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Evaluation of Land Cover and Use through Artificial Intelligence in the Premontane Humid Forest of the Munchique Natural Reserve, Quilichao River Basin, Cauca, Colombia

[a]David Alejandro Muñoz, [a]Diego Fernando Tarapuez B. [b]Elkin de Jesús Salcedo H. [c]Yesid Carvajal Escobar, [d]Adriana Martínez Arias

[a]Universidad del Valle, Cali Colombia, Faculty of Natural and Exact Sciences, Research Group GeoRiesgos Cali Postal code: 760042

[b] Universidad del Valle, Cali Colombia, Faculty of Humanities, Department of Geography, Research Group GeoRiesgos Cali Postal code: 760042

[c] Universidad del Valle, Cali Colombia, Faculty of Engineering, Research Group IREHISSA Cali Postal code: 760042

[d] Universidad Nacional de Colombia-Palmira-Faculty of Engineering and Administration, Department of Engineering-Hydrobiological Resources Research Group, Palmira, Postal Code 763533

INTRODUCTION & AIM

Land cover and land use assessment is crucial for the sustainable management of natural resources and biodiversity conservation, especially in diverse and fragile ecosystems such as Andean forests. The objective of this research was to identify changes in vegetation cover and their impact on land use in the Munchique Natural Reserve, in the Quilichao river basin, Cauca, Colombia, an area that harbors high biodiversity and numerous ecosystem services. This study aims to analyze the spatio-temporal dynamics of LULC and subsequently predict future land use using neural networks.

