS, there are fundamental functions that GIS can perform so as to enable efficient data processing and analysis. These functions can be name basically as *measurement functions, re-classification functions, scalar operations, overlay operations, connectivity operations, and neighborhood operations.*

Measurement functions provide line, area and volumetric measurements. Re-classification functions provide *comparison operations* as equal to (=), greater than (>), less than (<), greater than or equal to (≥), less than or equal to (≤); *scalar operations* as addition, subtraction, multiplication, division and exponentiation. They also provide *overlay operations* through which the comparison and manipulation of spatial features in two or more layers are enabled so as to produce new regions in a new attribute layer. Overlay operations can be arithmetic overlay (+, -, x, /) or algebratic and statistical overlay (average / power / rank / minimum / maximum). There are *logical operations* based on Boolean Algebra as intersection (and), union (or), and complement (not). The *connectivity operations* provide proximity, buffering, spread and network analysis. Besides, there exist *neighborhood operations* in connection with *search operations*, and *point / line in polygon operations* which GIS analysis functions provide. Last but not least are the *surface operations*, which allow analysis through DEMs and DTMs such as viewshed analysis.

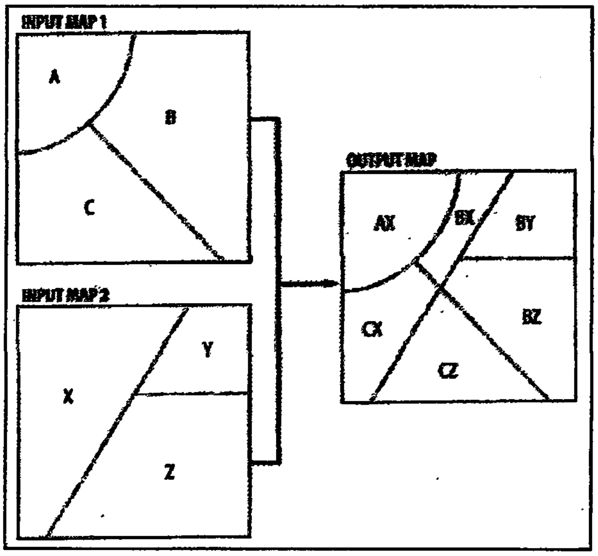

figure 3.15. Representation of a common overlay procedure for polygon data layers (from Malczewski 1999: 42).

Together with these properties and functions associated with the components of GIS, a variety of possibilities and advantages are provided while dealing with spatial data. Data collection, entry and correction feature of GIS allow working with different types and formats of data compiled from different sources. These can be either non-graphic attribute data or graphic data in different formats, scales and details, which are obtained from different sources and through different procedures. Different types of spatial data are entered to the system according to their exact geographical location in space and with the same coordinate system, which is called 'georeferencing'. The data entry is provided in 1/1 scale by using a measurement unit determined according to the requirements of the subject of concern. This brings about the unification of information coming from different scaled and detailed sources within the same environment.

Data storage, structuring and retrieval feature of provides the storage of geographically referenced spatial data in the system together with their attribute data sets stored in relational databases. Any information entered into the system is stored as a part of the whole in a structured way. The spatial data in GIS are structured by classifying them according to their characterization using complex groupings and the patterning of spatial and attribute characteristics for the purposes of management. The data classification is obtained through defining various thematic layers constituting of different spatial objects and their attribute data to make them easier to handle. The data classification is assigned by the user / designer of the system in order to provide the most efficient utilization of spatial data. Data storage, structuring and retrieval feature also allows easy revision and change of the existing data, as well as the entry of new ones whenever necessary.

Data Management and Analysis feature of GIS allows making analysis and evaluations by querying on the spatial data through their geographical and attribute data sets. Analysis function available on the system provides the necessary information using the available data. Hence, the quality of the information produced depends on the intelligent use of a systematic analysis approach. That is, appropriate set of questions and analysis methods can be specified depending on the answers that are to be provided. Associated with data management and analysis feature, is modeling property of GIS, which provides

3D models and predictive models. 'Digital Terrain Models' (DTM) and 'Digital Elevation Models' (DEM) allow working with 3-dimensional data for different analysis and evaluation purposes. Whereas, 'Predictive Models' are used to foresee what will happen or has happened in another location or at another point in time. They allow checking different alternatives that will occur in different circumstances.

Last but not least, is the data visualization, output and reporting feature of GIS through which raw and processed data can be generated in the desired scale, detail and format. Besides the graphic outputs of different phases of the study, it also allows the production of reports concerning different aspects of the subject and study.

3.4. Structure of the Proposed Method: Assessment of Historical Stratification with GIS

The aim of the proposed 'decision supporting study' is to assess the historical stratification in the towns with 'multi-layered' character so as to contribute the whole urban conservation management process. Within this framework, a method is proposed for the 'decision supporting study', which provides terminological, syntactic and structural standards for the assessment of historical stratification in multi-layered towns. It is a fact that, providing 'standards' for 'decision supporting study' does not mean that the proposed assessment method is unchangeable. The elements of analysis, information types and the structural scheme for ruling the relations amongst them can change according to the specifications of the layers and periods constituting the historical stratification and according to the requirements arising in different cases. The aim in defining the 'standards' is not to set up a rigid model but to provide a flexible method of assessment for the 'decision supporting study' on historical stratification in multi-layered towns.

The method of assessment is constructed considering the specifications of the multi-layered towns, the objectives of the 'decision supporting study' and the competences of GIS. Hence, dealing with 'multi-layeredness', elements of analysis, information types and GIS have been studied as the major issues for the constitution of the method.

The main structure of the method is majorly configured taking into account the common structure of the studies dealing with multi-layeredness in connection with the structure of GIS based studies. Accordingly, the major phases of the proposed assessment method are:

- Identification of layers, determination of stratigraphic units and their stratigraphic sequence
- Stratigraphic recording and representation:
    - Data collection, entry and correction
        - Collection and classification of raw data
        - Conversion of raw data into digital data
    - Data storage, structuring and retrieval: Constitution of GIS data model
        - Spatial data structure
        - Attribute data structure
- Stratigraphic correlation, analysis and evaluation: Data manipulation and analysis
- Presentation of results: Data visualization, output and reporting

3.4.1. Identification of Layers, Determination of the Stratigraphic Units and Stratigraphic Sequence

An overall review of the studies dealing with 'multi-layeredness' and the models for the representation of 'spatiotemporal data' reveals that the first phase in any kind of study related with 'multi-layeredness' is to determine the layers embraced by the subject of concern, the units based on those layers and the sequential relation between them.

In relation to the distinguishing features and the interfacial changes indicating the differentiation in the content, the 'layers' which are the distinct divisions referring to different time intervals are determined. Following this, either each single layer or two or more layers forming a group are assigned as the 'units' of the stratigraphical study according to the subject of concern. Along with the determination of the layers and units, the stratigraphic sequences and relative chronologies of layers and units are ascertained.

The first phase of the proposed assessment method is not different than the first phase of any stratigraphical study. Hence, the interfacial changes, which correspond to major events causing socio-economic and political changes reflected in the physical structure of the town, are determined. In between those interfacial changes are the main layers making up the historical stratification of the town. Departing from the major concern as 'conservation', the layers to be combined and considered as 'units' of the study are decided upon, considering also the quantity, complexity and composition of layers constituting the historical stratification as well as the level of detail aimed to be achieved. That is, the periods demonstrating discrete urban and architectural properties with respect to other layers necessitates to be indicated as separate units, whereas, those revealing similar urban and architectural properties with each other can be handled together as a single unit. The determination of layers within the historical stratification of the town and the units of the 'decision supporting study' should be accompanied by the determination of their stratigraphic sequence as a part of this first phase of the study (figure 3. 16)

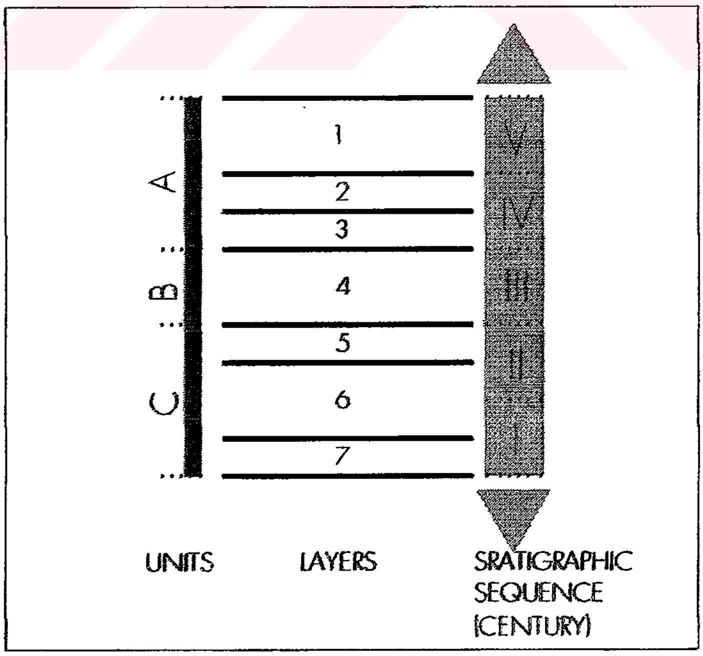

figure 3.16. The relation between 'units', 'layers' and their stratigraphic sequence.

3.4.2. Stratigraphic Recording and Representation

Stratigraphic recording and representation is the second phase of all the studies dealing with multi-layeredness. This phase of the study contend with the determination of 'spatiotemporal data' recording and representation method or model that is to be utilized as well as the elements of analysis and the types of information concerning them which are to be indicated for each unit.

The overall review of the models developed for the conception of time / space relationship as well as the stratigraphic record and representation methods utilized in different disciplines dealing with layers reveal that all of them are based on similar concepts and follow similar attitudes even though they are named differently. Among those various methods and models of recording and representation, the choice of the model or method to be utilized depends upon the requirements of the subject of concern and the objectives of the study.

Hence, in the choice of the method of documentation and representation in a 'decision supporting study' for the assessment of historical stratification in multi-layered towns, the objectives and the framework of the study should be considered. In such a study, the major objective is to provide information on historical stratification concerning the whole town together with each component of it so that this information can be utilized for the conservation and planning decisions and implementations in various scales. This necessitates the knowledge on the urban structure of each phase of the historical development process including the current situation separately as well as their relation with each other as a whole. Such an approach provides an equal evaluation of each of the different phases and prevents disregarding any trace of historical stratification free from its observability in the contemporary town. Therefore, the urban structure of each phase of the historical development process of the town needs to be documented and studied separately by the specialists of those phases, which will then come all together to form up the system, as previously mentioned while defining the organizational framework of the study[51].

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[51] See Chapter 2.3.

Considering all these aspects for the assessment of historical stratification in multi-layered towns, utilization of a plan-based method seems to be more advantageous than 'space-time cube model' or a section-based method, although they can accompany the main method to better represent the stratification more globally by 'space-time cube model' or more detailed at specific points by stratigraphic sections and diagrams.

The plan-based method or model to be utilized needs to provide easy handling of each phase separately. Therefore, 'sequent snapshots model', which reflect the state of layers at the interfaces directly, is found to be the most proper model for such a study. This is also why 'sequent snapshots model', is preferred more than other plan based models, such as 'base state amendments model' which necessitates to evaluate each state with respect to the previous one, in producing 'single context' or 'diachronic plans' in disciplines dealing with layers, although they are found to be disadvantageous due to their storage of redundant data in cartography and temporal GIS. Besides, 'sequent snapshots model' is also convenient with the basic approach and process of historical research, analysis and assessment defined in legal documents concerning conservation decision-making process in Turkey[52]. These documents indicate the necessity to equally handle the spatial development of monumental and civil edifices as well as the whole settlement beginning from the earliest known era till today, which sequence snapshots model allow to do so.

The 'space-time composite model', which is found to be the most enhanced model from the viewpoint of cartography and GIS based studies, in fact, cannot replace the 'sequent snapshots model' in studies dealing with layers. 'Space-time composite model' provides information about the final state of the stratification and needs to be based upon full information on each phase and their final situation, whereas 'sequence snapshots model' provides information about formations, transformations, continuities and discontinuities of constituents of different layers through historical development process and can be handled separately both during the compilation of data as well as their visualization,

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[52] Refer to Chapter 3.2.3. where the related parts of 'Technical Terms of References for the Preparation of Urban Conservation Plans' have been explained while defining 'information for decision-making in Turkey'.

analysis and evaluations. For such a study, 'space-time composite model' can be utilized in the representation of the evaluations produced through the overlay and analysis of the 'sequence snapshots', which is one of the end products of the study[53].

As a result, within the objectives and framework defined for the 'decision supporting study', the sequence snapshots model will be utilized for recording and representing the spatiotemporal data. The elements of analysis will be recorded and represented as they appear at the interface between the next stratigraphic unit for each unit of the study. That is, each of the element of analysis will be represented and recorded for each stratigraphic unit as long as it exists as an integral part of the urban form of that unit, regardless of being constructed in a previous period or not, and consequently, being represented in the previous stratigraphic units or not.

Departing from this basic decision as to the model to be utilized, it becomes possible to define the content of the stratigraphic recording and representation stage. Stratigraphic recording and representation is composed of two basic phases. First one is the data collection, entry and correction, and the second one is the data storage, structuring and retrieval.

3.4.2.1. Data Collection, Entry and Correction

While defining the framework of the 'decision supporting study', it has already been mentioned that the data collection and entry concerning each of the defined stratigraphic units will be carried on by the specialists of the period or periods forming up the stratigraphic unit[54]. Data collection, entry and correction has two major stages. Parallel to the basic stages of GIS operations[55], first one is the collection and classification of raw data, and the second one is the conversion of raw data into digital data.

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[53] This will be explained also in Chapter 3.4.3.

[54] Refer to Chapter 2.3.

[55] Basic stages of GIS operations were defined in Chapter 3.3.2. together with the representation by D. Martin in figure 3.14.

Accordingly, as the first stage, the data sources concerning each of the stratigraphic unit should be collected and classified separately. Data for such a study can be derived from different sources. These can be contemporary or historic visual sources, written sources, as well as written and visual sources.

Historic visual sources can be exemplified as historic maps, engravings, old pictures, drawings and photographs. Contemporary visual sources can be such sources as plans and projects, drawings produced during archaeological excavations, plans concerning different periods of the town, measured drawings, existing maps, contemporary photos, aerial photos and satellite images. Historic written sources cover archival sources such as town histories and books, whereas, contemporary written sources cover reports of plans and projects, reports of archaeological excavations, articles and books concerning different aspects of the urban form, and the like. There are also historic written and visual sources such as travelers' books and contemporary ones such as inventories. These sources can be extended according to the period and town in concern, and they can be better evaluated and defined by the specialists of the related periods of the town. Besides these major sources of data, site survey is always the most important data source concerning the existing situation of the elements of analysis belonging to different periods.

In the utilization of different types of sources, what is important is to give reference to the source and to indicate reliability of the source. It should always be considered whether the source provides direct information concerning the urban form and the elements of analysis or is an indirect source, which should be interpreted in view of other sources, and thus, handled with care.

Following the collection of raw data, is their conversion into digital data format. This can be realized by directly entering the data into GIS. However, as GIS are not as advanced as CAD softwares in drawing facilities[56] and as the proposed 'decision supporting study' necessitates producing detailed drawings, it seems more efficient to convert the raw data into digital data first by utilizing CAD softwares and then transferring them to GIS environment.

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[56] Refer to Chapter 2.2.1.

In any case, whether raw data is directly converted to GIS data or first converted into digital data in another software and then to GIS data, what is important in this phase is to classify the data according to the way they will be structured in GIS. Therefore, while creating the spatial data, first of all the elements of analysis concerning the existing situation of the town should be provided with the exact coordinates by utilizing the existing maps of the town, those are 1/25000, 1/5000 and 1/1000 maps for Turkey. Ensuing the conversion of the existing maps into digital format, the raw data concerning each of the stratigraphic units should be converted into digital data in reference to the existing situation separately. If there exist coordinates in the sources utilized, then these coordinates can be utilized. However in most of the cases, especially while dealing with historic sources, there are no coordinates and even sometimes no scale information. In that case the elements of analysis should be placed in reference to the existing maps.

For this 'decision supporting study', both vector and raster data formats are to be utilized during the data input process. The spatial data concerning the elements of analysis for different periods, which will be utilized for analysis and evaluations about historical stratification, are to be in vector format, as vector format provides more precise results[57]. Raster data format is primarily used for providing a basis for vector data entry during the digitizing process. It is also used to keep the original data source, especially the sources like aerial photos, satellite images and scanned images, so as to allow their visualization and comparison with the elements of analysis concerning different historic periods and the contemporary situation. However, it should not be forgotten that the major data format in defining the elements of analysis concerning different historic periods as well as the existing situation should always be in vector format.

The digital data input concerning the existing situation and historic periods by different specialized groups, is followed by compiling all so as to control and correct the possible errors and mismatching data between different layers. At the end of this stage, the major spatial data concerning both the existing situation and the different historic periods referring to stratigraphic units of the study will be provided in digital data format and will be interrelated with each other.

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[57] Comparison of raster and vector data formats as well as their advantages and disadvantages over each other have been defined previously in Chapter 3.3.1.

3.4.2.2. Data Storage, Structuring and Retrieval: Constitution of GIS Data Model

Data storage, structuring and retrieval is the phase in which the GIS data model of the 'decision supporting study' is set up. GIS data model comprises geographical objects, which are represented through spatial data in connection with attribute data. Each spatial data type corresponds with an element of analysis, which is represented as a single layer with a unique spatial object group definition in the GIS data structure.

In determining the GIS data structure of the 'decision supporting study', it is necessary to consider the requirements of both the spatiotemporal data representation model and the GIS data model together. Due to the selection of spatiotemporal data model to be utilized for this 'decision supporting study', which is 'sequence snapshots model', the elements of analysis concerning each of the stratigraphic units of the study necessitate to be recorded and represented separately. On the other hand GIS data structure necessitates handling each spatial data type, which corresponds to different elements of analysis types, as a separate layer.

Therefore, the data structure, which will be utilized for this 'decision supporting study', necessitates to be both time and object oriented. That is, in the GIS data model of this study, each element of analysis for each stratigraphic unit should be handled as a single layer (figure 3.17). The geographical objects belonging to each layer should be in vector data format. However for the necessary geographical objects in each layer a 'hyperlink' can be created to provide the connection with the related original scanned data, which are in raster data format.

The second constituent of the GIS data structure is the attribute data. As previously defined, attribute data are the descriptive data that are stored in tables concerning the geographical objects. Hence, for each layer representing a spatial data, the attribute data should be structured. Within the attribute data structure, each geographical object belonging to a layer is represented as a record, and each category of information is represented as a field.

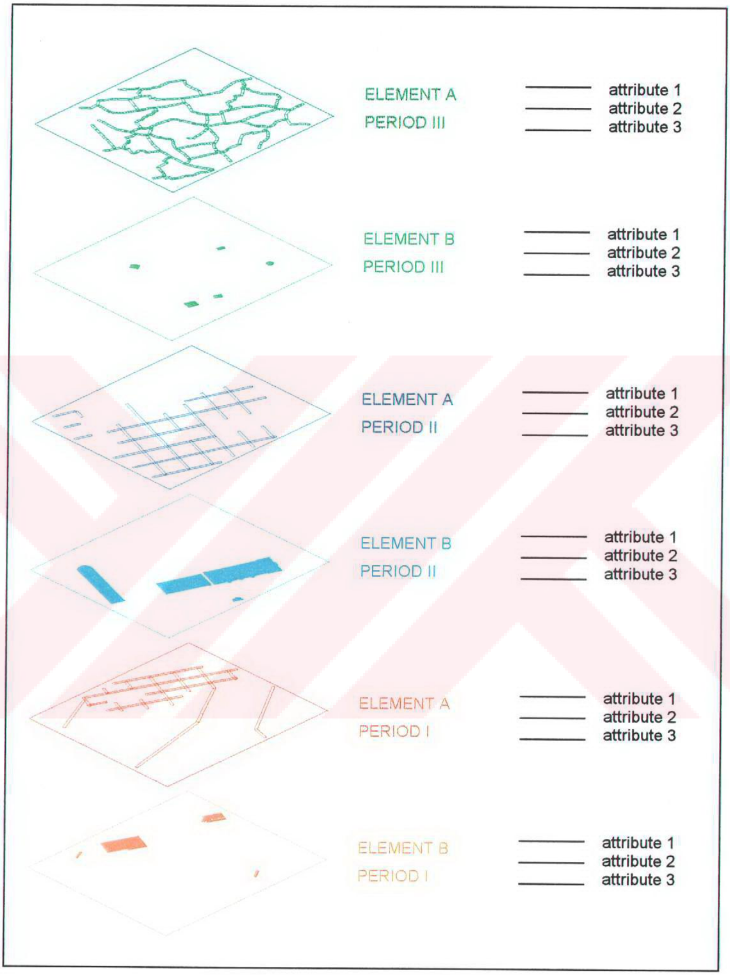

figure 3.17. Schematic representation of the 'object / time' oriented GIS data model of the proposed 'decision supporting study'.

