

Driving Factors of Urban Expansion in Peri-Urban Areas of Greater Cairo Region

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1 ABSTRACT

Since the early 1980s, the Greater Cairo Metropolitan Region (GCMR) has witnessed a rapid urban expansion that has been mainly concentrated in the peri-urban areas (PUAs). Most of this expansion was against urban planning laws and has presented a critical challenge to the urban environment. It has also led to spatial fragmentation and loss of enormous agriculture lands. This research analyses the urban expansion in the PUAs of the GCMR, during the period (2001-2017) using GIS and remote sensing. In addition to presenting a set of driving factors of this expansion, which were extracted from the literature review and previous studies. The results of this research show that the urban expansion rate during the mentioned period reached to 461 hectares per year. Moreover, the population growth and accessibility were the most significant driving factors in the PUA of the GCR.

Keywords: Greater Cairo region, metropolitan region, peri-urban areas, driving factors, urban expansion

2 INTRODUCTION

Urban expansion in developing countries has generally been more rapid and chaotic and the most of this expansion was directed to peri-urban areas (Mbiba and Huchzermeyer, 2002, Dutta, 2012). Peri-urban areas (PUAs) have been commonly defined as transitional zones located between the city and the countryside which are neither strictly rural nor urban (Allen 2003). The urban expansion of metropolitan cities usually occurs in peri-urban areas, where the rural villages are spread. Thereafter, a merging process happens with existing villages, which creates distorted areas in terms of land tenure, land use, access to services, and other measures of social, economic and political integration (McGregor, Simon, and Thompson 2006).

Recently, several scholars discussed the driving factors of urban expansion in the PUAs in developing countries through different case studies, for instance (Brimoh and Onishi 2007) mentioned that the migration from rural areas was the primary cause of urban expansion in the PUAs of Lagos in Nigeria. While (Lawanson, Yadau, and Salako 2012) argued in their study of Lagos and Ibadan in Nigeria that the affordable rent in PUAs was the most important factor. (Appiah et al. 2014) discussed two other factors in Ghana; the demands for new housing and the accessibility of settlements. (McGregor, Simon, and Thompson 2006) argued that speculation in the housing market is a very important factor in urban expansion process in PUAs in developing countries.

However, many of metropolitan regions in developing countries have a shortage of this kind of studies. The Greater Cairo Metropolitan Region (GCMR) in Egypt is considered one of these regions. Notwithstanding that the most of urban expansions of the Greater Cairo Metropolitan Region (GCMR) were directed to the PUAs during the last 30 years. The driving forces in PUAs have not been studied in a separate study till now, whereas the most of previous studies focused on the driving forces of urban expansion in the main urban agglomeration mainly and rarely referring to other parts out of the main agglomeration. For example, (Osman T et al., 2015) investigated the driving forces in the west part of the PUAs only. While (Mohamed 2012) presented the driving factors in the urban peripheries within 5 km only around the GCMR during his study of urban growth for Cairo. As well, (Salem 2015) showed the economic factor which influences the urban expansion process in the GCMR. On the other hand, (Nada 2014) explained the legal factor of urban expansion in the PUAs during his study of the urban expansion policies in Egyptian cities.

Therefore, the goals of this study are measure the urban expansion in the PUAs of the GCMR during 2001 – 2017, then analyse the driving factors in all PUAs within the boundary of the GCMR and finally give some recommendations for planners and decision makers to improve the plans in these areas.

3 METHODS AND DATA

3.1 Study area

Greater Cairo Metropolitan Region (GCMR) is located at latitude 30° 06' N and longitude 31 28' E. The region comprises; Main agglomeration, New Urban Communities (NUC) and peri-urban area (PUA). PUAs are situated in north and west of the main agglomeration. (see Fig. 1)

Currently, peri-urban areas represent a quarter of the region's population (approximately 5 million inhabitants). In addition, the annual rate of growth for these areas reached to 3.3%, while the average of GCR not exceed than 2.1% (Salem 2015).

