Urban Green Infrastructure Loss (2002-2022) and its Environmental Implications in Malawi's Urban Areas

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Abstract:

Rapid urbanization poses a major challenge to environmental sustainability and requires the integration of ecological principles into urban planning. This study analyses the environmental impact of urban green infrastructure (UGI) loss in Malawi’s largest cities: Blantyre, Lilongwe, Mzuzu and Zomba. Remote sensing analyses were used to investigate the changes in land use and land cover between 2002 and 2022. The results show a significant decline in green spaces, with built-up areas increasing at the expense of vegetation and water bodies. Encroachment into natural landscapes threatens biodiversity and water quality and exacerbates the effects of the urban heat island. The annual rates of change emphasize the urgency of proactive measures to preserve UGI and promote sustainable urban development. Despite the policy commitment to sustainability, challenges persist due to insufficient coordination and funding. Addressing these problems requires evidence-based strategies and policies tailored to the Malawian context. By understanding the consequences of UGI loss and implementing targeted solutions, Malawi can strive to build healthier, more resilient, and sustainable cities.

Keywords: Urban Green Infrastructure, Land Use and Land Cover, Environmental Implications, Sustainable Urban Development, Malawi.

Introduction

With rapid urbanization amplifying environmental concerns, integrating ecological principles into modern city planning is crucial for achieving sustainable development(Bera, et al, 2023; Heymans, et al, 2019). This comprehensive approach aligns perfectly with several United Nations Sustainable Development Goals (SDGs), specifically goals 6 (clean water and sanitation), 8 (decent work and economic growth), 11 (sustainable cities and communities), 13 (climate action), 14 (life below water), and 15 (life on land). As cities grow rapidly and ecosystems strain under the weight of human activity, urban Green Infrastructure (UGI) has risen to the forefront, promising to create cities that are not only functional and aesthetically pleasing but also sustainable and resilient in the face of environmental challenges(Yuan, et al, 2022; Zhang, et al, 2023). Climate change is driving a surge in urban vulnerability, with increasing weather variability impacting cities on both short-term and long-term scales. This underscores the critical need for urban sustainability and resilience.
Research demonstrates that these concepts are not just about environmental protection, but also about ensuring the social and economic well-being of urban populations (Egerer et al., 2021; Elmqvist et al., 2019). UGI, for instance, plays a vital role by equipping cities with the resilience needed to thrive in a changing climate and is key to achieving urban sustainability (Pamukcu-Albers et al., 2021). The vast array of challenges facing cities, from the 70% contribution to global greenhouse gas emissions (Elmqvist et al., 2019), to urban flooding and heat islands (Feyisa, Dons, & Meilby, 2014; Quaranta, Dorati, & Pistocchi, 2021), can be mitigated or even eradicated by implementing robust sustainability and resilience measures, such as those championed by UGI. Despite recognizing the importance of preserving UGI, Malawi faces several limitations in effectively addressing this issue as it is currently struggling with rapid and unplanned urban expansion, which is leading to significant environmental and social impacts, as outlined in a World Bank report (World-Bank, 2022). This expansion has led to a significant loss of forest cover due to deforestation of land for agriculture and fuelwood extraction, coupled with unsustainable agricultural practices leading to soil degradation. The escalating trends of urbanization and population growth combined with inadequate regulatory frameworks are exacerbating the disappearance of green spaces that play a critical role in providing environmental services that are essential for maintaining ecological balance and improving the overall quality of life.

Given the potential of UGI to provide multiple ecosystem services to urban populations (du Toit et al., 2018), it is essential to understand its importance in the context of Malawi. UGI can effectively coordinate environmental, social, and economic development and prove to be a crucial strategy for achieving sustainable development. However, there is an urgent need for a comprehensive understanding of the problems, impacts and solutions related to UGI in developing cities like the selected case studies in Malawi. Although the 2019 National Urban Development Policy (GoM, 2019) expresses a commitment to promoting sustainable, competitive and resilient cities, the practical implementation of these goals faces significant barriers. The lack of coordination and coherence between different sectors and policy levels are significant hurdles that hinder the successful implementation of urban GI projects and the achievement of the policy’s overarching objectives.

