Land Use Land Cover Analysis of Peri-Urban Area of Murad Memon Goth-Karachi

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Abstract Agricultural activities are historically practiced in Murad Memon Goth i.e. the peri-urban (PU) region of Karachi, located on the northwestern side of Malir River. This study seeks to examine the agricultural and non-agricultural land use land cover (LULC) of the peri-urban region. A very high-resolution satellite image of the SAS planet has been used to digitize on Arc Map 10.8 for the LULC of the study area. The obtained results revealed that the estimated settlement sprawl had increased up to 9.6% in Murad Memon between 2013 and 2021. The maximum cropland area was observed by 38.86%, whereas the lowest farmhouse area was 1.76% in 2013. The highest cropland area was noted at 26.11%, but the lowest dairy farm area was observed as 1.14% in 2021. The LULC of peri-urban areas will be useful in examining Land use land cover change in the study area and identifying the encroachment of settlements in the study area.

Keywords; Urban and peri-urban agriculture, Land-use land cover analysis, object-based, urban growth boundaries, urban sprawl.

Introduction

In recent times, agriculture has been practiced in urban areas (Appeaning Addo, 2010; Jansma et al., 2022; Bhattarai and Adhikari 2023). To fulfill the basic requirement of citizens, the type of agriculture i.e. urban and peri-urban agriculture in which fresh vegetables and fruits are grown; is practiced in the vicinities of urban regions (Kausar, 2015). Murad Memon Goth is historically involved in providing fresh vegetables to the residents of the Karachi metropolis. On its western, margin Malir River passes through. Though its seasonal river water is percolated in the ground due to which agricultural activities can easily be performed in that area. Pakistan's agricultural sector's GDP per capita is estimated at 19.19%. Agriculture nevertheless is the main sector of the economy (Dethier and Effenberger 2012). Peri-urban areas of Karachi are the producers of fresh vegetables and some fruits, though Urban and Peri-urban agriculture is largely ignored by agricultural planners as well as scholars (Kausar, 2015). From 2018 to 2050, the worldwide projected urban population will increase by 2.8 billion and this 90% urban population increase will be possible in Asia and Africa (UNDESA 2019). Therefore, the number of mouths to feed will increase intensively in the metropolis of Karachi as well. Agriculture in peri-urban areas of Karachi has historically been practiced since pre-independence. Due to the distant agricultural locations, Karachi is an urban and peri-urban area predominantly adjacent to Malir River and its tributaries are famous for agricultural practices through the ages (Kausar, 2015; Ahmed et al., 2020). According to Deelstra and Girardet (2000), far beyond the physical boundaries; cities impact expenses, therefore urban agriculture is an important enterprise on which the future of cities' sustainability strongly depends. As cities are expanding, agricultural land use is being encroached upon by urbanization. It is the common trend of Karachi agricultural lands by increasing settlements. A sharp sprawl has been recorded along the west bank of Malir (Kausar et al., 2014). Murad Memon Goth lies on the Eastern part of Malir and it is connected with the edge of the western bank of Malir; urbanization is also recorded here, though its pace is slow. Obviously the agricultural land of Murad Memon is under serious threat in future because of urban sprawl. Encroachment of urban land uses on lands covers, which were previously un-urbanized, is called urban sprawl and in developing countries, it has become a recurrent phenomenon (Liu et al., 2011). Low-density development with residential and commercial activities, inaccessibility, and lack of interaction spatially, is the urban sprawl (Hamidi et al., 2015). Worldwide boundaries between rural and urban localities are set to delimit urban sprawl. In 1958 1st urban growth boundary was demarked around Lexington, Kentucky, USA (Nelson and Duncan, 1995). Citizens of any city want to move towards