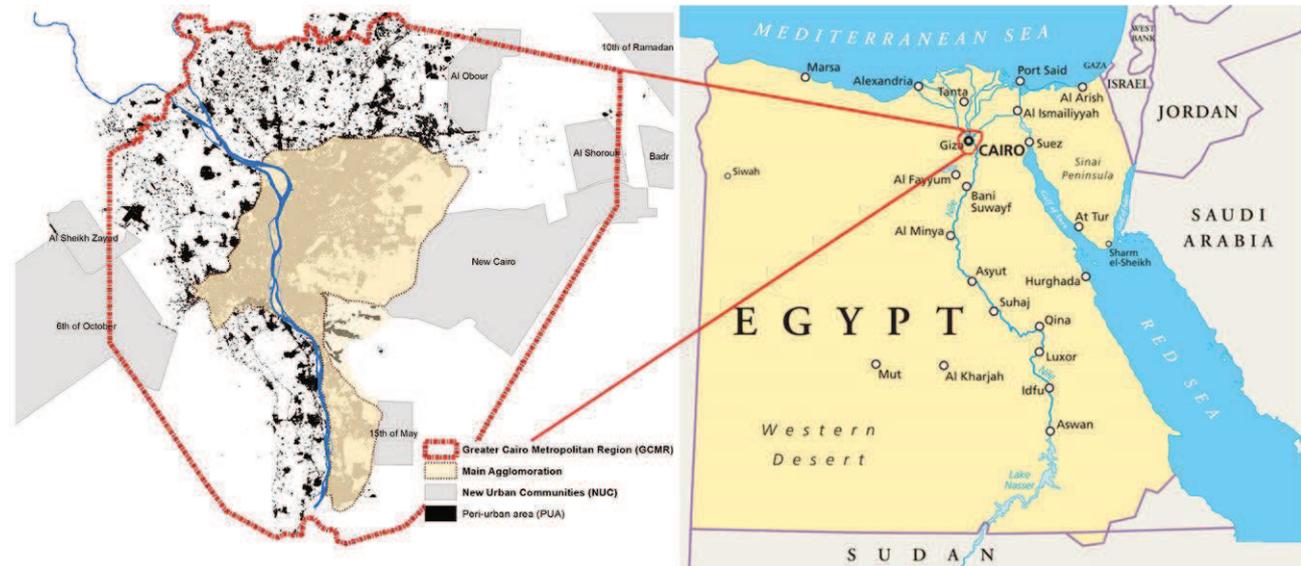


Fig. 1 Study area

The size of settlements in PUA varies greatly, from small villages and hamlets with populations of less than 5000 persons to huge agglomerations of more than 100,000 persons. Although, the role of agriculture has diminished significantly in these areas, the most of these still classified as rural areas (World Bank 2008).

3.2 Data

The basic data source for the urban expansion within the study area was Landsat imagery from 2001, 2007 and 2017. As supplementary data, 1/10,000 and 1/5000 detailed land use for 2001 and 2007 taken from land use database of General Organization of Physical Planning (GOPP) in Egypt. In addition to Google Earth Pro for reference of 2017 image. On the other hand, we used Arc GIS tools to create Triangular Irregular Networks (TIN) files in order to analyse the topography of the GCMR; therefore, a better understanding of the natural driving factor of urban expansion there.

3.3 Extraction of peri-urban area, Image Classification and Accuracy Assessment

The peri-urban areas (PUA) of Greater Cairo Region (GCR) were extracted from the Landsat images using Extract by Mask in Arc GIS. The supervised classification was applied using Arc GIS to determine the land cover type. About 150 training sites (signatures) were chosen in each image to represent four land cover classes; urban area, agricultural land, water and desert. The maximum likelihood algorithm was applied for classification process.

Later, 100 random points were selected at each classified image on a stratified random approach and compared digitally with the corresponding pixels of the original images as a reference data. Kappa index was applied to compute the accuracy, which showed accuracy rate 87.3%, 88.4% and 92.1% for 2001, 2007 and 2017, respectively.

