IOCFF 2026 Conference

The 1st International Online Conference on Fractal and Fractional

13–15 April 2026 | Online

MDPI

The Morphological Marc of Inequality: Fractal Reveals Structural Spatial Segregation in Alagoinhas (BA)

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INTRODUCTION & AIM

- Mathematical and computational approaches can quantify the spatial complexity of cities (Filomena; Verstegen; Manley, 2019).
- Fractal dimension is a metric capable of describing urban patterns (Trentin; Ferreira, 2014).
- Accordingly, the spatial complexity of the urban fabric of Alagoinhas, Bahia, Brazil, was investigated using fractal analysis across three income groups (Classes A, B, and C).

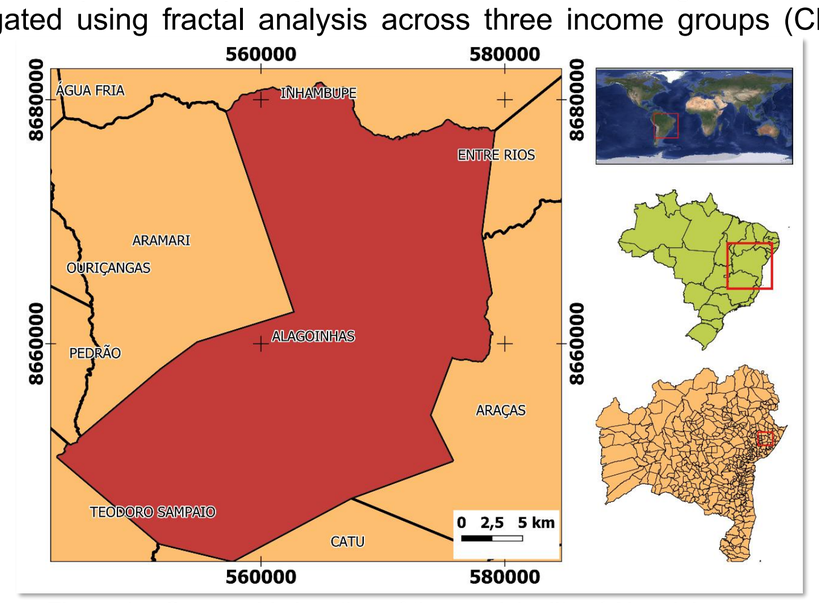

Figure 1 – Geographic location of the municipality of Alagoinhas

METHOD

- Data selection; Standardization of data collection procedures; Data preprocessing (Digital Image Processing – DIP)

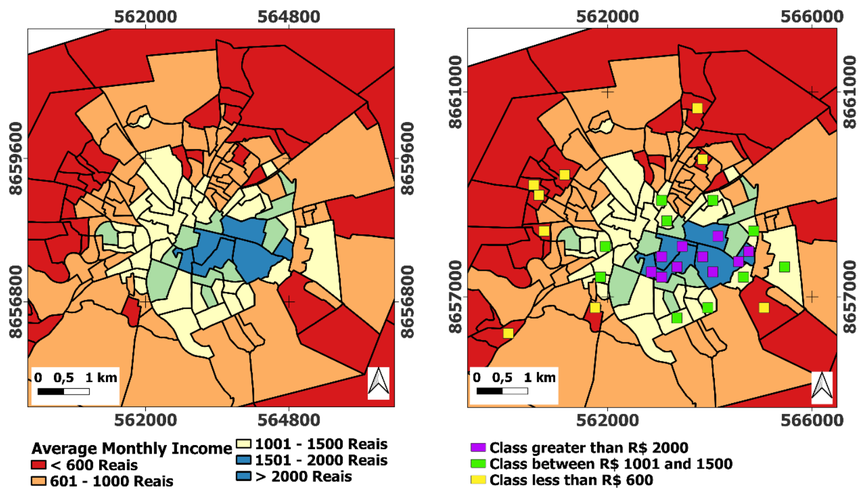

Figure 2 – Spatial distribution of income and sampling points in Alagoinhas..

