# ASSESSMENT OF LAND USE AND LAND COVER (LULC) CHANGES AND THEIR ENVIRONMENTAL IMPACTS IN BELLANWILA-ATTIDIYA WETLAND

***H. K. U. Dewmini****

*Department of Geography, University of Sri Jayewardenepura, Sri Lanka*

Wetlands are vital ecosystems that provide essential ecological services. Bellanwila-Attidiya Wetland, which is one of the most significant urban wetlands in Sri Lanka, has experienced considerable land use and land cover (LULC) changes in the past few decades, causing serious environmental impacts. The objectives of this research were to assess the land use and land cover changes within the Bellanwila-Attidiya wetland area between 1995-2024 and to evaluate the resulting environmental impacts. Supervised classification of Landsat images from 1995, 2011, and 2024 was performed using ArcGIS, followed by a change detection analysis to track LULC changes. The results of LULC changes revealed a sharp decline in vegetation cover from 60% in 1995 to 36% in 2011, reflecting intense urbanization, with only a slight recovery to 38% by 2024. Built-up areas have increased significantly from 119.92 ha (32%) in 1995 to 198.97 ha (54%) in 2024, becoming the dominant land cover. To assess environmental impacts of LULC changes in the Bellanwila-Attidiya Wetland, a household survey was conducted alongside the geospatial analysis with 55 long-term residents selected through stratified random sampling from three Grama Niladhari divisions near the wetland. Moreover, the analysis of environmental impacts was further supplemented by key informant interviews to gather additional insights. The results of the environmental impacts indicated that during 1995-2024, about 110 ha of wetland habitat were lost according to the spatial analysis of the study area. Invasive alien species such as *Annona glabra*, *Eichhornia crassipes*, and *Hypostomus plecostomus* have spread rapidly due to increase of built-up areas. Between 1995 and 2024, vegetation cover in the Bellanwila-Attidiya Wetland decreased by 37.8%, with 39.2% of the loss converted to built-up areas, 7% to water bodies, and 0.9% to open areas, indicating a significant loss in vegetation cover. A significant reduction in biodiversity has been observed, with a 52% reduction in bird species, 87% reduction in fish species and extinction of amphibian species such as *Philautus leucorhinus*. These findings emphasize the urgent need for integrated conservation and land-use planning to protect the Bellanwila-Attidiya Wetland and ensure the survival of its biodiversity.

*Keywords*: environmental impacts, GIS, land use and land cover change, wetlands

**Corresponding author: udaradewmini24@gmail.com*

# ASSESSMENT OF LAND USE AND LAND COVER (LULC) CHANGES AND THEIR ENVIRONMENTAL IMPACTS IN BELLANWILA-ATTIDIYA WETLAND

***H. K. U. Dewmini****

*Department of Geography, University of Sri Jayewardenepura, Sri Lanka*

## INTRODUCTION

Wetlands are among the most valuable ecosystems globally, providing essential ecological services such as flood mitigation, water purification, and biodiversity support. However, they are increasingly threatened by anthropogenic pressures, particularly land use and land cover (LULC) changes that are rapidly transforming wetland habitats into urban areas. The Bellanwila-Attidiya Wetland, a significant urban wetland in Sri Lanka's Western Province have been experiencing considerable LULC changes over the past few decades. Despite its ecological importance, comprehensive assessments of LULC dynamics and their environmental consequences in the Bellanwila-Attidiya Wetland remain limited, highlighting a critical research gap. This study addresses this gap by applying geospatial technology to assess LULC changes in the Bellanwila-Attidiya Wetland from 1995 to 2025, evaluating the resulting environmental impacts, and proposing conservation strategies to mitigate these effects. By integrating satellite imagery analysis with environmental impact assessment, this research provides a novel spatial-temporal framework for understanding the extent and implications of wetland transformation in an urbanizing context, contributing valuable insights to wetland management and urban ecological planning.

## METHODOLOGY

To identify LULC changes between 1995 and 2024, cloud-free Landsat satellite images from the years 1995 (Landsat 5 TM), 2011 (Landsat 5 TM), and 2024 (Landsat 8 OLI/TIRS) were acquired from the USGS Earth Explorer. All images were selected from the same season to minimize seasonal variation and ensure comparability. The images were preprocessed for radiometric corrections.The images were classified into four primary LULC categories as vegetation, water bodies, built-up areas, and open areas using supervised classification in ArcGIS 10.8. The Maximum Likelihood Classification algorithm was applied with training samples generated through Google Earth references and field observations. To validate the LULC classification, an accuracy assessment was conducted using 100 ground truth points collected from field surveys and satellite imagery. A change detection analysis was then conducted by generating intersected and dissolved polygons to analyze LULC transitions from 1995 to 2024.