Regarding the above facts and while studies on UGI in Malawi exist, there is a significant gap exists in comprehensively evaluating its potential environmental implications in urban areas. Existing research has primarily focused on specific aspects like UGI policy, UGI fragmentation, a holistic approach that considers its full influence on the environment amidst evolving urban conditions in Malawi has been limited. In this article, we will investigate the environmental implications of UGI loss in Malawi's urban areas of Blantyre, Lilongwe, Mzuzu and Zomba, exploring its effects on biodiversity, air and water quality, and resilience to climate change. Furthermore, we will examine potential strategies and policy interventions to mitigate these impacts and promote sustainable urban development that prioritizes the conservation and enhancement of UGI. By understanding the consequences of UGI loss and identifying actionable solutions, we can strive towards building healthier, more resilient, and sustainable cities in Malawi.

Materials and Methods

General Information of the Study Areas in Malawi

Urban areas in Malawi comprise the primary cities of Blantyre, Lilongwe, Mzuzu, and Zomba, along with smaller towns, administrative centers known as Bomas, and officially designated town planning areas (NSO, 2018). As of 2018 16 percent of the population resided in the urban areas of the country. Within this urban population, 12 percent lived in the four major cities, while the remaining 4 percent were distributed among other towns and Bomas. The urban population in Malawi has shown a consistent upward trend, growing from...
approximately 850,000 in 1987 to 1.4 million in 1998, 2.0 million in 2008, and reaching 2.8 million in 2018. This study specifically focuses on the four major cities, and Figure 1 depicts their geographic locations.

Figure 1. Study Areas—Malawi Major Cities of Blantyre, Mzuzu, Lilongwe and Zomba

Drawing from the Malawi Population and Housing Census Report 2018, the Malawi Poverty Report 2020, and Urban Profiles, variations are highlighted. While the country’s overall urbanization level is modest (18% as of 2018), the urban population is experiencing robust growth rates ranging between 3.7% and 4.2%. Despite a relatively high Gross Domestic Product (GDP) growth averaging 4.7% from 2009 to 2019, the concurrent challenges of rapid urbanization and an agriculture-dependent economic structure pose significant obstacles to addressing poverty and improving urban housing and infrastructure. Malawi faces an acute poverty situation, with 70.9% of the population living below the international poverty threshold of USD 1.90 per day. According to the Malawi Poverty report, Lilongwe registered the highest poverty rate at 15% in 2019/2020, followed by Blantyre at 14.9%, Zomba at 13.5%, and Mzuzu with the lowest poverty rate at 11.5% as seen in Figure 2.

Figure 2 Percentage of poor population in Malawi per District in percentage  
Source: NSO (2021)

A hierarchy of the four urban areas is displayed in table 1. Manda (2013) contends that the growth of the four major cities in Malawi can be primarily attributed to natural population increase, rural-urban migration, and reclassification. The unregulated sprouting of
settlements plays a significant role in this expansion, with each factor contributing unevenly. This surge has led to the emergence and enlargement of informal settlements, accompanied by inadequate infrastructure and basic service provision. The challenges are exacerbated by the inefficient management of urban land and a lack of political commitment to enhance urban areas, resulting in insufficient funds and capacity for urban development. And as such despite the government of Malawi recognizing that well-designed cities should incorporate some elements of UGI practices for public use and UGI having a significant importance on the urban environment it is put under duress. Currently, the utilization of certain types of UGI in Malawian cities remains limited due to a nationwide state of disrepair. Public spaces have suffered from significant neglect, while others have been subject to encroachment and conversion to alternative uses. Consequently, the functionality of the remaining UGI has deteriorated to the point of disuse (Ministry_of_Lands, 2021). Therefore, UGI preservation and implementation in Malawian cities needs to be matched by scientific evidence and appropriate guidelines to realize benefits from the three perspectives in Malawi and ensure sustainable urban development.