Samples	Nº of Samples	Size of each polygon	Extension Type	Image resolution
Class_A	10	40,000m²	.tif	0.5m
Class_B	10	40,000m²	.tif	0.5m
Class_C	10	40,000m²	.tif	0.5m
Total	30	1.2Km² / Class	-	0.5m

Table 1 – Number of samples by income class in Alagoinhas.s.

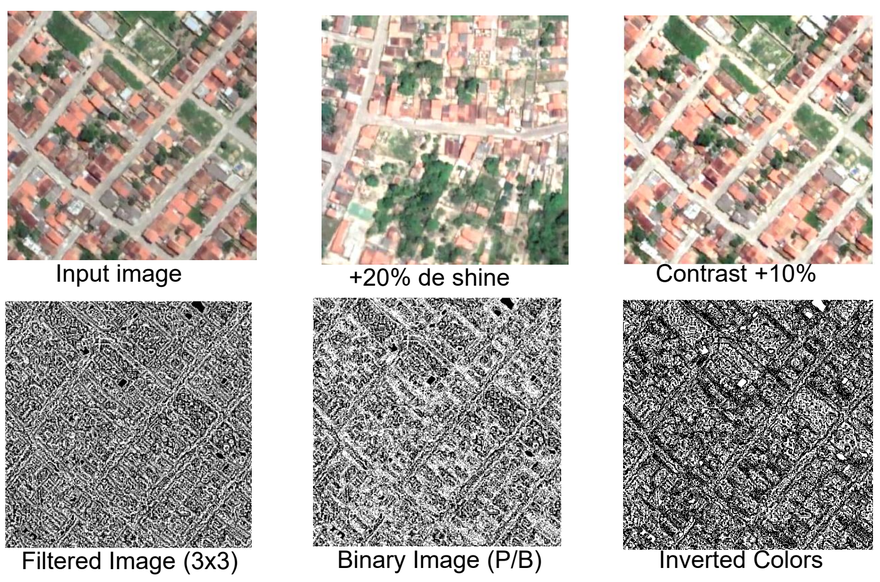

Figure 3 – Preprocessing phases for fractal analysis.

RESULTS & DISCUSSION

In Figure 4, Class A exhibits the highest fractal dimension values, indicating greater spatial complexity. The fractal dimension values shown in the graph were multiplied by 10 to facilitate visualization.

In Figure 5, no clear graphical correlation is observed; however, a weak correlation becomes apparent when applying K-means clustering.

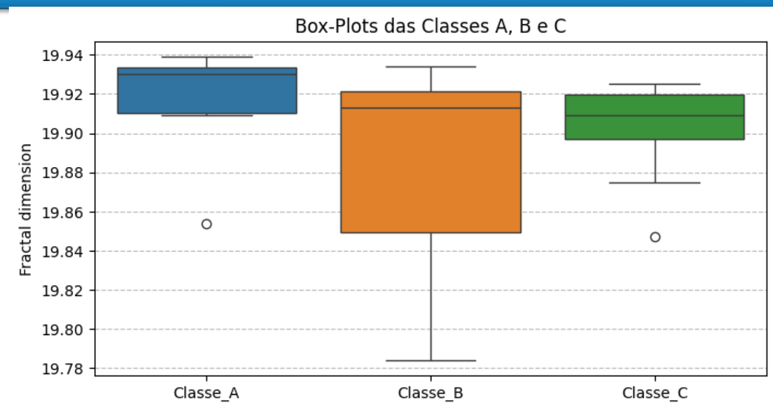

Figure 4 – Statistical comparison of fractal dimensions across the three studied classes using a box plot.