less expensive lands, which is the major cause of urban sprawl that may also lead to a rule violation. The set boundaries between urban and rural lands may be deliberately marked for residential purposes. Ball et al. (2014) discussed their study area Melbourne Metropolitan in Australia, where residential land prices were affected because of urban growth boundaries and at the urban fringe, undeveloped land dealings have been recorded. This is the first study, carried out in Murad Memon Goth to assess Land use and land cover along with the urban growth boundaries dimension. Present study was aimed to assess the temporal change in urban sprawl and identify urban growth boundaries (UGBs) and land use/ land cover in Murad Memon. To justify the results of land use/ land cover satellite images were classified. Thus, the main objectives of this study were: a) to calculate the settlement sprawl during 2013 and 2021, b) to identify Urban Growth Boundaries (UGBs), and 3) to analyze and assess land use (LULCs) of the study area.

Materials and Methods

Study Area

The present study was carried out at Murad Memon Goth, which is located in the Malir agricultural region (Fig. 1). The seasonal Malir River runs throughout its northwestern margin. Its North Eastern boundary is attached to the urbanized area of Gharibabad. The southeastern boundary lies near the agricultural lands of Ghazi Dawood Brohi. The southern portion is slightly connected with the urbanized land use of Quaidabad, while the western part is close to the agricultural land use of Landhi.
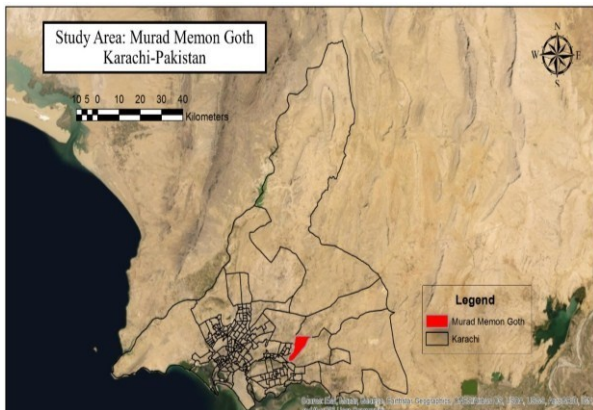

Fig. 1 Murad Memon Goth.

Google Earth Images were used to identify settlement patterns and agricultural land use/ land cover for the year 2013. SAS planet images were used to identify settlement patterns and agricultural land use/ land cover for the year 2021. Transformation in agricultural land use analyses were conducted on Google Earth and SAS planet

images manually. Landsat 8 (Table 1) for the year 2013 and Landsat 9 (Table 1) for the year 2021 were used to the assessment of unsupervised classification.

Table 1. Band configuration of Landsat 8 and Landsat 9.

Bands	Landsat 8		Landsat 9	
	Wave Length	Resolution	Wave Length	Resolution
1	0.433 to 0.453 μm	30m	0.43 - 0.45 μm	30m
2	0.450 to 0.515 μm	30m	0.450 - 0.51 μm	30m
3	0.525 to 0.600 μm	30m	0.53 - 0.59 μm	30m
4	0.630 to 0.680 μm	30m	0.64 - 0.67 μm	30m
5	0.845 to 0.885 μm	30m	0.85 - 0.88 μm	30m
6	1.56 to 1.66 μm	30m	1.57 - 1.65 μm	30m
7	2.10 to 2.30 μm	60m	2.11 - 2.29 μm	30m
8	0.50 to 0.68 μm	15m	0.50 - 0.68 μm	15m
9	1.36 to 1.39 μm	30m	1.36 - 1.38 μm	30m
10	10.3 to 11.3 μm	100m	10.6 - 11.19 μm	100m
11	11.5 to 12.5 μm	100m	11.5 - 12.51 μm	100m

### Geospatial Analysis/Techniques

In multi-band images, both Landsat 8 and Landsat 9, unsupervised classification without the analyst's intervention has been conducted to find spectral classes (cluster). For this in Arc Map Image, the classification toolbar provided access to the tools to create and analyze the clusters and therefore access to classification tools (Esri, 2022).

