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SUSTAINABLE TOURISM MANAGEMENT AT POTENTIAL WORLD HERITAGE SITES: LAND USE ANALYSIS BY USING GIS: CASE STUDY: JERASH ARCHAEOLOGICAL SITE, JORDAN

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Abstract

The current study aims to analyse the land use changes in the cultural landscape of Jerash Archaeological Site and identify the impacts of modern urbanization which influenced it, as a potential World Heritage Site, during the period between 1953 and 2016. This study employed Geographic Information System (GIS) as a main tool of the analysis. The results show that significant changes in land use have occurred. For instance, in 1953, the unused spaces have estimated at about 65.8%, whereas the modern urbanization areas covered 3.1%. In 2016, the unused spaces decreased to about 1.8%, while the modern urbanization areas increased significantly to 57.6%. These land use changes caused urban development encroachments which damaged and caused visual pollution to the archaeological and traditional remains. GIS mapping was used to produce archaeological zoning maps through delineating buffer zones around the City Wall area and the antiquities areas. Buffer zoning could be a rational guidance to policy

makers and tourism planners to limit the urban encroachments onto the cultural landscape of Jerash archaeological site.

Keywords

Sustainable Tourism, Modern Urbanization, World Heritage Site, Jerash Archaeological Site, Land use, Zoning, Geographic Information System

1. Introduction

Jerash is one of the best examples in the Middle East of a prosperous Roman city; it is considered as one of the three great classical city sites in the Near East. It is different from Petra and Palmyra archaeological sites. The greatness of Jerash is mixed by a charm to which one can relate immediately. The ancient city of Jerash "Gerasa" is one of ten Greco-Roman cities in northern Jordan which formed the Decapolis (Philadelphia, Pella, Gadara, Documanus, Scythopolis, Hippos, Canatha, Dium and Raphana) (Afanasyeva, 2004); it took its name from the confederation of the ten cities that dominated its extent. Jerash city was a mega city during the Roman and Byzantine period and this indicated by the construction of impressive monuments and cultural landscape. Cultural landscapes are cultural properties that represent the "combined works of nature and man, they are illustrative of the evolution of human societies and settlements over time" (UNESCO World Heritage Centre, 2008). According to this definition, the cultural landscape of Jerash represents an evolution of human society because of its various architectural monuments and settlements that refer to many periods like Prehistoric, Roman, and Islamic periods. The succession of the ancient cultures in Jerash gave the ancient city its historical value; also, it has scientific, aesthetic, educational, religious, and many other values. These values enhanced the significance of the ancient city to be one of the most important tourist destinations in Jordan.

Jerash area has seen enormous human and economic development over the past 50 years especially in the modern city of Jerash. Because of this, significant changes to the environment and the landscape have occurred. These changes are largely related to tourism development, commercial development, population growth, infrastructure, and increased utilization of natural resources. Because of the proximity of Jerash archaeological site to the modern city of Jerash, there is a necessity to study the changes and impacts of urban development of the modern city on the cultural landscape of the archaeological site. Although it is characterized by its significant

values and features, these rich and dense natural and cultural features interact with their surroundings, or are at least affected by it. Accordingly, Jerash site has yet to be awarded the status of a World Heritage Site by UNESCO.

Jerash site was nominated as cultural property to be one of the World Heritage Sites in 13/1/2004; this nomination was prepared by the Ministry of Tourism and Antiquities (UNESCO World Heritage Centre, 2007), but this attempt was failed due to the impacts of modern urbanization which in conflict with the integrity criteria of the World Heritage Sites. The failure to nominate Jerash archaeological site to be one of the World Heritage Sites is attributed to the poor management of site integrity, population growth and the expansion of the modern city; many important monuments of the site were damaged and disappeared and the environmental quality of the site has declined (Al-Saad, 2014). To be included on the World Heritage List, Jerash archaeological site must be of outstanding universal value; the integrity of the site must be protected, and meets at least one out of ten World Heritage selection criteria (UNESCO World Heritage Centre, 2008). The cultural landscape of Jerash city is therefore at a turning point, therefore the ministry must give the site its attention to conserve it and its urban areas. Any threat to the cultural landscape of Jerash site would harm its integrity and authenticity. The threats on Jerash cultural landscape include the rapid expansion of the modern urbanization and how it has caused the overcrowding of the city. The increase of private and public transport, the growth of technical and industrial infrastructures, and the growth of tourism has produced a hard break in the harmonious balance created by mankind through the ages.

Due to the importance of the cultural landscape of Jerash and because of the rapid development in tourism and commercial sectors, there is a necessity to protect this unique cultural landscape, thus the principal goal of this study is to analyse the land use changes, impacts and root causes of these impacts which have influenced the cultural landscape of Jerash archaeological site during the period between 1953 and 2016. The current study aims to: 1) Prepare a large-scale monitoring and digital documentation to the site, including both the built and the natural environment because it is importance for the protection of Jerash cultural landscape from impacts of modern urbanization; 2) Drawing archaeological zoning plan through delineating buffer zones around sensitive archaeological and traditional areas in the site, to protect and enhance the visual appearance of Jerash site.

