The CLGE Young Surveyors' Contest 2023

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Title:

Exploring Open Data: Creating an Online Map for Analysing Population and Migration Dynamics as Factors for Data-Driven Urban Planning and Housing Demand Prediction in the Stuttgart and Karlsruhe Administrative Districts by 2040.

Author(s): *Cynthia Ogechukwu Okeke, Rediet Negash Mengistu, Selorm Komla Darkey.*

Name of Academic Institution: Hochschule für Technik Stuttgart

Level of study or work: Master
(Bachelor thesis, master, research, project, etc.)

Information about you (and your team):
We are master's students in MSc. Program Photogrammetry and Geoinformatics from Hochschule fur Technik Stuttgart. Our Core modules include Photogrammetry, GIS, and Remote Sensing.

Area of interest
(Identifying the problem, explain why it is important and the current relevance of the topic, up to 250 words)

The need for timely, data-driven decision-making regarding housing and accommodation demands in the urban space is of great importance to both city managers and urban developers considering the rapid changes in the urban space. Equally important is understanding population and migration trends and growth patterns for informed planning decisions.

Since the population and migration trends are dynamic and vary from one city to another, and are as well affected by many factors, it is important for city managers and other stakeholders to monitor, learn and predict these factors with high accuracy to ensure efficient allocation of resources to adequately meet future needs of urban dwellers, create sustainable living spaces and make investments in urban spaces viable.

This project's study areas include Stuttgart City, Karlsruhe City, Esslingen City, Stuttgart Administrative District, and Karlsruhe Administrative District.

Approach to the problem
(Describe your methodology or technology and how it will solve the problem you identified, up to 300 words)

Our methodology is an automated GIS system that uses web crawling techniques to capture historical population data, retrieve existing housing data from Open Street maps, analyses the data to determine the population growth rate, uses machine learning regression methods to learn the patterns in growth and predicts the populations for the cities by 2040.

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For Data Collection, web crawling was used to extract non-spatial data from the Baden-Wurttemberg Statistics website (www.statistik-bw.de). Two significant population datasets were downloaded to comprehend the population growth trends in these regions. Population by Nationality (Germans and foreigners) and Population by Age groups (from the population under 15 to the population above 65 years) from 1970 to 2022. These datasets were analyzed to comprehend the growth in the population of Germans and foreigners in these regions.

The spatial data for the study areas were extracted from OpenStreetMap and filtered to include land use, education, and tourist attraction data. The spatial datasets are intended for use in analyzing population and migration differences between the districts and cities and the factors that account for these differences.

This project utilized the ESRI ArcGIS software suite for Data Analysis and Visualization, which included the desktop geospatial data analysis software (ArcGIS Pro v3.1) for data analysis and modeling and ArcGIS Online for web-map visualization, ArcGIS Dashboard for web application visualization.

Data capture, data cleaning, and storage in PostgreSQL were automated to ensure up-to-date population and migration data. Geo-processing was performed using ArcGIS Pro model builder. This process was also automated to ensure continuous analysis of the data.

The predicted growth and rate of change in population for the five study areas by 2040 were then used as a basis to model housing demand in the cities by 2040.

Results, conclusions, and next steps
(Present your research results and conclusions of your study, up to 250 words)

The final output of the GIS system is a live dashboard that includes an online map for the various locations including their building information, information about major land uses as well as charts and graphs that show the trend in population, predicted population numbers by 2040, and predicted housing demand for each location by 2040.

Stuttgart City is projected to experience the highest demand for housing at a 22.4% increase in the current housing population within the areas of study. Karlsruhe City follows with a 9.7% increase, the Stuttgart administrative area expected a 5.8% increase, Esslingen City housing demand is expected to rise by 5.3% and the Karlsruhe Administrative area should expect a 3.9% increase in housing demand by 2040.

For further consideration, the authors suggest including more parameters in the prediction of the population such as the growing industry presence

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and age of current buildings will make the predictions and housing demand numbers more accurate.