3.4 Change Analysis

The post-classification change detection is one of the most accurate and quantitative techniques. This process was carried out using Land Change Modeler (LCM) in Terrset software. The purpose of using this technique of change detection was not only to estimate the urban expansion of urban land area between 2001 and 2017,

but also to highlight the spatial trend of change. In the light of change analysis, we could determine the most important driving factors of urban expansion in PUA.

4 RESULTS AND DISCUSSIONS

The urban expansion in PUA OF GCMR encroached on a wide area of agricultural lands between 2001-2017. The urban expansion from 2001 to 2007 was estimated at 2,300 ha, with an average loss of 383 ha per year. While, the urban expansion increased significantly from 2007 to 2017 to reach to 5400 ha, with an average loss of 540 ha per year, as shown in Fig. 2

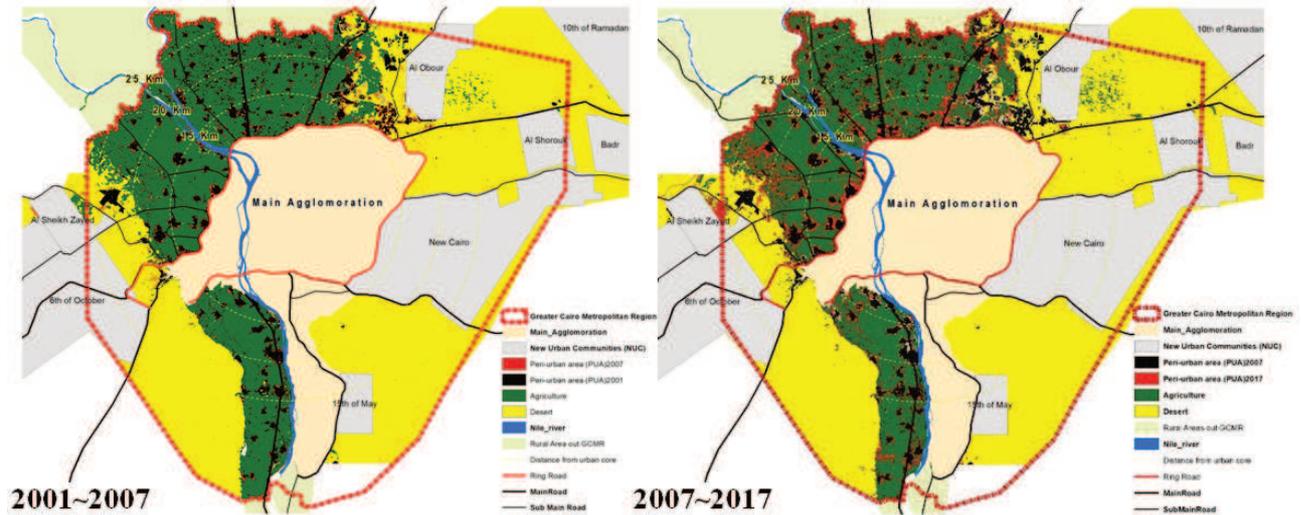


Fig. 2 Urban expansion in PUA OF GCMR from 2001 to 2007 and from 2007-2017

Urban expansion exists within agricultural areas just like scattered islands. Over the 2001-2017 period it was calculated that agricultural land lost was running at an average of 461 hectares per year, with an annual reduction of 0.73%. (The total area under agriculture was calculated to be 63,000 hectares in 2001.)

The most of urban expansion has occurred within a radius of about 20 km from the urban core of main agglomeration. The direction of urban expansion was mainly toward north and northeast, especially along or near main and sub main roads.

Some experts argue that the significant impact on the spread of urban expansion in PUAs during the last few years is a reflection of the weak of Egyptian government during and after the 25th of January Revolution (Nada 2014). However, Others argue that the high rate of urban expansion reflects the nature of housing demand and related mechanisms that governed the expansion process in GCMR .

