Random Sampling Generates the Total Operating Characteristics for Evaluating Newly Develop Built-up Index

Vanchy Li (3rd Year Ph.D. student, Graduate School of Geography)

(Advisors: Professor Florencia Sangermano & Professor Robert Gilmore Pontius)

CLARK UNIVERSITY

Introduction:

This study introduces a novel built-up index derived from Sentinel-2 satellite imagery, tailored to enhance built-up extraction, particularly in areas dominated by white roofs. The index is further used for urban landscape pattern analysis. The Total Operating Characteristics approach provides a more scientifically rigorous evaluation compared to traditional accuracy assessment methods, which is applied for this study for evaluating the performance of the newly built-up index. This study holds significance in advancing the field of remote sensing and urban landscape analysis, offering potential insights into urban development and environmental sustainability.

Results & Discussion:

1. Both the NDVIBI and NewBI demonstrate effectiveness in distinguishing urban pixels from non-urban pixels, as evidenced by strong associations revealed by the Total Operating Characteristics (TOC), with an AUC of 0.949 for NewBI and 0.903 for NDVIBI.
2. NewBI effectively highlights white and light roofs while deemphasizing waterbodies compared to NDVIBI. However, both NewBI and NDVIBI struggle to differentiate bare soil from red roofs, and roads and cement ground may be erroneously classified as bare soil.
3. The NewBI - NDVIBI plot illustrates the contrast between these two indices, emphasizing NewBI's capability in highlighting urban areas, particularly light roofs, and its ability to differentiate waterbodies and high-density vegetation areas from urban areas.

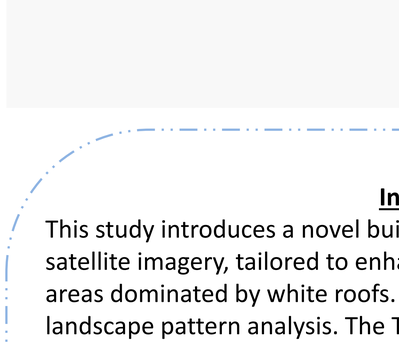

Fig 1: True Color Sentinel-2 in Cordoba, Argentina (Date: 2024/01/24)

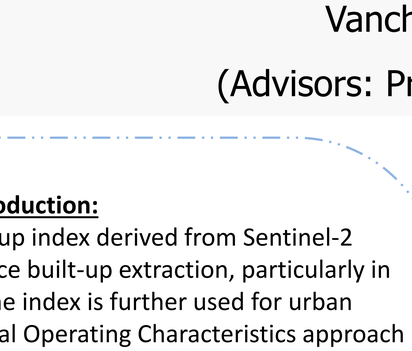

Fig 2: False Color Sentinel-2 (B8, B4, B3)

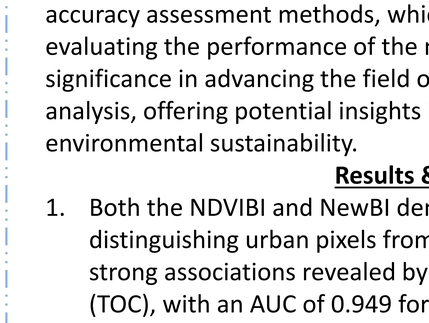

Fig 3: NDBIVI (formula: (NDBI + NDVI) / (-1 / 2))