2. Literature Review

The cultural landscape concept as World Heritage site includes concepts of belonging, outstanding, significance, locality, meaning, value and singularity of place. In a balancing way, it is also provoking thought about the concept of World Heritage itself. For every landscape has its locally significant feature and finds a validity as a local place must be with more prestigious designations like a National Park or World Heritage Site (Fowler, 2003). The application of the cultural landscape concept created questions about the World Heritage requirements with respect to authenticity and integrity. Each cultural property nominated must meet the test of authenticity in design, material, workmanship or setting and in the case of cultural landscapes their distinctive character and components.

Sustainable tourism involving protection of the cultural landscapes of World Heritage Sites from the impacts of modern urbanization. It is indispensable for managers to use GIS in the protection of the cultural landscapes which has become cornerstone for long term sustainable tourism planning. Because GIS techniques are ideal for large scale monitoring, they have been extensively employed for this purpose. These studies are recent because of the modernity of GIS techniques. Because GIS is suitable to manage and understand the cultural landscapes which have both cultural and natural resources at the same time, Ayako et al. (2005) studied the cultural landscape of Kanazawa City with its cultural and natural resources in Japan by using GIS; their project members developed a web-based 3D GIS to manage and conserve the cultural heritage of the city.

In Jordan, Al-Ruzouq and Abu Dabous (2017) adopted an integrated methodology based on photogrammetry and Three-Dimensional (3D) Geographic Information System (GIS) to capture and model essential details needed for the proper management of archaeological sites. They used Orthophoto, Digital Elevation Model (DEM), structures geometry and site layout and 3D textured model to document and assess the archaeological structures of Ajloun Castle in northern Jordan. In the capital city of Amman, Al-Rawashdeh and Saleh (2006) conducted a study for the detection and analysis of land use changes in Amman. GIS and remote sensing techniques had been applied to investigate the negative impacts of modern urbanization on fertile lands and to quantify the growth of urban areas in Amman. The study illustrated that the urban area was increased by 162 km² over the period 1918–2002, which represents 509 times the original urban area. The fertile lands decreased by 86 km², which represents 23% of loss. Moreover, the urban expansion over 1918–2002 was analysed and its impacts on the Amman area environment were

assessed. In Irbid city, El-Khalili (2005a) analysed the current situation of the urban development in cultural landscape of historical buildings in Irbid city centre during the last decades of the 20th and 21st centuries due to the urbanization growth and urban development in the city centre of Irbid city. There were two studies were done about the Jerash ancient city, El-Khalili (2005b); he studied the current impacts which threaten the cultural landscape of Jerash archaeological site, he prepared a proposal for a full treatment and curative management for the new buildings and the revitalization of the disturbed natural and cultural resources of Jerash. With using the different technologies such as GPS, satellite images, photogrammetry, and classical instrumentation, Al Bayari (2005) had started to build a GIS and precise base maps for the archaeological site of Jerash. GIS and 3D model for the residential areas were produced to study the expansion effect of the modern city on the ancient Roman site.

Control of land use change and sustainable tourism management of the built environment tends toward a dynamic process with the purpose of satisfying emerging needs. In addition to safeguarding physical structures and environmental relationships, urban conservation also needs to include the maintenance of appropriate functions and, where feasible, traditional types of use. Sustainable tourism management of cultural landscapes necessarily requires the full involvement of different stakeholders (Al-Saad, 2014), including city planners, architects, sociologists and administrators. Chuamuangphan (2016) indicated that gaining the perspectives of all actors based within specific geographical case study areas can contribute to overcome sustainable tourism challenges. At the same time, an important part of the work is raising the awareness of the local people, technicians and administrators about heritage values and the significance of historic structures, advising in the use of traditional materials, regular maintenance and timely repair, as well as establishing criteria for the introduction of new structures and facilities, if unavoidable. Considering the complexity of the task, the scope of these guidelines is necessarily limited to highlighting some selected aspects of the conservation planning process. (Feilden & Jokilehto, 1993, p.77).

3. Materials and methods

The methods represent the ways and instruments that used to achieve the objectives of the study. This study combines between the historical and practical approaches. Describing landscapes and the environment of a context needs a rooting corpus of the historical memory in the area (Pandolfi et al, 2017). Historical research attempts to critically investigate events,

development and experiences of the past aiming to ascertain and describe history of any area of human activity, subject or event by means of scientific processes (Špiláčková, 2012). The historical approach has explained the history of the modern city of Jerash and its urban growth during different periods. The practical approach depends mainly on the Geographic Information System (GIS) to analyse land uses in and around Jerash archaeological site, then delineating buffer zones around the site. The purpose of zoning is to demarcate specific areas for different types of land use and the development of standards to apply within each land-use zone to control land use according to the plan and to ensure standard compliance (Inskip, 1991). Documents, maps and aerial photographs related to the study have been gathered from different sources such as libraries, Department of Statistics, Royal Jordanian Geographic Centre (RJGC) and nongovernmental organizations. GIS would be beneficial to examining past and potential tourism developments and other land-uses which may cause negative impacts to tourism resources (Aminu, et al, 2014). Therefore, it was used to produce several maps which analyse the growth of modern urbanization and its impacts on the integrity of the cultural landscape during the period between 1953 and 2016.