Recent images for the year 2021 were extracted from SAS Planet which was the platform of high-resolution images. In the SAS planet user interface select Esri → ArcGIS imagery → select base map → selection manager tool → select or edit the last selection → select area with the selection tool → select resolution from selection manager (19 in existing case) → selection same resolution from cached title map → click on start → go to stitch tab after downloading → select format, name .w in georeferencing file → select zoom → start. The images were downloaded. Downloaded images have been analyzed through transformation analysis. Land use and land cover (LULC) of the study area have been digitized (Kausar et al., 2014), and then classified (geo-coded), i.e., object-based analyses (Kausar et al., 2021, 2023, 2024). Different classes have been identified during the object-based analysis. These are agricultural land use and settlements. Agricultural land use is further classified into eight classes i.e. cropland, fallow land, orchard, ploughed land, cultivable waste, dairy farm, farmhouse, and range land.

Results and Discussion

Transformation of the Settlements

According to the map, it is observed that the settlement sprawl of Murad Memon Goth has been increasing many folds (Fig. 2). It is observed that urban growth boundaries are also affected by the western margins of Murad Memon Goth's boundary and all the settlements are growing. In 2013 the settlements' covered area was 2270795 sq. meters which was 10.26% of Murad Memon, while in 2021 settlements' covered area in the study area expanded up to 4386214 sq. meters which became 19.82 % in the year 2021. It is a matter of eight years in which sprawl 9.6% sprawl of settlements was recorded. Salvati et al. (2013) compared the differences in Land Cover Changes (LCCs) and LCRs observed during the two urban phases as a result *Per-capita* built-up area was observed to be ominously advanced in the sprawl than in the dense growth stage. Wang and Wang (2022) stated that during 2005–2030, the area of water, urban land, and other built-up land will rise by 72.56, 162.63, and 1152.67 km^2, whereas the area of woodland and fallow land will decline by 107.05 and 13.38 km.[2.]
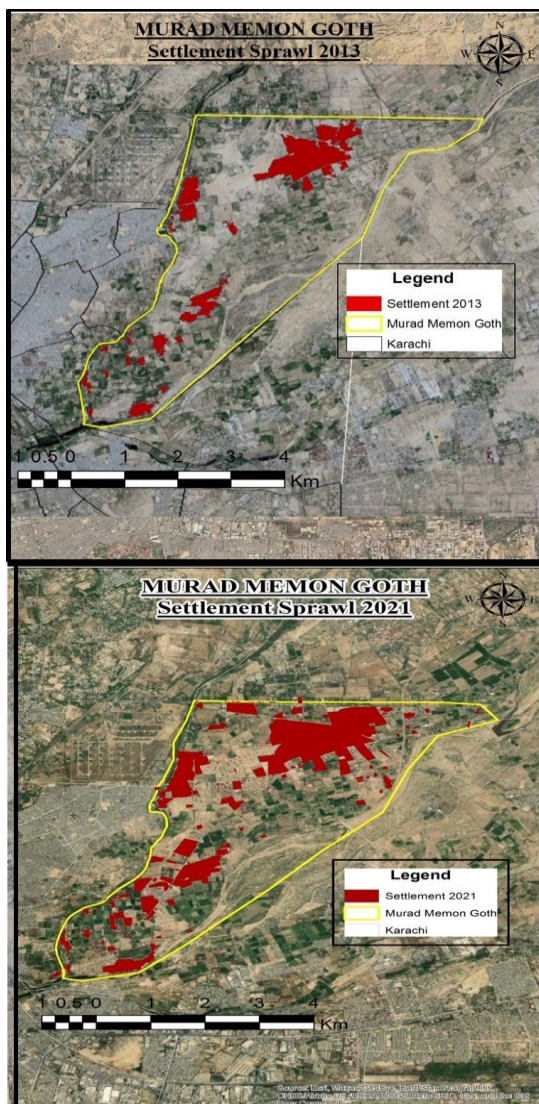
Another alarming situation arises in two settlements; Bilal Jokhio Goth and Murad Memon Goth i.e. vacant Land (Open Land) between these two settlements is going to vanish (Fig. 3). Almost 1406221 sq. meter area of open land is now part of development schemes where construction work is already completed/started. In Fig. 3 it was easily spotted in the 2021 map, where the settlement (70408.25 sq. meters) has been daunting in between Bilal Jokhio and Murad Memon localities. Though it was approximately 5% sprawl but the completely open land is part of the residential scheme now.
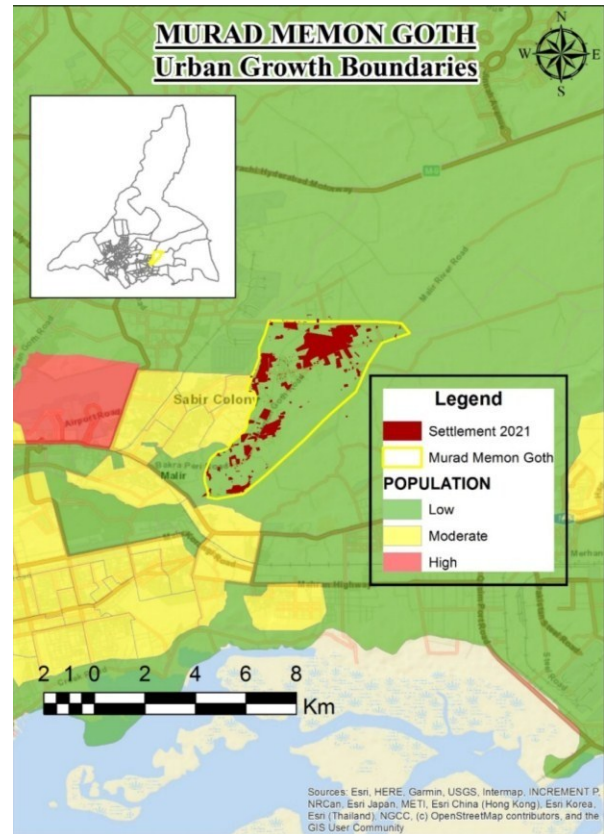