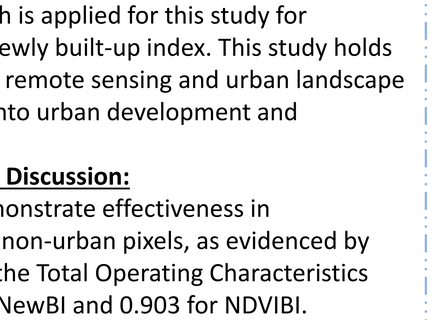

Fig 4: NewBI

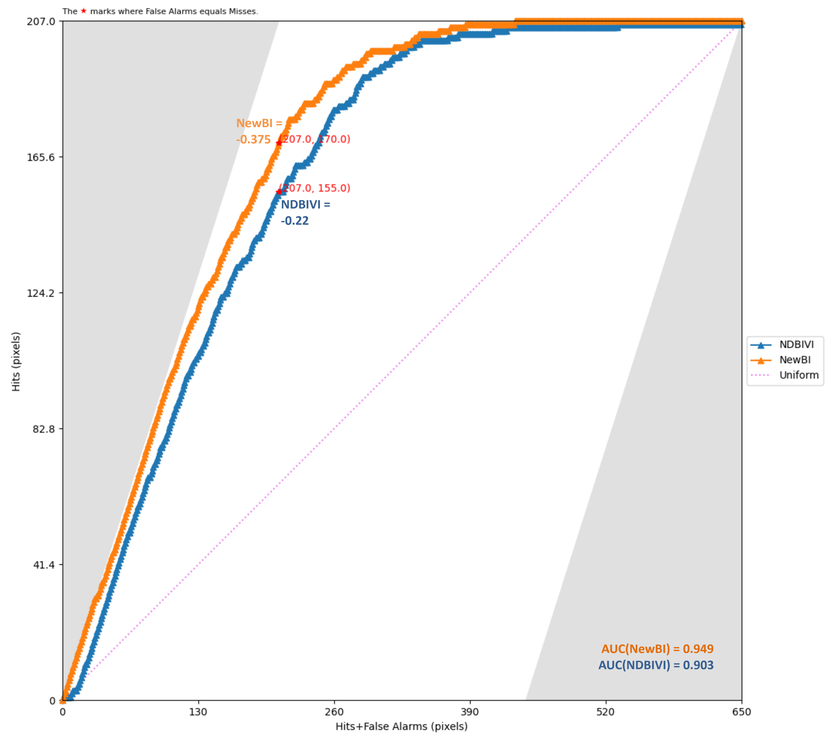

Fig 5: TOC for NDVIBI and NewBI

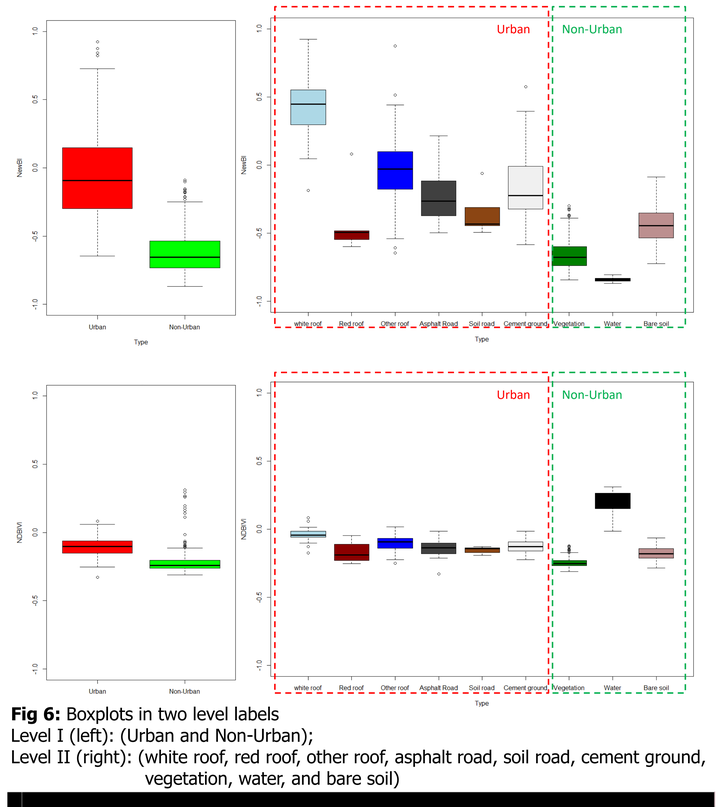

Fig 6: Boxplots in two level labels
Level I (left): (Urban and Non-Urban);
Level II (right): (white roof, red roof, other roof, asphalt road, soil road, cement ground, vegetation, water, and bare soil)