Data collection: Data related to the impacts and causes of modern urbanization were collected from various sources. References, Institutional reports (Governmental reports) and archived information from the Ministry of Tourism and Antiquities and Municipality of Jerash were collected. The archived information includes all the information about the tourist activities and commercial projects that constructed around Jerash archaeological site from the last years. The aerial photographs (1953, 1978, 1992, 2000, 2007 and 2016), and topographic map for the study area have a 1:25000 scale, whereas 1:30000 scale for the aerial photograph 1992, to know the magnitude of the modern urbanization around the archaeological site. Information about the population numbers for the study area was collected from the Department of Public Statistics. Information about the activities of modern urbanization around Jerash site was collected by personal communications and interviews with Jerash Municipality staff.

Explorative field visits were conducted to know the infrastructure of the city, its districts and the commercial areas in order to determine the land uses in the study area, also to ensure from the accuracy of the information obtained from the aerial photographs and to make sure that they were correct, in order to add and update all the human activities and urban growth changes, in addition to gather information and statistics about Jerash city in order to draw precise land use

maps. Field photography was done to record the different locations of the modern urbanization impacts in the study area.

Data Processing: The aerial photographs for these periods (1953, 1978, 1992, 2000, 2007 and 2016) have been manipulated by using ArcGIS of ESRI version 10.3. This program was used to analyse the aerial photographs and topographic map of the study area. The manipulating process began with scanning the hardcopy of the aerial photographs at high resolution level (800 DPI) to provide integrated database storage, and to be an introduction to spatial analysis. Then insert them by using ArcMap and ArcCatalog to make rectification of the photos and georeferencing with assistance of GPS and topographic map after converting the coordinates from latitude / longitude to Universal Transverse Mercator (UTM) coordinates in order to connect their coordinates with the Earth coordinates precisely. To obtain precise georeferencing process, it is necessary to use at least three control points. Then the aerial photographs have been rotated, scaled, and warped as needed to fully register them to the Earth coordinates (fixed referenced points) on the aerial photograph (Table 1). These points were referenced by using Universal Transverse Mercator (UTM).

Table 1: Fixed referenced points with UTM coordinates

Referenced points	UTM Coordinates (E, N) or (X, Y)
Point (1)	E: 35.895589 N: 32.28390
Point (2)	E: 35.887389 N: 32.269503
Point (3)	E: 35.899492 N: 32.274725

Maps were produced to generate new information with new form from the inputting spatial and attribute data. Thus, it is possible to make different analyses such as statistical analyses, spatial analyses, and map overlying to get more information from one map that has more than one layer. The program has the ability of digitizing by using different tools. The scale of the maps has been determined. Also, this program can deal with the third dimension (Z factor) especially when dealing with contour maps. This technique has been conducted after georeferenced all the aerial photographs in order to analyse them, then determining the boundaries of the study area on these photos and determining the different land uses in the area by using digitizing in order to draw the unused spaces, commercial areas, streets, agricultural lands, the various levels of population density, and the archaeological site, each one represents one layer.

These thematic maps consisted of basic geographical entities called points, lines or areas. After that calculating the total area and volume to each land use whether it was construction use, agricultural use, or commercial use...etc. In order to know the magnitude of the modern urbanization in Jerash archaeological site and its surrounding area, some maps and table have been produced: Base map to the study area, land uses maps for the study area and their development during these years (1953, 1978, 1992, 2000, 2007 and 2016), table shows the percentages of land use changes in the study area during these years (1953, 1978, 1992, 2000, 2007 and 2016), and maps show the impacts of modern urbanization on the cultural landscape of Jerash archaeological site.

4. Land use analysis in and around Jerash Archaeological Site

The Jerash city was predominantly unused spaces in the period that preceded 1953. After this year, the land uses changes began to appear, as can be seen in Table 2, and Figure 1, a number of facts become apparent. In 1953, the largest part of the total area about 65.8% consisted of unused spaces, whereas agricultural lands covered about 15.6% of the area, and antiquities areas accounted for 15.4% of the area. The remainder was divided between high density population 0.5%, moderate density population 0.9% and low density population 1.7%. As illustrated in Table 2, and Figure 2, this period represents preliminary indicator about the beginning of the modern urbanization in the area. In 1978, the unused spaces around the site decreased to about 32.2%, the commercial areas began to appear to 1.2%, and the population numbers began to increase to 1.2% for high density population, 4.7% for moderate density population and 16.9% for low density population.