### Table 1 Present Urban Hierarchy in Malawi for the for Major Cities

<table>
<thead>
<tr>
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<td>2</td>
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</tr>
<tr>
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</tr>
</tbody>
</table>

### Environmental Monitoring Using Remote Sensing

Remote-sensing systems has long been used to collect information about the structure of landscapes, the natural environment, and the location of sites and features (Conolly & Lake, 2006). In this study, we conducted an analysis of Land Use and Land Cover (LULC) changes in selected cities using ENVI Software (Liu et al., 2022). The objective of the LULC analysis was to comprehensively understand the intricate and dynamic relationship between social and natural systems. The study employed a historical analysis (spanning two decades) to quantify the changes of land cover classes within Malawi's four major urban areas. The research further investigated the environmental implications of these transformations using secondary data. Notably, the conversion of permeable land cover types, such as wetlands and vegetation, to impermeable surfaces like pavements, was posited to diminish rainwater infiltration and escalate surface runoff (Idowu & Zhou, 2021). This phenomenon, the authors argued, could not only engender substantial disruptions in physical water systems but also culminate in the loss of human life, devastation of socioeconomic infrastructure, and societal disorder (Li, Uyttenhove, & Vaneetvelde, 2020).

### Data Acquisition and Preprocessing

The mapping of Land Use Land Cover maps was done using Landsat Satellite imagery. The study focused on the Land Use Land Cover for 2002, 2012 and 2022. Landsat has 3 sensors which have been used for imagery data collection. Based on the years focused on, Landsat 4/5 ETM was used for 2002 and 2012 and Landsat 8/9 OLI was used for 2022. Landsat 4/5 ETM, launched in 1984, featured Multispectral Scanners (MSS) and the Thematic Mapper™ instruments. With its seven bands, including the Blue Band for bathymetric mapping and differentiation of soil and vegetation, the Green Band highlighting top vegetation, and the Thermal Infrared Band for thermal mapping, it provided valuable Earth imaging data for nearly 29 years. For this study, three band compositions were utilized depending on the monitoring focus. Landsat 8/9 OLI, previously known as Landsat Data Continuity Mission, deployed in
2013, featured the Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) instruments. It extended the capabilities of its predecessor, offering bands such as the Coastal Aerosol Band for coastal studies and the Near Infrared Band for biomass content detection. The satellite imagery offered spatial resolutions suitable for various applications. Following the production of band composite images, regions of interest (ROIs) were classified into water bodies, vegetation, bare land, and built-up areas using supervised classification, with the Maximum Likelihood algorithm chosen for generating the desired output.

**Figure 3. Technical Route for Creating the LULC Change Maps**

**Results and Discussion**

**Greenspace Variations in Urban Areas (from past to present)**

Green spaces play a pivotal role in urban ecosystems, contributing significantly to improvements in economic, social, and environmental aspects (Jin, Wang, & Li, 2018; Niu et al., 2022). This study focuses on evaluating the variations in green spaces across the four major cities in Malawi. To achieve this, a method for detecting changes in land use and land cover was employed, utilizing satellite images from 2002, 2012, and 2022. This method effectively quantifies the impact of urbanization on changes in vegetation cover, providing valuable insights into the alteration of the urban landscape within a radius of approximately 30–40 km (Du et al., 2019). The significance of vegetation cover cannot be overstated for the sustainability of urban ecosystems; however, urban areas have witnessed notable transformations in this regard (Jin et al., 2018). The land cover change maps from the study unmistakably illustrate a notable increase in built-up areas within urban areas, indicating the encroachment of urbanization on natural vegetation and agricultural land. This expansion is a direct consequence of the simultaneous growth in population and accelerated urbanization, leading to a noticeable reduction in the availability of green spaces (Asabere et al.,...
As emphasized by Azagew and Worku (2020), unlike the commonly employed NDVI, which assesses the status of UGI but overlooks various components of green spaces within the city, the use of LULC quantification allows for the comprehensive evaluation of different elements of green spaces.

This section highlights the interconnected dynamics between urbanization, land use changes, and the subsequent reduction in UGI.

It highlights the significance of these dynamics by emphasizing their impact on the environment.

**Lilongwe City**

Prominent changes in LULC classes in Lilongwe city investigated in this study for 2002, 2012 and 2022 based on the supervised classification process of Landsat images are shown in Figure 4.