Thereupon, for this 'decision supporting study', elements of analysis concerning each different stratigraphic unit refers to spatial data, whereas, the information types concerning each element of analysis refers to attribute data. That is, a table is structured for each element of analysis, in which the geographical objects belonging to that element of analysis, or in other words that layer, are represented as different records and the information types concerning each element of analysis are represented as the fields of the table.

According to the above-defined basic structural rules of the 'decision supporting study', GIS data structure comprising of spatial data, spatial object classes and attribute data are defined in the following tables (tables 3.4 - 3.12). As the elements of analysis and required information types differ for historic periods and existing situation, they are all defined in different tables. Besides, the elements of analysis and the related information types are also categorized in different groups according to the level of analysis, which can then be utilized in the determination of minimum and maximum display scales of the elements of analysis in those different groups. Following the determination of the spatial and attribute data structure of the 'decision supporting study', the study can be set up in the GIS environment. The first step in setting up the study is to start with a new and empty GIS project file and to define the projection type and map units of the study. After that, the digital data can be transferred according to the defined spatial and attribute data structure. Due to the utilization of the same projection system and coordinate system, all the layers created share the same geographical space with each other, and consequently, all the geographical objects belonging to various layers are geographically referenced with each other. Just like the vector formatted geographical objects of the project, the plan-based images related with the town, such as aerial photos, satellite images and various plans belonging to different periods, are all transferred into the system in raster format and are geographically referenced by utilizing either coordinates or reference points. Once the images in raster format are placed in their exact geographical position, they are saved in georeferenced file format, as a result of which they always carry the geographical coordinate information together with them. As a consequence of all these above-defined processes the GIS data model of the 'decision supporting study' is constituted and the system becomes ready for different data manipulation and analysis functions.

table 3.4. GIS data structure concerning topographical features to be represented in all levels of analysis.

	Spatial Data (Elements of Analysis)	Spatial Object Class	Attribute Data (Information Types)
TOPOGRAPHICAL FEATURES FOR ALL LEVELS OF ANALYSIS	contours	line	record no elevation sources of information
	slant	area	record no sources of information
	hill	point	record no name sources of information
	creek	area	record no sources of information
	river	area	record no name sources of information
	lake	area	record no name sources of information

table 3.5. GIS data structure concerning the existing situation to be represented in the level of territorial organization.

	Spatial Data (Elements of Analysis)	Spatial Object Class	Attribute Data (Information Types)
LEVEL OF TERRITORIAL ORGANIZATION	settlements	area	record no type town village farm etc. name sources of information
	territorial network	line	record no type main road secondary road railway etc. name sources of information

table 3.6. GIS data structure concerning the existing situation to be represented in the level of settlement layout organization.

	Spatial Data (Elements of Analysis)	Spatial Object Class	Attribute Data (Information Types)
LEVEL OF SETTLEMENT LAYOUT ORGANIZATION	settled area	area	record no type urban settlement area municipal area contiguous area archaeological area military area commercial center graveyard farm etc. name sources of information
	settled area boundary	line	record no type citywalls open edge city gates etc. name sources of information
	municipal area	area	record no sources of information
	adjacent area	area	record no sources of information
	'site'	area	type urban site archaeological site 1st, 2nd, 3rd degree archaeological sites urban archaeological site sources of information

table 3.7. GIS data structure concerning the existing situation to be represented in the level of intra-settlement organization.

LEVEL OF INTRA-SETTLEMENT ORGANIZATION	Spatial Data (Elements of Analysis)	Spatial Object Class	Attribute Data (Information Types)
	street axis	line	record no type main axis in urban composition secondary axis in urban composition angle sources of information
	street	area	record no type main street secondary street pedesterian street etc. name district sources of information
	block	area	record no block no district sources of information
	block outline	line	record no angle sources of information
	built-up area	area	record no block no district sources of information

table 3.8. GIS data structure concerning the existing situation to be represented in the level of building block organization.

	Spatial Data (Elements of Analysis)	Spatial Object Class	Attribute Data (Information Types)
LEVEL OF BUILDING BLOCK ORGANIZATION	edifices	area	record no
			built-up record no
			block no
			plot no
			district
			type
			building
			bridge
			fountain etc.
			name
			registration status
			inventory no
			number of floors
			number of basements
			sources of information
	plots	area	record no
			plot no
			owner
			sources of information
	remains	area	record no
			type
			name
			registration status
			inventory no
			sources of information
	remain zone	area	record no
			sources of information
	seperators	line	record no
			type
			wall
			fence
			barbed wire etc.
			sources of information

table 3.9. GIS data structure concerning the historic periods to be represented in the level of building territorial organization.

	Spatial Data (Elements of Analysis)	Spatial Object Class	Attribute Data (Information Types)
LEVEL OF TERRITORIAL ORGANIZATION	settlements	area	record no type town village farm etc. name period degree of knowledge on existence 1.factual 2. 3. 4. 5.hypothetical sources of information
	territorial network	line	record no type main road secondary road railway etc. name period degree of knowledge on existence 1.factual 2. 3. 4. 5.hypothetical sources of information

table 3.10. GIS data structure concerning the historic periods to be represented in the level of settlement layout organization.

	Spatial Data (Elements of Analysis)	Spatial Object Class	Attribute Data (Information Types)
LEVEL OF SETTLEMENT LAYOUT ORGANIZATION	settled area extent	area	record no type urban settlement peripheral settlement akropolis commercial center necropolis tumuli graveyard farm etc. name period degree of knowledge on existence 1.factual 2. 3. 4. 5.hypothetical state of survival 1.intense remains reflecting a homogeneous tissue 2.moderate remains reflecting a heterogeneous tissue 3.sparse remains with no tissue character 4.gap 5.unknown state of survival position and perception 1.overground - visible 2.over & underground - partially visible 3.underground - not visible sources of information
	settled area boundary	line	record no type citywalls open edge city gates etc. name period date degree of knowledge on existence 1.factual 2. 3. 4. 5.hypothetical state of survival 1.whole / intact 2.part of a whole 3.remain 4.gap 5.unknown state of survival position and perception 1.overground - visible 2.over & underground - partially visible 3.underground - not visible minimum altimetry maximum altimetry sources of information

table 3.11. GIS data structure concerning the historic periods to be represented in the level of intra-settlement organization.

	Spatial Data (Elements of Analysis)	Spatial Object Class	Attribute Data (Information Types)
LEVEL OF INTRA-SETTLEMENT ORGANIZATION	street axis	line	record no type main axis in urban composition secondary axis in urban composition period degree of knowledge on existence 1.factual 2. 3. 4. 5.hypothetical angle sources of information
	street	area	record no type main street secondary street name period degree of knowledge on existence 1.factual 2. 3. 4. 5.hypothetical state of survival 1.whole / intact 2.part of a whole 3.remain 4.gap 5.unknown state of survival position and perception 1.overground - visible 2.over & underground - partially visible 3.underground - not visible sources of information
	block	area	record no period degree of knowledge on existence 1.factual 2. 3. 4. 5.hypothetical sources of information
	block outline	line	record no period degree of knowledge on existence 1.factual 2. 3. 4. 5.hypothetical angle sources of information

table 3.12. GIS data structure concerning the historic periods to be represented in the level of building block organization.

	Spatial Data (Elements of Analysis)	Spatial Object Class	Attribute Data (Information Types)
LEVEL OF BUILDING BLOCK ORGANIZATION	edifices	area	record no type building bridge fountain etc. name period date degree of knowledge on existence 1.factual 2. 3. 4. 5.hypothetical state of survival 1.whole / intact 2.part of a whole 3.remain 4.gap 5.unknown state of survival position and perception 1.overground - visible 2.over & underground - partially visible 3.underground - not visible minimum altimetry maximum altimetry sources of information
	plots	area	record no plot no owner period degree of knowledge on existence 1.factual 2. 3. 4. 5.hypothetical sources of information

3.4.3. Stratigraphic Correlation, Analysis and Evaluation: Data Manipulation and Analysis

Just like in all the studies related with stratigraphy, for the 'decision supporting study' on the assessment of historical stratification in multi-layered towns, the stratigraphic recording and representation is followed by stratigraphic correlation, analysis and evaluations.

Stratigraphic correlation is the natural outcome of the GIS data structure in which all the spatial data concerning different elements of different periods share the common geographical space. Hence, as the first stage of data manipulation and analysis, through the superimposition of different layers, the geographical objects of different periods are visualized in combination with each other. The stratigraphic correlation allows the analysis of formations, transformations, continuities and discontinuities of different aspects and constituents of layers.

In accordance with the 'object / time' oriented GIS data model of the 'decision supporting study', different stratigraphic correlations can be obtained from the spatial data. First type of stratigraphic correlations which can be achieved as an outcome of such a GIS data model is the 'time' oriented correlation of spatial data. In this type of correlation different elements of analysis belonging to the same period range defined as a stratigraphic unit are correlated with each other. Through such a correlation, the urban form of the town in a selected period can be provided. Hence, by making such a correlation to all the determined stratigraphic units of the study, 'sequence snapshots model' of the multi-layered town is achieved (figure 3.18).

Another type of stratigraphic correlation is 'object' oriented correlation of spatial data. In this type of stratigraphic correlation the same elements of analysis in different periods are correlated with each other. Accordingly, the formations, transformations and disappearences concerning the same elements of analysis through various periods within the historical development process of the multi-layered town can be visualized and analyzed as a result of such a stratigraphic correlation (figure 3.19).

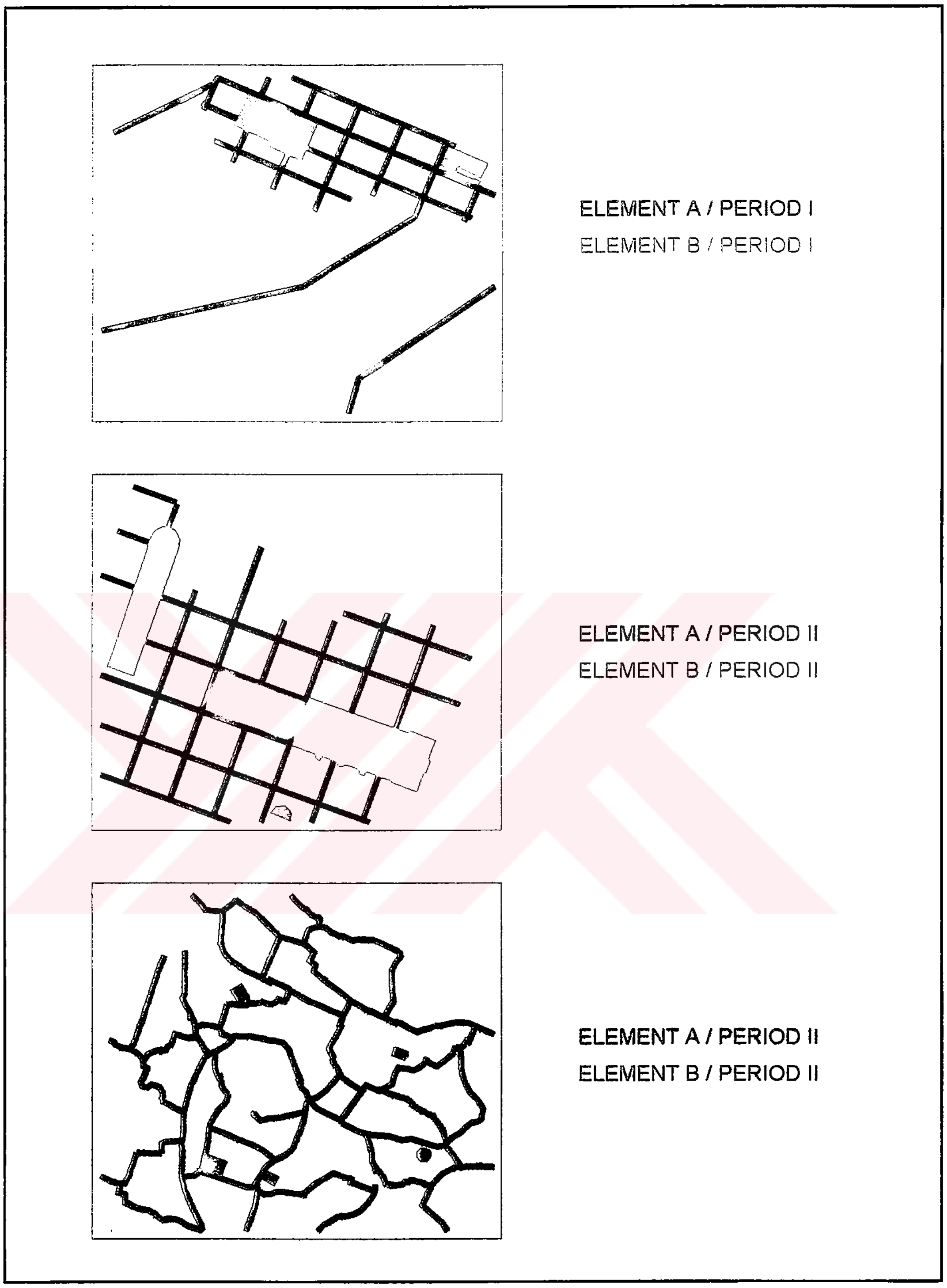

figure 3.18. 'Time' oriented correlation of spatial data, which allows the visualization of different elements of analysis belonging to the same period. As a consequence, 'sequence snapshots model' of the multi-layered town is provided.

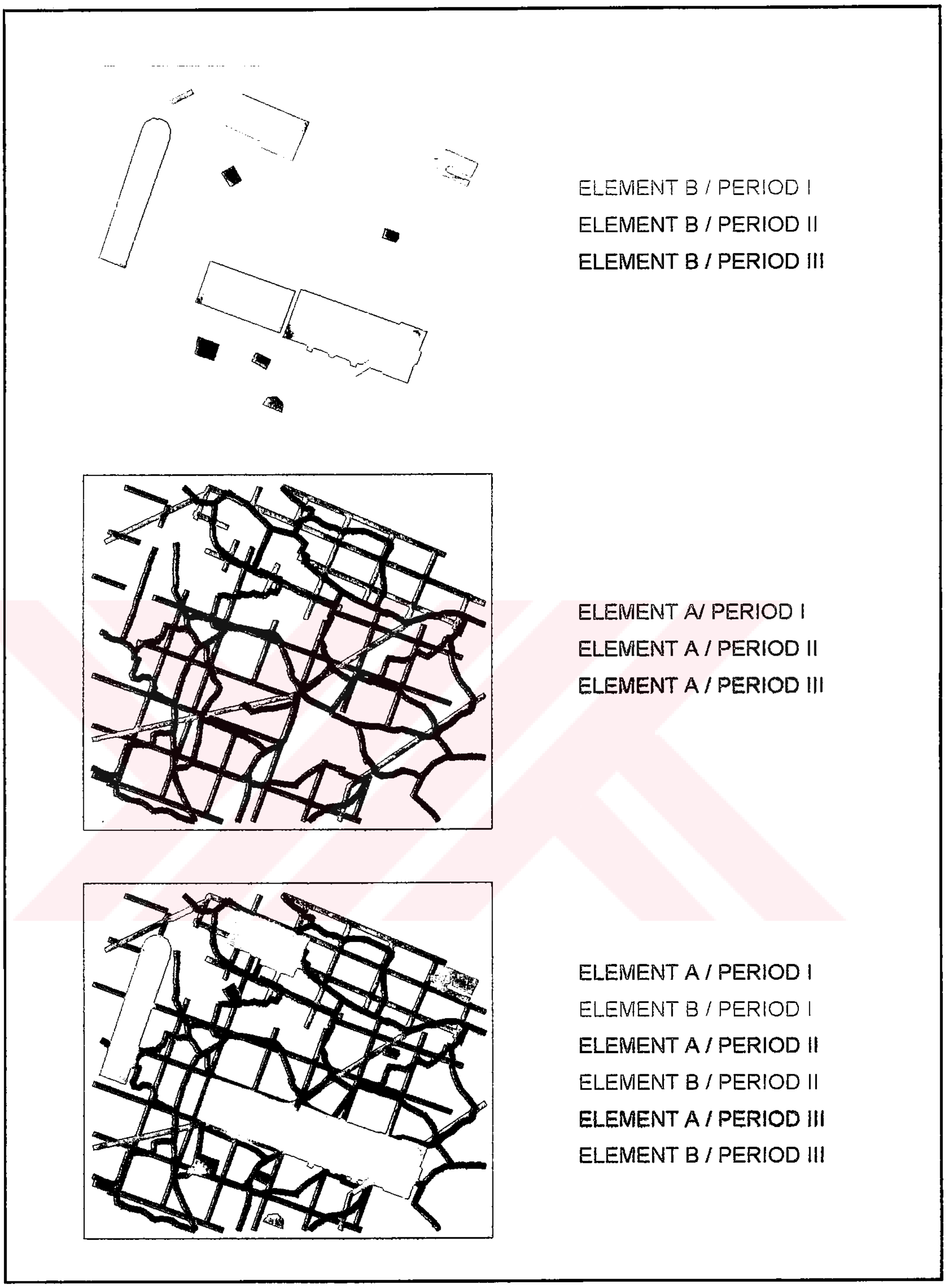

figure 3.19. 'Object' oriented correlation of spatial data, which allows the visualization of the same elements of analysis in different periods. Through this correlation it is possible to analyze the formations, transformations and disappearences concerning the same elements of analysis through the historical development process. It is also possible to provide'object / time' oriented correlation of spatial data, which allows altogether visualization of different elements in different periods.

Last but not least, stratigraphic correlation of spatial data also provides the visualization of all / some of the elements of analysis belonging to all / some of the stratigraphic units according to the requirements of the case and the needs of the end users of the 'decision supporting study'. Accordingly, it becomes possible to provide 'object / time' oriented correlation of spatial data, which allows altogether visualization of different elements in different periods.

Besides the stratigraphic correlations, which mainly provides the visualization of different spatial objects in relation with each other, stratigraphic analysis is one of the most important stages, in which various analysis are made through the spatial objects as well as the attribute data. At this phase, major data analysis and manipulation functions of GIS are used in order to achieve the destined information required for assessing historical stratification.

'Revealing sensitivity' and 'resolving continuity' have already been defined among the primary objectives of the proposed 'decision supporting study'. Hence, this study necessitates to provide 'information for characterizing historical stratification' by assessing sensitivity, material and trace continuity in different levels of geographical space through different analysis functions of GIS. At that point, major operations of data analysis and manipulation function of GIS are to be made use of in achieving the destined information. Accordingly, overlay, connectivity, neighborhood, comparison and search operations are chosen to be carried out among various other operations of GIS.

The overlay operation, as previously mentioned, allows the intersection of two different layers as a result of which a third layer is produced. During the overlay operation, not only the spatial data are overlaid with each other in a new layer, but also their attribute data are combined with each other to form up the attribute data of that new layer. Hence, this operation helps for revealing sensitivity concerning various elements of analysis in different levels of geographical space.

The primary overlay operation is realized through the overlay of settled areas of different periods so that at the end of this operation the zones, which have passed through different historic periods, are provided. As a result of this overlay operation, different sensitivity areas of different combiations of historical stratification are provided. The resultant of this operation contributes to the information for characterizing historical stratification as well as information for decision-making for 'site' designations.