Year	Population of PUA (1000 person)	Urban expansion in PUAs from previous census (ha)	Rate of lose (ha/year)
1986	1661.5	-	-
1996	2857.5	5120	512
2001	3412.2	2350	470
2007	3942.3	2300	383
2017*	5231.4	5400	540

Table 1. Urban expansion in PUA (Source: CAPMAS, General Census of Population and Housing, * the population estimated)

4.1 Identifying driving factors of urban expansion

The process of urban expansion in PUAs is driven by a set of factors. This section will discuss these factors, depending on the findings that were derived from the literature review and previous studies of the GCMR.

4.1.1 Population Growth

According to (MHUUC 2016) and (World Bank 2008), the primary driving force for urban expansion in the PUAs is the accelerated population growth. According to last official census, the population growth rate of PUAs reached to 3.1% annual, while the population growth rate in the main urban agglomeration not exceed

than 2% annual [15]. The increased population translated to more urban expansion. However, urban expansion in PUA outpaced population growth¹, see table 1.

4.1.2 Accessibility

According to the study of (JICA 2008) and (Osman, Divigalpitiya, and Arima 2016), the accessibility was the main factor for urban expansion in the villages around the GCMR.

The accessibility in this study was measured in terms of the connectivity to roads and railways, which facilitate the connection with main agglomeration area. The occurrence of a large part of urban expansion was observed adjacent to roads and railways that are attractive to both residents and businesses. Within the northern areas, the greatest urban expansions of settlements were happened, particularly in the following axes, (see Fig. 3.):

- First, the northeast axis (Cairo - Balbes agricultural road), where Al-khosos – Siryaqus - Abu Zabal
- Second, the north axis (Cairo - Alexandria agricultural road), where Qalyub and Sindiyun
- Third, the northwest axis (Ard AL lewa road), where Bashtil- Burtus - Manshiyyat al-Qanatir