Starting from the late 1960 one could witness the uncontrolled urbanization of the city which modified the preceding harmonious development. This was accompanied by a continuous threat to the ancient remains of the site. Starting from the mid 1970 Jerash Municipality promoted a housing development plan which mostly concerned with roads construction and general infrastructure services but without archaeological zoning plan (Table 2 and Figure 2). Jerash Municipality put a development plan for Jerash in 1984; the plan was based upon undifferentiated land division according to the current situation and to the existing parcelling. The plan provides for housing areas alone, while the urbanization roads are mere connectors of the peripheral areas to the traditional civic and commercial centre. During the period between 1984 and 1992, the unused spaces around the archaeological site decreased to 14.2%, the commercial areas began to

increase to 2.5%, and the population numbers began to increase to 1.5% for high density population, 14.9% for moderate density population and 21.3% for low density population (Table 2, and Figure 3). In 2000, the unused spaces around the site decreased sharply to about 2.3%, the commercial areas began to increase to 3.6%, many shops and restaurants were constructed near the archaeological site, and the population numbers began to increase to 4.1% for high density population, 30.8% for moderate density population and 23.3% for low density population (Table 2, and Figure 4). After seven years, the unused spaces around the site decreased gradually to about 1.4%, the commercial areas are still constant as in 2000 (3.6%), and the population densities were increased slowly to 5.8% for high density population, 31.4% for moderate density population except the low-density population was decreased to (20.6%) (Table 2, and Figure 5). In 2016, the unused spaces around the site decreased to about 1.8%, the modern urbanization areas are still (57.6%).

These population densities and the commercial areas were concentrated in the modern city of Jerash. This part of the city now covers about 40% of the land; it was situated within the ancient City Wall of Jerash. These land use maps reveal the scale of the archaeological site along the City Wall and its proximity to the urban areas without sensing of the specific characteristics of older urban areas, views and vistas across the urban area to the archaeological site. The growth in urban areas occurred at the expense of unused spaces. This can be explained by an increasing trend to seek the tourist and commercial opportunities around the archaeological site.



Figure 1: Land use in Jerash city, 1953.

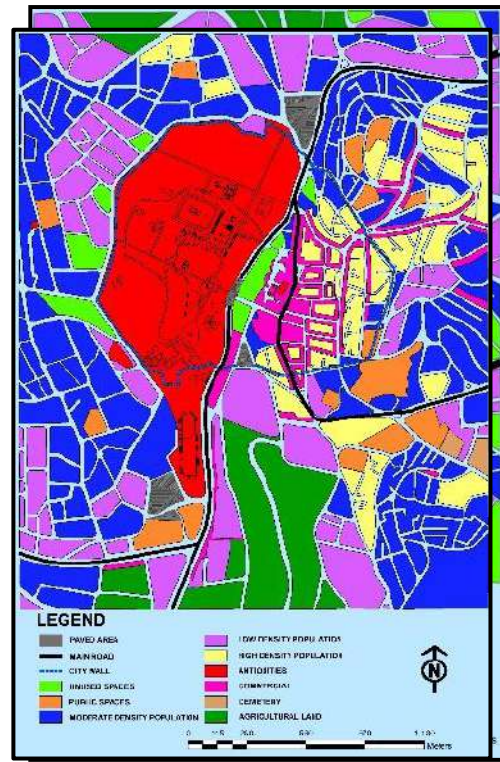


Figure 2: Land use in Jerash city, 1978.

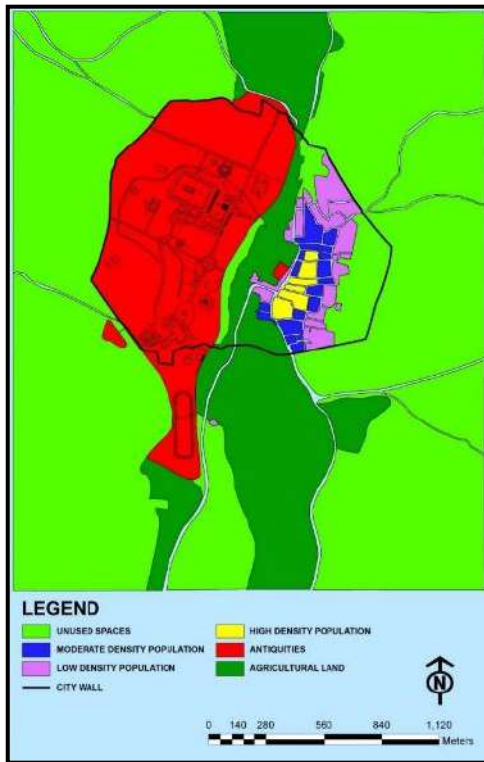


Figure 3: Land use in Jerash city, 1992.

