International Cartographic Association
Association Cartographique Internationale

Mapping the spatial profile and susceptibility of illegal land occupation: A case study of the Cape Town Metropolitan area, South Africa

Curtis J Bailey [a,*], Kyle Loggenberg [a]

[a] *Department of Geography and Environmental Studies, Stellenbosch University, cbailey@sun.ac.za, kyleloggenberg@sun.ac.za*

* Corresponding author

Keywords: informal settlements, illegal land occupation, susceptibility mapping, spatial modelling

Abstract:

Illegal land occupation has become a major challenge to sustainable development in urban areas[1]. Developing countries, such as South Africa, experience a greater incidence of illegal land occupation due to rapid urbanisation, high unemployment rates, and shortages in land ownership amongst historically disadvantaged individuals (Hendricks & Pithouse 2013.; Mkhize 2014). Illegal land occupation presents various environmental hazards, impedes effective governance, and contributes to economic losses (Mutero & Makwara 2018). Analysing the spatial characteristics of illegal land occupation can drive effective policy development, deter illegal land use cases, and help determine areas susceptible to illegal land invasions. However, limited research has been done on the spatial dynamics of illegal land occupation. The absence of comprehensive spatial information pertaining to illegal land occupation is, therefore, the primary motivation for this research. This abstract presents a preliminary case study on the Cape Town Metropolitan Area and aims to map land areas' susceptibility to an illegal land invasion.

The selection of variables used to create the susceptibility model was primarily literature-driven and comprised proximal, socio-economic and environmental factors which have historically exerted influence on the site selection of informal settlement establishments (Sirueri, 2015, McCartney & Krishnamurthy, 2018). The informal settlement and proximity data used to train the model covers the historical period up to 2018 and were obtained in shapefile format from the City of Cape Town's spatial data portal. The rasterised terrain data were obtained from Stellenbosch University's Centre for Geographical Analysis. Prior to analysis, all data were subjected to geometric and logical consistency checks to ensure data quality. Table 1 provides an overview of the variables used in the study.

Spatial metric	Variable
Proximity	1. Areas of Informality 2. Nature Reserves/Parks 3. Bus Routes 4. Public Health Facilities 5. Industry 6. Landfill Sites 7. Police Stations 8. Taxi Routes 9. Rivers 10. Wetlands 11. Land Use and Land Cover (LULC)

[1] According to the Western Cape Provincial Government, illegal land occupation refers to the act of unlawfully occupying land for the purpose of establishing a settlement upon it. Connotations such as 'squatting' and 'land invasion' have also been used to contextualise the illegal occupation of land in existing literature and policies. Settlements which arise as the result of illegal land occupation are thus referred to as 'informal settlements' or 'areas of informality' (AOI's).

https://doi.org/10.5194/ica-abs-6-12-2023

Terrain	1. Elevation (DEM) 2. Slope 3. Curvature 4. Aspect

Table 1. List of variables used for analysis and modelling.

Using the variables listed in Table 1, the study followed a simplistic approach to create a predictive model to determine how susceptible an area would be to illegal land occupation. The model was built using random forest regression (mtry = 10 and ntree = 500) and utilised samples of prevalence (points representing known areas of illegal/informal settlements) and pseudo-absence (points representing areas with no known presence of illegal occupation) as input. A total of 1902 samples were collected (951 points per class), with 70% used to train the model and 30% used for validation. The model sensitivity values were used to define a threshold value of 0.88, which was then used to classify the predicted probability values as points of prevalence or absence. The model produced an r^2 value of 0.77, demonstrating that the model could explain 77% of the variability in the validation data. Root Mean Square Error (RMSE) and Mean Absolute Error (MAE) values of 0.25 and 0.06, respectively, indicate that the average error between the predicted and actual values was low, suggesting that the model has substantial predictive capability.

An equal-interval classification scheme (with class intervals of 0 – 0.33, 0.33 – 0.66, 0.66 – 1.0) was used to partition susceptibility likelihood into three classes (low, medium and high) for visual purposes. The modelled results (Figure 1) show that areas most suspectable to illegal land occupation for informal settlement establishment are those which immediately border the periphery of existing areas of informality, whereafter a distance-decay relationship is observed. Similarly, industrial areas – including the CBD – also exhibit relatively high to medium susceptibility.