In the same manner, overlay operation is used for other elements making up the urban tissue so so as to analyze sensitivity and continuity concemig them. Accordingly, axes in urban composition of stratigraphic units and edifices belonging to different historical strata have been subject of analysis.

Besides the overlay operation, comparison and search operations are used for resolving trace and sensitivity in the urban form. Therefore, analysis of angles of street axes and block outlines are carried on over the attribute data that stores the angle information. By comparing the angles of street axes and block outlines of different periods, and consequently, by selecting the similar angles of existing street axis and block outlines information concerning trace continuities within the existing urban form are achieved. This information also gives clues about the sensitivity areas within the town, where there is no visible stratification exists but there is the possibility of invisible or underground stratification.

Last but not least, are the connectivity and neighborhood operations, which necessitates to be carried on as a part of the data manipulation and analysis phase. Proximity and buffering provided through connectivity operations are followed by neighborhood operations in connection with search operations so that the features of the existing urban form which fall into the nearby surrounding of materially existing elements or sensitivity areas of different historical units are determined. The results of this analysis are to be considered during various levels of the conservation decision-making process, which includes the decisions of conservation councils, conservation plans and projects as well as the decisions and interventions of the local authorities within the multi-layered town.

In addition to the above-mentioned major analysis, various spatial and attribute analysis can be carried on according to the requirements of the case in concern or the demands of the end users of the 'decision supporting study'.

3.4.4. Presentation of Results: Data Visualization, Output and Reporting

The final stage of the 'decision supporting study' is the presentation of results for the end users. The results of the study can be presented in different formats. First choice is to provide the users the data in digital format and so allow them to carry on the analysis according to their needs. Especially the partakers of the project such as the ministry, local authority and the academic institution should be able to carry on different analysis and visualize the GIS data according to their needs. The most important point in such a shared utilization is to control that the data are not changed by different users. This is possible in most of the GIS softwares. As a consequence of such a presentation, the GIS data can be shared and visualized by different users through the web, which is a commonly discussed and enhancing issue.

Another way of presenting the results is providing hard copies of the resultant analysis and evaluations in different scales and details. This kind of presentation is more proper if the end user will not be producing additional analysis or if the end user is not authorized to visualize the whole data without control. This is the most common and the easiest way of presenting the results of the 'decision supporting study'.

Finally, there comes the production of reports out of the results of analysis. This kind of a presentation is utilized especially when the results of the study are to be represented briefly to the end users. The last two presentation types can accompany each other so as to provide a more extensive representation of the results of the 'decision supporting study'.

CHAPTER 4

APPLICATION AND EVALUATION OF THE METHOD AND THE TOOL ON THE CASE OF BERGAMA

Bergama has been subject to continuous habitation since the early ages onwards like most of the towns in Anatolia. This continuous habitation is known to date back to Prehistoric ages, but the material remains of this historical continuity are still visible, or at least traceable to an extent, since Geometric and Archaic Eras onwards[1], within the contemporary urban form of Bergama. Similar to continuous habitation, Bergama has almost always been a subject of continuous research by many scholars from different disciplines for more than a century. Bergama has been an appealing site for travelers since 1250s onwards. This interest on Bergama has been converted into a scientific research subject since 1870s onwards beginning with the first archaeological studies under the responsibility of Carl Humann (Radt 2002: 11-14). Since then, the scientific researches concerning Bergama have increased in number as well as extended to comprise other disciplinary areas including history of art and architecture and, more recently, planning[2]. The results of those interests in Bergama have been transformed into scientific information and documents. Correspondingly, these researches encompass almost all the periods within the historical development process of the town, and the resultant scientific information and documents elucidate the urban form of Bergama with respect to those historical periods.

Bergama has been chosen as an appropriate case to appraise the proposed assessment method for the 'decision supporting study' on historical stratification in multi-layered towns. The above-mentioned peculiarities justify the choice of

[1] For further information refer to (Radt 2002: 21-23).
[2] For further information concerning the research tradition in Bergama refer to (AVP XV2 1991: 3-6) and (Radt 2002: 307-328).

Bergama as a representative subject for this kind of a study. Another distinguishing aspect of Bergama to be chosen as a case among other similar multi-layered towns is its appropriate scale, which makes it controllable in order not to exceed the initial scope and limits of the study. This maintains the provision of instant feedback to testify and develop the method further.

Besides the above-mentioned factors, that Bergama has been studied by the author as mentioned previously[3], supplies a foundation in terms of extensive scientific data and knowledge about Bergama. For that very reason, the rest of this chapter will focus on the application of the proposed assessment method onto the case rather than the detailed description of the case.

4.1. Application of the Proposed Method for the Assessment of Historical Stratification in Bergama

This study aims at constituting a 'decision supporting study' for the assessment of historical stratification in Bergama with the intention to allow conscious integration of information on historical stratification to the conservation decisions and interventions so as to sustain its 'multi-layered character'. Considering the importance of dynamism / flexibility, integrity and continuity in 'decision supporting studies', this study is tried to be configured to provide these basic properties both with its method as well as with its major tool, GIS.

Computer technology played an important role in the realization of the study. As to the hardwares, personal computers (PCs), CD-RW, A4 and A0 scanners, A3 printer and A0 plotter are made use of. The major system properties of the PCs utilized are Pentium III – 750 with 250 MB RAM, 20 GB HDD, 16 MB Graphic Card. The accomplishment of the study necessitated the utilization of various softwares among which GIS played the major role. The major softwares utilized are *Adobe Photoshop 5.0*, *AutoCAD R14*, and *ArcViewGIS 3.2*.

Such a 'decision supporting study' on the assessment of historical stratification in Bergama, necessitates to be realized within an organizational framework described in Chapter 2 while following the method proposed in Chapter 3. However, within the limitations of this thesis, it is not possible to provide a multi-disciplinary team composed of specialists of different subjects and different

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[3] Refer to Chapter 1, footnote 2.

aspects of Bergama. The multi-disciplinary character of the study have been tried to be achieved by consulting different specialists concerning GIS as well as different periods and aspects of the case when necessary. As a consequence, the whole study has been realized by the author of the thesis keeping always in mind that it should have been realized by a multi-discipinary and specialized team.

4.1.1. Identification of Layers, Determination of the Stratigraphic Units and Stratigraphic Sequence in Bergama

The first phase of the assessment method proposed for the 'decision supporting study' on historical stratification in Bergama has been determination of layers, units and their sequential relation with each other. According to the interfacial changes, which correspond to major events causing socio-economic and political changes reflected in the physical structure of the town, and according to the major periods defined for Bergama in literature, the layers in historical stratification of Bergama are determined. Following the determination of layers, the major units of the 'decision supporting study' are decided upon according to the divergences and similarities of the urban and architectural properties. The determination of layers within the historical stratification of the town and the units of the 'decision supporting study' on Bergama are accompanied by the determination of their stratigraphic sequence as a part of this first phase of the study.

The inhabitation in Bergama is told to be dating back to prehistoric eras in some of the sources, even though it has not yet been proved archaeologically. The earliest proved existence of settlement had been during Archaic and Classical eras, which is known due to the remains of the city walls as well as written sources. However there is not much information about the urban form of the town in those periods. It is only after the 3rd century B.C. onwards that data about the urban form and its components become available. Bergama starts to be a very important city together with the declaration of the city as the capital of Pergamon Kingdom in 3rd century B.C. 2nd century B.C. had been another important period as the city of Pergamon started to extend during this period with the construction of new city walls and new monuments. This extension lasted till the 1st century B.C. when the city was donated to Roman Empire. During the 1st century B.C. there had been much difference neither in the urban structure nor in the administrative structure of the town although the city was legally unified with

Rome. However, beginning from 1st century A.D., the dominance of Rome had started to be felt and Pergamon became one of the important provinces of Rome in Asia. As a consequence, new building activities continued in the city in 1st century A.D. and reached its greatest development in the 2nd century A.D. At the end of 2nd century A.D. the city was expanding outside the 2nd century B.C. city walls over the valley with many of the monumental structures besides preserving and using the walled part and Acropolis. In the 3rd century A.D., owing to the acceptance of Christianity, the walled part of the city and Acropolis started to be desolated and destroyed as they accommodated the temples of Godless periods. In 306, Constantinople was declared as the capital of Byzantium and Christianity had been accepted as the legal religion of the Empire. These showed their effects in Bergama and in its urban form, resulting in the beginning of a new period for the town. Even though Bergama preserved its importance in its region as a Bishopric, its center was reduced to the Acropolis and lost its urban form physically, turning into scattered settlements. This period lasted with many outer attacks and natural disasters till the end of 13th century. At the end of the 13th century, Bergama society started to be muslimised and at the beginning of 14th century the reign of Turks and Karesi Principality started. During this period new Muslim city of Bergama had been established as a town with quite a different urban form with its center at the riverbank. The reign of Karesi Principality lasted quite short till the town was joined to the Ottoman sovereignty in 1330. Bergama as a relatively important urban center under Ottoman reign, extended as a new Ottoman city in the valley section. There had been many construction activities in Bergama during this period as a result of which many important monumental structures have been built. This period lasted till the establishment of Turkish Republic in 1923. After 1923, although the main structure of the city shaped during the Ottoman reign did not change at all, the city continued to extend towards South and Southwest directions with an increasing acceleration.

The above-mentioned main events, which have occurred during the historical development process of Bergama, had been important turning points in determining the main layers forming up the historical stratification of the town commonly utilized by many scholars.

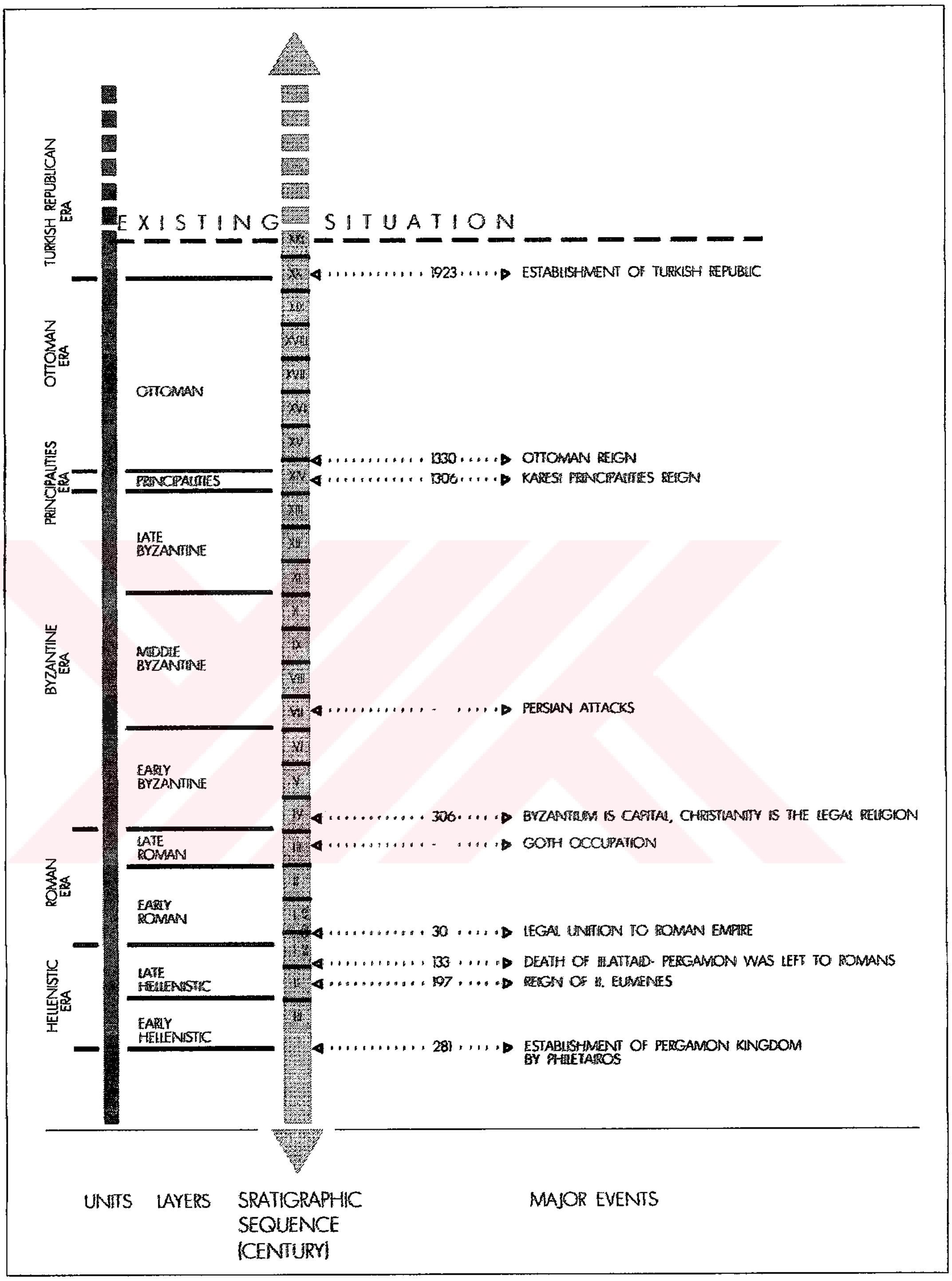

figure 4.1. The major events, layers and units in relation to stratigraphic sequence in Bergama

In the common literature on Bergama, 3rd century B.C. is defined as the Early Hellenistic Era, 2nd century B.C. as the Late Hellenistic Era, the period between 1st century B.C. and 2nd century A.D. as Early Roman Era, and 3rd century A.D. as Late Roman Era. The period between 4th - 6th centuries is generally named as Early Byzantine Era, 7th - 10th centuries as Middle Byzantine Era, and 11th - 13th centuries as the Late Byzantine Era. The period between 1300 and 1330 is the Principalities Era, even though in some of the documents this period is underestimated and included within the Ottoman Era. The period between 1330 and 1923 is the Ottoman Era. Finally is the Turkish Republican Era, which has been lasting since 1923.

While defining the stratigraphic units of the 'decision supporting study', the divergences and similarities in the general urban form of the town had been an important factor. Besides, the rarity of material remains and traces belonging to a layer has also been considered as an important factor in order not to cause the melting of these very few material remains in such a conservation oriented study and consequently in the conservation decisions based on this study. Therefore, more than the extent of period, its contribution to the urban form has been considered as the basic criteria in defining the stratigraphic units of the study. Accordingly the major units for this 'decision supporting study' on the assessment of historical stratification in Bergama are defined as Hellenistic Era, Roman Era, Byzantine Era, Principalities Era, Ottoman Era and Turkish Republican Era reflected by the existing situation of the town (figure 4.1).

4.1.2. Stratigraphic Recording and Representation

Following the decision on the stratigraphic units of the study, the stratigraphic recording and representation phase starts[4]. The stratigraphic recording and representation constituted of two major stages as the stage of data collection, entry and correction and the stage of data storage structuring and retrieval.

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[4] As mentioned previously, this phase of the study necessitates to be carried on by the specialists of periods forming up the stratigraphic units of the study. However, for this thesis such an organizational scheme is not possible. Hence, the stratigraphic recording and representation for each of the unit is carried on separately by the author of this thesis.

4.1.2.1. Data Collection, Entry and Correction

Data collection, entry and correction have been carried on in two stages as collection and classification of raw data and conversion of raw data into digital data. The collection and classification of raw data concerning the different historic periods as well as the existing situation of the town has also been realized in two stages. The first stage had been the collection of raw data from various publications and documents concerning different periods of the town. For this, an extensive literature and archival survey had been carried on so as to provide data concerning the urban form of Bergama in different periods[5].

The data concerning the urban form of Bergama in different periods are not homogeneous in both quantity and context. The major data sources about the Hellenistic and Roman Pergamon are the results of archaeological excavations and researches carried by the German archaeologists, which have been lasting since the 19th century onwards. Consequently, there are a lot of data concerning the urban form in these periods, which are also unified and interpreted altogether so as to provide more compact information together with the lately prepared studies about the urban structure of Hellenistic and Roman Pergamon by Dr. Ulrike Wulf-Rheidt and Prof. Dr. Wolfgang Radt.

The major data sources pertaining to the Byzantine era are also the results of archaeological excavations and researches carried by German archaeologists. However, they are relatively recent and as a consequence, the data concerning the urban form of Byzantine era Pergamon are not as extensive as those concerning the Hellenistic and Roman eras.

Among all the periods within the historical continuity of Bergama, Principalities era is the most disadvantaged one with respect to the data sources. As a result of both not being studied at all and not being conserved materially, there are very few documents or existing remains belonging to this period from which data about the urban structure of Bergama in Principalities era can be provided. Hence the major data source for Principalities era becomes the site survey.

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[5] See Appendix B for the list of major documents providing the raw data for the case study on Bergama.

table 4.1. Major types of sources utilized in 'decision supporting study' on the assessment of historical startification in Bergama together with the information as to whether they provide direct or indirect information concerning different periods of Bergama.

	Visual Sources														Written Sources							Written and Visual Sources		
	Historic					Contemporary									Historic			Contemporary				Historic	Contemporary	
PERIODS	Historic Maps	Engravings	Pictures	Drawings	Photographs	Plans and Projects	Drawings of Archaeological Excavations	Plans Concerning Different	Measured Drawings	Pictures	Photographs	Existing Maps	Aerial Photos	Satellite Images	Archival Sources	Town Histories	Books	Reports of Plans and Projects	Reports of Archaeological Excavations	Articles	Books	Travellers' Books	Thesis	Inventories
HELLENISTIC	I	I	X	I	I	D	D	D	D	I	D	D	D	D	I	X	I	D	D	D	D	I	D	D
ROMAN	I	I	X	I	I	D	D	D	D	I	D	D	D	D	I	X	I	D	D	D	D	I	D	D
BYZANTINE	X	I	X	I	I	D	D	D	D	I	D	D	D	D	I	X	I	D	D	D	D	I	D	D
PRINCIPALITIES	X	X	X	X	X	X	X	X	D	X	D	D	D	D	I	X	X	D	X	X	X	I	X	D
OTTOMAN	I	I	I	I	I	D	X	D	D	I	D	D	D	D	I	I	I	D	X	D	D	I	D	D
TURKISH REPUBLICAN	X	X	X	X	X	D	X	D	D	I	D	D	D	D	X	X	X	D	X	D	D	X	D	D

The data sources about the Ottoman period in Bergama are quite extensive including a variety of historic and contemporary visual and written sources as well as site survey. Among those various data sources, most of the historical and contemporary documents and studies provide data about single structures that are mainly the monumental buildings such as mosques, khans, and market places, whereas the data concerning the more modest components of the urban tissue are relatively few. Hence, it becomes difficult to provide data concerning the whole Ottoman urban tissue from those documents. At that point, the existence of a 1904 map of the city prepared by German cartographer Otto Berlet becomes the major document, which provides most of the data about the urban tissue of this era (AVP I 1913). The rest of the data concerning the urban tissue and its more modest components come from the site survey owing to the still standing structures belonging to this period.

After determining the major data sources regarding different periods within the historical continuity of Bergama, collected sources had been classified according to the period or periods about which they provide information and they are specified according to whether they can be used directly or they need be interpreted and utilized with care (table 4.1).

The collection of raw data was followed by the site survey in Bergama. The main objective of the site survey was to update the main features of the existing maps of Bergama dating from 1960, which have not been revised since then. Another objective was to document the historical stratification that can be observed within the contemporary town as much as possible. According to these main objectives, the traces and remains referring to the historical stratification in Bergama has been documented through the observations and survey in the whole town. Besides, in a smaller zone, that is Red Hall and its near surrounding which have been selected as the zone of maximum stratification, the data concerning the existing situation and remains belonging to different historical strata have been documented and revised. By the literature and archival survey as well as the site survey in Bergama, the raw data collection phase of the 'decision supporting study' has been concluded. This was followed by the classification of the raw data according to the defined units of the study.