References
(Additional information, publications, or links, up to 200 words)

Alex C Ezeh, John Bongaarts, & Blessing Mberu (2012). Global population trends and policy options, *380*(9837), 142–148. Retrieved from https://doi.org/10.1016/S0140-6736(12)60696-5.

Anand V. Saurkar, Kedar G. Pathare, Shweta A. Gode. (2018). "An Overview On Web Scraping Techniques And Tools". *International Journal on Future Revolution in Computer Science &Amp; Communication Engineering* 4 (4):363-67. https://www.ijfrcsce.org/index.php/ijfrcsce/article/view/1529.

Daniela Fecht, Samantha Cockings, Susan Hodgson, Frédéric B Piel, David Martin, Lance A Waller, Advances in mapping population and demographic characteristics at small-area levels, *International Journal of Epidemiology*, Volume 49, Issue Supplement_1, April 2020, Pages i15–i25, https://doi.org/10.1093/ije/dyz179).

ESRI (2023, January 26). What is a dashboard—ArcGIS Dashboards | Documentation. Retrieved from https://doc.arcgis.com/en/dashboards/latest/get-started/what-is-a-dashboard.htm

Gillespie, B. J., & Mulder, C. H. (2020). Nonresident families as a motive for migration. Demographic Research. (42), 399–410. Retrieved from https://www.jstor.org/stable/26936793

Goodchild, M. F. [M. F.] (2010). Towards geodesign: Repurposing cartography and GIS? Cartographic Perspectives, *66*, 7-22.

Khder, M.A., (2021). Web Scraping or Web Crawling: State of Art, Techniques, Approaches, and Application. *International Journal of Advances in Soft Computing & Its Applications*, *13*(3).

Li, W., Batty, M., & Goodchild, M. F. [Michael F.] (2020). Real-time GIS for smart cities. *International Journal of Geographical Information Science*, *34*(2), 311–324. https://doi.org/10.1080/13658816.2019.1673397

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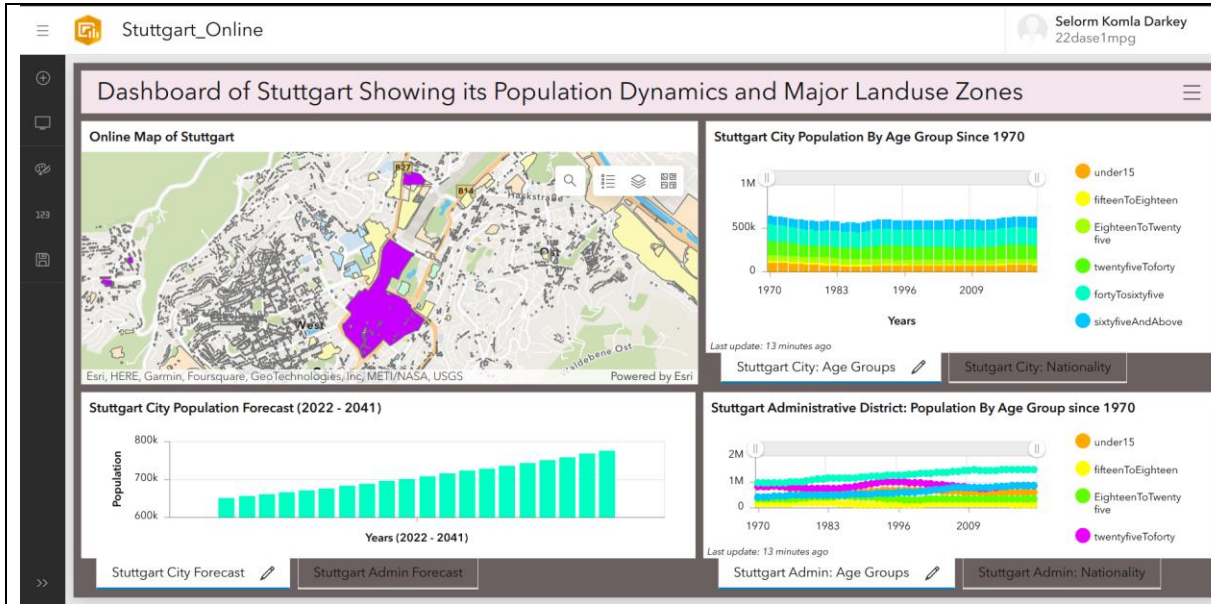**Link to short video on the project:** https://youtu.be/H-GCY9xvKJI