![Figure 4. Classified LULC Maps for Lilongwe City, 2002, 2012 and 2022](image)

Table 2 shows the temporal changes in the LULC from 2002-2022. The analysis of change detection in Lilongwe revealed that in 2002 the city predominantly consisted of bare land, encompassing 61% of its total area, equivalent to 241.61 km² out of 392.30 km². Built-up areas covered 14% (54.23 km²), vegetation 16% (61.76 km²), and water bodies 9% (34.69 km²). Fast-forwarding to 2012, significant transformations occurred. Breland saw a nearly 50% reduction, decreasing to 164.42 km² (42% of the area). Conversely, built-up areas almost doubled, expanding from 54.23 km² to 103.38 km² (26% of the area). Vegetation increased from 61.76 km² to 98.19 km², and water bodies reduced from 34.69 km² to 26.31 km².

In addition, the results show that between 2012 and 2022, notable changes transpired. The most substantial shift was observed in built-up areas, soaring from 103.38 km² to 257.62 km² in a decade. Conversely, bare land diminished from 164.42 km² to 62.05 km². Vegetation and water bodies covered 34.13 km² and 38.51 km², respectively, highlighting the dynamic and transformative nature of Lilongwe City's land cover over the years which consequently poses a risk to the city's overall livability. This accounts for the drastic growth in urbanization in Lilongwe since a large proportion of land was converted from other LULC classes into built-up area. As per the population and housing census that was conducted by the National Statistics Office, the population of Lilongwe city...
exhibited an increase from 674,448 people in 2008 to 989,318 people in 2018, indicating a population growth of 314,870 persons (NSO, 2018). The primary driver of the land cover change was the relocation of the capital city from Zomba to Lilongwe. This shift triggered rapid growth in Lilongwe, accompanied by a significant influx of people through rural-urban migration (Manda, 2013). Most of the population sought employment opportunities across various sectors of the economy, desired access to quality education for their children, and generally aimed to enhance their standard of living. Consequently, these factors collectively contributed to the substantial transformation in land cover and thereby affecting UGI development.

Table 2. LULC Distribution for Lilongwe City (2002-2022)

<table>
<thead>
<tr>
<th>No.</th>
<th>LULC Classes</th>
<th>2002</th>
<th>2012</th>
<th>2022</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Area (Km²)</td>
<td>%</td>
<td>Area (Km²)</td>
</tr>
<tr>
<td>1</td>
<td>Bareland</td>
<td>241.61</td>
<td>61</td>
<td>164.42</td>
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<tr>
<td>2</td>
<td>Waterbody</td>
<td>34.69</td>
<td>9</td>
<td>26.31</td>
</tr>
<tr>
<td>3</td>
<td>Vegetation</td>
<td>61.76</td>
<td>16</td>
<td>98.19</td>
</tr>
<tr>
<td>4</td>
<td>Built-Up Area</td>
<td>54.23</td>
<td>14</td>
<td>103.38</td>
</tr>
</tbody>
</table>

Figure 5. LULC Change Statistics for Lilongwe City in 2002, 2012, 2022

An analysis of existing research reveals that the reduction in vegetation (UGI) in urban areas, such as Lilongwe, can be attributed to the rise in informal settlements, use of fuelwood for household energy needs, poorly managed greenspaces, population growth, lack of ecological vision and awareness, competing land uses (Appiah-Opoku, Manu, Asibey, & Amponsah, 2023; Buffam et al., 2022; Guenat, Lopez, Mkwambisi, & Dallimer, 2021; Ngulani & Shackleton, 2022). This phenomenon is a prevalent and serious issue in Third World countries, commonly associated with insufficient attention to urban sustainability issues in the face of escalating urbanization (Adegun, 2017; Nassar & Elsayed, 2018). Preserving GI and other natural areas is imperative for fostering a sustainable and pleasant urban environment for its inhabitants. Efforts to safeguard these environmental assets are crucial for ensuring Lilongwe’s long-term viability and quality of life for its residents (LCC, 2021).

Blantyre City

Blantyre City covers 227.88 km² within the broader expanse of Blantyre District. The overall area of Blantyre was categorized into four distinct classes: Bareland, Built-Up Area, Vegetation, and Water Bodies, each of these classes exhibited dynamic changes over time for the years 2002, 2012 and 2022, as visually represented in Figure 6. The classification of
Blantyre city in this study establishes a framework for understanding the dynamic spatial composition. It highlights significant changes in the sizes of various land cover categories over time. The results indicate a decrease in persistent areas for vegetation and bare land and even the waterbodies during subsequent periods.