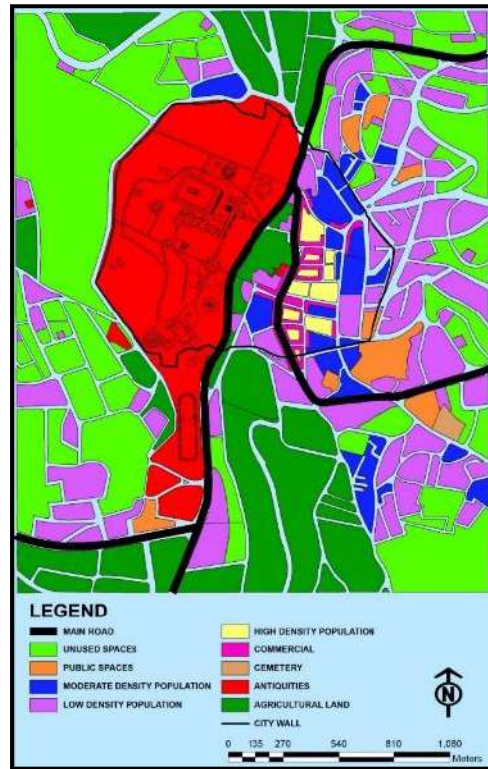


Figure 4: Land use in Jerash city, 2000.



Figure 5: Land use in Jerash city, 2007.
Figure 6: Land use in Jerash city, 2016.

Table 2: *The percentages of land use changes in the study area during the period between 1953 and 2016*

Year	Moderate density population	High density population	Low density population	Agricultural land	Cemetery	Commercial	Antiquities	Unused spaces	Public spaces
1953	0.9%	0.5%	1.7%	15.6%	No data	No data	15.4%	65.8%	No data
1978	4.7%	1.2%	16.9%	20.1%	0.3%	1.2%	20.6%	32.2%	2.6%
1992	14.9%	1.5%	21.3%	19.4%	0.3%	2.5%	21.9%	14.2%	3.8%
2000	30.8%	4.1%	23.3%	8.2%	0.5%	3.6%	22.7%	2.3%	4.4%
2007	31.4%	5.8%	20.6%	9.2%	0.5%	3.6%	23.0%	1.4%	4.4%
2016	31.9%	6.2%	19.5%	9.4%	0.5%	3.6%	22.4%	1.8%	4.7%

In conclusion, it can be seen that significant changes in land use have occurred from 1978 to the present (Figure 5), while natural spaces have been much neglected in their original state, houses and buildings have essentially replaced areas which were unused spaces. Land to the west of the site is zoned as residential. These changes were mainly due to the following reasons: a) significant increase in the number of people during the period between 1953 and 2016, which increased the need for more building areas; b) the tourist and commercial importance of the city; c) the City Wall area is a home for the commercial activities and infrastructure services that concentrated around the archaeological site. Consequently, there is an implicit right to develop the city even though the modern urbanization in this area has negative impacts on the cultural landscape of the archaeological site.

5. Modern Urbanization Impacts on the Jerash Site

The impacts of modern urbanization on the integrity of World Heritage cultural landscapes stem from new developments in the landscape, provision of utility services, adaptation of historic structures for new uses, commercial activities in the buffer zone, visitor pressures and associated infrastructure (Lennon, 2003). The rapid growth of modern urbanization within Jerash has had significant impacts on the integrity of Jerash cultural landscape. This can be demonstrated by the loss of the archaeological monuments and remains; Jerash has seen the destruction of much of the architectural heritage within the City Wall, both Roman and later traditional house types. The direct impacts on the cultural landscape of Jerash arise from a variety of sources including: commercial activities, and construction development projects. To investigate the impacts of these activities on Jerash cultural landscape, we should know the magnitude of urban development in Jerash archaeological site and its surrounding area.

Impacts of commercial activities: Jerash city has high spatial concentration of commercial activities which are centralized in the modern city of Jerash; these activities were creeping toward the archaeological site. The area dimension of the archaeological site is approximately 2.5 km² and the greater part of this area is occupied by modern buildings in addition to many traditional buildings. This area hosts the principal economic activities such as shops, markets, private offices, banks, restaurants, government offices and administrative authorities. Also, there are many maintenance shops for repairing cars. It is obvious that there are many commercial and administrative activities which increase the economic benefit of the city.

The major restaurants of the city are: (Janet Jerash, Al-Bait At-Turkey, Al-Wadi Al-Akhdar, Gerasa, Al-khayyam, Abo Ahmad, Yahala and Nahr El-thahab), they are too close to the archaeological site. All these restaurants are situated near the archaeological site. The ownership of these restaurants is varied between private and public sector; furthermore, the ownerships of the private sector refer to different nationalities (Jordanian, Syrian and Turkish). These restaurants were built from new materials and have modern designs that incompatible with the design of the archaeological monuments in Jerash site; therefore, they dilute the clarity and the quality of the setting of the archaeological remains and cause visual pollution to the cultural landscape of the site, especially Yahala Restaurant because it is a high-rise building which distort the scenic view of the monuments that situated behind it. Commercial development has increased the pressure on the remaining fragile archaeological remains and on the later traditional houses and buildings. Also, intrude into the views of the monuments and lead to further deterioration of the public spaces and monuments.

Impacts of housing: The increasing of Jerash population numbers in an accelerating way began from 1960-1980, during these years the construction of modern and new buildings spread east of Chrysorhoas River and various parcels on the western part of the city. After that the random construction and haphazard building appeared as houses and buildings on the western and eastern hills. These buildings caused filling all the gaps in downtown area with eliminating some archaeological and traditional buildings, instead of them constructing new ones.