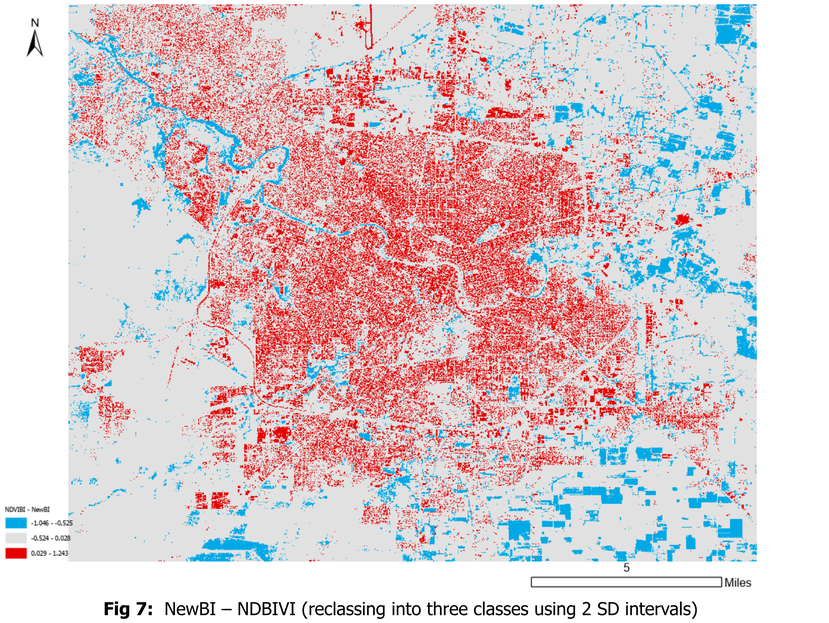

Fig 7: NewBI – NDBIVI (reclassing into three classes using 2 SD intervals)

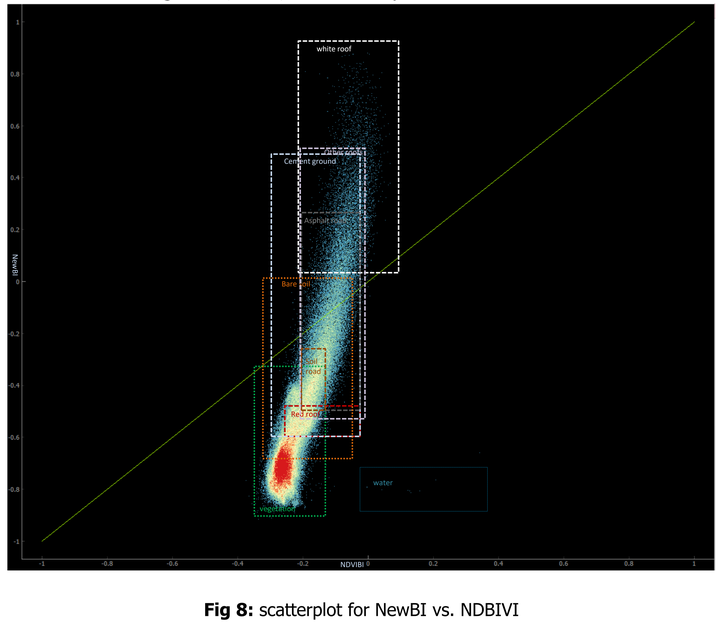

Fig 8: scatterplot for NewBI vs. NDBIVI

Key Reference:

Anderson, J. R. (1976). A land use and land cover classification system for use with remote sensor data (Vol. 964). US Government Printing Office.

Pontius Jr, R. G., & Si, K. (2014). The total operating characteristic to measure diagnostic ability for multiple thresholds. International Journal of Geographical Information Science, 28(3), 570-583.

Zha, Y., Gao, J., & Ni, S. (2003). Use of normalized difference built-up index in automatically mapping urban areas from TM imagery. International journal of remote sensing, 24(3), 583-594.

Acknowledgement:

I am grateful to Prof. Florencia Sangermano for granting me the opportunity to evaluate this new Built-up Index, and to Prof. Robert Gilmore Pontius for providing invaluable methods for this research endeavor.