The second stage of data collection, entry and correction has been the conversion of raw data into digital data. For this, first of all, all the visual raw data sources have been transferred into the computer environment by scanning. After the scanning process, the scanned images have been transferred as raster image into AutoCAD R14, which is the software chosen for digital data production, and they are converted into vector format by on-screen digitizing. The digital data production has been carried on primarily for the existing situation of the town through the different scaled existing maps. For this, first of all the existing maps have been digitized as separate files and then integrated with each other to obtain a single existing map for the whole town by utilizing the coordinates on the maps. By this way a digital map of Bergama was obtained, which is the combination of 1/1000, 1/5000 and 1/25000 maps reflecting the existing situation.

After the production of the digital existing map of Bergama, raw data concerning different periods have been converted into digital format in AutoCAD. During the digital data production concerning different historic periods, all the raw data sources are digitized separately as separate files first, which are then united with each other, and in reference to the existing situation, according to the determined stratigraphic units so as to cover all the required elements of analysis. At the end of this stage, a single file for each of the stratigraphic units has been obtained. Finally, those separate files for separate units of the study are also combined with each other and with the existing situation, so as to control the correctness of all the spatial data with respect to each other.

During the whole 'data collection, entry and correction phase', the major problem was the unification of raw data for each of the stratigraphic units as they were derived from various sources differing in accuracy and detail. The lack of the previously defined 'essential team work' for the 'decision supporting study' showed its reflection as the difficulties in interpreting various documents providing inconsistent data on the same subject, which required the opinion of specialists. Although this problem was tried to overcome by consulting the specialists from time to time, there can be still some errors in the spatial data produced at the end of this phase. From then on, these possible errors are tried to be minimized by defining the degree of knowledge as attribute data associating the spatial data in the GIS data model in the following phases of the study.

4.1.2.2. Data Storage, Structuring and Retrieval: Constitution of GIS Data Model

The second stage of stratigraphic recording and representation is the constitution of the GIS data model for the 'decision supporting study'. During this stage the digital data produced in AutoCAD are converted into GIS data structure by utilizing ArcView 3.2. The spatial and attribute data concerning the GIS data structure explained in Chapter 3 (tables 3.4 - 3.12) have been directly utilized for the case of Bergama. However, since the data concerning each phase of the town are not homogeneous, all the determined elements of analysis could not be specified for each period. In any case, as GIS provides a flexible and integratable environment, the missing data do not mischief the 'decision supporting study' and they are supposed to be completed in time.

The previously determined spatial data referring to elements of analysis, which have been also used as AutoCAD layers, are transferred to GIS *project file (.apr)* as *shape files (.shp)* in connection with *database files (.dbs)*, and are added to the *views* as separate layers called *themes* in ArcView. Different *views* are created so as to classify the *themes* in main groups as topographical features, elements of analysis relecting the existing situation and those reflecting the urban form of different historic periods. In different views containing different *themes*, the *legend* properties are defined for each theme, by the help of which the color, line type, symbpl, and hatching can be assigned. Meanwhile, the *theme* properties, which also include minimum and maximum *display scales*, are defined. This property helps to classify different elements of analysis according to the different levels of geographical space (figures 4.2, 4.3, 4.4, 4.5). Afterwards, for each of the *themes,* attribute data tables are structured by adding and defining the necessary *fields* according to previously determined information types. Following this, the attribute data entry is made for each geographical object as different *records* (figure 4.6). Besides the spatial objects in vector format, images in raster format are also transferred to the system. These raster images are either added to the views according to their correct geographical position and saved in georeferenced file format (figure 4.7) or a *hyperlink* is created with the related spatial object which allows the visualization of the raster image each time it is called with hyperlink tool (figure 4.8).

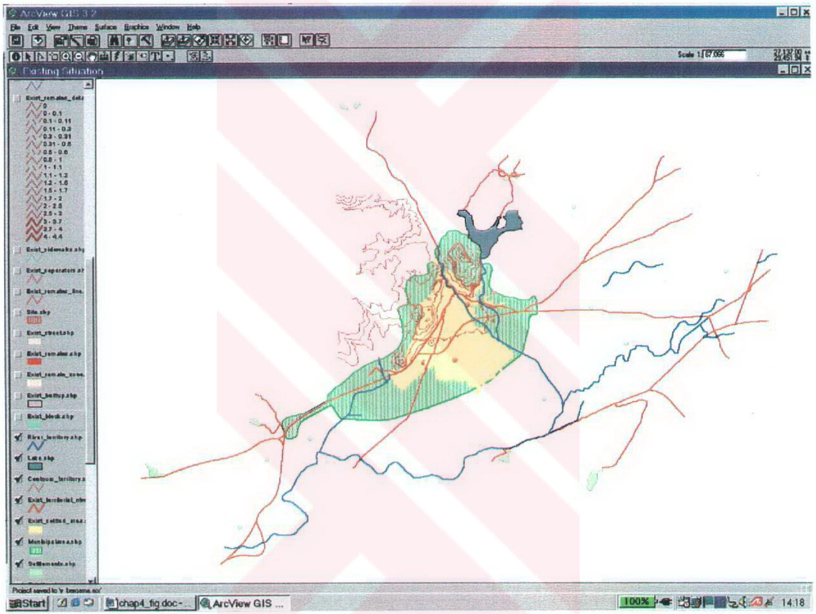

figure 4..2. Existing situation of Bergama at the level of territorial organization.

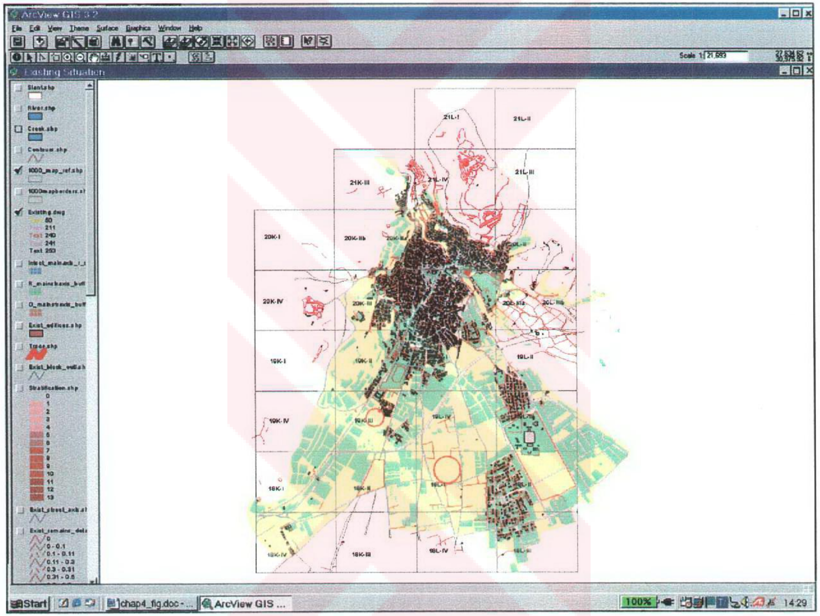

figure 4.3. Existing situation of Bergama at the level of settlement layout organization.

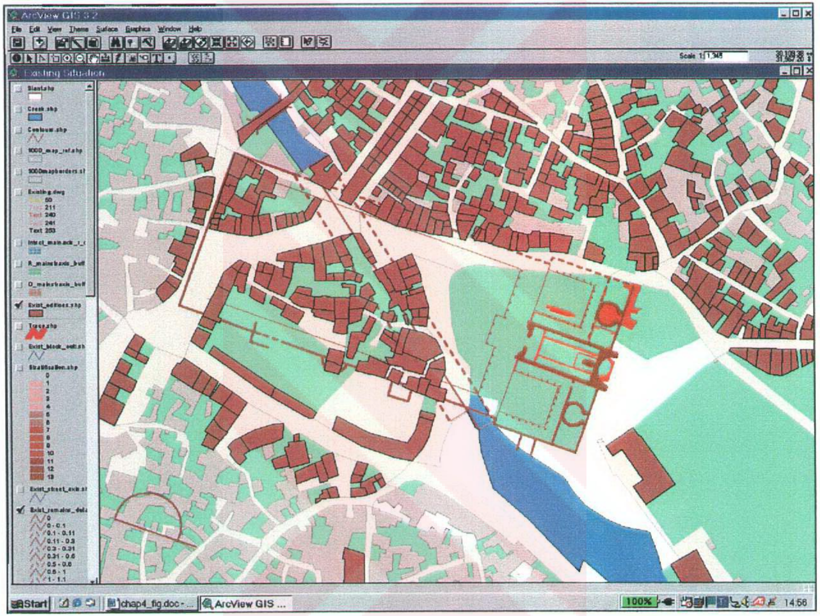

figure 4.4. Existing situation of Bergama at the level of intra-settlement organization.

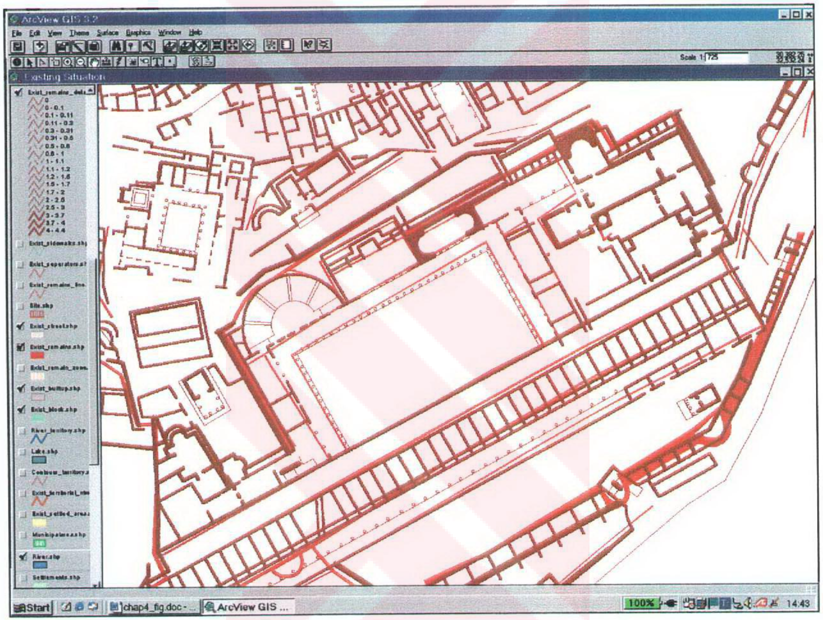

figure 4.5. Existing situation of Bergama at the level of building block organization.

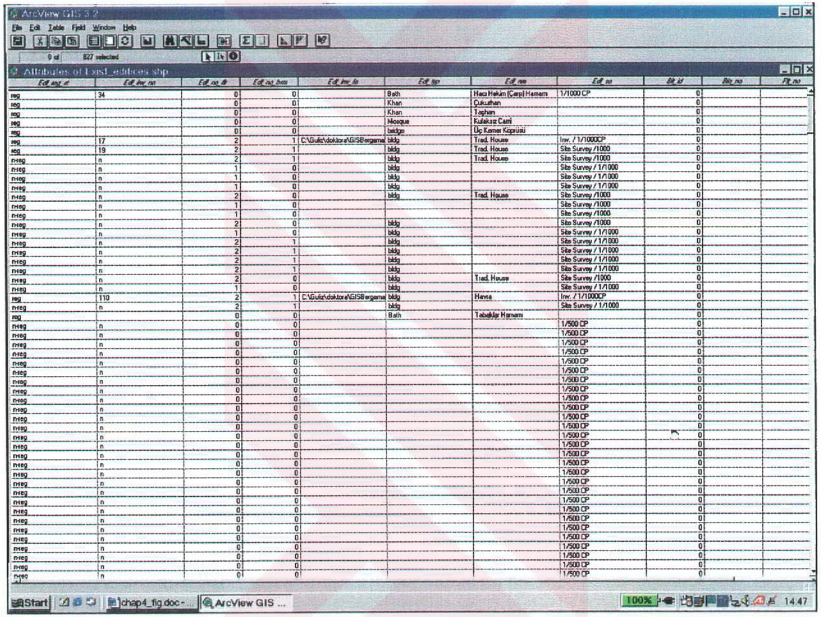

figure 4.6. Attribute table of existing edifices.

figure 4.7. Visualization of 1904 plan of Bergama, as georeferenced raster image,together with the existing urban form.

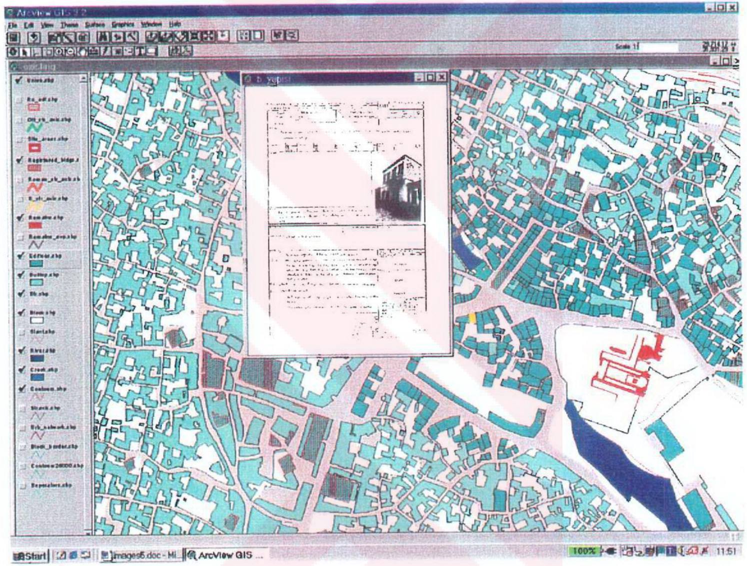

figure 4.8. Visualization of an inventory form, in raster format, hyperlinked with the registered builging it belongs to.

4.1.3. Stratigraphic Correlation, Analysis and Evaluation: Data Manipulation and Analysis

Stratigraphic correlation, analysis and evaluations ensue the establishment of the GIS data model. The analysis are shaped according to the major objective of the study, which is to support the conservation decision-making process by determining the historical stratification of urban form and components belonging to different periods within Bergama and by comparing the relation of the historical stratification with the existing conservation decisions concerning the town.

The produced 'object / time oriented' GIS data model for Bergama directly allows stratigraphic correlation as all the spatial data related to the existing situation and historic periods share the same geographical space. In accordance with the sequence snapshots spatio-temporal data model, which was found to be the most compatible model with this study, 'time' oriented correlation of spatial data provided the visualization of the elements of analysis constituting the urban form of the town during Hellenistic, Roman, Byzantine, Principalities and Ottoman eras seperately (figures 4.9, 4.10, 4.11, 4.12, 4.13). Whereas, 'object' oriented correlation of spatial data allowed the visualization of the same elements of analysis in different periods are correlated with each other (figure 4.14).

Similar to 2-dimensional plan-based visualization, 3-dimensional stratigraphic correlations have also been produced through the 'digital terrain model' (DTM) of Bergama. DTM of the town has been produced through the elevations of the contour lines, which is then visualized with different covarages (figure 4.15). Accordingly, the spatial data concerning the different periods of Bergama covered DTM, as a result of which analyzing and evaluating the historical development process of the urban form through the 3-dimensional model of Bergama have been possible (figures 4.16 - 4.20). In addition to vectoral covarages, DTM has also been covered with the aerial photographs of Bergama and 3-dimensional aerial photo of the town is obtained. This 3-dimensional aerial photo model is also covered with spatial data concerning different periods of the town, as a result of which the 3-dimensional visualization and stratigraphic correlation of the urban form of different periods in relation with the existing situation and the topography have been possible (figures 4.18 - 4.22).

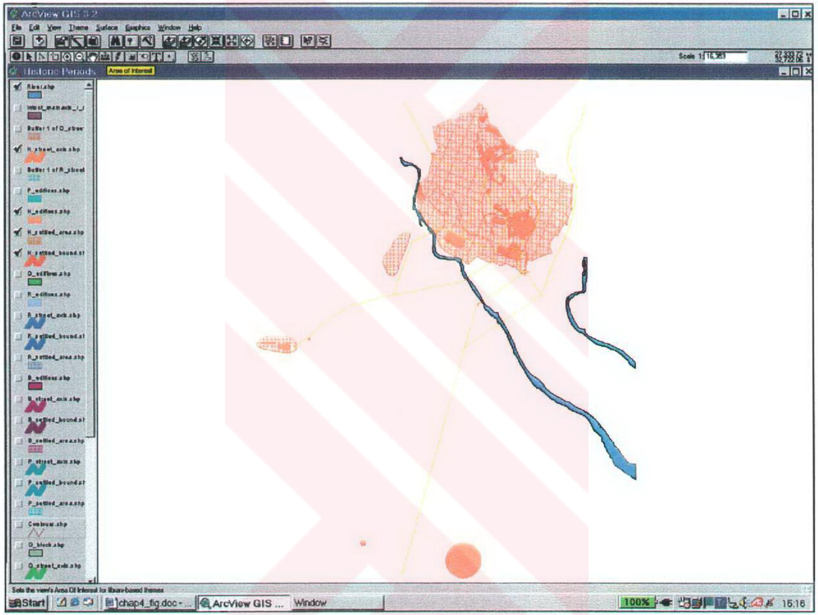

figure 4.9. 'Time' oriented stratigraphic correlation showing the major elements of analysis concerning the Hellenistic era.

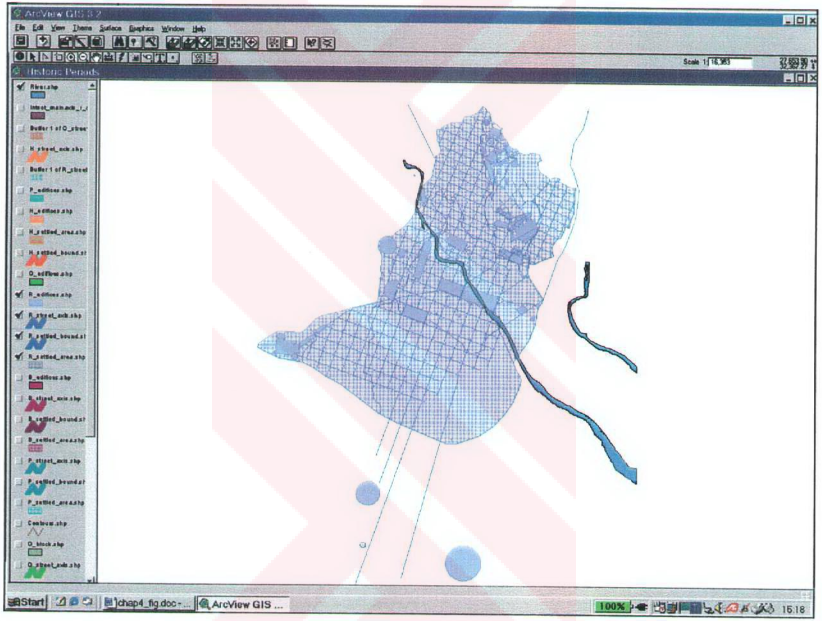

figure 4.10. 'Time' oriented stratigraphic correlation showing the major elements of analysis concerning the Roman era.

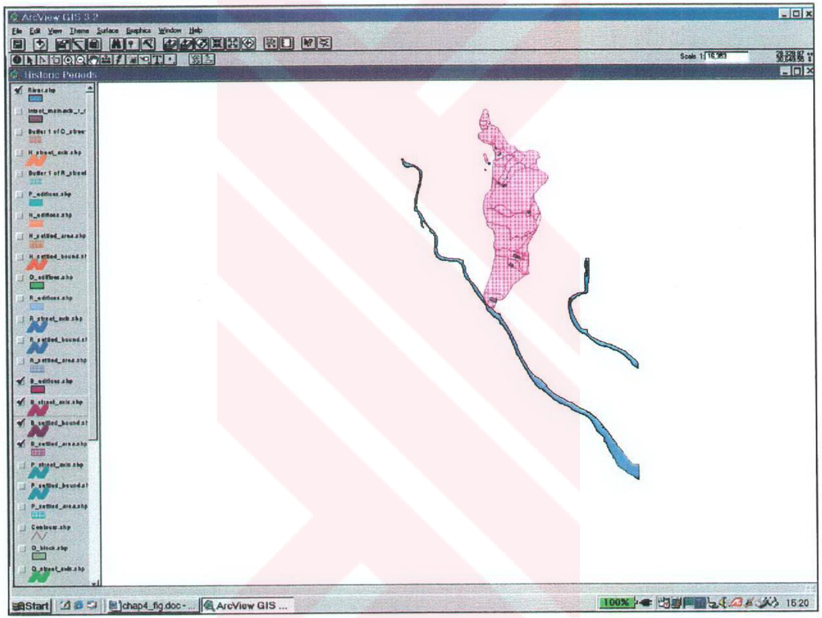

figure 4.11. ‘Time’ oriented stratigraphic correlation showing the major elements of analysis concerning the Byzantine era.

