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AN EMPIRICAL CASE STUDY GEOAI USAGE FOR SUSTAINABILITY SCORING OF UNIVERSITY CAMPUSES

Ampirik Bir Vaka Çalışması: Üniversite Kampüslerinin Sürdürülebilirlik Puanlaması için GeoAI Kullanımı

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Abstract

UI GreenMetric (GM) ranking system is a methodology to score and rank the university campuses in several categories. The campuses are measured according to their various sustainability indicators in this methodology. The base of this research to study on how we can use geoAI to calculate GM Setting & Infrastructure (SI) score. By this empirical case study to have ideas connected with the relation of score point and geospatial metrics by recognized of google map geotiff images of university campuses. In our paper we analyze three university campuses and give some insights related with the statistical and quantitative geographical information comparisons. We recommend geoai metrics for a practical way of GM and similar scale assessments for the experts. To develop a geoIA methodology with KooMap cloud service in the purpose of sustainability scoring would provide a practical, accurate and pretty objective algorithm for a smart campus evaluation. In the way of transforming to smart city these applications and utilizations of geoAI are the digital trends of new era.

Keywords: *geoAI, sustainability, university campus, greenmetric, smart campus*

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Literature

The campus sustainability importance for universities` circular economy is studied in the research (Nunes, B. T. et al 2018). It is specified that sustainability is one of the key roles of the university economy.

Future Trends in geospatial information management report (United Nations Committee of Experts, 2020) presents the drivers of geospatial information management from five perspectives and gives the trends of next ten years in our digital era. It mentions that the advanced technologies such as digital twin, deep learning, artificial intelligence and big data processing with integrated data will be trend topics due to the evolution of user requirements to smart cities.

The universities` geographical locations are compared with their academic and sustainability performance (Muñoz-Suárez, M. et al 2020). It is declared that the highest performance universities are much more in Europe than other continents.

The relationship between sustainability ranking metrics and academic performance is searched (Atici, K. B. et al 2021). 5 different campus ranking system scores one of that is sustainability metric named UI GreenMetric are analyzed with statistical regression analysis. In conclusion it is approved that the UI GreenMetric ranking of universities provides significance in explaining the academic performance.

It is shown that the results of usage of unmanned aerial vehicles` three dimensional gis (geographical information system) data for image detection analysis of UI GreenMetric SI indicators (Fuentes, J. E. et al 2022). The universities` some campus measurements (km^2 & ratio to total campus area) such as vegetation area, total area, open space area, forest area and building area are analyzed. It is indicated that the suggested methodology is an easy and optimized way to expand understanding of SI criterions, make estimations and visualize time changes. Moreover, this data collection and analysis technic can be easily integrated with the smart campus trend, where sustainability processes, and the physical planning of the campus can be integrated into a GIS to support decision-making within the university campus.

The insights related with data space, digital twin, gis (geographical information system), open data, smart city, drone data, disaster risk management and fair principle are given in the report (data.europa.eu, 2023). GeoAI methodology is explained with use cases, investigation topics and results.

The geospatial data is analyzed of Ostim Technic University by using geoAI (Sivrioglu Aslan, D. et al 2024) to make decisions for sustainability planning.

The SI Score of UI GreenMetric World University Rankings 2023 (Universitas Indonesia, 2023) gives basic information of the university policy towards green environment related with the space for greenery and in safeguarding environment, as well as development of sustainable energy. The key indicators of SI score are given below.

- The ratio of open space area towards total area
- Total area on campus covered in forest vegetation
- The total open space area divided by total campus population
- Total area on campus covered inplanted vegetation
- Conservation: plant, animal and wildlife, genetic resources for food and agriculture secured in either medium or long-term conservation facilities
- Total area on campus for water absorption besides the forest and planted vegetation
- Percentage of operation and maintenance activities of building during Covid-19 pandemic
- Campus facilities for disabled, special needs and or maternity care
- Security and safety facilities
- Health infrastructure facilities for students, academics and administrative staffs wellbeing
- Percentage of university budget for sustainability efforts

Methodology

Google earth map (http://mt0.google.com/vt/lyrs=s&hl=en&x={x}&y={y}&z={z}) was used for this research. The tiff files of universities are obtained from QGIS version Desktop 3.36.0, https://www.qgis.org/en/site/. The campus maps area includes the external environment of the campus.