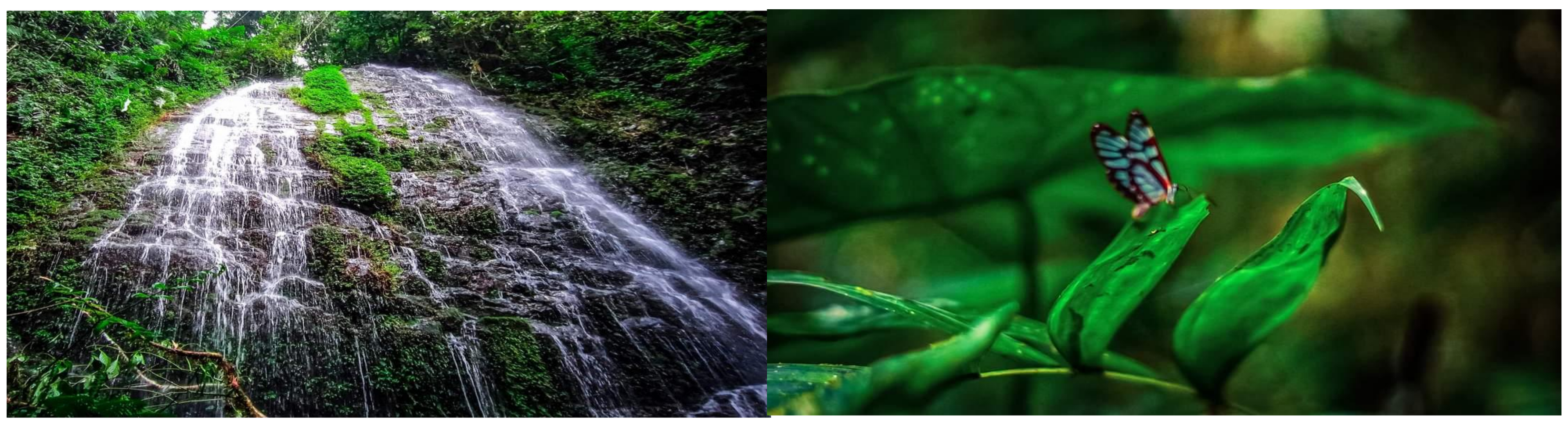

Figure 1. Munchique Natural Reserve, Quilichao River Basin

METHOD

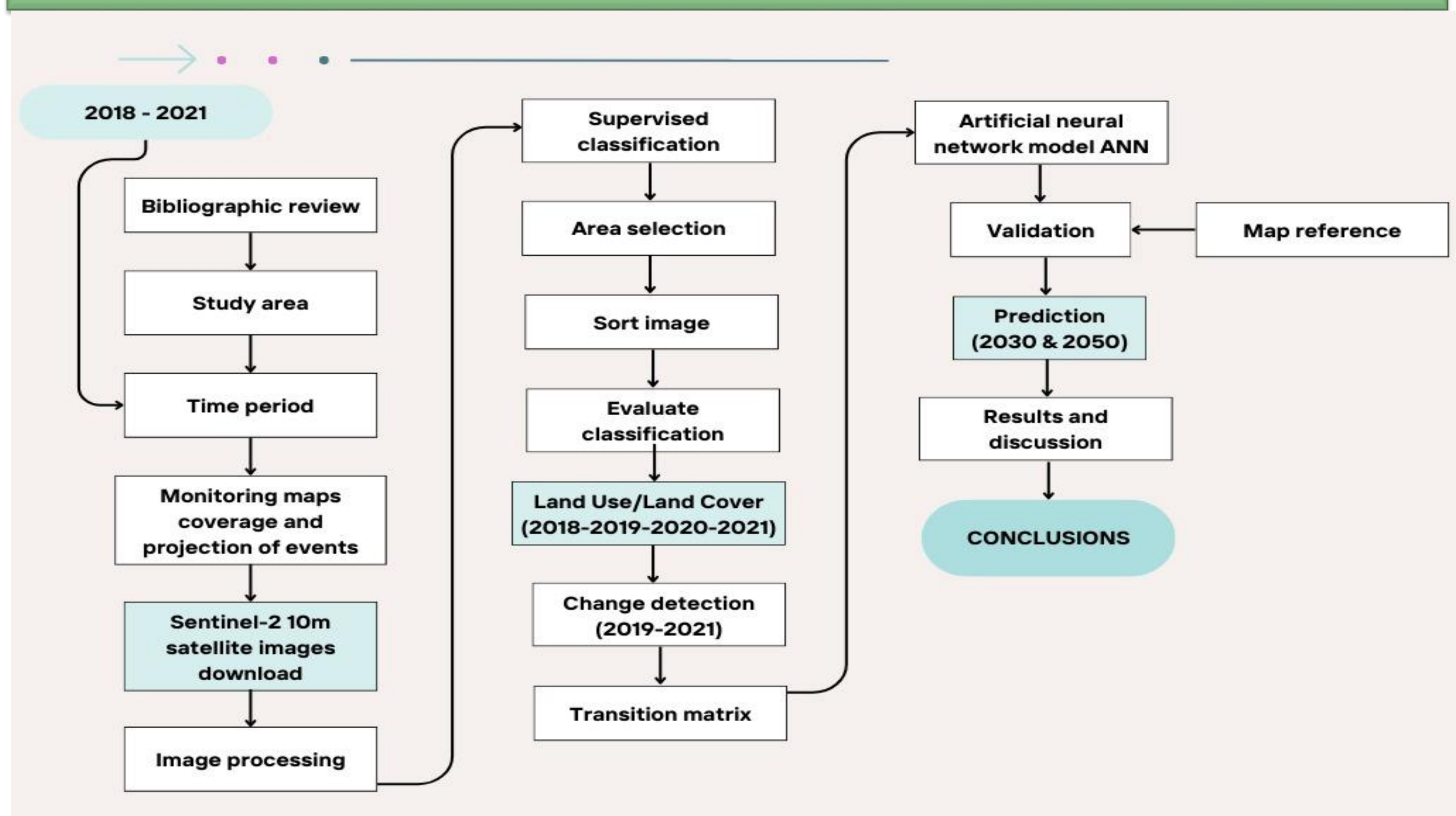

Figure 2. Methodology Source: Own elaboration

Data Acquisition: The research required accessing information from public entities like the mayor's office of Santander de Quilichao and regional corporations. CORINE Land Cover (CLC) data, adapted for Colombia, was used to delineate and reclassify a study area for analysis with the MOLUSCE plugin.