Fig. 3 Open land study area.

Violation of Urban Growth Boundaries

Sabir Colony from the western limits was completely connected with Bilal Jokhio Goth (Fig. 3) which was the locality of the study area (Fig. 4). Due to expansion in the Bilal Jhokio Goth settlement of Murad Memon is connected with the already sprawl settlement of Sabir Colony located in Gharibabad which is part of the contiguous sprawl with the Jaffer Tayer and Khokarapar. Gennaio et al. (2009) revealed that the boundary controlled most development in building regions and endorsed augmented building compactness. Normally, building density is enhanced in the building regions but reduced outside the building areas. Liang et al. (2018) determined that the process could support urban planning by making possible patterns for urban growth boundaries (UGBs) under different planning situations.
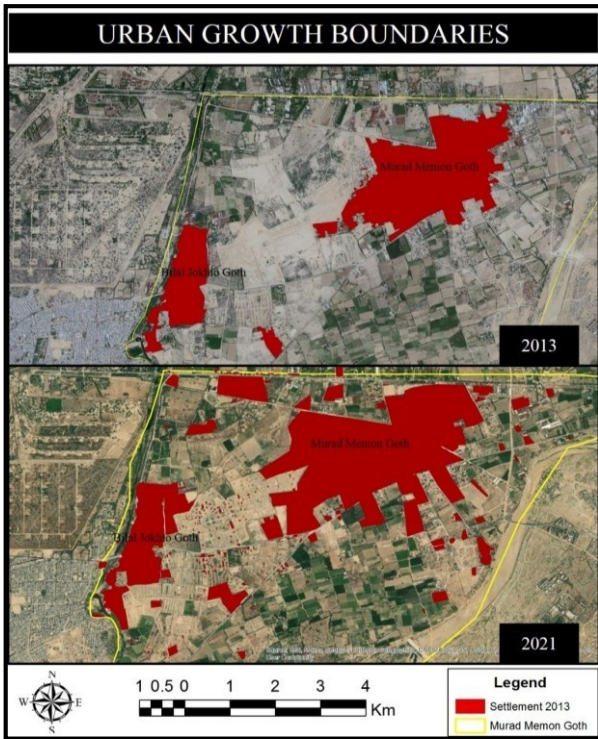
Fig. 4 Urban Growth Boundaries 2021.