To gather data regarding environmental impacts caused by LULC changes in Bellanwila-Attidiya Wetland, a household survey was conducted using a semi-structured questionnaire with 55 residents who had been living in the study area for more than 15 years. The Bellanwila-Attidiya is spread across 8 Grama Niladhari divisions. For this study, a sample was selected from 3 Grama Niladhari divisions which are Bellanwila 535A, Attidiya North, and Attidiya South. From the total population of 4,700 households in these 3 Grama Niladhari divisions, approximately about 1,100 families live close to the wetland area. From these families, 55 households were selected as a 5% sample from the total population based on stratified random sampling method.

Therefore, 15 households were chosen from Bellanwila 535A division, 25 from Attidiya North, and 15 from Attidiya South. The household questionnaire was designed to gather data on demographic details, observed environmental changes, and perceived impacts of LULC transformations in the Bellanwila-Attidiya Wetland. It included a mix of closed-ended, Likert-scale, and open-ended questions. In addition, interviews with key informants were conducted to gather further information regarding the environmental impacts in the study area.

## RESULTS AND DISCUSSION

According to the spatial assessment as indicated in Figure 1, the Bellanwila-Attidiya Wetland has undergone dramatic changes during 1995 and 2024. In 1995, vegetation dominated the landscape, especially, in the central and northern parts, while water bodies occupied a notable area in the centre. By 2011, vegetation areas had notably decreased, particularly in the Southern and Eastern Zones, while built-up areas expanded considerably around the wetland, indicating increased urbanization. Water bodies also expanded during this period. By 2024, vegetation has shown a slight recovery, but built-up areas have further increased and become more fragmented across the region.

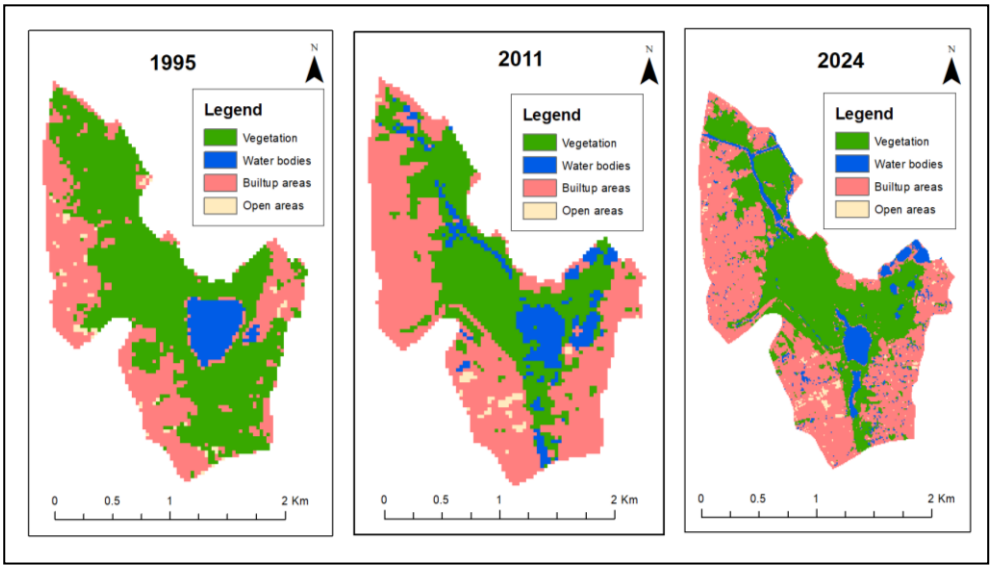


*Figure 1: Spatial and temporal variation of Land Use and Land Cover (LULC) changes in Bellanwila-Attidiya Wetland (1995-2024)*

*Table 1: Land Use and Land Cover (LULC) changes by area in Bellanwila-Attidiya Wetland 1995–2024*

| **Land Use** | **1995** | | **2011** | | **2024** | |
|---|---|---|---|---|---|---|
| | **Area (ha)** | **%** | **Area (ha)** | **%** | **Area (ha)** | **%** |
| Vegetation | 225.20 | 60% | 135.33 | 36% | 140.82 | 38% |
| Water bodies | 22.23 | 6% | 37.94 | 10% | 30.45 | 8% |
| Built-up areas | 119.92 | 32% | 193.44 | 52% | 198.97 | 54% |
| Open areas | 5.10 | 1% | 4.25 | 1% | 5.08 | 1% |

According to Table 1, the vegetation cover in the Bellanwila-Attidiya Wetland declined from 60% in 1995 to 36% in 2011, indicating a 40% decrease over 16 years due to urbanization and land conversion. A slight recovery to 140.82 ha (38%) was observed by 2024, possibly due to restoration efforts, but still below 1995 levels. Built-up areas increased significantly from 119.92 ha (32%) in 2008 to 198.97 ha (54%) in 2024, becoming the dominant land use, reflecting rapid urbanization driven by population and infrastructure demands. Water bodies expanded from 6% in 1995 to 8% in 2024, possibly due to seasonal variation or artificial additions. Open areas showed minimal change throughout the period despite major shifts in other land use types.