Changes and Evolution (2018-2050): Data processing with ArcGIS 10.8 compared land cover layers from 2018 and 2050 for the Quilichao River basin. Detailed maps were created to illustrate spatial distribution, identify patterns, and classify areas based on their use, including agriculture, forests, and urban areas.

Simulation and Prediction: The MOLUSCE plugin in QGIS was used to simulate land cover transitions using an artificial neural network (ANN), and predict changes from 2018 to 2050.

Class	Use Class	Description
1	Water bodies	rivers, ponds, lakes, oceans, flooded salt flats.
2	Dense vegetation	Plantations, broadleaf forests, coniferous forests.
3	Natural meadows	natural meadows and fields with little or no tree cover, open savanna
4	Flooded agriculture	flooded mangroves, emerging vegetation, rice fields and other agricultural activities that are flooded and heavily irrigated.
5	Crops	Cereals, grasses and crops planted/laid out by humans not at tree height
6	Shrubbery	Mixture of small groups of plants or individual plants scattered in a landscape
7	Urban areas	Man-made structures; major road and rail networks; large homogeneous and impermeable surfaces
8	bare ground	Areas of rock or soil with very little or no vegetation throughout the year

Table 2. Legend of CORINE LAND COVER Coverage: *Classes and description of LULC*. Source: (Karra et al., 2021)

RESULTS & DISCUSSION

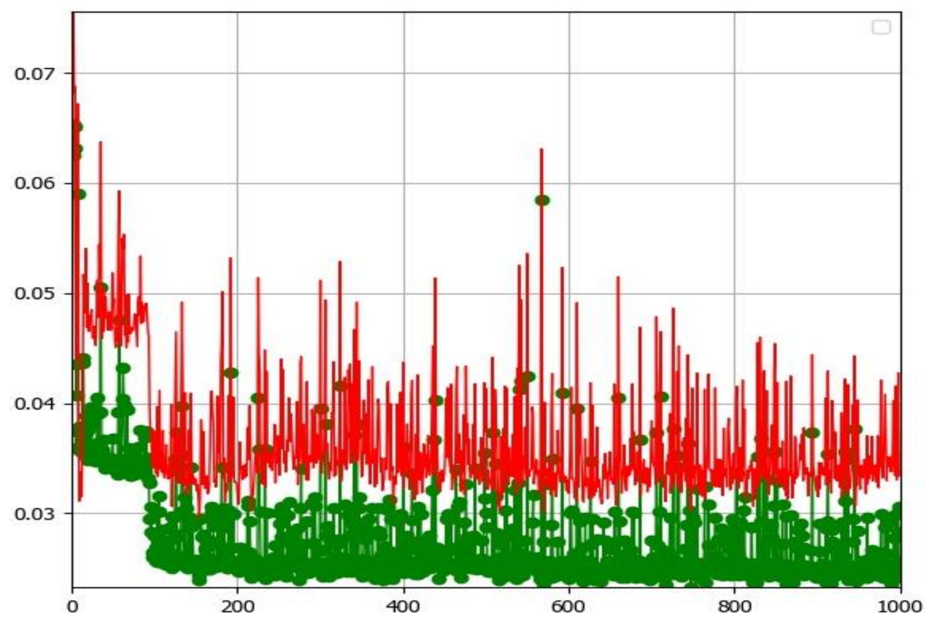

Figure 3. Change transition potential modeling based on artificial neural networks (ANN), Neural network learning curve.

Using the multi-layer perception strategy of artificial neural network (ANN). Modeling of the transition potential was performed using an artificial neural network (ANN), which is governed by the multi-layer perception method employing neighborhood (1px), learning rate (0.01), maximum iteration (1000) , hidden layer (12), momentum (0.05), fixed overall precision (−0.0018), minimum error for validation (0.0317), and validation kappa (0.987). According to the fixed value (learning rate of 0.01).