PROJECT IMAGES.

Fig 1: A snapshot of Stuttgart Dashboard from the project.
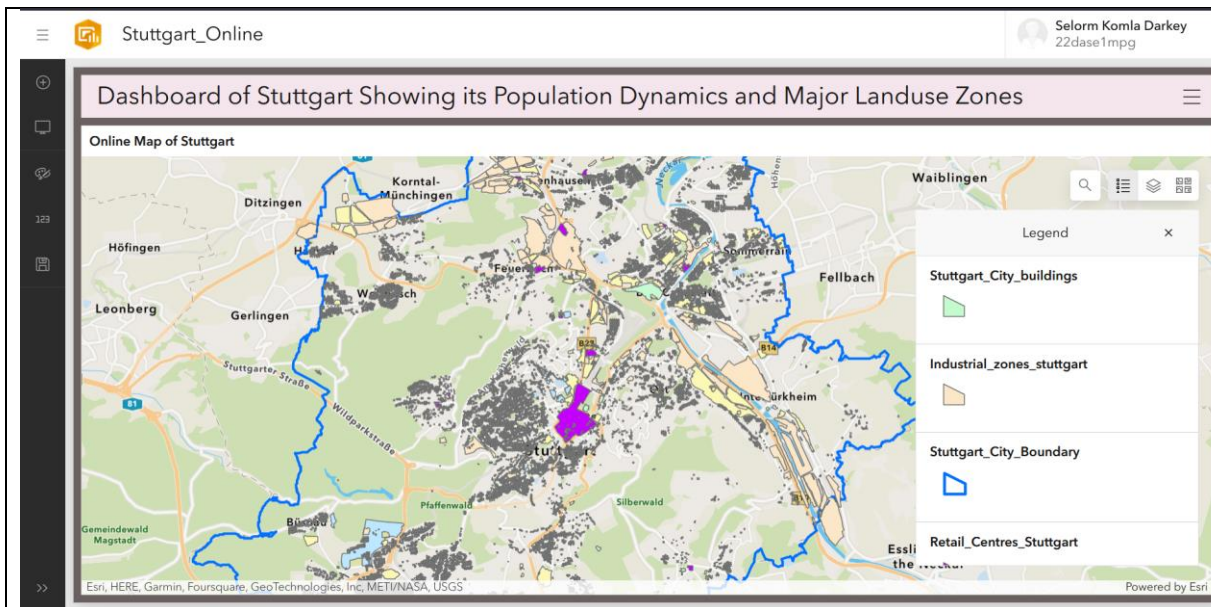
Fig 2: A snapshot of Stuttgart Online Map from the project.