The modern city of Jerash is expanding predominately in its buildings towards the east and northeast though there is some expansion to the south along the Mafraq highway. There is a trend to expand residential structures to the hills west of ancient Jerash, to an area along the northwest City Wall, and up the valley along the road to Birketein. Residential use is also creeping into Wadi Jerash area in that portion within the ancient City Wall. The unused police office is near the South Gate. On the west side of the Wadi Jerash as are some commercial establishments. The so-called Turkish building, located on the archaeological site below the Temple of Artemis, is used as an office and staff housing for Jerash Construction and Development Project that established by the Department of Antiquities.

All modern constructions between the Wadi Jerash and the Heritage Site distort the clearness and the quality of the setting of the archaeological remains. Some constructions, for example, the five-storey building adjacent to the South Bridge and Yahala Restaurant, are so

dominant and unfamiliar in form and character to the ambience of the Heritage Site, that they are seriously harmful to the full enjoyment of the visitor experience. The main problems of the population growth and housing are: congestion, concentration of the work place in the centre of the city, the migration from the villages to the city which is adding pressure on the services, the irregular construction and housing activities, etc. housing development was increasing pressure on the remaining fragile archaeological remains and on the later traditional houses and buildings. Many buildings were built on the banks of the Wadi have completely spoiled the natural environment and its species; the ancient terraces have been damaged, the Wadi itself has been turned into an open-air sewerage; their vicinity to the Roman bridge itself is intolerable, this way cause harmful impacts including erosion, damage to vegetation and water pollution.

Impacts of infrastructure: The growth of a city and the development of its economic power depended in a large extent on its geographical situation and its accessibility (Karampela, et al, 2014). When disclosed by a new transportation infrastructure, these areas start changing rapidly. Establishment of new services and infrastructures in the heritage sites may detract from the original monuments and their contextually significant setting. Any street, infrastructure services, and bus station need to be carefully planned so as to protect the integrity of the site. The impacts of transportation infrastructure on the cultural landscape are various, before approximately forty years; the following projects represent some of these impacts: 1) In 1984, Jerash municipality made Southward prolongation of the market street by demolition of a homogeneous group of traditional buildings (Jerash municipality, Personal communication, January 5, 2017). 2) Destruction of a number of traditional buildings in the upper part of the city in order to create a bypass road between the northern stretch of the Amman-Irbid road and the Mafraq road. 3) Demolition of the south-eastern corner tower of the Ancient City Wall for the creation of a street to serve new housing development (Jerash municipality, Personal communication, January 5, 2017). 4) To the north of the site, views of the North Gate are obscured by infrastructure cables and poles.

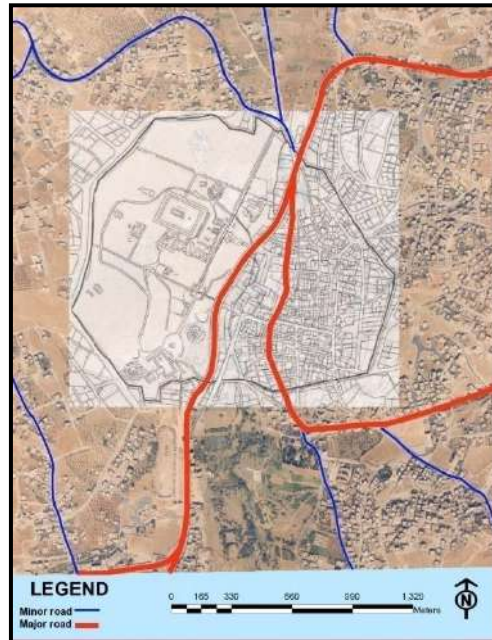


Figure 7: Roads network in Jerash city

Impacts of Amman-Irbid Road: The main urban transport service in Jerash city is Amman-Irbid road. In the late 1960, the improvement of this road played a determinant role in the future development of Jerash city. This was planned to bypass the already crowded market street by means of a new route which runs on the opposite, west bank of the Wadi (Department of Antiquities, Personal communication, January 20, 2017). This road has contributed to the continuing population growth and as a result put development pressure on the land between the older parts of modern Jerash and the road. The road from the city centre directly east towards and the link road north have been the main influences on such growth. The main road separates the Heritage Site from the modern city (Figure 7).

The most detrimental part of Amman-Irbid road system is the alignment of the international highway which cuts through the City Wall on a north-south axis. Bulldozed through the ancient city in the early 60's with complete disregard for the integrity of this outstanding antiquity, this road is a physical intrusion and pedestrian barrier which absolutely separates the ancient city from Wadi Jerash and its distinguished historic structures, the Roman Bridge and the Eastern Baths. In addition, this road caused destruction of several rock-cut tombs close to Hadrian's Arch and the obliteration of the remains of the Byzantine church of the prophets, Apostles and Martyrs.