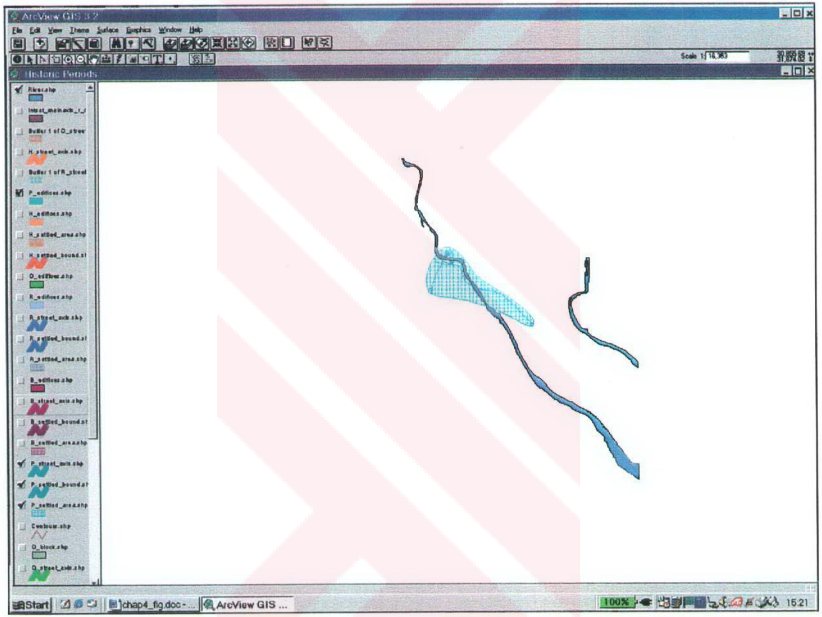

figure 4.12. 'Time' oriented stratigraphic correlation showing the major elements of analysis concerning the Principalities era.

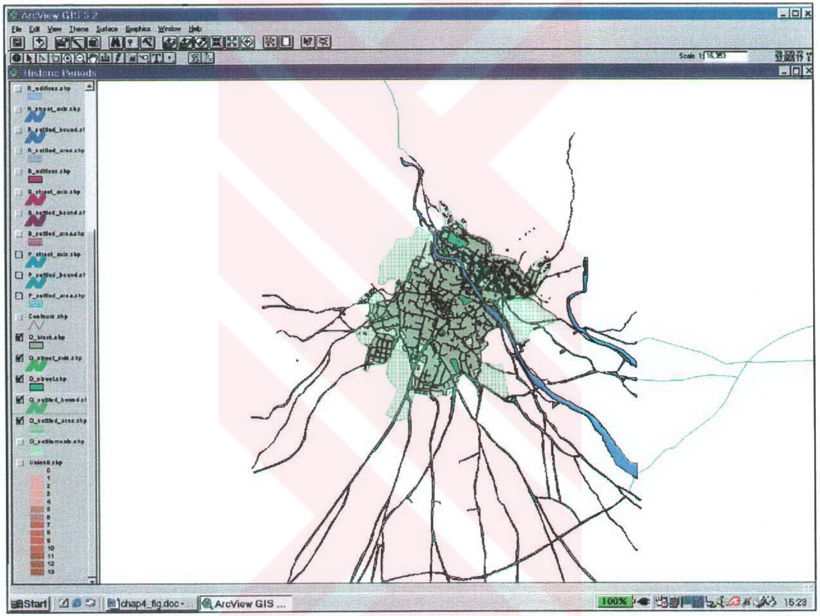

figure 4.13. 'Time' oriented stratigraphic correlation showing the major elements of analysis concerning the Ottoman era.

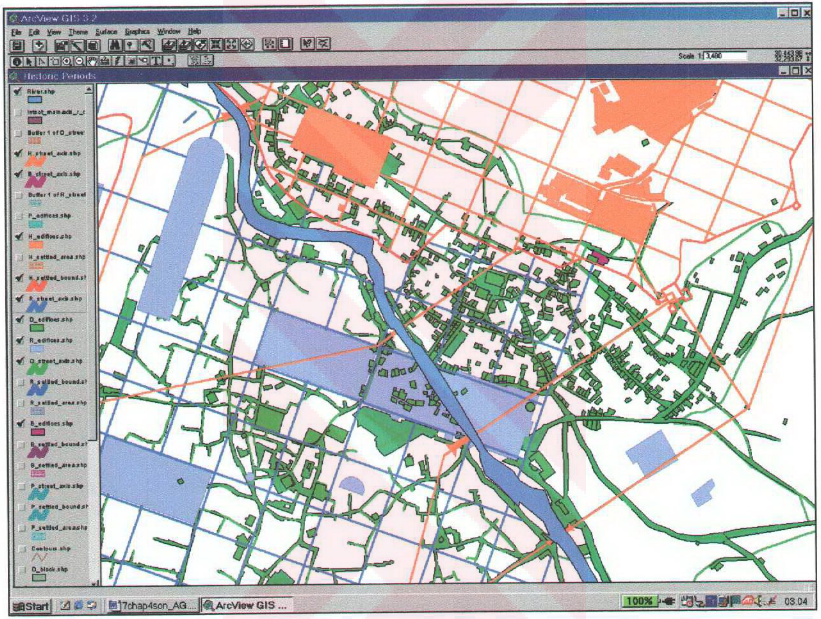

figure 4.14. 'Object' oriented stratigraphic correlation showing street axes and edifices in all the defined stratigraphic units in Bergama.

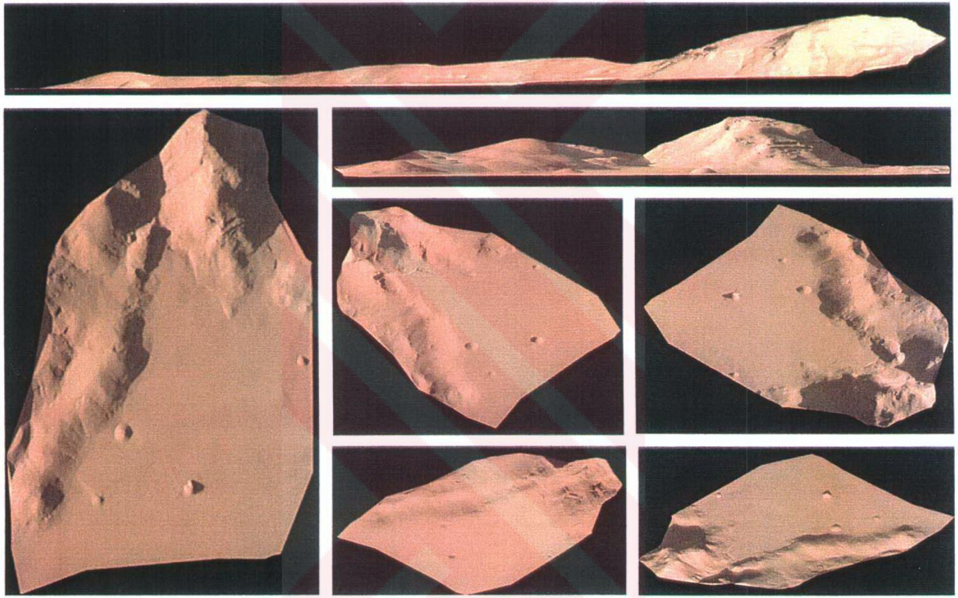

figure 4.15. DTM of Bergama from different view points.

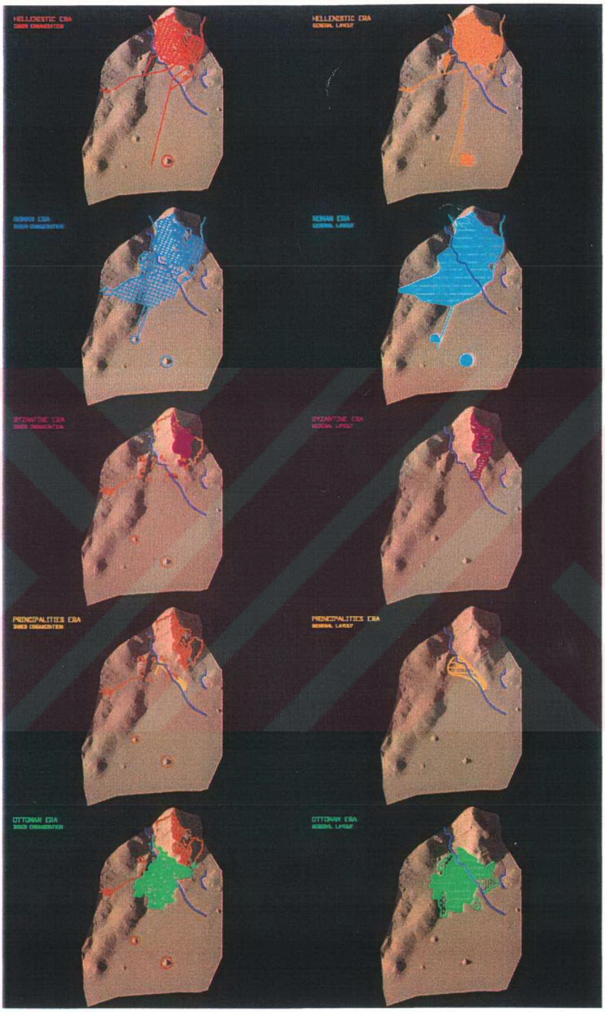

figure 4.16. DTM of Bergama covered with elements of analysis in settlement layout organization and intra-settlement organization levels in different eras.

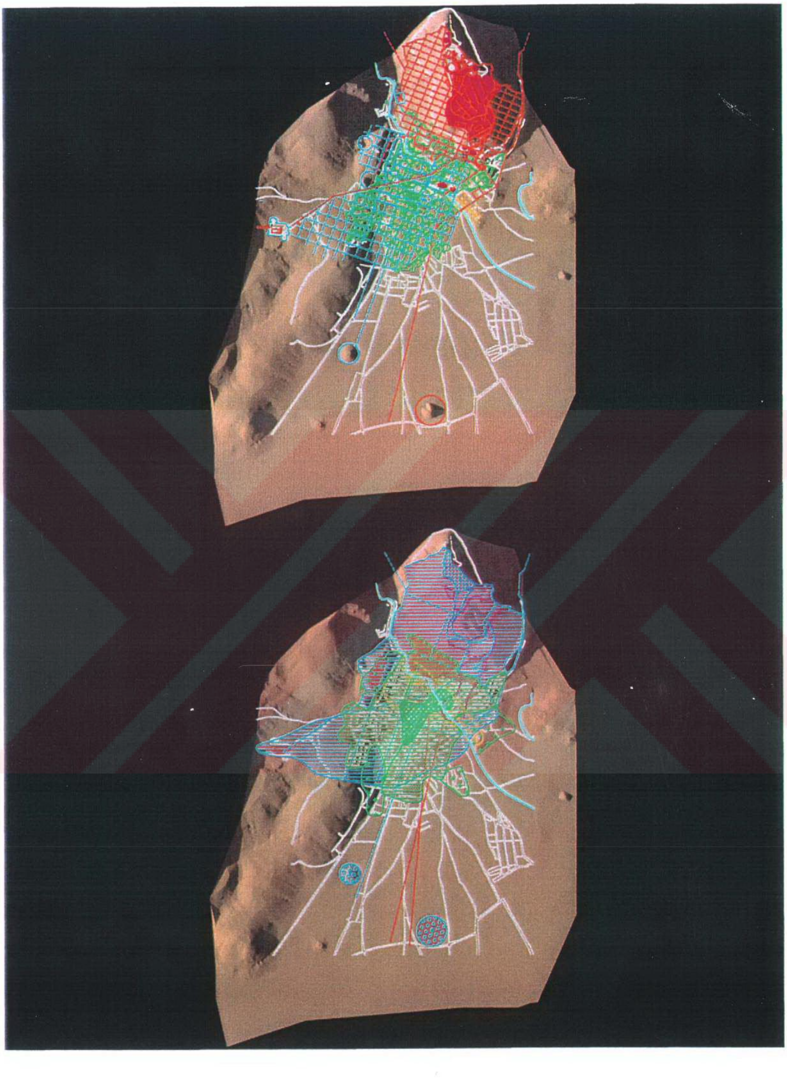

figure 4.17. DTM of Bergama covered with object and time oriented stratigraphic correlation in settlement layout organization and intra-settlement organization levels.

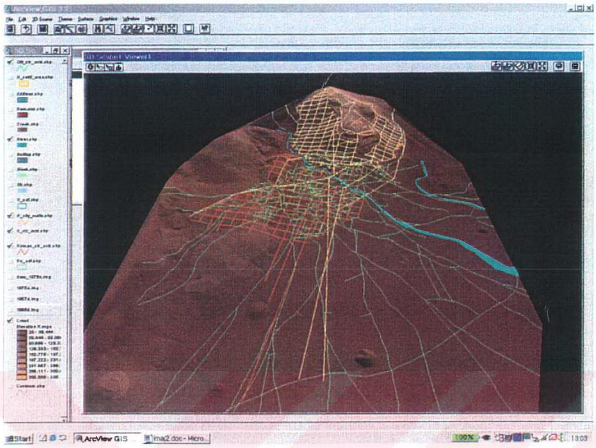

figure 4.18. DTM of Bergama covered with street axes of Hellenistic, Roman, Byzantine, Principalities and Ottoman eras.

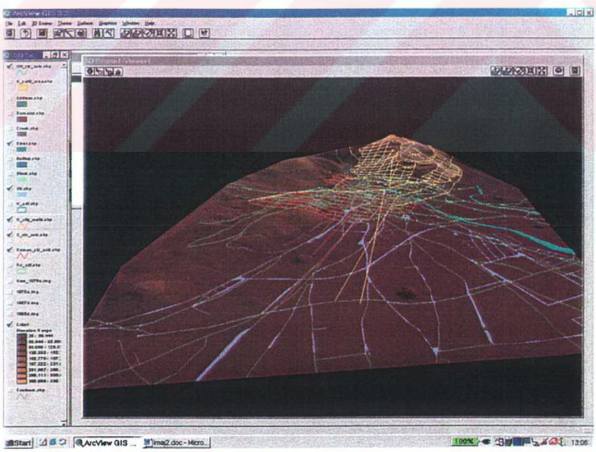

figure 4.19. DTM of Bergama covered with street axes of different historic periods and existing situation.

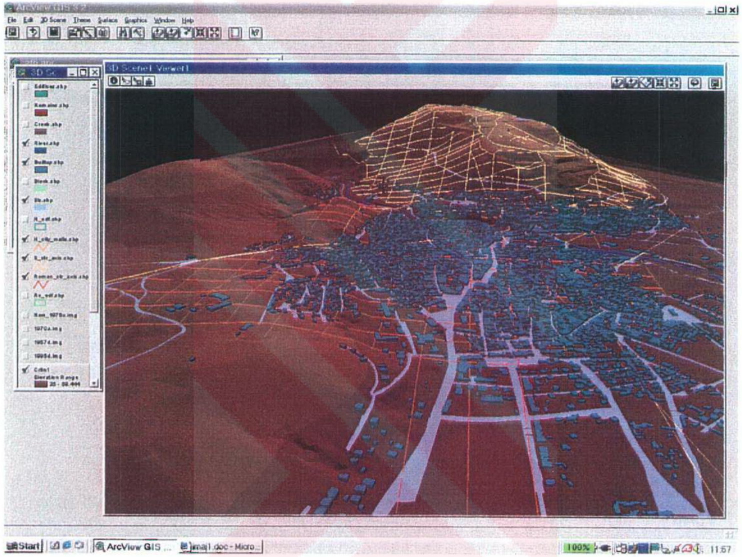

figure 4.20. DTM of Bergama covered with existing streets and built-up areas and street axes of Hellenistic, Roman and Ottoman eras.

figure 4.21. DTM of Bergama with 1995 aerial photo covarage.

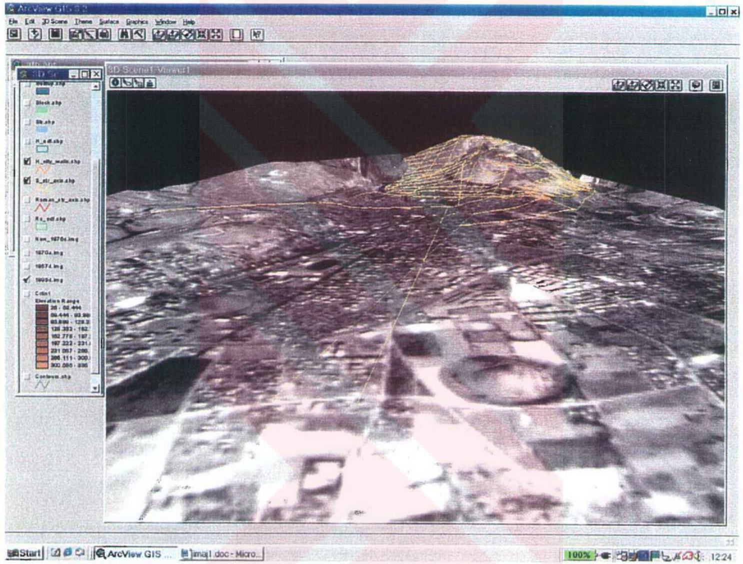

figure 4.22. DTM of Bergama with 1995 aerial photo covarage together with Hellenistic intra-settlement organization.

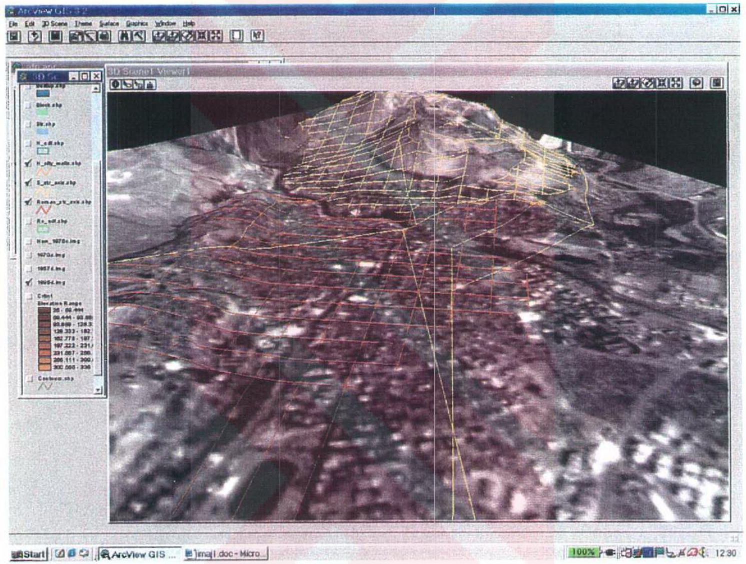

figure 4.23. DTM of Bergama with 1995 aerial photo covarage together with Hellenistic and Roman intra-settlement organization.