A trend becomes apparent when looking at Table 3, which gives a summary of the LULC distribution in Blantyre City. In 2002, bare land made up the majority of Blantyre's land area, covering 131.71 km² or 58% of the total. At the same time, vegetation and water bodies occupied 15.11 km² and 45.20 km², respectively, while the built-up area filled 35.87 km², or 16 percent, of the city. In 2012, significant changes occurred within the Blantyre City Zone. Bareland increased marginally to 139.50 km², indicating a 61% change from its 2002 coverage of 58%. The built-up area expanded to 42.08 km² from 35.87 km² in 2002. Water bodies and vegetation underwent alterations, covering 15.72 km² and 30.58 km², respectively. Fast-forwarding to 2022, bareland reduced significantly to 97.90 km², constituting 43% of Blantyre City. The built-up area witnessed a substantial increase, surging from 42.08 km² to 73.82 km², covering 32% of Blantyre City. Simultaneously, water bodies and vegetation covered 27.87 km² and 28.29 km², respectively. With less bare land and more built-up regions, Blantyre's LULC has dynamically changed throughout time, indicating a complex interaction between environmental concerns and urban development.

<table>
<thead>
<tr>
<th>No.</th>
<th>LULC Classes</th>
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<th>2012</th>
<th>2022</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Area (Km²)</td>
<td>%</td>
<td>Area (Km²)</td>
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<tr>
<td>1</td>
<td>Bareland</td>
<td>131.71</td>
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<td>139.50</td>
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<td>Waterbody</td>
<td>42.20</td>
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<td>3</td>
<td>Vegetation</td>
<td>15.11</td>
<td>6</td>
<td>30.58</td>
</tr>
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<td>4</td>
<td>Built-Up Area</td>
<td>32.87</td>
<td>16</td>
<td>42.08</td>
</tr>
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</table>
Mzuzu City

Mzuzu City spans an area of 111.816 km², with a significant focus on four key land cover classes within the scope of this study. Variations in coverage over specific periods, specifically the years 2002, 2012, and 2022 were examined. Illustrative insights into these changes are presented in Figure 8, derived from a supervised classification process applied to Landsat images. This method offers a systematic approach to understanding and visualizing the evolving land cover dynamics in Mzuzu City over the designated time intervals.

The LULC distribution in Mzuzu, as outlined in Table 4, illustrates dynamic changes over the years. In 2002, the city’s landscape comprised 51.66 km² of bareland, constituting 46% of the total coverage. Built-up areas covered 20.12 km² (18%), while vegetation and water bodies accounted for 16.01 km² (14%) and 24.18 km² (22%), respectively. By 2012, expected transformations in the LULC distribution had occurred. Bareland reduced from 51.66 km² to 39.16 km², representing a shift from 46% to 35% coverage. Conversely, built-up areas expanded...
from 20.12 km² to 28.98 km² (18% to 26%). Vegetation and water bodies also experienced changes, with vegetation increasing from 16.01 km² to 22.07 km² (14% to 20%) and water bodies decreasing from 24.18 km² to 21.76 km² (22% to 20%). In 2022, further alterations were observed. Bareland coverage decreased to 32.12 km², constituting 29% of the total area, down from 35% in 2012 (39.16 km²). The built-up area, which covered 28.98 km² in 2012, diminished to 17.78 km², resulting in a decrease from 26% to 16%. On the other hand, vegetation increased to 26.97 km² (24%) from 22.07 km², and interestingly water bodies expanded to 35.10 km² (32%) from 21.76 km². This progression emphasizes how Mzuzu's LULC has changed over time, highlighting changes in bareland, built-up regions, flora, and water bodies. Consequently, offering important insights into the city's environmental dynamics and urban development.

Table 4. LULC Distribution for Mzuzu City (2002-2022)

<table>
<thead>
<tr>
<th>No.</th>
<th>LULC Classes</th>
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<th>2022</th>
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</thead>
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<td></td>
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<td>%</td>
<td>Area (Km²)</td>
<td>%</td>
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<tr>
<td>1</td>
<td>Bareland</td>
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<td>Waterbody</td>
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<td>21.26</td>
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<tr>
<td>3</td>
<td>Vegetation</td>
<td>16.01</td>
<td>14</td>
<td>22.07</td>
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<tr>
<td>4</td>
<td>Built-Up Area</td>
<td>20.12</td>
<td>18</td>
<td>28.98</td>
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</table>

Figure 9. Statistical Presentation of LULC in Mzuzu City

Zomba City

With a total size of 39.81 km², Zomba City was divided into four main land cover classes, each of which have seen dynamic shifts throughout time. As shown in Figure 10, the changes in coverage were recorded using a supervised classification approach with Landsat images, offering insights into the changing temporal patterns from 2002 to 2012 and 2022.