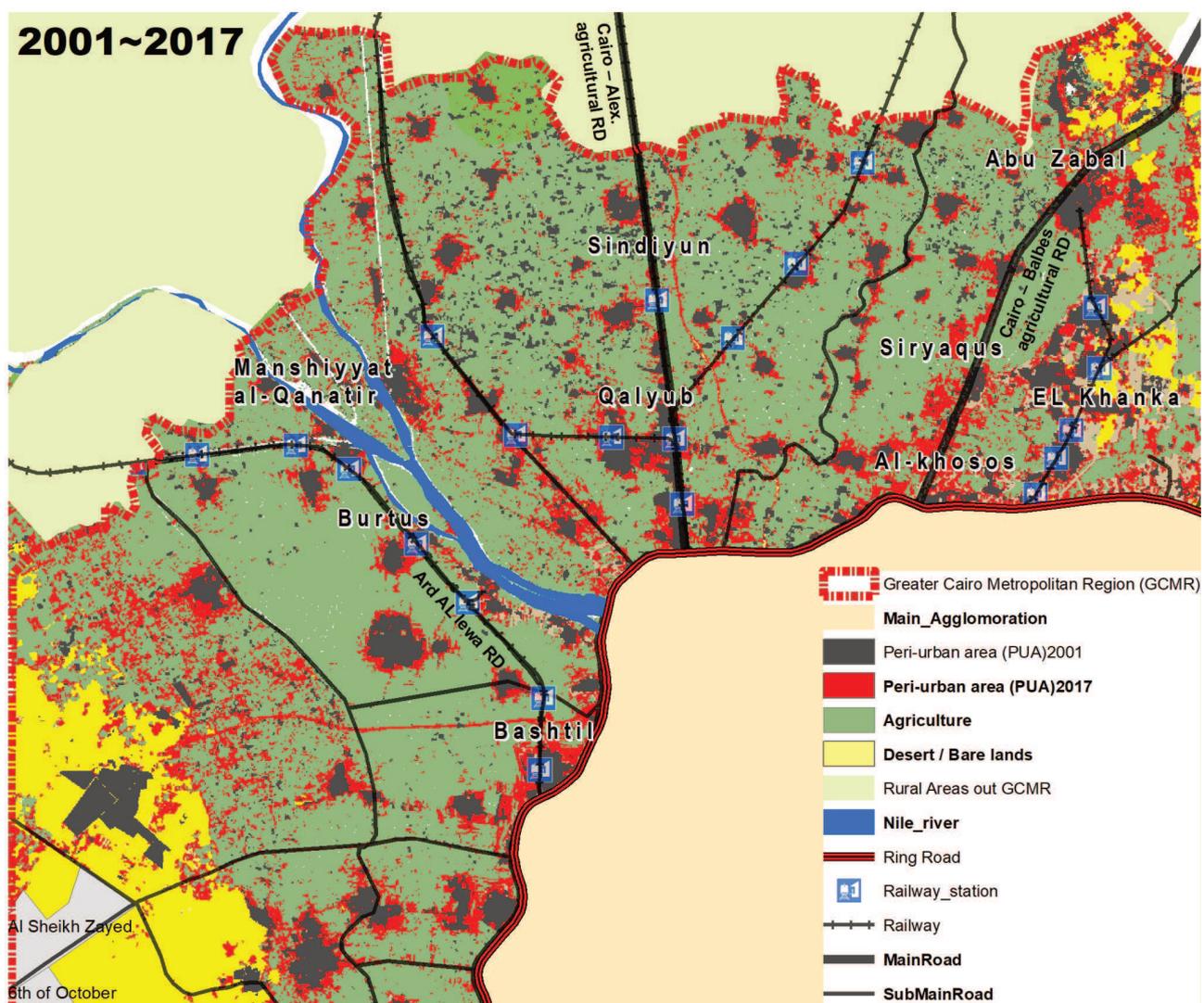


Fig. 3 The connectivity to roads in the northern part in the PUA of the GCMR

4.1.3 Topography

Based on the results of (Mohamed 2012), the regional topography was an influencing factor which drove the urban expansion toward agricultural lands, particularly in the northern frontiers. This study made an overlay

¹ Some scholars argue that the increased speculation on the agriculture lands in this area is the reason for the increase of the urban expansion than the population growth, and this point will be explained in the economic factor.

of the PUAs on a topographic layer to show how was the expansion of PUAs was directed in the light of this topography.

In general, most of the built-up area of the GCMR exist on a semi-flat area, its topography less than 70 m above sea level. This flat area extends to the north and south parallel to the Nile river. Unlike the north and the south, the topography of the eastern and western parts exceeds than 200 meters above sea level. This rugged terrain represents a constraint for urban expansion in both directions.

That's why the most of urban expansion during all expansion stages was directed mainly to the PUAs in the north and western north of the GCMR. In addition to the south but the opportunities for expansion there are limited due to the narrow agricultural plain, see the fig. 3