The image of .tiff files that were analyzed with deep learning image recognition are given in Figure 1, Figure 2 and Figure 3. The image recognition operations are arranged by KooMap Beta Version (Huawei Cloud Service). In this research paper the LULC (land-use land cover) features of the university campuses are detected and deduced the relationship between the SI Score and LULC features. To make this assessment, the percentage of building, road and vehicle area of total analyzed geospatial area are compared. In this way the usage of geoAI technology is tried to figure out the SI capability which is important for sustainable and smart cities and campuses.

Figure 1 Geotiff Image of Ostim Technic University

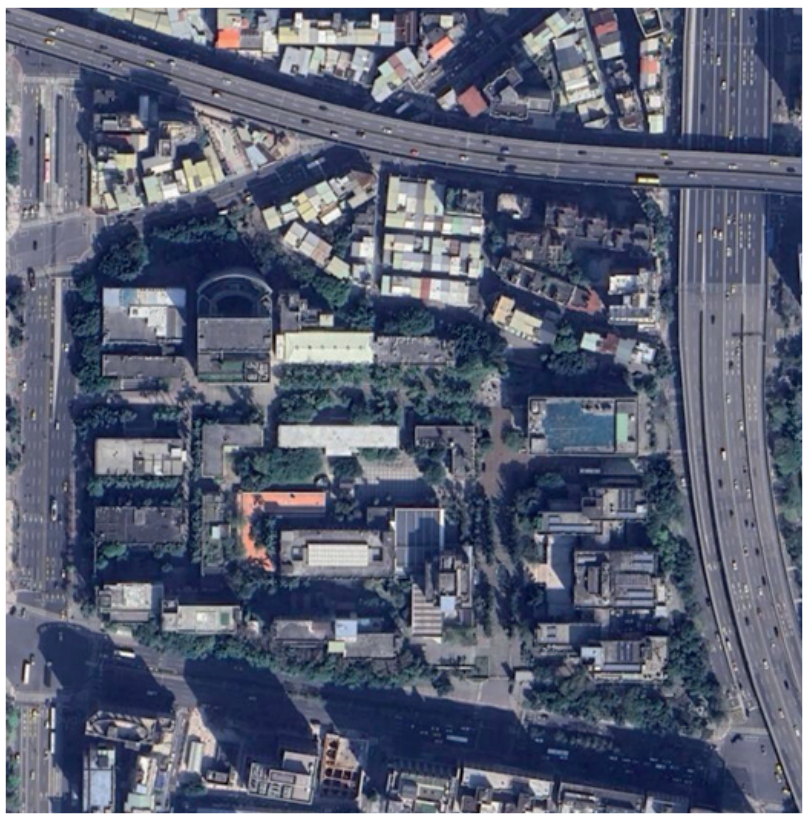

Figure 2 Geotiff Image of National Tapei University of Technology

Figure 3 Geotiff Image of Shokan Ualikhanov Kokshetau University

Table 1 Ratio of Different Area of Universities

University Name	Building Area in Total Analyzed Area	Tree Area in Total Analyzed Area	Road Area in Total Analyzed Area	Vehicle Area in Total Analyzed Area
Ostim Technic University, Turkey	2.8645%	0.0007%	0.1443%	0.0346%
National Tapei University of Technology, Chinese Tapei, Asia	15.8770%	No Data	0.1852%	0.0004%
Shokan Ualikhanov Kokshetau University, Kazakhstan, Asia	0.7886%	No Data	0.0188%	0.0001%

Table 2 University Measurements Recognized by GeoAI

University Name	Total Score	SI Score	Latitude	Longitude	Geospatial Area Analyzed (km2)	Building Area (km^2)	Tree Area (km^2)	Road Area (km^2)	Vehicle Area (km^2)
Ostim Technic University, Turkey	4425	545	39°58'4.28"E - 39°58'13.99"E	32°44'29.84"N - 32°44'48"N	0.22	0.006302	0.00014	0.01299	0.004154
National Tapei University of Technology, Chinese Tapei, Asia	8220	1035	25°2'29.57"N - 25°2'44.13"N	121°31'57.45"N - 121°32'13.36"N	0.244	0.03874	No Data	0.00370	0.000258
Shokan Ualikhanov Kokshetau University, Kazakhstan, Asia	4585	835	53°16'55.17"E - 53°17'3.10"E	69°22'9.99"N - 69°22'20.37"N	0.132	0.001041	No Data	0.00244	0.000043

XLSTAT v2024.1.0 application is used for statistical analyses. GM Score and Table 1 factors are analyzed with statistical linear regression modeling. The regression models are tried to establish.