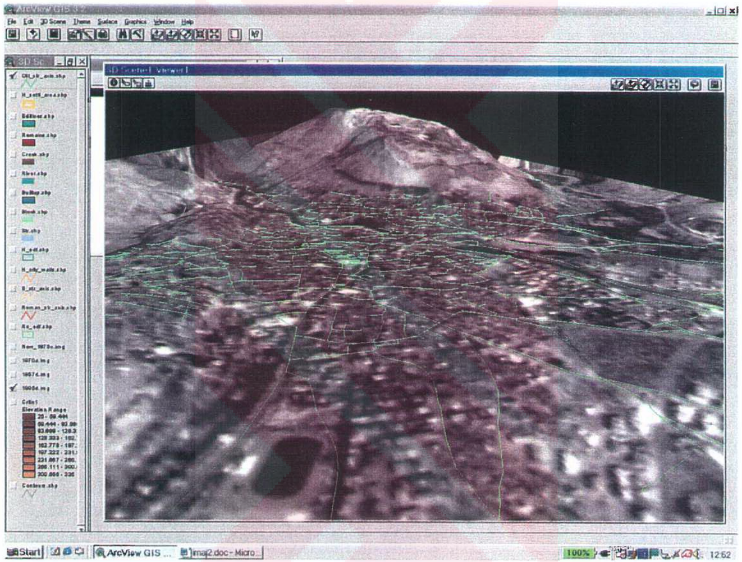

figure 4.24. DTM of Bergama with 1995 aerial photo covarage together with Ottoman intra-settlement organization.

Following the spatial correlation of spatial data and their visualization in various combinations, stratigraphic analysis are realized through the spatial objects and their attribute data by using data analysis and manipulation functions of GIS.

The first group of the spatial analyses is carried on by using overlay operation. As a first step, overlay of settled areas of different periods are made, at the end of which different zones with different stratification and different degrees of knowledge on existence, state of survival, and position and perception are provided (figure 4.25). As the result of the overlay operation, a new data layer is obtained, which includes the attribute data of all the overlaid themes. This operation is repeated for other components of the urban form including the edifices and street axis (figures 4.26, 4.27). After that, both the settled area and the components belonging to the urban form of different historic periods have been overlaid with the contemporary urban form of Bergama. By this way, it has been possible to visualize and analyze the remains, traces and sensitivity zones related to different periods in the contemporary town. Consequently, a system, which warns and directs the decision-makers about the structures and zones of existing or probable historical stratification, has been obtained. This system brings the possibility of not only visualizing the relationships of different spatial objects with each other but also visualizing and querying the information on historical stratification through the attribute data produced as a result of overlay operation.

The second group of spatial analyses is realized by comparison and search operations. The specialists of Hellenistic and Roman eras state that the city should have had a grid-iron street system during these periods (Wulf 1994; Radt 1993; Radt 2002). Hence, the similarity of the angles of that grid system with the outlines of the existing building blocks and street axes may point out any kind of continuity, either material existence of the previous periods or trace continuity, which are both important values to be considered in conservation decision-making process. In order to find out the sensitivity and continuity, angles of street axes and block outlines are analyzed through the attribute data that stores the angle information. After defining an angle range for possible deformations and comparing the angles of existing street axes and the existing block outlines, the ones with similar angles are selected which are then converted to a new theme (figure 4.28).

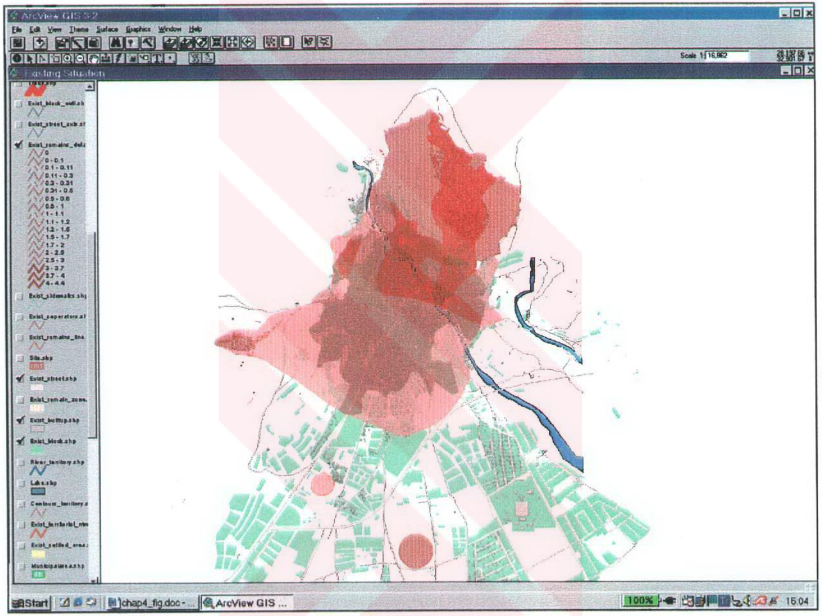

figure 4.25. Overlay of settled areas in different historic periods and the existing urban form.

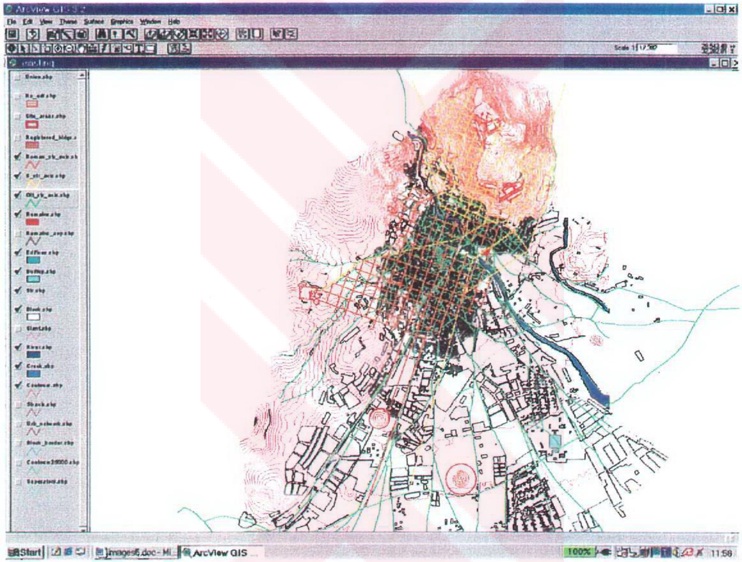

figure 4.26. Overlay of the street axis and edifices in different historic periods with those of the existing town.

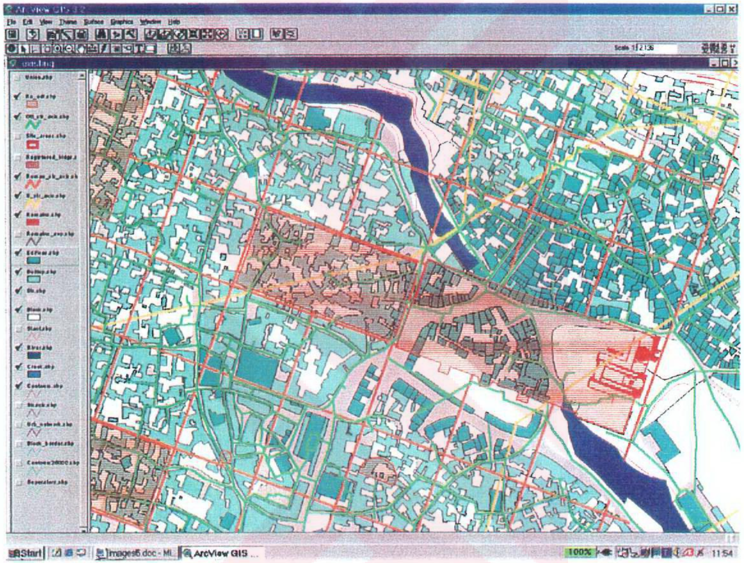

figure 4.27. A closer view of the result of the overlay operation which gives information about sensitivity areas .

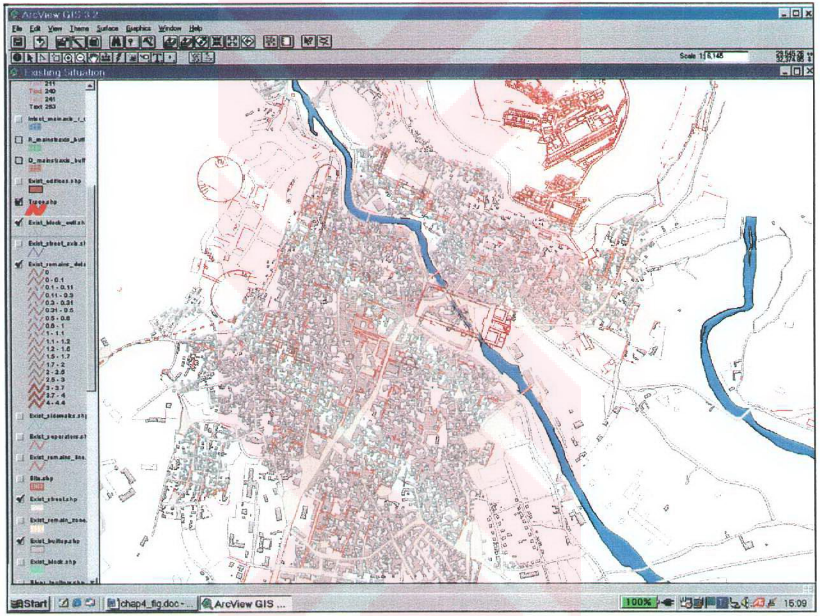

figure 4.28. Result of the comparison and search operation over similarities between angles as an important information as to the continuities.

The third group of analyses is realized by connectivity and neighborhood operations. The connectivity operation provides proximity and buffering around the spatial objects. Hence, buffers are defined around the main street axis and edifices of the historic periods (figure 4.29).

Hereafter, search operation is carried on to determine the features of the existing urban form falling into the nearby surrounding of materially existing elements or sensitivity areas of different historical periods. This information is then united to the attribute data of the components of the existing urban form (figures 4.30). The resultant information is utilizable in various levels of the conservation decision-making process. The integration of the results of all the analysis, allows the visualization of the reflection of historical stratification in the whole town as well as in each single component of it (figures 4.31, 4.32).

The review of the historical stratification and existing conservation decisions reveal once more the incompatibility of them with each other (figure 4.33). After realizing such a detailed and 'information-based decision supporting study', it is recognized more apparently that in a multi-layered town like Bergama, it is not possible to make decisions over generalized information, as historical stratification may change at every point of it.

4.1.4. Presentation of Results: Data Visualization, Output and Reporting

The final stage of the 'decision supporting study' on Bergama has been the presentation of results to the end users. By the end of the study, the results are already prepared to be presented in digital format whenever needed.

Another way of presenting the results is providing hard copies of the resultant analysis and evaluations in different scales and details. This is made for this case study, as it is the most common and the easiest way. Hence various outputs have been produced in different scales out of this 'decision supporting study'. Accompanying the graphic outputs, outputs in the form of databases and reports are also provided.

It is also possible to present and share the results with the end users over internet; however, this needs further studies with the specialists of the subject, and hence has not been realized for the case of Bergama.

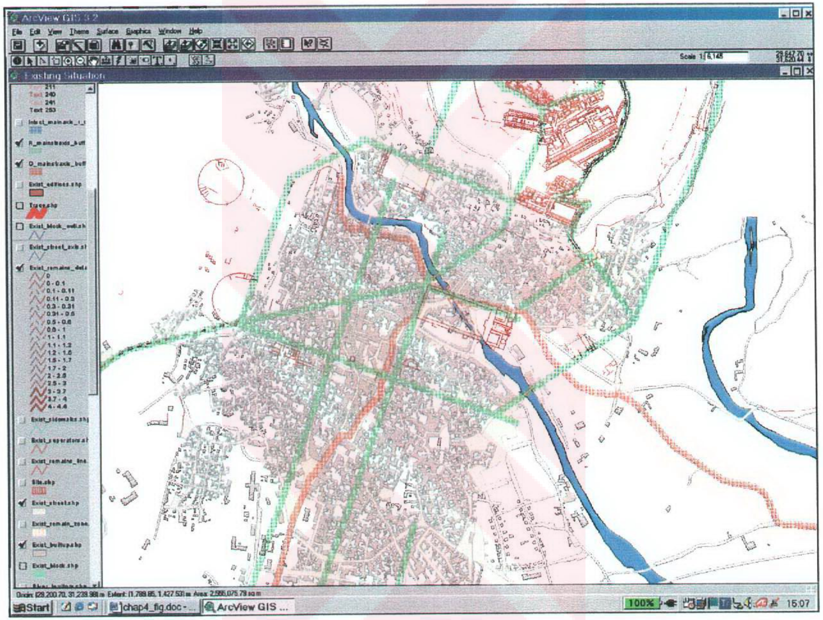

figure 4.29. Buffer zones around the main street axes of different historic periods.

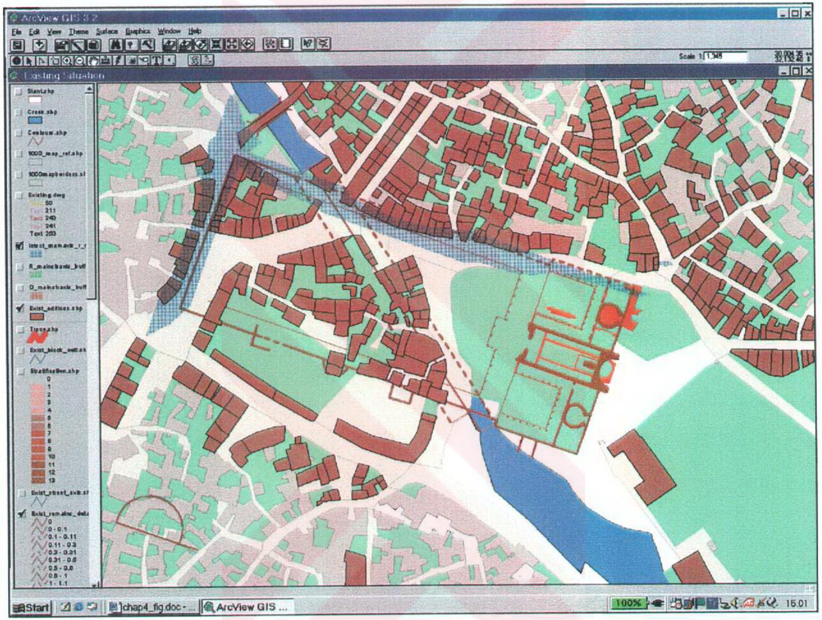

figure 4.30. Buffers defined around the street axis which have been the main axis in all the historic periods.

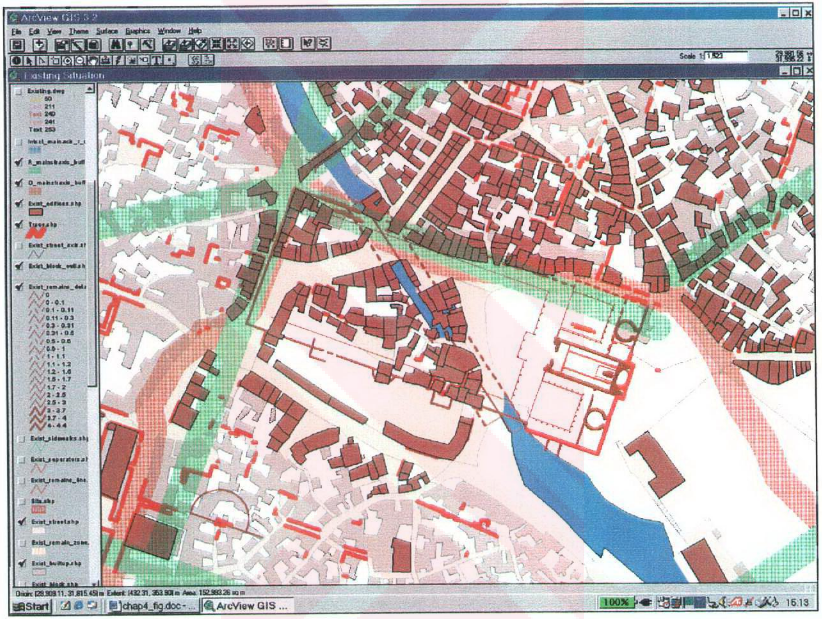

figure 4.31. The unification of the results of all the analysis to the existing urban form.

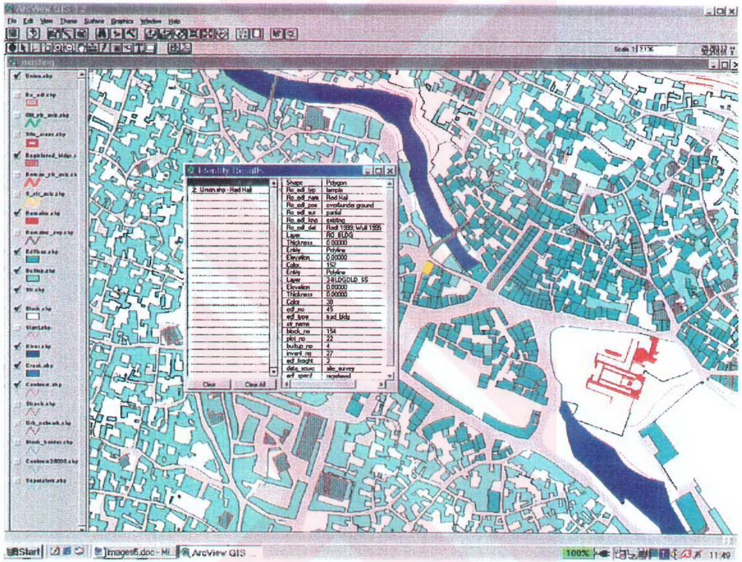

figure 4.32. Visualization of the database of an edifice as one of the components of urban formç which includes all the results of the analysis .

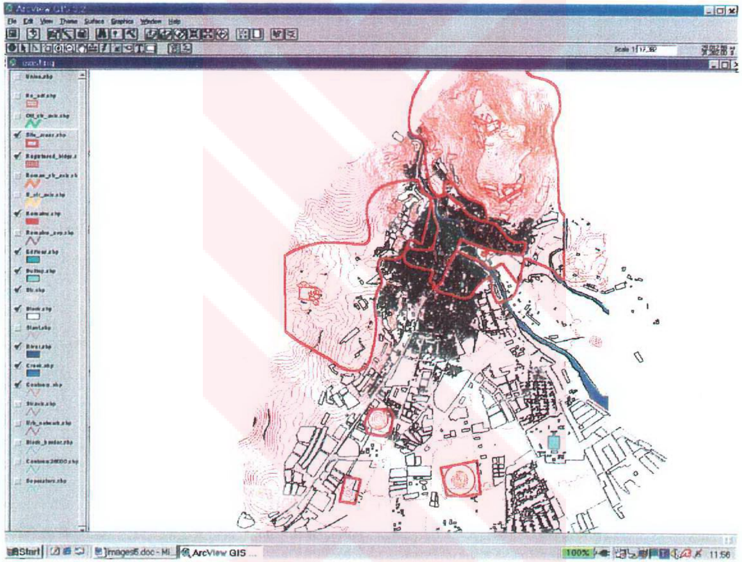

figure 4.33. Comparison of the current 'site' decisions with the historical stratification in Bergama .

4.2. Results of the Case Study and Critical Remarks

The case study on Bergama allowed testifying the proposed 'decision supporting study' on the assessment of historical stratification in multi-layered towns. The 'decision supporting study' on the case provided both the assessment of the contributions of such a 'decision supporting study' as well as the properness of the proposed method of assessment and the tool: GIS.

First of all, after realizing this study on Bergama, it will not be wrong to state that the proposed 'decision supporting study' will support the conservation decision making process by providing an information-base which covers all the related data on historical development process of the town, and hence, will have many contributions to the conservation of the multi-layered character of the towns with historical continuity.

Besides this general evaluation, departing from the case, it can also be stated that the proposed assessment method is convenient to be utilized as a starting point for such a study, which can be enhanced by testifying the method on different cases in time.

As to the advantages and disadvantages of GIS, results of the case study reveal that GIS have many potentials to be utilized as an integral part of such an assessment method, whereas, they have also some shortcomings as they are not softwares especially produced or enhanced according to the requirements of such a study.