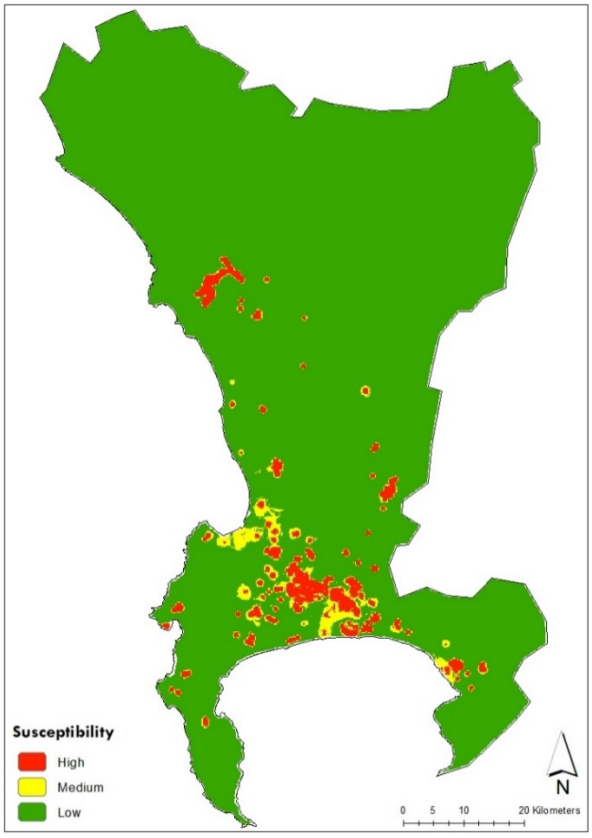

Figure 1. Susceptibility to illegal land occupation.

Additionally, a form of qualitative validation was performed on the resulting susceptibility raster using illegal land occupation site data that took place after 2018, specifically for the 2020-21 period. The post-2018 illegal land occupation incidence was overlayed on the susceptibility raster (Figure 2) as polygons to visually assess if they occurred in areas deemed to be susceptible to illegal land occupation per model output. Visual inspection of this showed that new sites of illegal land occupation occurred predominantly within regions classified as having high to medium susceptibility by the model. Furthermore, summary statistics computed for the overlay supported this notion, as

https://doi.org/10.5194/ica-abs-6-12-2023

94% of all new illegal land occupation sites occurred within high susceptibility zones, suggesting strong model performance.

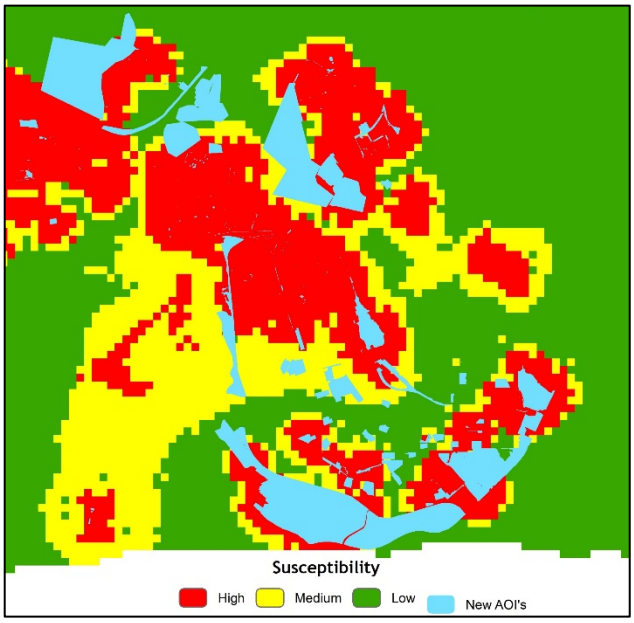

Figure 2. Location of post 2018 illegal land occupation (AOI) with respect to modelled susceptibility.

Illegal land occupation is a persistent challenge for the City of Cape Town, presenting the municipality with a variety of social, economic and environmental implications and challenges. Our results show that the central, and fringes of the metropole, where large areas of informality already exist, are most susceptible to illegal land occupation along with industrial areas. This spatial configuration is not surprising as it reflects not only the lasting impact of historical Apartheid spatial planning policies but also recent exacerbated rural-urban migration patterns due to increased economic stress. Thus, unless these issues are addressed, illegal land grabs are expected to persist into the future. Furthermore, the model presented here demonstrates only a single probabilistic approach to profile susceptibility and may benefit from the inclusion of more socially structured parameters or by using simplified overlay and refined expert knowledge approaches.

References

Hendricks, F. and Pithouse, R., 2013. Urban land questions in contemporary South Africa: The case of Cape Town. The promise of land. Undoing a century of dispossession in South Africa, pp.103-129.

Sirueri, F., 2015. Comparing spatial patterns of informal settlements between Nairobi and Dar es Salaam (Doctoral dissertation, Unitversity of Twente).

McCartney, S. and Krishnamurthy, S., 2018. Neglected? Strengthening the morphological study of informal settlements. SAGE Open, 8(1), p.2158244018760375.

Mkhize, N., 2014. Game farm conversions and the land question: unpacking present contradictions and historical continuities in farm dwellers' tenure insecurity in Cradock. Journal of Contemporary African Studies, 32(2), pp.207-219.

Mutero, W. and Makwara, T., 2018. The Economic impact of illegal land invasion: a case study of lwandle informal settlement, Cape Town, South Africa. International Journal of Economics, Commerce and Management, pp.47-58.

https://doi.org/10.5194/ica-abs-6-12-2023 |