Urban Expansion Effects on Landscape Pattern:  
The case of Ramallah Area.

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Abstract

Urbanization is a worldwide phenomenon particularly in the developing countries. Urban  
expansion and changes along with its effect on the natural landscape and environmental  
consequences have been investigated. The study used a number of time sequence aerial  
photos analysis and urban landscape index model for the period 1993-2016. In addition,  
GIS and RS were applied for interpreting the results that are related to various factors in  
natural landscape change.

The study showed that urbanization rate of Ramallah area is about 60% and is much more  
in comparison to other cities of the West Bank, which is mainly driven by uncontrolled  
urban expansion process due to increasing internal migration since 1993 and up today.  
Urban expansion has brought serious loses of agricultural and natural vegetation cover that  
affected adversely on the natural landscape, in addition to variety of urban related  
environmental issues such as air and water pollution. Results also indicated a reduction in  
the forest area by about 3.5%, a reduction of 57% in the uncultivated land, and a reduction  
22% in olives groves. Such reduction in land use attributes has been accompanied by an  
increase of about 55% in urban areas. In addition, the Landscape Expansion Index (LEI)  
has changed from in-filling to edge-expansion in the first stage of urbanization process,  
then started to be an out-lying expansion landscape pattern in a later stage which is  
indicating high landscape change.

Major urban expansion areas occurred in the north-west direction of the study area where  
most of land use was classified as green area. In addition, the continuous urban expansion  
has a profound effect on the green areas, in addition to environmental, economic and social  
implications.

Key word: Urban expansion. Landscape Expansion Index. Ramallah area. Land use, GIS.

Introduction

Today the urban area has been augmented rapidly and the majority of world population  
lives within main cities as compare to the last few decades (OECD, 2012 and Shabu,  
2010). Such a quick urbanization process has an effect on existing landscape and greenery  
areas, especially when urbanization is unplanned.  
Rapid urban expansion in the Ramallah area tend to reveal noticeable spatial and temporal  
variations of landscape into the existing green areas. This process usually greatly affected
by geopolitical factors especially in the Palestinian case, and is associated other socio-economic factors (Huang et.al, 2008). Palestinian urban and socio-economic transformation that has occurred since the onset of the Palestinian Authority (1993) were the main driving factor for such a rapid and unplanned urbanization process (Hilal and Saqa 2015; Abu-Lughod Institute for International Studies, 2013; Duraidi, 2009; Taraki, 2008; Khamaisi, 2006; Roy, 2005; Coon, 2001; Leinwand, 2001 and Hilal, 1997).

In this context, the landscape changes has obtained a focus in the West Bank of Palestine since two decades, especially in the case of Ramallah area that is being considered as one of the distinctive example of landscape changes. Ramallah area has been historically characterized by a low density of urban area. However, the process of landscape changes was significantly accelerated after 1993 due to the onset of Oslo agreement between the Palestinian and the Israeli side, since then; the Palestinian authority settled in Ramallah area as the interim capital for the Palestinian statehood, and by 1995 the new residential areas extending all around the study area center and its suburbs areas, especially into the green landscape.

Such a rapid population growth with the associated urbanization was mainly directed by the internal migration from other governorates of the West Bank, whereas the net immigrants to the city was estimated at 7451 persons in 1997. This number increased in 2007 to 13500 immigrants, constituting 5.1% of the total population (Duraidi, 2009).

The influence of the immigrants is strongly visible in the land use that transform the green areas to urbanized areas, as a result of the suburbanization process that took place since the mid of 1990s.

The main objective of this study is to present the main features, dynamics and indices resulted from ongoing landscape changes in Ramallah area, a sub objective is to identify the Landscape Expansion Index and its associated landscape pattern. Also to investigate the main effect of urban expansion or agglomeration on the green landscape. In addition, to support planners and policy-maker to preserve the natural landscape and the environment of the study area, particularly the vegetative cover.

The Study area

Ramallah metropolitan area consists of three major cities; Ramallah, Al-Bireh and Betuniya where Ramallah extends on an area of 14706 dunums, Al-Bierh is 22045 dunums and Betuniya is 24000 dunums, the metropolitan area has a total population of 180000 (Ramallah, Al-Bireh and Betuniya municipality, 2015) with a growth rate of 3.5%.

The study area is mountainous and is situated in the mid of Palestine Central highland region with 850 meters elevation above sea level, 16 km north to Jerusalem. The study area comprises 15 % of the total area of Ramallah Governorate (total area of the governorate us 850 km²). The study area is also an important corridor between the southern and the northern parts of Palestine, and representing an important trading link in the past as well as currently. In addition, the prevailing climate in the study area encourages Palestinians to settle either permanently or temporarily in the area.