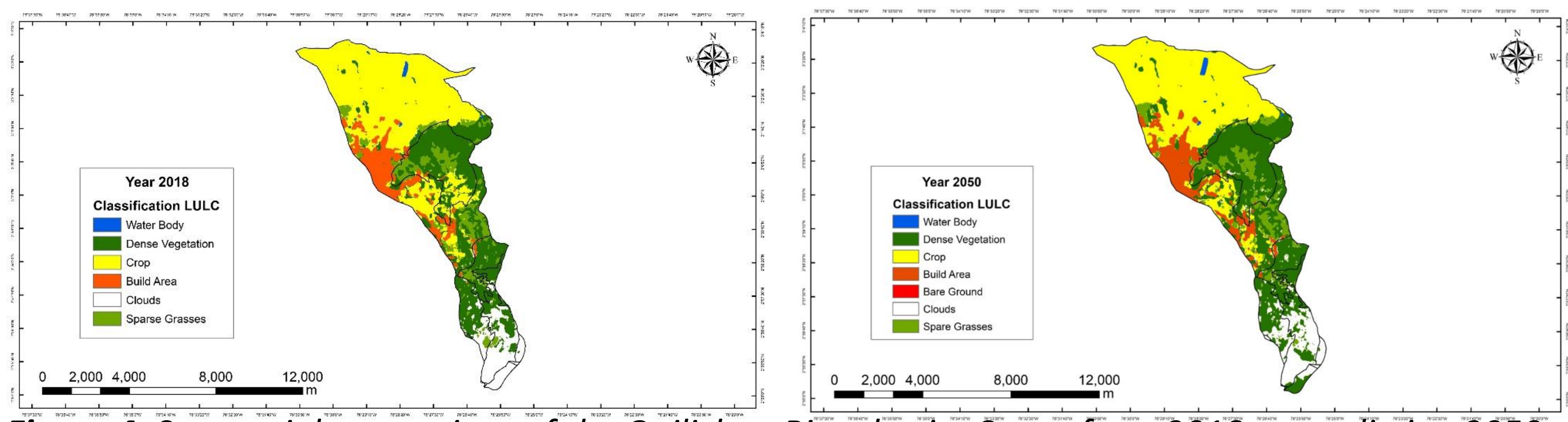

Figure 4. *Sequential comparison of the Quilichao River basin, Cauca from 2018 to prediction 2050*

In the context of the prospective study for the year 2050, graphical validation and Kappa coefficient analysis are critical steps to ensure the robustness and reliability of the generated LULC scenarios, which in turn contributes to a better understanding of the possible impacts environmental and more effective planning for the sustainable future of the Quilichao River basin. The Kappa values obtained during the validation period, the % correction, Koverall, Khisto and Kloc were 0.987, 0.981, 0.986 and 0.994, respectively. All Kappa coefficient values exceeded the 80% threshold, indicating that the precision was sufficient to predict future land cover changes.

The prediction indicates that between 2018 and 2050, crops will increase by 435.42 hectares, impacting biodiversity, landscape connectivity, soil stabilization, and ecosystem services. Without proper planning for sustainability, these changes could negatively affect the livelihoods of rural and urban communities areas (Rengifo, EP, Bastos Monsalve, MB, et al 2022). The results highlight land use conflicts in the Quilichao River basin, revealing a lack of conservation measures. This absence could lead to the loss of ecological dynamics and disrupt ecosystem goods and services in future scenarios (Wang, S., and Zheng, X. 2023)

CONCLUSION

- The proposal emphasizes Territorial Ecological Planning (TEP) to assess ecosystem interactions and enhance environmental services through informed decision-making and public policies. It incorporates a participatory process to establish short- and long-term objectives for sustainable development.
- Additionally, the plan aims to build consensus around biodiversity management and ecosystem service monitoring, promoting socio-ecological resilience at various levels, from national to local.

FUTURE WORK / REFERENCES

This study of long-term LULC changes will serve as a tool for decision makers to propose ecosystem management and planning strategies for the Quilichao River basin, aligned with Colombia's climate goals for 2030 and 2050. It can also be replicated to establish baselines for soil change trends.

Acknowledgments

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