The change detection analysis of the Bellanwila-Attidiya Wetland from 1995 to 2024 (Figure 2) indicates significant land use and land cover transformations. A total of 105.85 ha of vegetation were lost, primarily converted into built-up areas (88.14 ha or 23.3%), water bodies (15.76 ha or 4.2%), and open areas (1.95 ha or 0.5%). Despite these losses, 118.33 ha (31.3%) of vegetation remained unchanged. Built-up areas expanded by 92.38 ha (24.4%), mostly from vegetation, and retained 100.67 ha (26.6%) of their original extent. Water bodies showed dynamic changes, with 6.75 ha (1.8%) remaining stable, 14.75 ha converted to vegetation, and 6.15 ha gained from built-up areas. Open areas were the most unstable, with only 0.085 ha (0.02%) remaining unchanged. These shifts highlight rapid urbanization and ecosystem degradation, emphasizing the urgent need for conservation and sustainable land management.

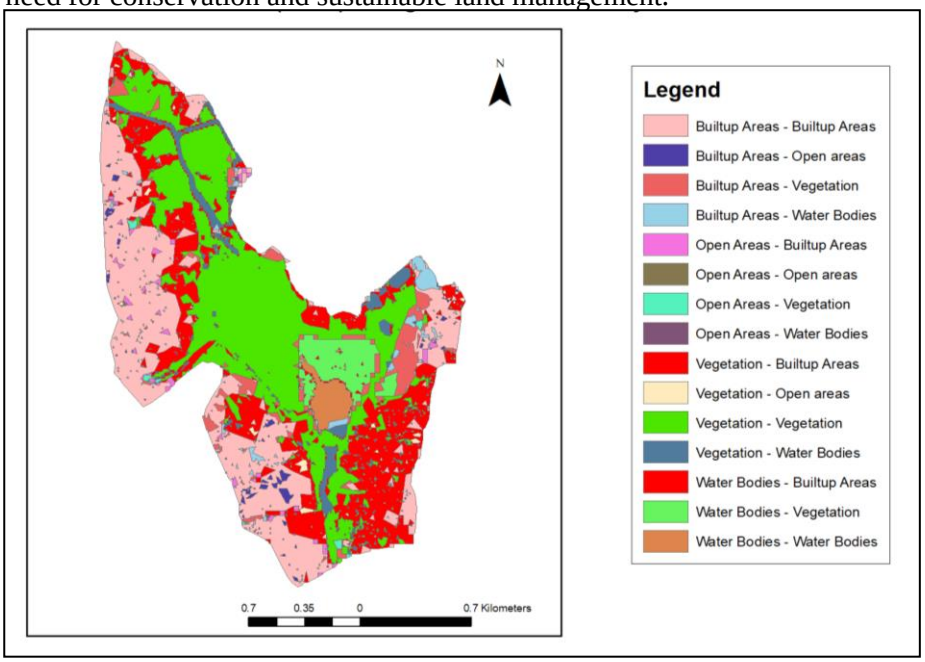


*Figure 2: Change detection analysis of Bellanwila-Attidiya Wetland (1995-2024)*

Habitat loss, increased spread of invasive alien species, decreased vegetation cover, and biodiversity decline are major environmental impacts caused by LULC changes. According to the geospatial analysis, between 1995 and 2024, approximately, 110 ha of wetland habitat in the Bellanwila-Attidiya Wetland. Field observations and interviews with key informants confirm that land reclamation, urban development, and human encroachment were the main reasons for habitat loss in the study area. Survey data showed that 36% of respondents strongly agreed and 33% agreed that habitat loss is a major consequence of LULC changes in the study area. Furthermore, the LULC changes in Bellanwila-Attidiya Wetland has also resulted in habitat

fragmentation along with the habitat loss. While losing the wildlife habitats, the existing wetland cover has also got divided into small isolated patches due to encroachment of built-up areas. This issue of habitat fragmentation is even more serious than mere habitat loss, as it prevents species from accessing essential resources like food, shelter, or mates.