In addition, since the mid-1990s, the area has acquired more importance due to establishing the Palestinian authority, and thereafter an increase in jobs and employment opportunities occurred, with an increase in the economic development with a continuous expansion of suburbanization that resulted in new residential areas, especially for immigrants from the northern and western parts of the West Bank who were job seekers, all of those encourages Palestinian settled in the study area.
Map 1: The Study Area

Methodology

The data analysis about the landscape model is carried out by applying quantitative data that acquired from seven executive aerial photos between the year of 1997 and 2016. These data were then used to create a series of land use maps by directed digitizing method for seven different times spanning over 19 years: 1997, 2000, 2004, 2007, 2010, 2012, 2016. The focus of analysis was on the spatiotemporal of landscape changes, for that, the maps had 5 landscape classes: built up-area, olive groves, forest, crops field and uncultivated land.

By converting the land use of 1997 and 2016 from vector format to raster format, in order to obtain the correct result, the two raster files were orthogonal and concurrent. Then, interact old landscape classes with new landscape classes to identify the spatial and temporal changes of different landscape classes and tough simplify the interpretation of the results. This process has applied in in ArcGIS which consider as powerful and effective tools in the study of spatio-temporal changes in landscape (Long et.al, 2008).

In addition, the study used the Landscape Expansion Index (LEI) indicators (liu et.al, 2005 Limin et.al, 2015) to detect landscape expansion and associated changes over the time. This study has used landscape indices that were obtained using computation based on the ratio between the new urban areas and the total area of the urban landscape which as a result provided the characteristics of the patches of the new urban landscape. The study has
assumed different urban model (infilling, edge-expansion and leapfrog of outskirt) based on a number of studies and though the study has applied the same model (Li et al., 2013).

Results and discussion
Spatial and Temporal analysis of Landscape Change
The analysis of the land use map of the study area for 1943 shows that the Ramallah area has been dominated by agricultural land use, with also an increase in built up area that is associated with the population growth. However, in later stage; between 1948 and 1967 war, the population growth continued to increase due to the prevailing political and security conditions, at the same time the green area began to decline and urban area continued to increase since then up today (figure 1).

For all the seven chronological aerial photos, five land uses were identified in these photos; these are: Built-up area, olive groves, field crops, forest, and uncultivated land (figure 2). Analysis of these aerial photos showed a decreasing trend in the green area, in contrast to what’s happening for the built up area and land construction; where both were increased by 58%.

![Figure 1: The Built-up Area Development in the Study area: 1997-2016](image)

However, the analysis revealed that there is an increase in the built-up area from 27% in 1997 to 58% in 2016; this is due to urban expansion development that related to the rapid increase in population as a result of flourishing of economic activities. Moreover, figure 2, shows that, the forestland decreased by 3.5 %, while olive groves decrease by about 24 %, cultivated land by about 17 %, and un-cultivated land (bare land) by 55.5 % as compared between 1997 and 2016. In contrast, the built-up area increased by 54 % with an increase trend all over the researched period. In addition, the fragmentation of natural landscape may strongly influence the ecological process and the structure and function of the local environment.
However, to understand the change in landscape pattern that affected the old dominant landscape of the study area over time, and to investigate the actual landscape pattern statistically, the study has applied the Landscape Expansion Index (LEI) model to quantify the changes.

According to Xiapoing et al., 2010, the model provides three different urban landscape growth patterns which is dependent on the value of LEI that ranges from 0 to 100, the three LEI classes are:

**Infilling**: where the value of the LEI ranges from 0 to 50

**Edge-expansion**: where the value of the LEI ranges from 50 to 100

**Outlying or spontaneous growth**: where the value equals to 0

The equation that has been used to calculate LEI is the following:

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LEI = \frac{LC}{P}
\]

Where LC is the total area including the new and old built up (Both old and new urban areas between 1997 and 2016) and P is the perimeter of the new built up area after 1997.

The analysis indicates that the urbanized area increased and crossed the second level of the urban landscape hierarchy during 1997 and 2016, which is one of the most noticeable urban agglomeration in the study area, particularly the proportion of new urban patches such as rural-urban cities that is classified within the third mode of LEI (outlying expansion), such areas are located within a buffer zone of 6 Km.

However, during the period of 2007-2016 new urban areas developed, mainly taking place along the main transportation network between Ramallah area and Birzeit area. Such a newly developed area is characterized by scattered distribution and is classified into the “as outlying expansion” class of the LEI, which are mainly characterized by sporadic and separated environ patches into Ramallah area and located within 6 km distance from the centroid point of Ramallah.
These new patches have played an important role in changing the old rural landscape that was mainly green to rural-urban landscape that is mainly cemented blocks without planning for greenery recreational nor necessary infrastructure and services (Map 2).

Map 2: landscape of Ramallah Area between 1943 and 2016

**Driving force for landscape change**
There are many factors that lead to the concurrent landscape changes, in this study mainly driving factor is related to the existing geopolitical and socio-economic conditions. Due to the recent new political divisions of the West Bank as a result of the signed Oslo agreement, which has led to an appreciable increase and a concentration in the existing public institutions of the Palestinian Authority in Ramallah city. Such an increase in the public institutions was also accompanied by an intermigration from all over the West Bank to Ramallah area; leading to an increase in construction and infrastructure, and consequently resulting in major landscape change. The population between 1997 and 2015 has increase by about 146%, which is strongly related to this rapid increase in population and the associated increase in residential areas (figure 1).