Agricultural Land-Use Comparison between 2013 and 2021

By the comparison in Land-Use and Land Cover (LULC) analysis, the decline in cropland has been observed as 12% (Table 2). There is an increase in cultivable waste recorded which was observed as 6%, and cropland, fallow land, and ploughed lands are collectively called productive land for cropping (Table 2). In the year 2013, the productive land of the study area was 61%, which is in a declining situation, as observed in 2021. Productive land declined by 58.9%. Therefore, a 2.09% decline has been recorded. Rangelands which are the habitat of natural fauna and flora have declined by 8.3%. It is observed in Figure 5a, that some of the range lands are converted into orchards which is at least a good sign in terms of fact, i.e. the land is still involved in agricultural activity. There is no major change in farmhouses, only 0.59% of the land has been increased in this category on one hand while on the other hand a minor decline in dairy farms has been recorded. The land use/land cover analysis map (Fig. 5a) of Murad Memon depicts the existing situation of Land use and Land cover of the study area very clearly which indicates that urban sprawl assimilates fertile agricultural land slowly but at a gradual pace. Figure 5b clearly shows there is sharp growth in the build-up land of Murad Memon Goth, which encroached over the agricultural land of Murad Memon. It is a matter of just eight years that the build-up area is enhanced in a such rapid manner. Suryanata (2002) suggested an alternative method to developing Hawaii's diversified farming. Moreover, the networks of social actors that comprise growers, processors, gourmet chefs, retailers, and customers have been able to generate feasible expanded farming despite the globalized agro-food methods.

Table 2. Land-Use and Land Cover (LULC) Analysis of Murad Memon Goth.

| S. NO.	Agricultural Land-Use	Year 2013*		Year 2021		% Change
		Area (Sq. m)	% Area	Area (Sq m)	% Area	
1	Crop Land	7260039.056	38.8672198	2870873	26.11056867	-12.7567
2	Fallow Land	1406791.287	7.531373559	1204208.389	10.95226638	3.420893
3	Orchard	820991.4941	4.395245895	991747.6254	9.019937307	4.624691
4	Ploughed Land	2732761.688	14.63006581	2405251.078	21.87574074	7.245675
5	Cultivable Waste	434025.3553	2.323590652	917460.1667	8.34429342	6.020703
6	Dairy Farm	370224.9678	1.982029999	125955.5948	1.145565202	-0.83646
7	Farm House	330130.3082	1.767379921	259735.2222	2.362289922	0.59491
8	Range Land	5324115.779	28.50309436	2219830.105	20.18933836	-8.31376
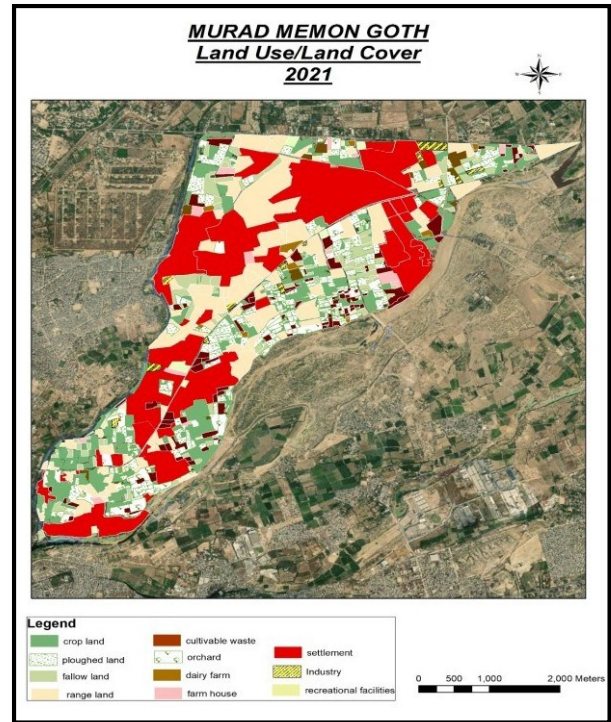
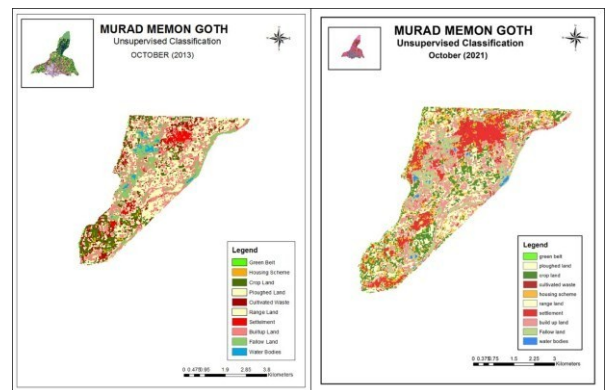*Fig. 5a* Murad Memon's Landuse/Land Cover Distribution.