LULC changes in the Bellanwila-Attidiya Wetland has facilitated the spread of invasive species, with 50% of respondents identifying *Annona glabra* and 35% noting *Eichhornia crassipes* as the most common invasive flora, while 90% of those aware of invasive fauna reported *Hypostomus plecostomus* (tank cleaner) as the dominant invasive fauna species. Field observations revealed that the dense mats of *Eichhornia crassipes* disrupt water flow, displace native species, and degrade water quality. Furthermore, the LULC changes in the Bellanwila-Attidiya Wetland has led to a drastic reduction in vegetation cover, declining from 225 ha in 1995 to 135 ha in 2011, with only a slight recovery to 140 ha by 2024. Major conversions of vegetation cover into other land uses include 88.14 ha to built-up areas, 15.76 ha to water bodies, and 1.95 ha to open areas. Community surveys revealed that 60% of respondents (35% agree + 25% strongly agree) observed significant vegetation changes due to transformation of wetland cover into human settlements. Moreover, severe declines in animal diversity can be observed in the study area due to LULC changes. With bird species dropping from 168 to 80 and fish species shrinking from over 40 to just 5, including the near-disappearance of endemic species like *Aplocheilus dayi*. Amphibian populations have also suffered, with two endemic *Philautus* species now extinct, while reptiles and mammals like the fishing cat have drastically declined due to habitat loss and human-wildlife conflict.

## CONCLUSION AND RECOMMENDATIONS

This study revealed severe degradation of the Bellanwila-Attidiya Wetland due to land use changes (1995-2024), with vegetation cover declining by 40% (225 ha to 135 ha) and built-up areas expanding from 32% to 54%. Key environmental impacts included 110ha of habitat loss, invasive species proliferation such as *Annona glabra* and a decline in biodiversity with bird species dropped from 168 to 80, fish species from 40 to 5, and two endemic *Philautus* amphibians went extinct.

Some recommendations can be suggested to minimize these issues and protect the Bellanwila-Attidiya Wetland in the future. It is necessary to enforce laws strongly in protected areas so that illegal usage of the land decreases and places that have been taken over illegally can be identified and retrieved. In addition, efforts to restore ecosystems should involve restoring native plant species back in place and to get rid of invasive species. Third, urban planners should introduce buffers around cities and use green infrastructure to stop more city expansion. In

addition, it is important to launch community activities that spread knowledge about wetlands and persuade local citizens to follow sustainable practices.

## REFERENCES

Abalo, M., Badabate, D., Fousseni, F., Kpérkouma, W., & Koffi, A. (2021). Landscape-based analysis of wetlands patterns in the Ogou River basin in Togo (West Africa). *Environmental Challenges*, *2*, 100013. https://doi.org/10.1016/j.envc.2020.100013

C. Max Finlayson, Everard, M., Irvine, K., McInnes, R. J., Middleton, B. A., Anne, & Davidson, N. C. (2016). The Wetland Book. In *Springer eBooks*. Springer Nature. https://doi.org/10.1007/978-94-007-6172-8

Chang, H., Makido, Y., & Foster, E. (2021). Effects of land use change, wetland fragmentation, and best management practices on total suspended solids concentrations in an urbanizing Oregon watershed, USA. *Journal of Environmental Management*, *282*, 111962. https://doi.org/10.1016/j.jenvman.2021.111962

D.M.S. Suranjan Karunarathna, A.A. Thasun Amarasinghe, Gabadage, D. E., Bahir, M. M., & Harding, L. E. (2010). CURRENT STATUS OF FAUNAL DIVERSITY IN BELLANWILA – ATTIDIYA SANCTUARY, COLOMBO DISTRICT – SRI LANKA. *TAPROBANICA the Journal of Asian Biodiversity*, *2*(1), 48–63. https://doi.org/10.47605/tapro.v2i1.27

Dou, X., Guo, H., Zhang, L., Liang, D., Zhu, Q., Liu, X., Zhou, H., Zhuoran Lv, Liu, Y., Gou, Y., & Wang, Z. (2023). Dynamic landscapes and the influence of human activities in the Yellow River Delta wetland region. *Science of the Total Environment*, *899*, 166239–166239. https://doi.org/10.1016/j.scitotenv.2023.166239

Guo, M., Zhou, N., Cai, Y., Zhao, W., Lu, S., & Liu, K. (2024). Monitoring the Landscape Pattern Dynamics and Driving Forces in Dongting Lake Wetland in China Based on Landsat Images. *Water*, *16*(9), 1273–1273. https://doi.org/10.3390/w16091273

## ACKNOWLEGDEMENTS

*The author did not receive financial assistance for this research.*