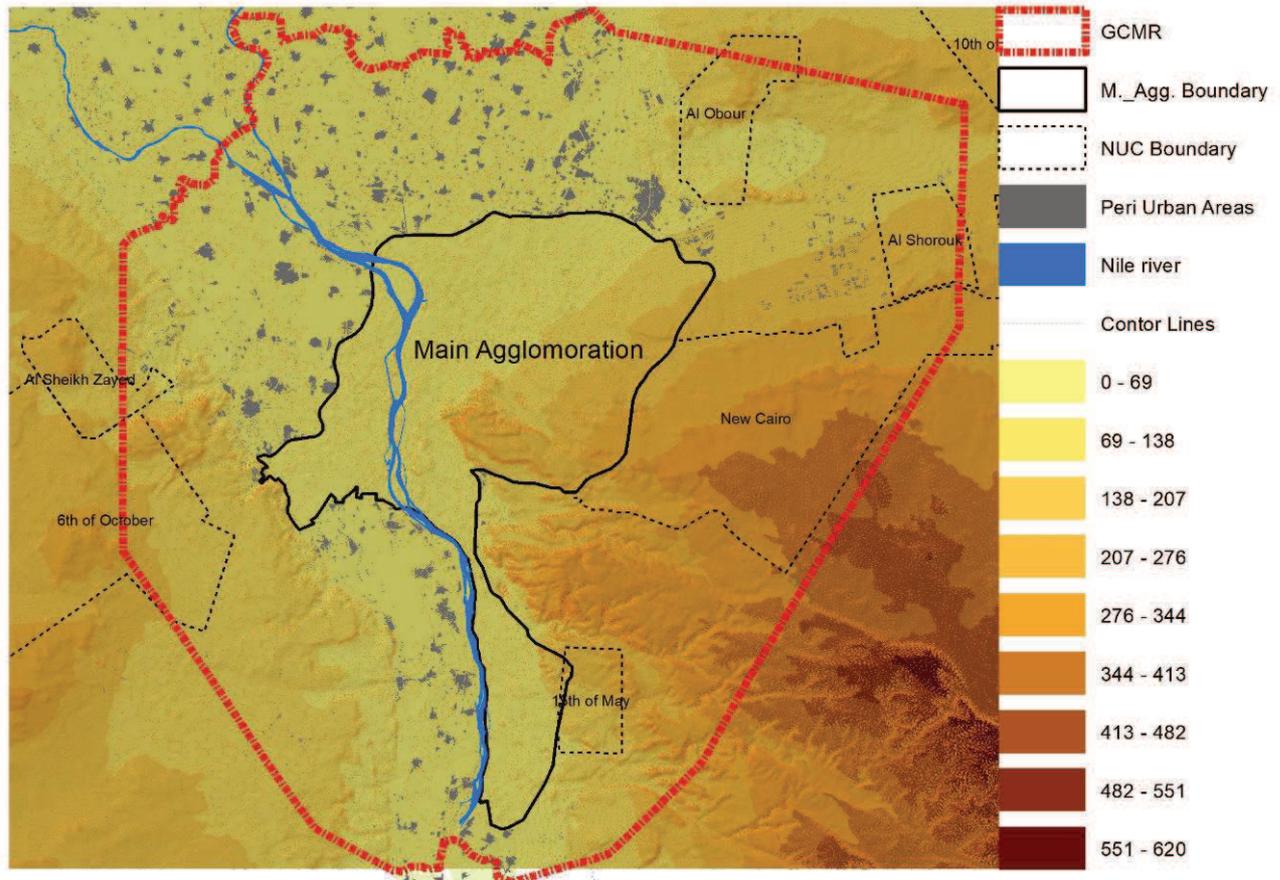


Fig. 4 Topography of GCMR

4.1.4 Economic and legal factors

Based on (MHUUC 2016) and (Salem 2015), the economic factor became one of the main driving factors for urban expansion in PUAs. There are many economic factors which push the urban expansion in PUAs. For instance, the affordable lands in PUAs are attracting the recent marriages and new immigrants, unlike the land values in the new urban communities (NUC) and the main agglomeration. At the same time, the expansion process in the PUAs is very gainful, where the price of the converted lands (from agriculture to buildings) exceed between 8 to 12 times the price of the same agricultural land (World Bank 2008). Moreover, almost all agricultural land in PUAs are privately held, so agricultural lands are easily bought and sold and subdivided into residential lands. For these reasons, the speculation on lands is very common in these areas.

On the other hand, Since urban expansion on agricultural land is officially prohibited, so the government cannot force planning procedures to manage the urban expansion in PUAs. As well as, officially the PUAs of GCMR are classified as rural, so there is no urban planning or land management carried out by government during last decades.

5 CONCLUSION

The findings of the research revealed the high rate of urban expansion in the PUAs in the GCMR, where the rate ranged between 383-540 hectare per year during the last decades. The urban expansion in (PUAs) was scattered and occurred within radius of about 20 km from the urban core of the main agglomeration. The most significant driving factors for this expansion according to the case study of GCMR were the population growth and accessibility of areas. Moreover, the topography of and land values in GCMR are contributed in direction of urban expansion towards the PUAs.

The decision makers must recognize and track the rapid population growth and the increasing concentration of urban expansion in these areas. As well, the government should utilize restricted policies to adjust urban expansion in the agriculture lands, which consider very important resource for all Egyptians. At the same time, these driving factors of urban expansion can be used to direct the future development in the GCMR and enforce planning policies

The research suggests more future research on the mechanisms of land management in PUAs, especially for the lands which situated along major roads, which the most of expansion occurred in it. The research also points to the importance of reconsidering the typology of the PUAs as rural areas. Thus, preparing the necessary plans for these areas should consider it as an integral part of the GCMR.