Within Zomba city, statistical analysis of change detection revealed that in 2002, bareland, encompassed 16.81 km² or 42% of the city's total area. Built-up areas covered 15.55 km², constituting 39%, while vegetation and water bodies covered 4.58 km² (12%) and 2.91 km² (7%), respectively. Illustrations of the land cover depict this distribution. As per the land cover data, over time, there have been significant changes. By 2012, bare land decreased to 16.00 km² (40%), built-up areas reduced to 13.15 km² (33%), vegetation increased to 9.74 km² (24%), and water bodies diminished to 1.02 km² (3%). Further changes were observed in a subsequent period (2022), with bare land decreasing to 12.43 km² (31%), built-up areas expanding to 16.24
km² (41%), vegetation covering 9.26 km² (23%), and water bodies increasing to 1.98 km² (5%). Table 5 provides a LULC distribution representation of these alterations from 2002-2022. These shifts in land cover percentages suggest dynamic changes in the city’s environment. Figure 11 represents the statistical figures of the LULC in Zomba city. This representation is asserted by a notable analysis of how recreational parks, green spaces, and playgrounds in Zomba City are reported to be in poor condition due to inadequate maintenance by the city council. Addressing these issues is imperative for enhancing the overall quality of life for residents and promoting sustainable urban development in Zomba City.

Table 5. LULC Distribution for Zomba City (2002-2022)

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<thead>
<tr>
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<td>Built-Up Area</td>
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<td>13.15</td>
<td>33</td>
<td>16.24</td>
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Figure 10. Classified LULC Maps for Mzuzu City, 2002, 2012 and 2022

Figure 11. Statistical Representation of LULC in Zomba City
UGI annual rate of Change

The urban areas selected for this study show a significant loss of UGI over the last two decades. This loss is particularly pronounced in the conversion of natural landscapes into built-up areas, which poses a significant threat to ecological integrity and biodiversity. The annual rate of change, as shown in Table 6 for all corresponding land use and land cover classes (LULC), emphasizes this trend, with vegetation continuously declining over time. This change disrupts critical habitats for various species and affects the ability of urban ecosystems to provide important ecosystem services such as carbon sequestration, air purification and temperature regulation.

In addition, the encroachment into water bodies and the destruction of existing green spaces exacerbate challenges related to water quality, hydrological balance, and resilience to climate change-induced events such as flooding and heatwaves. The reduction of green spaces also exacerbates the urban heat island effect, which increases temperatures in urban areas and further affects the well-being of residents. These environmental challenges highlight the urgent need for proactive measures to maintain and improve green infrastructure in urban areas. This would ensure ecological balance and promote sustainable urban development in Malawi.

<table>
<thead>
<tr>
<th>LULC Classes</th>
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<th>Blantyre</th>
<th>Mzuzu</th>
<th>Zomba</th>
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<td>1.2</td>
<td>3.9</td>
<td>1.6</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>-10.98</td>
<td>0.22</td>
<td>0.86</td>
<td>-0.95</td>
</tr>
</tbody>
</table>

Table 6. Annual Change rate (%) for Different Periods

Conclusion

The findings of this study highlight the urgent need for concerted efforts to address the loss of UGI in Malawi's major cities. The conversion of natural landscapes into built-up areas has a profound impact on the environment. These include loss of biodiversity, deterioration of air and water quality and reduced resilience to climate change related events. Urgent action is needed to mitigate these impacts and promote sustainable urban development. This requires comprehensive policies and interventions that prioritize the protection and enhancement of UGI while addressing broader issues such as population growth, urbanization, and socio-economic inequalities. By protecting UGI, Malawi can build healthier, more resilient, and sustainable cities for present and future generations. To effectively address the climate change shocks plaguing urban areas, the conversation must pivot towards the critical role of UGI.

Conflict of Interests

No conflict of interest.

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References