Results & Discussion

Table 1 depicts the ratio of the LCLA features of the three university campuses which are listed in `High Building` category in the UI GreenMetric World University Rankings 2023 (Universitas Indonesia, 2023). When the values are compared in Table 1, it is seen that National Tapei University of Technology has maximum building and road area and median vehicle area. Shokan Ualikhanov Kokshetau University has minimum road and vehicle and median building area. The comparison shows vehicle area ratio is maximum in Ostim Technical University. The count of vehicle and tread area with vehicle is an effective parameter for UI GreenMetric SI Score. In conclusion, it can be an inference of our study that the vehicle which is parked near campus are an impressive value because more parking area means that more road and less open space for other facilities. On the other hand, it is a cause of air pollution due to its carbondioxide and fuel oscillation. This result affects another score parameter of GreenMetric called Energy and Climate Change (EC) score (21%) and Transportation score (18%) to benefit by decreasing climate change and carbon footprint issues.

Table 2 depicts the total score and Settings and Infrastructure (SI) score (15%) of each university. National Tapei University of Technology and Shokan Ualikhanov Kokshetau University is the top universities which have the highest score.

According to test results only building area in total analyzed area variable bring a significant amount of information on total score. 97 % (R^2) of the variability of the Total Score is explained by the Building Area (%) with 90% confidence. The remainder of the variability is due to some effects (other explanatory variables) that have not been included in this analysis. These could be other UI Green Metric subcriteria effects. The equation of regression model is given below;

Total Score = 4057.86096317687 + 25890.3800311796*Building Area (%)

In literature, the research (Fuentes, J. E. et al 2022) is a good example for this publication in that it proves that geospatial analyses can give verified results to make decisions on GM SI criterions and engage them for GM university rankings. Our research supports this study and presents geoAI assessments for scoring. Although several limitations explained in Conclusion section, recommended methodology in our article could be more optimized, easier and cheaper that suggested in (Fuentes, J. E. et al 2022), if some advanced researches are conducted mentioned in Future Work section.

Conclusion & Future Work

Smart campuses are a given name for the small applications of the smart city facilities. The university campus is the example for the smart campus. In the vision of the smart campus for the future there are lots of studies that try to analyze land-use land cover (LULC) maps, and make decisions for planning campus area in the literature (Thu Tun, et al. 2018; Kinoti and Nyaga 2018; Hwang and Wiseman 2020; Bozdag et al. 2020; Haq and Panduardi 2020; Zaki et al. 2020; Papua et al. 2020; Srivastava and Chinnasamy 2021; Shao 2021; Hong et al. 2022; Li, and Guan 2024).

Working with civil engineers, urban planners and architectures can be future work to construct new campuses. We can review the geospatial data with their expertise and we can compare Ostimtech campus with other university campuses.

Our research proved that the applicability of GIS as a useful tool in campus planning in addition to the earlier case study (Haq and Panduardi 2020). The environmental sustainability impacts can be analyzed by GIS analytics demonstrated in (Zaki et al. 2020). Our research is supportive for this issue from the aspect of the GeoAI analysis usage. In next studies the dynamic monitoring and detection can be tried to solve campus sustainability problems by the IoT sensors and re-mote sensing. Because this research shows that GeoAI is so beneficial for smart campuses not only in planning but also in managing them. In instance like given in (Li and Guan 2024) the parking problem can be prevented by showing the drivers empty park areas utilizing outdoor parking sensors in the surrounding of the campus.

In our study the image based quantitative data is assessed in focus. The percentage area and counts information can be used to make decision for quantitative values of the potential actions as a future work. By this way the hydro-ecological parameters can be evaluated near GeoAI and can be made estimations related with condition changing. These estimations` accuracy can be increased by evaluating with the LULC changes in similarity with (Çalışkan 2023). The approaches utilized in (Çalışkan 2023) combined with our GeoAI methodology.

The scarcity of analyzed universities is a limitation of this research. As the future work the regression model statistical analysis should be performed with sufficient amount of data to develop the methodology for GM SI analysis and increase the confidence of the regression analysis. Furthermore, ANOVA hypothesis test and Principal Component Analysis (PCA) can be performed for quantitative factors which have impact on SI score.

It can be searched moreover which additional indicators of the GM rather than SI should be made decision by using geoAI. Thus, various practical and objective ways could be found for GM score calculation analysis.

In this study greenery area could not be analyzed due to image resolution limitations, updated satellite geographical images can be utilized for the geoAI analyses in KooMap.

Notes

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