6. Buffer zones around the city wall and the antiquities areas

This study aims to regulate the urban development and to define appropriate land-use zones around the City Wall and the Antiquities areas. The land use and buffer zone maps are essential for governing principles, strategies, and policies provide direction to land owners, developers, government staff and designers as they make land use decisions to protect the cultural landscape of Jerash archaeological site. A buffer zone is an area surrounding the nominated property which has complementary legal and/or customary restrictions placed on its use and development to give an added layer of protection to the property (UNESCO World Heritage Centre, 2008, p.25). Creating buffer zones around the City Wall and the antiquities areas requires producing modern base maps of Jerash area to be used in GIS modelling. These maps will be the rational guidance to the control of changes and planning of the built environment (Feilden & Jokilehto, 1993, p.77). They are useful in preparing archaeological zoning that guide the public, property owners and decision makers in order to control the negative impacts on the cultural landscape of Jerash site and to select alternative areas for urbanization activities and the alternative road based on different criteria. Also, the produced maps and the 3D model help more in performing more advanced analysis and studies in landscape planning.

The current boundaries of Jerash archaeological site include the traditional antiquity site within the ancient city wall and the major related monuments outside the wall, the Hippodrome, and the Triumphal Arch. Much of the Roman City Wall encircling the modern city of Jerash still remains. These boundaries are not enough to protect the integrity of Jerash site. To enable the World Heritage Committee to see and understand the boundaries of the Roman City, the ancient City Wall and the antiquities areas should be protected from the activities of modern urbanization. These activities are one of the main reasons for the failure of nominating Jerash archaeological site to be one of the World Heritage Sites. In order to inscribe Jerash site on the World Heritage List, the City Wall and the antiquities areas from the protection point of view must be contained within definable zones; therefore, the boundaries of the City Wall and the monuments outside the wall must be delineated in the urban planning to protect the cultural landscape of Jerash archaeological site, and to provide suitable development areas necessary for public use and management facilities.

Delineating buffer zones around the City Wall and the Antiquities areas will extend the conservation area control to those zones, limit urbanization activities and protect the integrity of

the site from different impacts of urbanization activities in the modern city of Jerash. For the purpose of preventing the impacts of modern urbanization, this study has been drawn buffer zones maps for two areas (the City Wall area and the Antiquities areas). Three Buffer zones of similar widths were drawn around the City Wall area and the Antiquities areas. Each one was buffered at 100 meters.

The study has been produced archaeological zoning map which including three suitable buffer zones around the City Wall and the Antiquities areas together (Figure 8):

- **Zone 1:** The City Wall and the Antiquities areas. There is poorly sited development in this zone; therefore, there is a necessity to remove most of the recent commercial and residential development and relocate Amman – Irbid road because they are situated in archaeological sensitive areas.
- **Zone 2 (0-100m):** This zone is proposed 100 meters around the City Wall and the Antiquities areas. This zone can allow for the visual setting of the archaeological site and the need to control the urbanization activities in the vicinity of the wall and the antiquities areas. Any urban development that is likely to block or interrupt the visual setting, including raising existing building heights beyond their existing three or four floors must be prevented.
- **Zone 3 (100-200m):** in this zone, the development must be controlled to protect the cultural landscape of Jerash site. It is allowed to construct visitor facilities, restaurants and parking which harmonize with the colours and materials of the archaeological and traditional remains.
- **Zone 4 (200-300m):** It is intended to protect the views and sense of the cultural landscape of Jerash site. These views have been identified, but encroachment by new buildings and increasing traffic detract from the aesthetic value of the cultural landscape. It is allowed to provide permissions for various shops and services with a greater amount of residential use and some areas of open spaces.

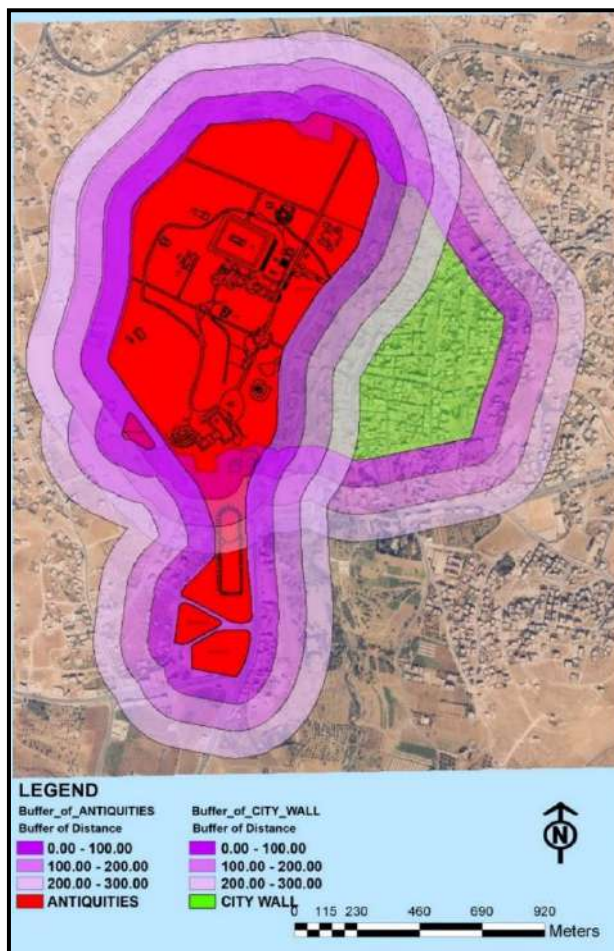


Figure 8: Zoning map for the City Wall area and the Antiquities areas

The implementation of an integrated zoning planning with legal authority for the city of Jerash would be the only practical means for effective protection to the site. That must be applied through the means of zoning at national, and regional levels; the objective of zoning being that of giving land and urban areas the destination compatible with the purposes for the protection of the cultural landscape of Jerash archaeological site from the impacts of modern urbanization.