Fig. 5b Unsupervised classification on Landsat 8 (2013) Landsat 9 (2021).

Conclusion

It was concluded that the settlement sprawl has been identified in Murad Memon Goth which is located near the rest of the urbanized neighborhood. It was estimated that settlements' sprawl increased in Murad Memon from 2013 to 2021. Another prominent change is the conversion of open land into a settlement. Two Goths (villages/rural localities) in the vicinity of Murad Memon administrative boundary i.e. Bilal Jokhio and Murad Memon Goth itself encroached on approximately 140622 sq. km of open land. Another important pattern has been observed i.e. Sabir Colony which was previously a small settlement, now connected with an already well-urbanized settlement. This encroachment is the occurrence of UGB (Urban growth boundaries), land use, and land cover analysis map, which depicts urban sprawl assimilates fertile agricultural land use gradually. In only eight years build-up lands in Murad Memon increased rapidly.

Acknowledgment

References

Ahmed, R., Khan, S. H., Mahmood, K. (2020). Evaluation of the irrigation water quality and cropped area of shrinking peri-urban agriculture in the Gadap Basin, Karachi: An application of Wilcox's classification and geospatial techniques. *Irrigation and Drainage*, **69**(5), 1106-1115.

Appeaning Addo, K. (2010). Urban and peri-urban agriculture in developing countries studied using remote sensing and in situ methods. *Remote Sensing*, **2** (2), 497-513.

Ball, M., Cigdem, M., Taylor, E., Wood, G. (2014). Urban growth boundaries and their impact on land prices. *Environment and Planning*, **46**(12), 3010-3026.

Bhattarai, K., Adhikari, A. P. (2023). Promoting urban farming for creating sustainable cities in Nepal. *Urban Science*, **7**, 54.

Deelstra, T., Girardet, H. (2000). Urban agriculture and sustainable cities. Bakker N., Dubbeling M., Gündel S., Sabel-Koshella U., de Zeeuw H. Growing cities, growing food. Urban agriculture on the policy agenda. Feldafing, Germany: Zentralstelle für Ernährung und Landwirtschaft (ZEL), 43-66.

Dethier J.J., Effenberger, A. (2012). Agriculture and development: A brief review of the literature. *Economic Systems*, **36**(2), 175-205.