The internal migration from all governorates of the West Bank towards the study area is one of the most important driving forces of landscape change since mid of 1990s up today, and it played a pivotal role in reducing the area of green landscape. Generally speaking, internal migration followed by newly urban areas is seen as an important factor of landscape change. In addition, the study area has also an economic driver that is connected
to the urban growth and population concentration into the city of Ramallah, leading to peripheral rural urbanization through newly urban areas expansion into the nearby rural areas. All these factors have empowered the economic situation in the study area by providing more job opportunities in both the public and the private sector. Statistics showed that after 1997 more than 30774 employees are now being involved into the private sectors, which is mainly due to better and diverse job opportunities with higher level of income (PCBS, 2013).

Furthermore, the study area is characterized by better infrastructure and services as compared to other cities and the surrounding rural area, amongst these services are better health, better quality of education and variety of entertainment and cultural facilities, etc. These factors encouraged the internal immigration to the study area (Shabu, 2010; Sinha, 2016; Skeldon, 2013 and De Haas, 2008).

Interviews with respondents, which has conducted in the study area, ensured that the quality of services was one of the main factors for their immigration, where the economic factor came in the first position.

The morphology of the old city and the traditional buildings are now replaced by new urban residential form and commercial centers. Moreover, in a later stage the study area has proceeded toward the new liberal cities, where at the same time maintained the role and the function as a city, but had lost the fabric and layouts of the old cities such as what is found in the cities of Nablus and Hebron.

The analysis of Ramallah area has shown new urbanism; acceleration of urban growth that associated with the concentration of population due to different reasons. Hence, the process of urbanization has driven the change on the existing landscape pattern, which is accompanied by adverse impact on environmental elements of the study area.

**Conclusion**

The increase of urban surface in the study area due to the internal migration and other factors after the mid of 1990s, accompanied with rapid increase of population causes a noticeable change in the natural landscape. Thus, the rapid and continuous expansion of the city center gradually has change the surrounding suburban and urbanized the surrounding rural landscape. Hence, Ramallah area nowadays is considered to be one of the fast growing cities in the West Bank.

Furthermore, the results indicates that the overall urban expansion rate of Ramallah area has continuously increased which affected adversely on the natural and cultural landscape, and the prediction revealed that the area will continue growing due to increasing of population.

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تأثير النمو العمراني على نمط المشهد الحضري والطبيعي: منطقة رام الله حالة دراسية

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الملخص
يعتبر التحضر ظاهرة عالمية وتميز دول العالم الثالث بشكل خاص بهذه الظاهرة نتيجة للهجرة من الريف للمناطق الحضرية. فالمقال يستعرض بعض التغيرات المرتبطة بالمشهد الحضري والبيئي ضمن حي مكاني يتمثل في منطقة رام الله من الضفة الغربية في فلسطين، وذلك من خلال التحليل الحيوي لمجموعة من الصور الجوية لفترات زمنية متتالية ما بين عام 1997-2016، باستخدام تطبيقات نظام المعلومات الجغرافية والاستشعار عن بعد. أظهرت الدراسة ارتفاعاً في نسبة التحضر لمنطقة الدراسة بما يقارب 60% حيث تعتبر نسبة مترفعة مقارنة مع باقي المدن الفلسطينية، وبعد ذلك نتيجة لارتفاع معدل الهجرة الداخلية التي رافقت عودة السلطة الوطنية الفلسطينية عام 1993 إلى التراب الفلسطيني بعد توقيع اتفاق أوسلو واتخاذ مدينة رام الله مركز السلطة الفلسطينية.

يجد الإشارة إلى أن هذا التحول ساهم بشكل ملحوظ في تغيير طبيعة المشهد الطبيعي والحضري في منطقة الدراسة ورافقه عدد من التأثيرات على بيئية المنطقة. أضاف إلى ذلك، أشارت نتائج التحليل إلى تراجع في نسبة مساحة الغطاء النباتي مع نماذج الزيادة بنسبة 3.5%، 57% من مساحة المناطق غير المزروعة و22% من مساحة أشجار الزيتون على التوالي. في حين قابل زوايا في نسبة مساحة المنطقة العمرانية بنسبة زيادة حوالي 58، ضمن مشهد عمراني أخذ نمط التركز في المرحلة الأولى ومن ثم على الأطراف في المرحلة تالية حسب (مؤشر التوزيع للمنشآت الحضرية).

بالإضافة إلى ذلك، ساهم الاحتلال الإسرائيلي في توجيه نمط المشهد الحضري في الإتجاه الشمالي الغربي، نتيجة للعادات العسكرية والعسكرية في المنطقة، مما انعكس سلباً على المشهد الحضري لمنطقة الدراسة.

كلمات مفتاحية: التوسع العمراني، مؤشر المشهد الحضري، منطقة رام الله، استخدامات الأراضي، نظم المعلومات الجغرافية