7. Conclusion

The main aim of this study is to protect the cultural landscape of Jerash archaeological site from the impacts of modern urbanization which influenced it during the period between 1953 and 2016. Two different methods were used in this study. This study combines between the historical and practical approaches. The historical approach has explained the history of the modern city of Jerash and its urban growth during different periods. The practical one employed GIS mapping and field study to analyse the land use changes and the impacts of the modern urbanization in the

study area. These results revealed significant changes in land uses around the archaeological site. This study illustrates the changes in land use around Jerash archaeological site during (1953, 1978, 1992, 2000, 2007 and 2016). In 1953, the unused spaces have estimated at about 65.8%, whereas the modern urbanization areas covered 3.1%. In 1978, the unused spaces decreased to half while the modern urbanization areas began to increase to 24%. In 1992, the unused spaces decreased again to about 14.2%, while the modern urbanization areas increased significantly to 40.2%. In 2000, the unused spaces around the site decreased sharply to about 2.3%, the modern urbanization areas largely increased (61.8%). In 2007, the unused spaces around the site decreased gradually to 1.4%, the modern urbanization areas reached (57.8%). After nine years, the unused spaces around the site decreased gradually to about 1.8%, the modern urbanization areas are approximately still constant as in 2007 (57.6%). The cultural landscape of Jerash site was influenced negatively by these changes leading to destruction of the archaeological and traditional remains and degradation of green spaces and wildlife including flora and fauna. The results of this study also showed the current impacts of modern urbanization on the cultural landscape of Jerash site. These impacts include: tourism, commercial and urban structure impacts, and how they damage and distort the visual appearance of the archaeological monuments and traditional buildings, also they influenced the integrity and authenticity of the cultural landscape of Jerash site. Archaeological zoning maps were produced to delignate buffer zones around the City Wall and the Antiquities areas for effective protection and to limit urban expansion onto the cultural landscape of Jerash. All of these will minimize the adverse impacts on the cultural landscape of Jerash archaeological site.

8. Recommendations and managerial implications

Based on extensive literature review and land use analysis in and around the cultural landscape of Jerash Archaeological Site, recommendations and managerial implications were suggested. These will contribute in guiding decision makers, tourism planners and tourism promoters to protect the cultural landscape of the site and minimise the negative impacts of modern urbanisation and tourism development. The recommendations and implications include: 1) The City Wall should be consolidated and restored especially the east side of the wall, in order to distinguish its boundaries clearly before any archaeological zoning plan; 2) To expropriate and demolish those constructions which cause destruction and visual pollution to the archaeological

and traditional remains; 3) The cultural landscape of Jerash site needs more legislations and laws that prevent the impacts of modern urbanization on it. The Ministry of Tourism and Antiquities must modify Article No 13 from the Antiquities Law by increasing the protection distance from 5 - 10 meters to 100 meters, in order to make this law a legal instrument for the protection of the sites integrity. Also, it must provide an action plan to enforce The Temporary Jordanian Law of Preserving the Cultural and Architectural Heritage, No 49. 2003, effectively inside the City Wall and its surrounding area; 4) Establish a specific agency for the protection of the cultural landscape of Jerash and the traditional buildings inside the City Wall. The agency should be separate from, but work closely with the Department of Antiquities and the Ministry of Tourism and Antiquities. It should have final say on all planning and protection matters in the City Wall and the surrounding area; 5) Integrating the interests of all stakeholders who involved in the management, use and maintenance of the site, together with those responsible for providing the supporting infrastructure and services, such that it is compliant with World Heritage Site standards and capable of being granted World Heritage status by UNESCO in the long term; and 6) Increase the local awareness towards the benefits of inscribing the cultural landscape of Jerash site to be on the World Heritage List.

9. Limitations to the study and scope of future research

The most essential consideration in continuing research in the field of land use change analysis is the usage of high-quality data set. The truth and accurateness of land use maps are inseparable to the quality of the change result. The old 1953, 1978, 1992, 2000 and 2007 images with no ground truth points make the produced maps less accurate. Accurate ground truth data based on previous field survey, with field pictures can enrich future research on land use change. For example, the availability of reliable ground truth data for every year for which there was an image, the digitization and classification would be more precise and real than they were. In addition, the inconsistency of georeferencing some Landsat images, through assigning real-world coordinates to each pixel of the raster, was time consuming to obtain consistent data.

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