One of the most important advantages of GIS, which can be visualized through the case study, is their ability to integrate different types and formats of data. The data as to the historical stratification of Bergama come from various sources, such as historical maps, excavation reports and drawings, aerial photographs taken in different years, old plans, cadastral maps, books, articles and documents prepared by specialists about different aspects of the town in different eras and about the different buildings in the town. Due to the variety of sources, the raw data provided from them reveal complex character with regard to their scales details and formats. However GIS allowed the utilization of all these different types, formats and scales of data within the same environment. Besides, they also allow classifying the data to obtain a utilizable document. Especially while working with data of complex character as in the case of Bergama, there is the risk of being mystified among a mass of data that cannot be utilized. For this, the data concerning the historical stratification and their existing situation in Bergama are classified according to the elements of analysis and stratigraphic units defined for the study. This provides the visualization of the data concerning different layers within the historical development process of the town both individually and in relation to one another. Thereby, the risk of being mystified among a mass of data as well as the risk of underestimating any data concerning any layer of the town are eliminated. As a consequence, data coming from various sources can easily be handled by the users.

Another important advantage of GIS, visualized through the case, is their providing a unique environment for analysis and evaluations, which can be over spatial data, attribute data and even over 3-dimensional vector and raster formatted data.

In addition to the above-mentioned advantages as to the data storage and classification, GIS provide a very precise environment, which is a prerequisite for all types of conservation related studies. However, during the preparation of this precise environment problems are faced with. The main reason of these problems is due to the incompatibility of the precision of the utilized data sources with the precision provided by GIS. In the case of Bergama, this problem can be observed most apparently while adapting the 1904 Plan prepared by Otto Berlet, which is a unique source on the urban structure of Bergama during the Ottoman era. When the 1904 map is tried to be overlaid with the existing map produced in GIS, although the shapes of building lots and ruins match with each other, distortions occur in their location and orientation. These are probably due to the differences of the coordinate and projection systems of the historical maps with those of the plans showing the contemporary situation, in addition to the insufficiency of the technology utilized in 1904 to obtain precise results. The 1904 map is tried to be overlaid with the existing map of Bergama as much as possible by making use of some fixed points in both of the plans. Yet, has not been possible to match them totally. As a result, the utilization of 1904 map necessitates some corrections based on personal interpretations, which are not appropriate with the precision aimed to be achieved in utilizing a GIS based environment.

There are also some other problems faced during the case study on Bergama about the utilization of GIS, such as they do not allow querying more than two spatial data at a time. Hence, it becomes necessary to make the same analysis many times as a result of which the procedures of analysis increase.

To sum up, it is possible to state that the 'decision supporting study' with the proposed method revealed many advantages for the conservation of multi-layered towns. GIS as the major tool for such a study is generally compatible with the objectives of the study and have much potential in that sense. However, being a tool not produced especially for such a study, standard GIS softwares reveals some problems which need to be studied further and solved in association with GIS analysts and programmers.

All these analysis, carried on the spatial data, attribute data and raster formatted images brought about invaluable information which allows questioning the existing decisions and which will support the conservation decision-making process and the consequencing interventions.

CHAPTER 5

CONCLUSION

Multi-layered towns, which have been inhabited continuously since early ages onwards, constitute an important part of world's cultural heritage, including that of Anatolia, which merit to be conserved together with their distinguishing multi-layered character. 'Multi-layeredness' brings about richness and variety of the physical environment formed through continuous historical development process. The variety and richness of the physical environment is a prime value for multi-layered towns, however, it can also turn out to be a prime problem for their conservation due to the complexities deriving from it. Hence, dealing with complex and multi-dimensional data related to historical stratification appears as an additional problem for the conservation of multi-layered towns, besides the common conservation problems deriving from legal, administrative and socio-economic reasons.

Consideration of the importance of comprehensive information in achieving proper conservation decisions and interventions reveals the necessity to process complex and multi-dimensional data so as to provide 'utilizable information' about historical stratification for the conservation of multi-layered towns. At that very point, management of information comes up as an important issue, which encompasses proper, systematic and efficient processing of data.

Data, data processing and information management have been in the agenda of different disciplines dealing with various types of data especially since 1960s, due to the rapid progress in the information technology and computer systems, which directly effected the efficiency and velocity of processing large amounts of data.

As a consequence of this development, it has become possible to handle the problems within a wider perspective with greater amount of data. Like it has been reflected to many disciplines, this development has also found its reflection in conservation studies and applications. Especially since 1980s the gradually increasing importance of data processing is seen in the form of inventories which have lately started to be considered under the concept of 'heritage information management'. 'Heritage information management' includes collection, classification, analysis, evaluation, presentation and continuous revision of data so that it can be used in the most efficient way. In parallel to those developments concerning information management, conservation started to be handled within the perspective of cultural heritage management, and similarly, urban conservation within that of management of cultural and built environment.

Although 'heritage information management' is a current issue for conservation studies, it is still not enough advanced to be well-defined and shaped according to many variables concerning contextual and organizational framework and method. Focusing on providing a method for the assessment of historical stratification in multi-layered towns, this thesis revealed the necessity of elucidating primarily the definition, framework and functioning of such a study within the conservation decision-making process, which should be followed by the constitution of a method especially set up according to the requirements of 'multi-layeredness' offering terminological, syntactic and structural standards for it, and finally a tool which will function as an integral part of the method.

Therefore, while defining framework of the study, the framework and terminology used by management sciences are referred to, as these concepts originate from there. They are well-defined and structured as a result of a long tradition of dealing with data, data processing and information. Hence, other disciplines have already been using their terminology and framework in that respect.

Reviewing the conservation process with a managerial perspective reveals that not different than any managerial activity, conservation process consists of various 'decision-making processes', all in which 'information' is of vital importance. Decision Supporting Systems (DSS) have emerged as important components of the decision-making process for managing information in order to increase the effectiveness of the decision maker by providing support in making a decision. Likewise, disciplines dealing with spatial problems also use the same frameworks and terminology with a spatial concern which is very similar to the case of conservation of multi-layered towns. Hence, it makes possible to reconsider the existing urban conservation process in Turkey as a spatial decision-making process. This once more reveals the role and importance of assessment of historical development and stratification in different levels of decision-making process. Similar to the advanced 'decision supporting systems' in management sciences, the study dealing with the assessment of information on historical stratification in multi-layered towns should be regarded as a 'decision supporting study', which can be integrated into the current system.

5.1. Appropriateness of the Proposed Assessment Method as a Decision Support for Multi-Layered Towns

In any urban conservation management process, information - especially the information about the historical background of the urban form and its components is an important information type which should be handled as a heritage information management process parallel to the urban conservation process. However, for the case of multi-layered towns this information should be handled with special care, i.e. with a special method especially developed to deal with multi-layeredness, and a special tool which is compatible with its complex multi-layered character. Hence, it becomes indispensable to design a 'decision supporting study' for the assessment of historical stratification in multi-layered towns which provides a method in accordance with the tool together with its contextual and organizational framework so as to manage information on historical stratification as much as possible and integrate it to the various decision-making processes in order to contribute to the conservation of their multi-layered character. This does not mean that 'decision supporting study' proposed within this thesis especially for multi-layered towns cannot be applied to any historic town with a more recent history and with less different historical periods. As in the method of stratigraphical studies, the units of stratification are determined at the very beginning of any stratigraphical method. Hence, for a town thousands of years may be defined as a stratigraphic unit, whereas for another town the units may be defined as a few years.

Since multi-layered towns are complex entities with complex urban features and relations each of which are formed through a different historical development process, it becomes quite hard to provide a standardization in elements of analysis and information concerning these elements for each different period of the town. On the other hand, as commonly pointed out by many of scholars for many other cases, it is not possible to provide a systematic and scientific platform for the assessment of historical stratification unless a standard language, method and tool is provided. As a consequence of this dilemma between variety of information and standardization of information, the risk of either the loss of common analysis platform with uniform information or an over-simplification and exclusion of some of the information for the sake of standardization occurs. What is chosen for this study is to provide data standardization not according to the minimum data but instead, according to the maximum data coming from the best known periods. In this case, at the beginning of the study, there is the possibility of not having uniform data for each different phase, it is expected that data concerning each phase will enhance to come up to a standardization in time also owing to the flexibility and dynamism anticipated while constructing the decision supporting study by defining the method and the tool in accordance.

One of the major conclusions of this thesis is that, production and continual revision of information is a process, which should have a well-defined contextual and organizational framework, a method providing terminological, syntactic and structural standards and a compatible tool for realizing all. Concerning the information on historical stratification in multi-layered towns, this process is defined as a 'decision supporting study', contextual and organizational framework of which is set up according to the requirements of conservation decision-making process in connection with those of GIS.

Setting up such a decision supporting study allows the production, unification, and revision of all the information about historical stratification within a single continuous study feeding all the levels of conservation decision-making process and getting feed-back from them similarly. In that way, the production and interpretation of information on historical stratification, which is only changeable in case new scientific data occur as the result of new scientific studies or as a result of the dynamism of the town, is released from being personalized and interpretative at different stages of decision-making process by different people.

Other important conclusions of this thesis are related to the proposed assessment method. First of all the method developed for assessment of historical stratification and multi-layeredness should differentiate from the commonly used methods in which multi-layeredness is of no concern. When any kind of stratification is in concern, the method of the study should be shaped to emphasize that stratigraphic structure. The overview of the methods of different disciplines dealing with multi-layeredness, reveals that the main structure, critical terminology and representation methods of all the stratigraphic studies are similar with each other.

The application of the proposed assessment method once more revealed that at every different point in multi-layered towns the character and properties of historical stratification change. Hence it is not possible to generalize such an information with a few zonings. Being a dominating information for conservation decision-making process, such generalizations cause losing some of the layers. Hence, the standard methods used in conservation plans and decisions, which are based solely upon area-based conservation decisions are not sufficient to be utilized in multi-layered towns. The proposed method allowed the integrity and continuity of the information on historical stratification analyzed in different scales. That is, it enables the reflection of the results of analysis carried on larger scales to smaller ones, and the vice versa. If the sustainability of 'multi-layeredness' is aimed, then the differing reflections due to the differences at different points should be considered during the whole decision-making process.

5.2. Pros and Cons of GIS in the Assessment of Historical Stratification

Considering that conservation of multi-layered towns is a 'multi-criteria spatial decision-making problem', GIS become suitable for such a study as they are powerful tools to deal with spatial information and spatial decision-making. The major functions and properties of GIS allow the integrity, continuity, dynamism and flexibility while dealing with spatial data and spatial decision problems concerning multi-layered towns. Besides, GIS with their multi-layered structure, are compatible with the nature of multi-layered towns as well as with that of the proposed 'decision supporting study'. In addition to these major reasons of compatibility, there are various contributions of GIS to the proposed 'decision supporting study'.

First of all, they allow the integration of different types and formats of data. In a multi-layered town integration and utilization of different types, formats and scales of data coming from various data sources concerning the historical stratification of the town together with all the layers it comprises is a requisite. GIS allow working with different types, formats and scales of data in a single environment in which all of them are geographically referenced with each other. Secondly, they provide the classification of the data to obtain utilizable information. The spatial and attribute data are classified under separate tables and layers, which are, in fact, combined with each other. Lastly, GIS obtain continuity between different scales, from which conservation of multi-layered towns can benefit considerably.

As mentioned previously, the utilization of GIS in conservation field is relatively recent as a consequence of which GIS are not used to their full potential in conservation field and they call for further examinations and experimentations. It should not be underestimated that, the conceptual and methodological integration of GIS into urban conservation studies can only be achieved by providing feed-back to the GIS software programmers. This necessitates realizing more applications by utilizing GIS so that the deficiencies and shortcomings of the GIS can be determined better, which later can be resolved in association with GIS programmers. Hence, it should be accepted fact that at the preliminary examples, GIS will not be able to fulfill all the expectations of a conservation focused study. This is also the case what happened during this study. Even though GIS appeared to be a very compatible tool with the properties of the multi-layered towns and also with those of 'decision supporting studies' in urban conservation, many deficiencies are recognized in utilization of GIS for the conservation of multi-layered towns.

One of the major difficulty in utilizing GIS for a decision supporting study for the assessment of historical stratification is that, GIS environment does not provide detailed and easily utilizable drawing and editing capacity. This is because GIS is mostly utilized for natural resources management problems or urban and regional scale application for built-up environment. Hence, it is not easy to draw smaller scale drawings. However, as an alternative solution to this problem, GIS provide an integrated environment in which the different facilities of CAD and modeling programs and systems are united so as to enhance their capacity for spatial analysis and evaluations. Another problem is that georeferencing various data with each other most of the time necessitates interpretation due to the use of differences in preparation technology, coordinate systems, and projections in different periods.

Finally, there can be problems deriving from the system users and designers. The success of GIS depends the intelligent use and management of the system which covers the determination of appropriate set of questions and analysis methods as well as the systematic review of the raw data. Besides, it should be mentioned that the preparation phase of the system takes a long time due to the altogether complexities of sources, data and the town itself.

5.3. Further Research Topic

This study gives way to further researches which could not be handled within the scope of this thesis. First one of these researches should be the application of the proposed 'decision supporting study' and assessment method on different cases so as to increase the experience which may help the progression of the method. In connection with that, as another research topic, GIS should be re-assessed over other similar cases. During these case studies the contribution of GIS specialists should be provided so that the existing deficiencies in utilizing GIS for such detailed studies can be overcome. This way GIS may develop according to the requirements of the conservation field. Besides, the existing conservation decision-making process should be reviewed according to the new possibilities obtained through the new developing tools. At that point, especially the validity of conservation 'site' decisions should be questioned as new tools allow the integration of decisions in different scales.

Although the decision support systems are originated from management disciplines, they have been so far in the agenda of many disciplines. As Ayeni points out (1997: 4), decision support systems are computer-based decision aids, which occur in all areas of scientific analysis and investigation. As a discipline dealing with spatial decision-making, it is possible to expect the design and application of DSS for the conservation field as well. Together with the enhancing role of computer systems in conservation, the decision supporting studies of today can turn out to be 'conservation decision support systems' in the near future by designing and developing systems which include all the components necessary for a DSS.

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APPENDIX A

EXAMPLES OF STRATIGRAPHIC REPRESENTATION METHODS IN DIFFERENT DISCIPLINES

Geology:

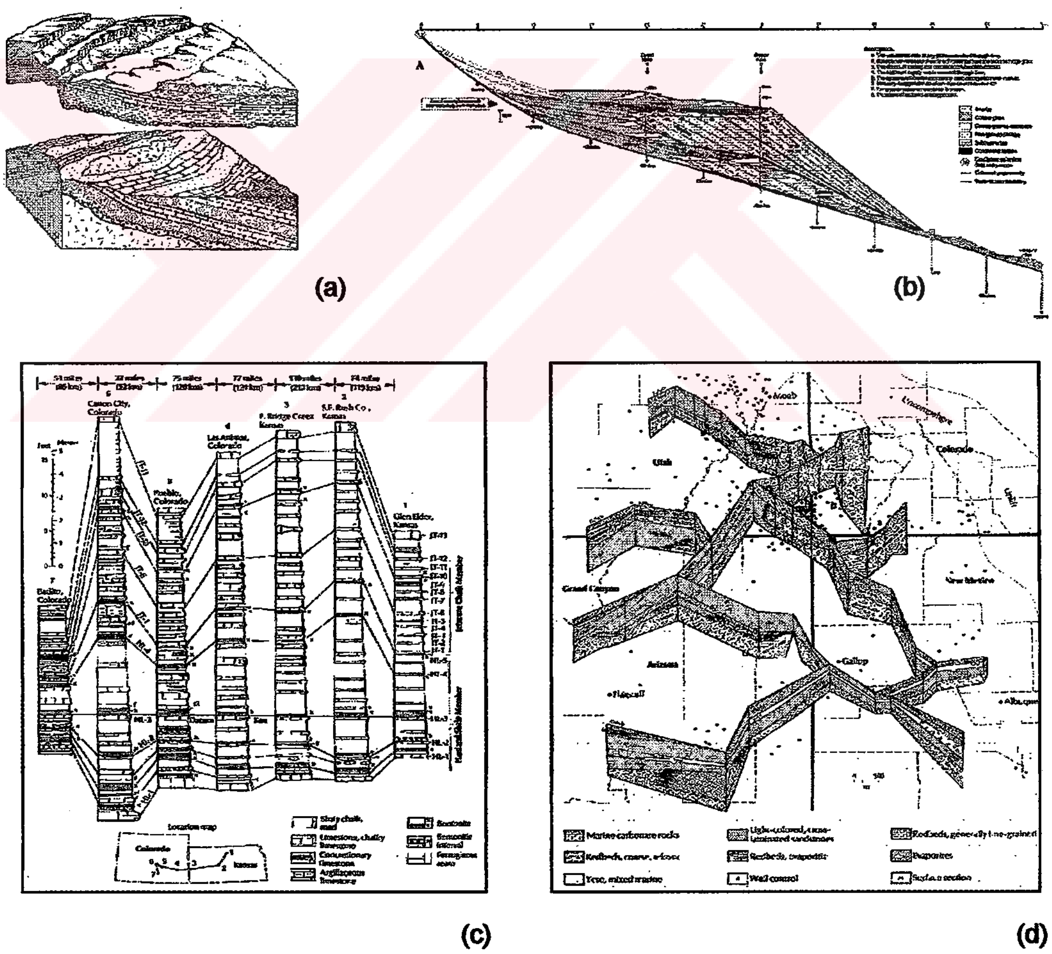


figure A.1. stratigraphic recording and representation methods: **a.** block diagrams **b.** geological cross section **c.** stratigraphical cross section **d.** fence diagram