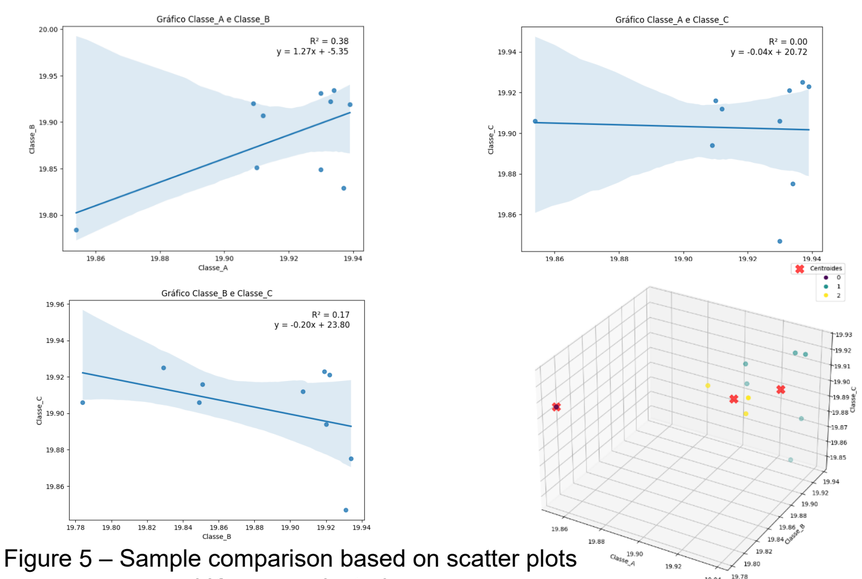

Figure 5 – Sample comparison based on scatter plots and K-means clustering.

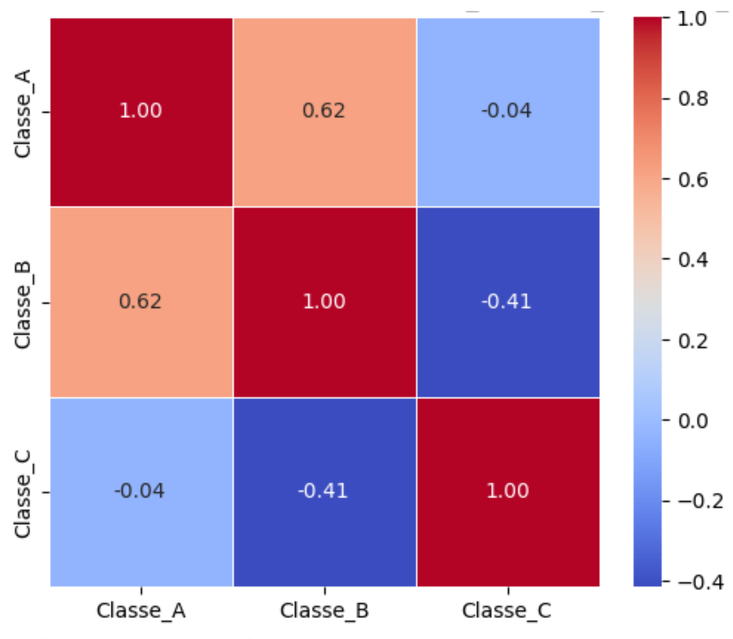

Figure 6 – Correlation matrix of fractal dimensions across the three classes.

The correlation matrix of fractal dimensions across the three classes highlights the distinct characteristics of the different agents shaping the urban space (Figure 6).

CONCLUSION

- The results showed that there are significant differences in the fractal complexity of the urban fabric across socioeconomic classes.
- The Box-Counting model proved to be appropriate for the analysis conducted.
- Fractal dimension is effective in quantifying inequality in urban environments.

FUTURE WORK / REFERENCES

- Future research should extend this analysis to other Brazilian and international cities with varying urban and historical contexts, and incorporate multiscale or multifractal models to capture finer nuances of spatial complexity.

FILOMENTA, G; VERSTEGEN, J. A.; MANLEY, E. A computational approach to 'The Image of the City'. Cities, v. 89, p. 14-25, 2018. https://doi.org/10.1016/j.cities.2019.01.006
TRENTIN, G.; FERREIRA, M. C. Directional analysis of urban expansion in medium-sized cities: an application of fractal dimension. *R. Ra'e Ga*, vol. 33, pp. 198–224, 2014.