6 REFERENCES

- Allen, Adriana. 2003. "Environmental Planning and Management of the Peri-Urban Interface: Perspectives on an Emerging Field." *Environment&Urbanization* 15. <http://journals.sagepub.com/doi/pdf/10.1177/095624780301500103> (November 1, 2017).
- Appiah, Divine Odame, John Tia Bugri, Eric Kwabena Forkuor, and Peter Kojo Boateng. 2014. "Determinants of Peri-Urbanization and Land Use Change Patterns in Peri-Urban Ghana." *Journal of Sustainable Development* 7(6): 95–109. <http://www.ccsenet.org/journal/index.php/jsd/article/view/40299>.
- Braimoh, Ademola K., and Takashi Onishi. 2007. "Spatial Determinants of Urban Land Use Change in Lagos, Nigeria." *Land Use Policy* 24(2): 502–15. <http://www.sciencedirect.com/science/article/pii/S0264837706000846> (January 9, 2018).
- Dupont, Veronique Ed. (Centre De Sciences Humaines). 2006. "Peri - Urban Dynamics : Population , Habitat and Environment on the Peripheries of Large Indian Metropolises." In *Population (English Edition)*, , 1–151. http://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers15-11/010036511.pdf (November 1, 2017).
- Geneletti, Davide, Daniele La Rosa, Marcin Spyra, and Chiara Cortinovia. 2017. "A Review of Approaches and Challenges for Sustainable Planning in Urban Peripheries." *Landscape and Urban Planning* 165: 231–43. <http://www.sciencedirect.com/science/article/pii/S016920461730021X> (October 9, 2017).
- JICA. 2008. 1 The Strategic Urban Development Master Plan (SDMP) Study For Sustainable Development Of The Greater Cairo Region.
- Lawanson, Taibat, Omoayena Yadau, and Idris Salako. 2012. "An Investigation Of Rural -Urban Linkages Of The Lagos Megacity, Nigeria." *Journal of Construction Project Management and Innovation* 2(2): 464–81.
- McGregor, Duncan, David Simon, and Donald Thompson. 2006. *The Peri-Urban Interface. Approaches to Sustainable Natural and Human Resource Use*.
- MHUUC. 2016. *Third United Nations Conference on Housing and Sustainable Urban Development (Habitat III) Arab Republic of Egypt National Report*.
- Mohamed, Hereher E. 2012. "Analysis of Urban Growth at Cairo, Egypt Using Remote Sensing and GIS." *Natural Science* 4(6): 355–61.
- Nada, Mohamed. 2014. "The Politics and Governance of Implementing Urban Expansion Policies in Egyptian Cities." *Égypte/Monde Arabe* 11(11): 18. <http://journals.openedition.org/ema/3294> (January 15, 2018).
- Osman, Taher, Prasanna Divigalpitiya, and Takafumi Arima. 2016. "Driving Factors of Urban Sprawl in Giza Governorate of Greater Cairo Metropolitan Region Using AHP Method." *Land Use Policy* 58: 21–31. <http://dx.doi.org/10.1016/j.landusepol.2016.07.013>.
- La Rosa, Daniele, Davide Geneletti, Marcin Spyra, and Christian Albert. 2017. "Special Issue on Sustainable Planning Approaches for Urban Peripheries." *Landscape and Urban Planning* 165: 172–76. <http://www.sciencedirect.com/science/article/pii/S0169204617300774> (October 9, 2017).
- Salem, M. 2015. "Peri-Urban Dynamics and Land-Use Planning for the Greater Cairo Region in Egypt." In *WIT Transactions on The Built Environment*, WIT Press, 109–19. <http://library.witpress.com/viewpaper.asp?pcode=SD15-010-1> (January 17, 2018).
- World Bank. 2008. *Towards an urban sector strategy in Egypt*.