Esri. Access on 21/9/2022. https://desktop.arcgis.com/en/arcmap/latest/extensions/spatial-analyst/image-classification/what-is-image-classification.htm#ESRI_SECTION1 _BB176EE6A3F343E3A6F5F204601204D5

Gennaio, M. P., Hersperger, A. M., Bürgi, M. (2009). Containing urban sprawl-Evaluating effectiveness of urban growth boundaries set by the Swiss Land Use Plan. Land use policy, **26**(2), 224-232.

Hamidi, S., Ewing R., Preuss I., Dodds, A. (2015). Measuring sprawl and its impacts: An update. *Journal of Planning Education and Research*, **35**(1), 35-50.

Jansma, J. E., Wertheim-Heck, S. C. (2022). Feeding the city: A social practice perspective on planning for agriculture in peri-urban Oosterwold, Almere, Netherlands. Land Use Policy, 117, 106104.

Kausar, A. (2015). Spatial assessment of truck farming and its commercial potential in Karachi through SRS/GIS techniques. Ph.D. theis, University of Karachi. Karachi.

Kausar, A., Mahmood A., Ahmed, R. (2014). Spatio-temporal transformation in agricultural land-use patterns in Karachi using geo-spatial techniques: A case study along West Bank of Malir. *Journal of Basic and Applied Sciences*, **10**, 414-418.

Kausar, A., Afsar, S., Wazir, Z., Lahori, A. H., Afzal, A., Arif, J., Sydorenko, V., Pruskyi, A., Tyshchenko, V. (2021). Land use analysis of Central Business District (CBD) of Metropolis Saddar Karachi through SRS/GIS techniques. *Ecological Questions*, **33**(1). https://doi.org/10.12775/EQ.2022.009.

Kausar, A., Afzal, A., Saeed, G., Maqsoom, A., Khan, O. I., Afsar, S., Anis, Y., Zehra, S. M., Vambol, V., Vambol, S. (2023). Land-Use/Land Cover analysis through object based technique: A case study of Shahrah-e-Faisal. *Ecological Questions*, **34**(2), 1–15. https://doi.org/10.12775/EQ.2023.024.

Kausar, A., Zubair, S., Sohail, H., Anwar, M. M., Aziz, A., Vambol, S., Vambol, V., Khan, N. A., Poteriaiko, S., Tyshchenko, V., Murasov, R., Ejaz, F., Khan, O. I. (2024). Evaluating the challenges and impacts of mixed-use neighborhoods on urban planning: An empirical study of a megacity, Karachi, Pakistan. *Discover Sustainability*, **5**(1). https://doi.org/10.1007/s43621-024-00195-5

Liang, X., Liu, X., Li, X., Chen, Y., Tian, H., Yao, Y., (2018). Delineating multi-scenario urban growth

boundaries with a CA-based FLUS model and morphological method. *Landscape and Urban Planning*, **177**, 47-63.

Liu, Y., Yue, W., Fan P. (2011). Spatial determinants of urban land conversion in large Chinese cities: A case of Hangzhou. *Environment and Planning B: Planning and Design*, **38**(4), 706-725.

Nelson, A.C., Duncan, J.B. (1995). Growth Management: Principles and Practice, American Planning Association, Chicago, IL.

Salvati, L., Sateriano, A., Bajocco, S. (2013). To grow or to sprawl? Land cover relationships in a Mediterranean city region and implications for land use management. *Cities*, **30**, 113-121.

Suryanata, K. (2002). Diversified agriculture, land use, and agrofood networks in Hawaii. *Economic Geography*, **78**(1), 71-86.

UN Department of Economic and Social Affairs. (2019). http://creativecommons. org/licenses/by/3 .0/igo/

Wang, Q., Wang, H. (2022). Spatiotemporal dynamics and evolution relationships between land-use/land cover change and landscape pattern in response to rapid urban sprawl process: A case study in Wuhan, China. *Ecological Engineering*, **182**, 106716.