Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Planning for cooler cities in Ghana: Contribution of green infrastructure to urban heat mitigation in Kumasi Metropolis

Isaac Sarfo [a,m,1], Shuoben Bi [b,c,*], Xiuhua Xu [d], Emmanuel Yeboah [e], Clement Kwang [f], Michael Batame [g], Foster Kofi Addai [f], Umar Wakil Adamu [f], Emmanuella Aboagye Appea [f], Michael Atuahene Djan [h], Henry Bortey Otchwemah [i], Vanessa Elikem Kudoh [f], Floribert Vuguziga [j,n], Olumide Samuel Olowe [k,2], John Ernest Koku [l]

[a] College of Geography and Environmental Science, Henan University, 475004 Kaifeng, Henan, China
[b] Research Base for Scientific Cognition and Protection of Culture Heritage, Nanjing University of Information Science & Technology, Nanjing, Jiangsu, China
[c] School of Geographical Sciences, Nanjing University of Information Science and Technology, 210044 Nanjing, Jiangsu, China
[d] Computer and Data Engineering College, NingboTECH University, Qianhu South Road, 315100 Ningbo, Zhejiang, China
[e] School of Remote Sensing and Geomatics Engineering, Nanjing University of Information Science and Technology, 210044 Nanjing, Jiangsu, China
[f] Department of Geography & Resource Development, University of Ghana, Legon, Ghana
[g] Department of Natural Resources Management, University of Twente, Enschede, the Netherlands
[h] Department of Geography, New Mexico State University, USA
[i] Pheebes Consult Limited, Accra, Ghana
[j] Key Laboratory of Meteorological Disaster of Ministry of Education (KLME), Collaborative Innovation of Meteorological Disasters (CIC-FEMD), Nanjing University of Information Science and Technology, Nanjing 210044 Jiangsu, China
[k] Department of Animal Sciences, Purdue University, 270 S Russell Street, West Lafayette, IN, 47907, USA
[l] Department of Social Sciences, Central University, Miotso-Tema, Ghana
[m] Organization of African Academic Doctors (OAAD), Off Kamiti Road, P. O. Box 25305000100, Nairobi, Kenya
[n] Rwanda Meteorology Agency (MeteoRwanda), Kigali, Rwanda

ARTICLE INFO

Keywords:
Garden city
Grand urban model
Land use
Urban heat island
Urbanization

ABSTRACT

This study investigates the spatial variability of some remote sensing indices representing built-up areas, vegetation, bareness, and urban heat island (UHI), based on time-series Landsat TM/ETM+ and OLI/TIRS datasets archived for 1980–2020 period from the US Geological Survey's website for Kumasi Metropolitan Area in Ghana. Modules for Land Use Change Evaluation (MOLUSCE) and Cellular Automata Artificial Neural Network (CA-ANN) algorithms and simulations in QGIS were used to predict future changes (2020–2050) for land-use systems in Kumasi. Findings revealed urbanization/built-up areas (+108.02%) contributed massively to the decline of forest areas (−93.34%) and farmlands/shrubs (−31.53%), thereby making Kumasi lose its once critical green position as the "*Garden City of West Africa.*" UHI moderately and strongly correlated positively against built-up (R^2=0.78, $p < 0.0001$) and bareness (R^2=0.96, $p < 0.0001$) indices, respectively. By contrast, UHI showed a statistically significant inverse relationship with the vegetative index (R^2=0.97, $p < 0.0001$). Future land-use scenarios revealed more forests, waterbodies, and farmlands/shrubs will be lost, influencing urban temperature and water supply. The multipurpose advantages of urban green space are ingrained in the grand urban model. Contextually, the Metropolis's resilience has been hampered by inconsistency in the performance of institutional roles, competition for land ownership rights over green areas, and little investments or prioritization of green spaces. An integrated collaborative governance framework is proposed to unify actions, address power crisis and factors that influence governance of green infrastructure, UHI and land cover change.

* Correspondence to: 210044 Nanjing, Jiangsu, China.
E-mail addresses: sarfo.power@gmail.com (I. Sarfo), bishuoben@163.com (S. Bi), xiuhua_x@163.com (X. Xu), emmanuelyeboah@nuist.edu.cn (E. Yeboah), ckwang@ug.edu.gh (C. Kwang), michaelbatame8@gmail.com (M. Batame), fkaddai001@st.ug.edu.gh (F.K. Addai), umarwakil6030@gmail.com (U.W. Adamu), appeaella@gmail.com (E.A. Appea), michaelatuahenedjan@gmail.com (M.A. Djan), henrybortey@gmail.com (H.B. Otchwemah), kudohvanessa@gmail.com (V.E. Kudoh), vfloribert@nuist.edu.cn (F. Vuguziga), oloweolumides@gmail.com (O.S. Olowe), johnniekoku@gmail.com (J.E. Koku).
[1] ORCID ID: https://orcid.org/0000-0002-6914-5764
[2] ORCID ID:0000-0002-1677-492X

https://doi.org/10.1016/j.landusepol.2023.106842