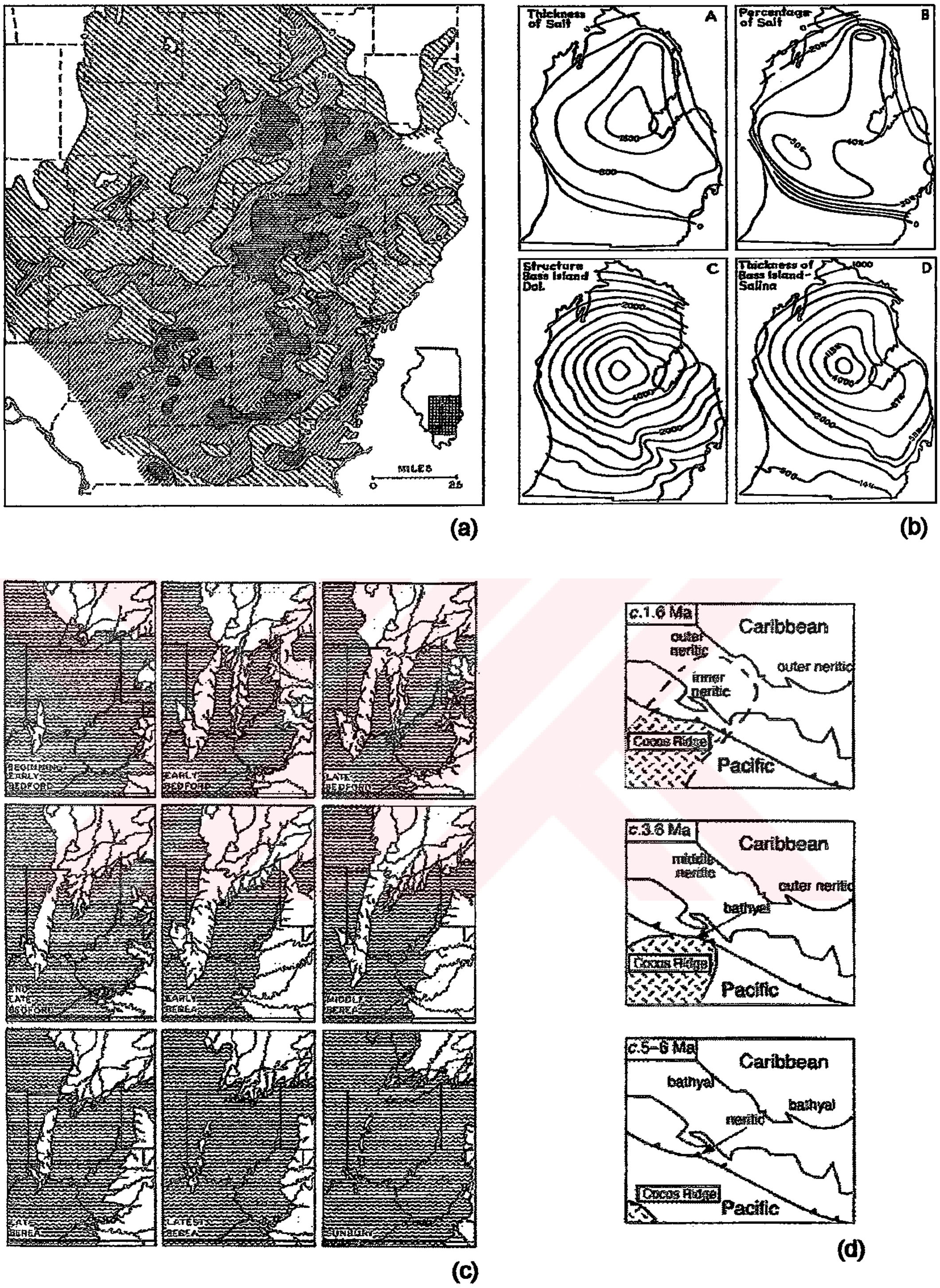
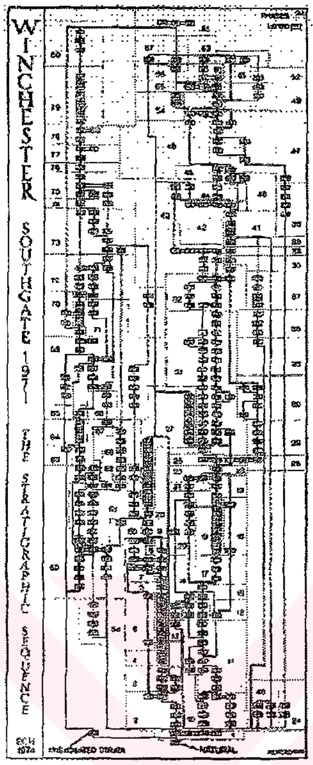
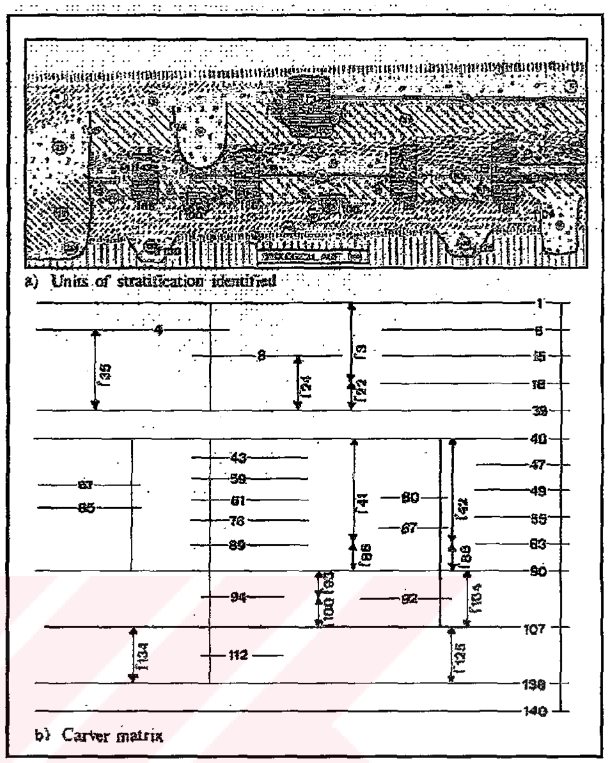


figure A.2. Stratigraphic mapping examples in geology: **a.** the overlay or combination of different phases making up the existing structure and stratification **b.** **c.** map series showing the situation in different time intervals **d.** map series showing the situation in different time intervals

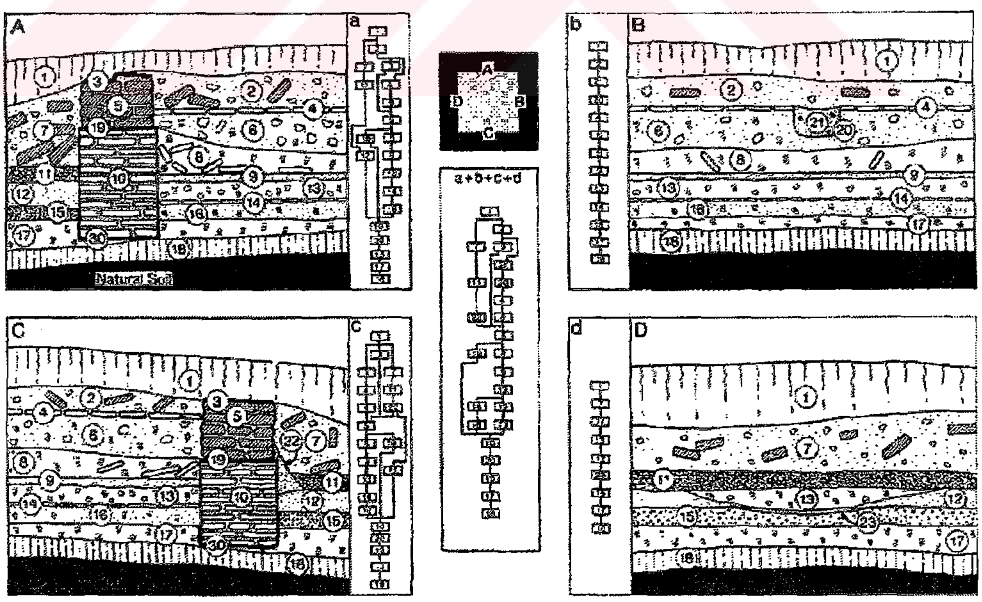
Archaeology:



(a)

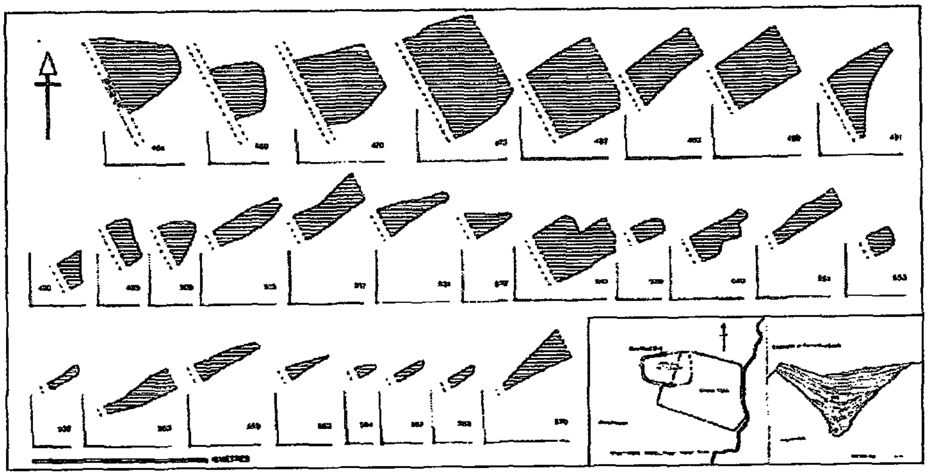


(b)

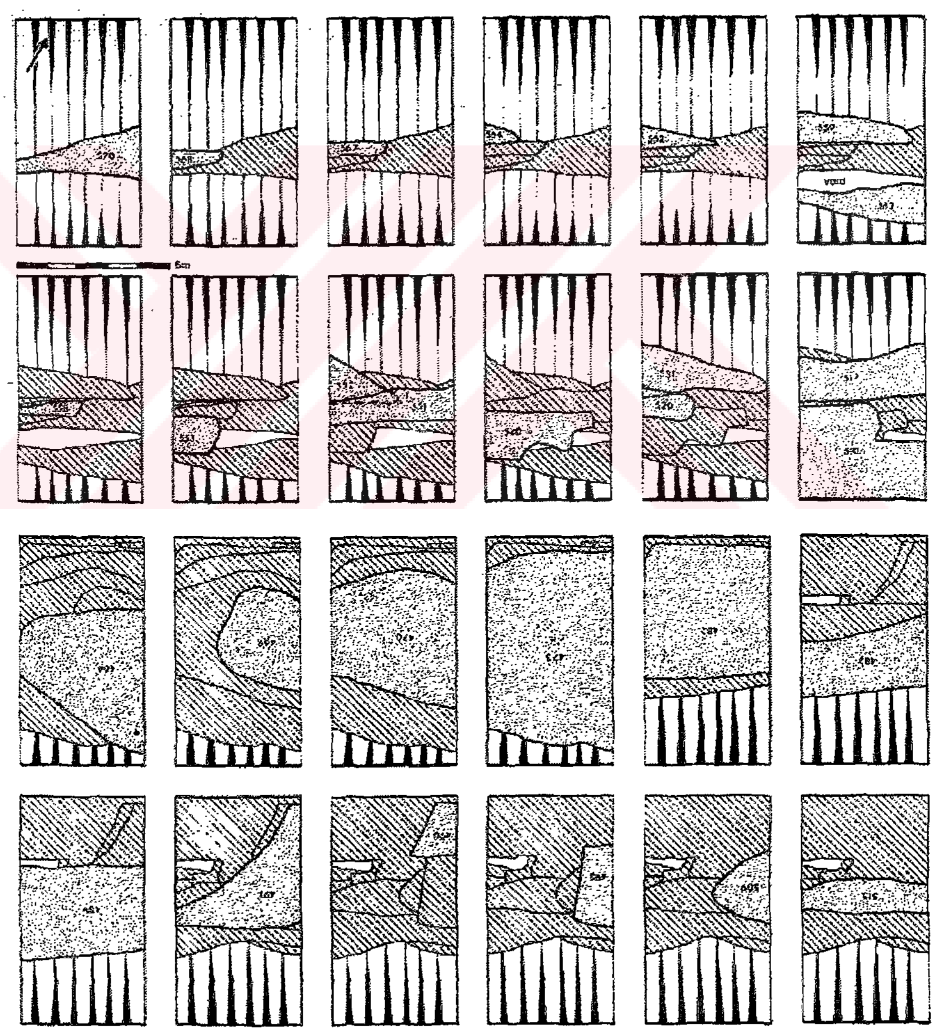


(c)

figure A.3. Stratigraphic recording and representation methods in archaeology: a. Harris matrix b. carver matrix c. stratigraphic diagram in association with stratigraphic sections to give a full information of stratification in a trench



(a)



(b)

figure A.4. Stratigraphic mapping examples in archaeology: **a.** single context plans **b.** composite period plans

Buildings Archaeology:

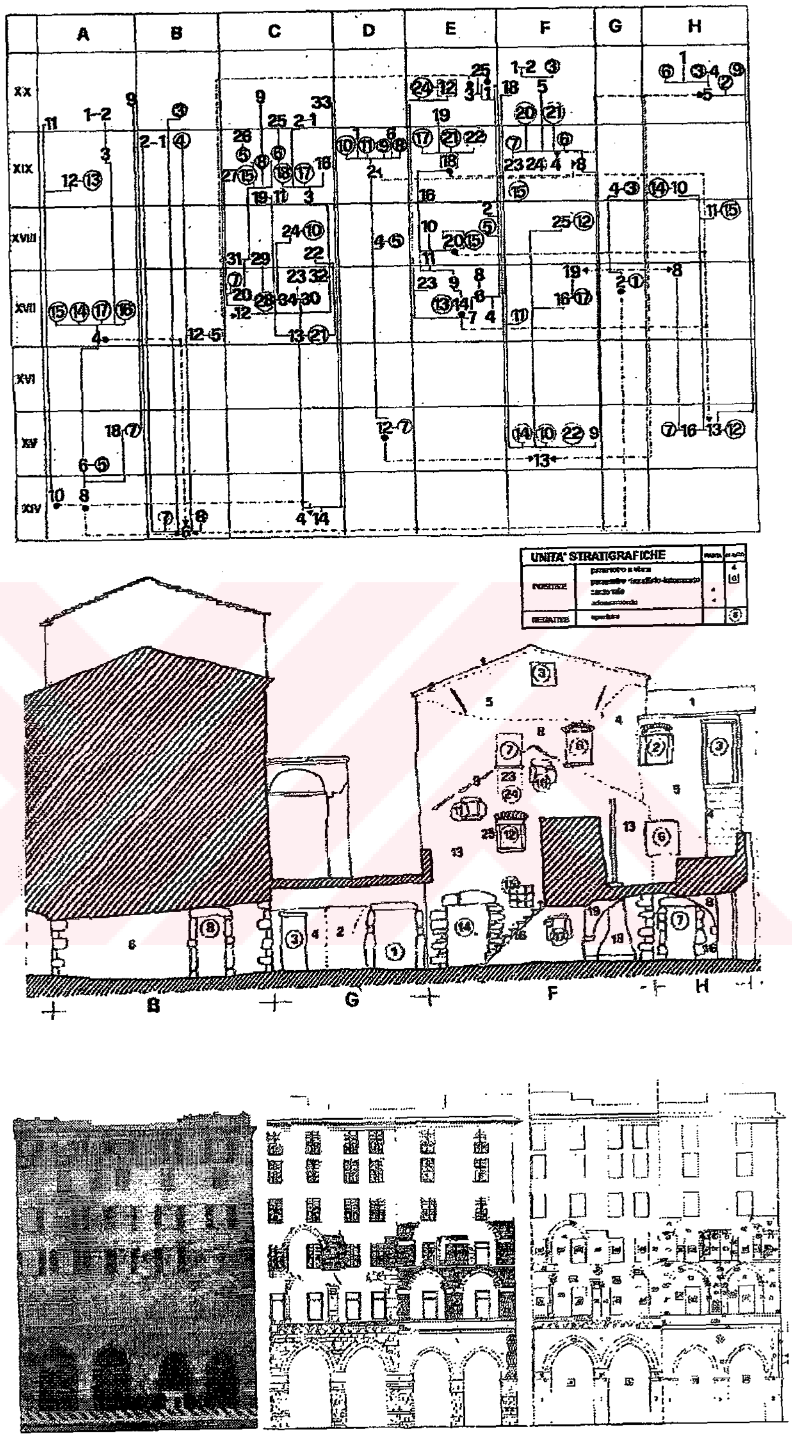


figure A.5. Stratigraphic recording and representation in buildings archaeology.

Urban Archaeology:

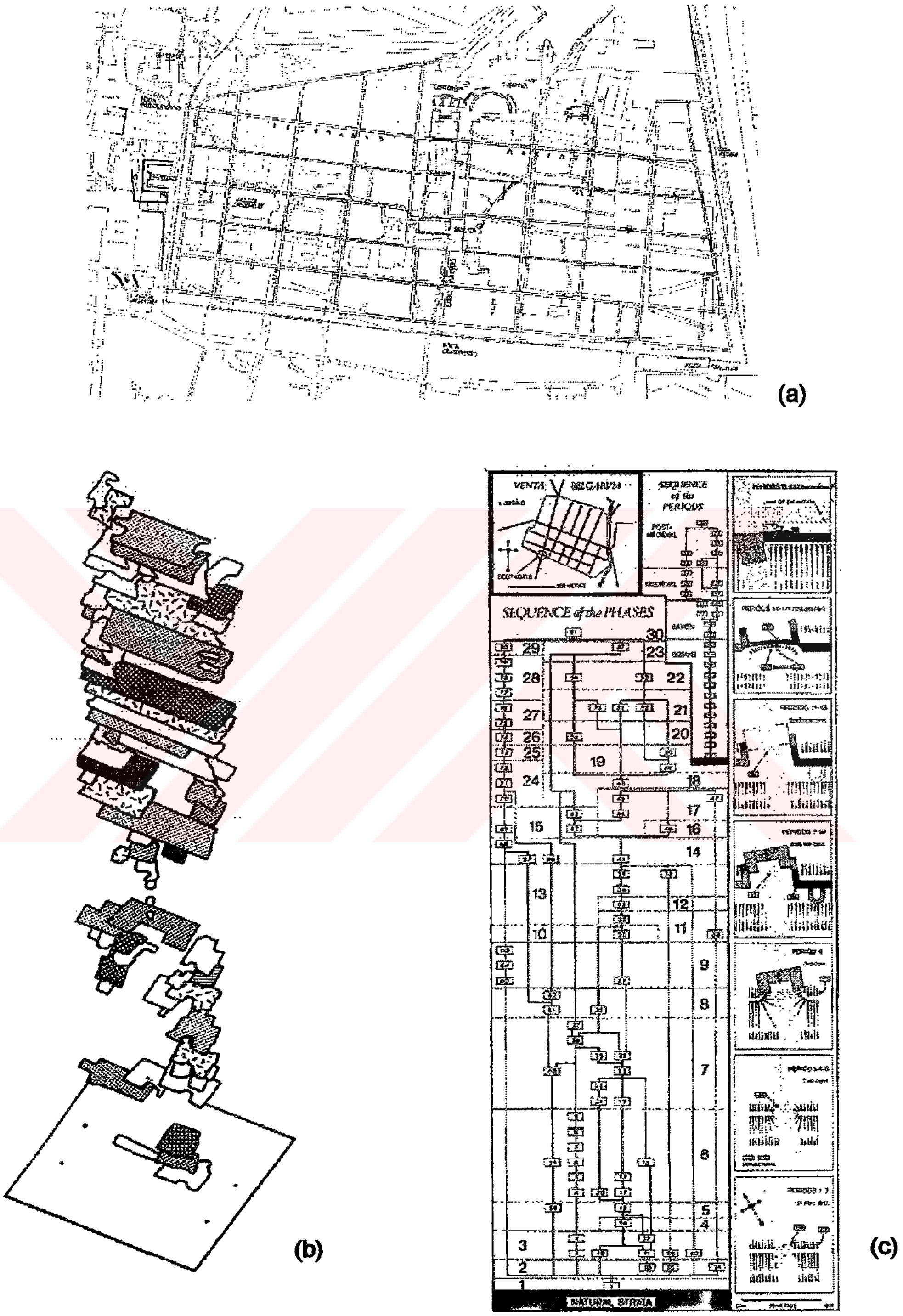


figure A.6. Stratigraphic recording and representation in urban archaeology: **a.** inner organization of a phase in a diachronic plan **b.** 3D stratigraphic representation of single context plans forming composite plan **c.** diachronic plans in association with matrix.

APPENDIX B

MAJOR DOCUMENTS USED FOR THE CASE OF BERGAMA

- Existing maps of Bergama prepared in 1960
    - 1/1000 Existing Maps (29 pieces)
    - 1/5000 Existing Maps (2 pieces)
    - 1/25000 Existing Map
- Aerial Photographs of Bergama which have been periodically taken and kept by General Commandership of Cartography:
    - 1957 Aerial Photo
    - 1970 Aerial Photo
    - 1976 Aerial Photo
    - 1995 Aerial Photo
- Plans, projects and their reports prepared for Bergama in different periods:
    - 1904 Map of Bergama
    - 1948 Development Plan and Plan Report
    - 1945 Tourism Planning Report
    - 1969 National Parks Project and Project Report
    - 1988 Revision Development Plan and Plan Report
    - 1995 Conservation Development Plan and Plan Report
- Reports and drawings prepared by the German archaeological teams that have been continuing the excavations and researches in Bergama since 19th Century.
- Various articles and books on different aspects and periods of Bergama
- The decisions of Conservation Councils concerning Bergama
- The inventories of the registered structures in Bergama
- Theses on different aspects of Bergama

VITA

A. Güliz Bilgin Altınöz was born in Ankara, on August 5, 1970. She received her B.A. degree in Architecture from the Middle East Technical University in June 1991. From March 1994 to September 1994 she studied as a visiting researcher in the University of Rome "La Sapienza" on urban archaeology. On January 1996 she received her M.S. degree in Restoration from the Middle East Technical University. From March 1998 to September 1998 she studied as a visiting researcher in the University of Genoa on Geographic Information Systems and urban archaeology. Since August 1993 she worked as an architect/restorer in various archaeological excavations. She has been working as a research assistant in the Department of Architecture in the Middle East Technical University since October 1995. Her main areas of interest are urban archaeology, conservation and planning of multi-layered towns, conservation, planning and presentation of archaeological sites, geographic information systems (GIS), utilizing computer programs in different phases of restoration/conservation studies and education. She has various publications and conference presentations on the above topics.