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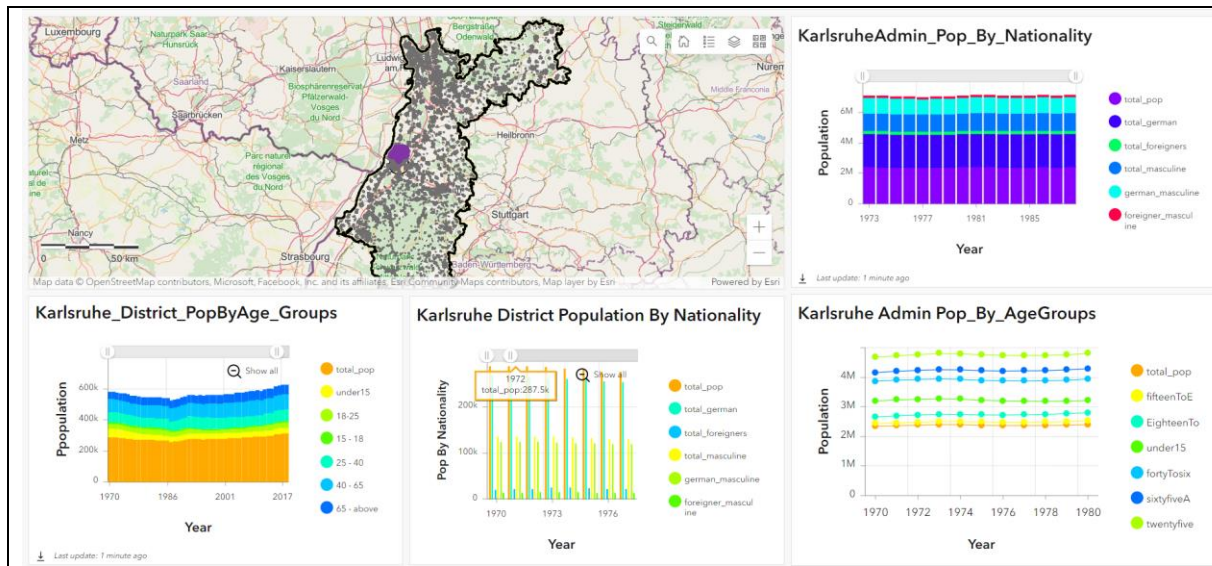
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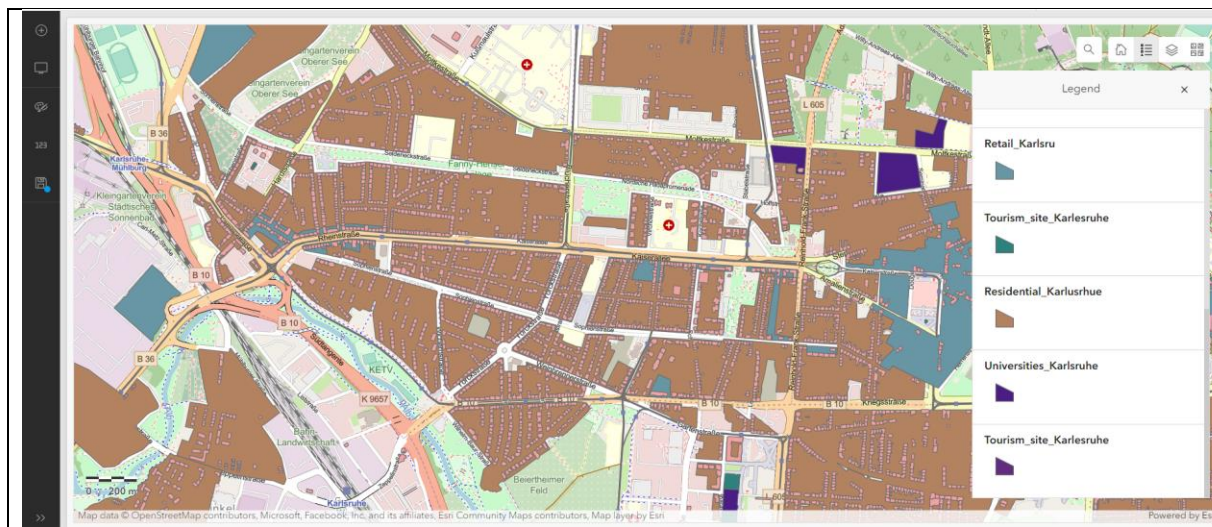**Fig. 3: A snapshot of Karlsruhe Dashboard from the project.**

Fig 4: A snapshot of Karlsruhe Online Map from the project.