Urban Tree Management for Climate Resilience in Würzburg

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Introduction

- Significant environmental problems are experienced in urban areas worldwide due to climate change.

- Urban trees, as the "green lungs" of cities, play a critical role in improving urban living conditions.

- This project aims to enhance climate resilience and improve living conditions in the city of Würzburg using urban tree data.

- Key question: How can urban tree data be used to increase climate resilience and improve living conditions in Würzburg?

Data Sources

- **Data Set 1:** Baumkataster der Stadt Würzburg

URL: https://www.govdata.de/web/guest/suchen/-/details/baumkataster-der-stadt-wurzburg

Description: This dataset contains comprehensive information on over 40,000 public trees in Würzburg. It includes attributes such as species (both common and Latin names), trunk circumference, height, crown width, and geographical coordinates.

- **Data Set 2:** Würzburger Klimabäume – Bodenfeuchte

URL: https://www.govdata.de/web/guest/suchen/-/details/wurzburger-klimabaeume-bodenfeuchte

Description: This dataset includes sensor data from selected trees planted in various soil types across Würzburg. It tracks soil moisture levels, which is critical for understanding tree health and the effectiveness of watering schedules under different urban conditions.

```
Original Data Set1: Baumkataster
        json_featuretype         baumart              baumart_la  kronenbrei ... source_id    category     city            geo_punkt
0  projectName.sp_baum_baum   Roß-Kastanie  Aesculus hippocastanum          13 ...     19540  Baumkataster  Würzburg  49.7999276117, 9.9054896408
1  projectName.sp_baum_baum    Spitz-Ahorn         Acer platanoides          14 ...     43513  Baumkataster  Würzburg  49.7961846899, 9.9466339388
2  projectName.sp_baum_baum  Schwarz-Kiefer     Pinus nigra Austriaca       11 ...     43353  Baumkataster  Würzburg  49.8138326017, 9.9688788031

[3 rows x 11 columns]


Original Data Set2: Klimabaeume
   tree_number          species_latin      species_german  latitude ... temperature_100 battery_percentage              timestamp         koordinaten
0        23631  Tilia Cordata Greenspire         Stadt-Linde  49.79344 ...           23.19               59.0  2023-07-12T10:18:26+00:00  49.79344, 9.94073
1       5463.1         Ulmus New Horizon  Ulme New Horizon  49.79600 ...           25.12               56.0  2023-07-12T10:04:33+00:00     49.796, 9.93272
2        58413         Ulmus New Horizon  Ulme New Horizon  49.79658 ...           24.40               58.0  2023-07-12T10:57:41+00:00  49.79658, 9.94169

[3 rows x 19 columns]
```
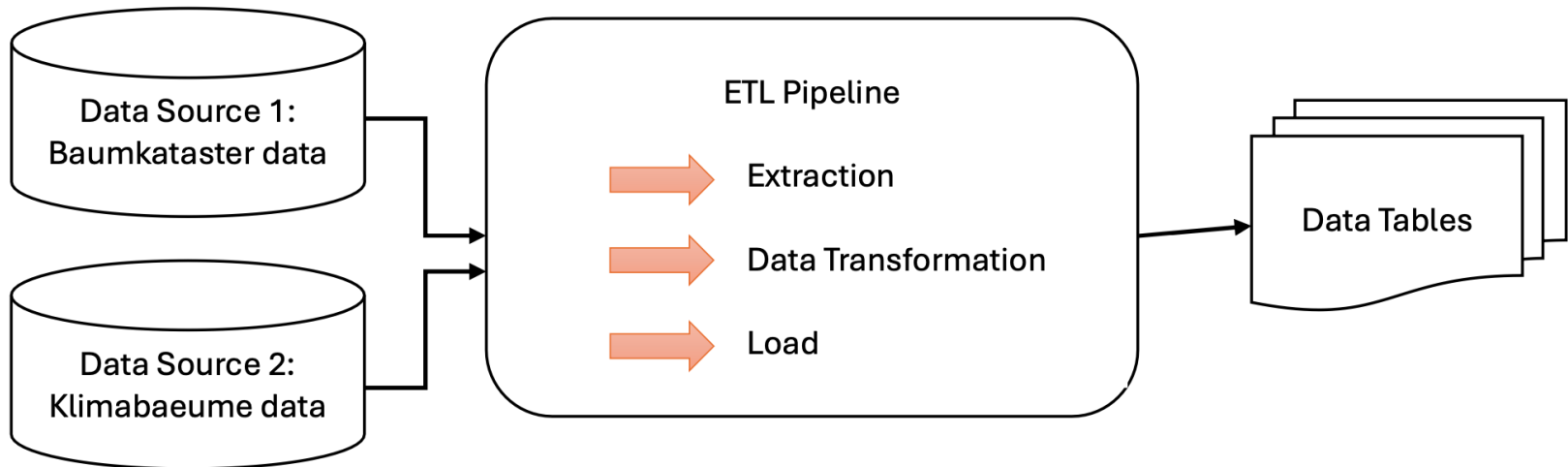
Data Pipeline

- Data extraction and cleaning steps: Download, remove unnecessary spaces, fill in missing values, standardize data formats.

- Transformation: Clarify column names, integrate different data sets.

- Loading: Upload the cleaned data to a SQLite database.

Methods

- Libraries Used: Pandas, Numpy, Seaborn, Matplotlib, os, requests.
- Data Pipeline: Data extraction, cleaning, transformation, and loading steps.

Cleaning Steps:

- Downloading data
- Removing extraneous whitespace
- Filling missing values
- Standardizing data formats
- Validating data types
- Loading cleaned data into SQL database

```
Data Set1: Baumkataster
        species        species_latin  crown_width  height  trunk_circumference  tree_type
0    Roß-Kastanie  aesculus hippocastanum          13    15.0               157.0   Laubbaum
1     Spitz-Ahorn        acer platanoides          14    18.0               185.0   Laubbaum
2  Schwarz-Kiefer    pinus nigra austriaca          11    16.0               112.0  Nadelbaum


Data Set2: Klimabaeume
   tree_number         species_latin  species_german  latitude  ...  usable_field_capacity_100 temperature_30 temperature_100 battery_percentage
0       23631  tilia cordata greenspire      Stadt-Linde  49.79344  ...                  58.823529          25.06           23.19               59.0
1      5463.1       ulmus new horizon  Ulme New Horizon  49.79600  ...                 119.047619          25.26           25.12               56.0
2       58413       ulmus new horizon  Ulme New Horizon  49.79658  ...                 122.222222          26.51           24.40               58.0

[3 rows x 17 columns]
```
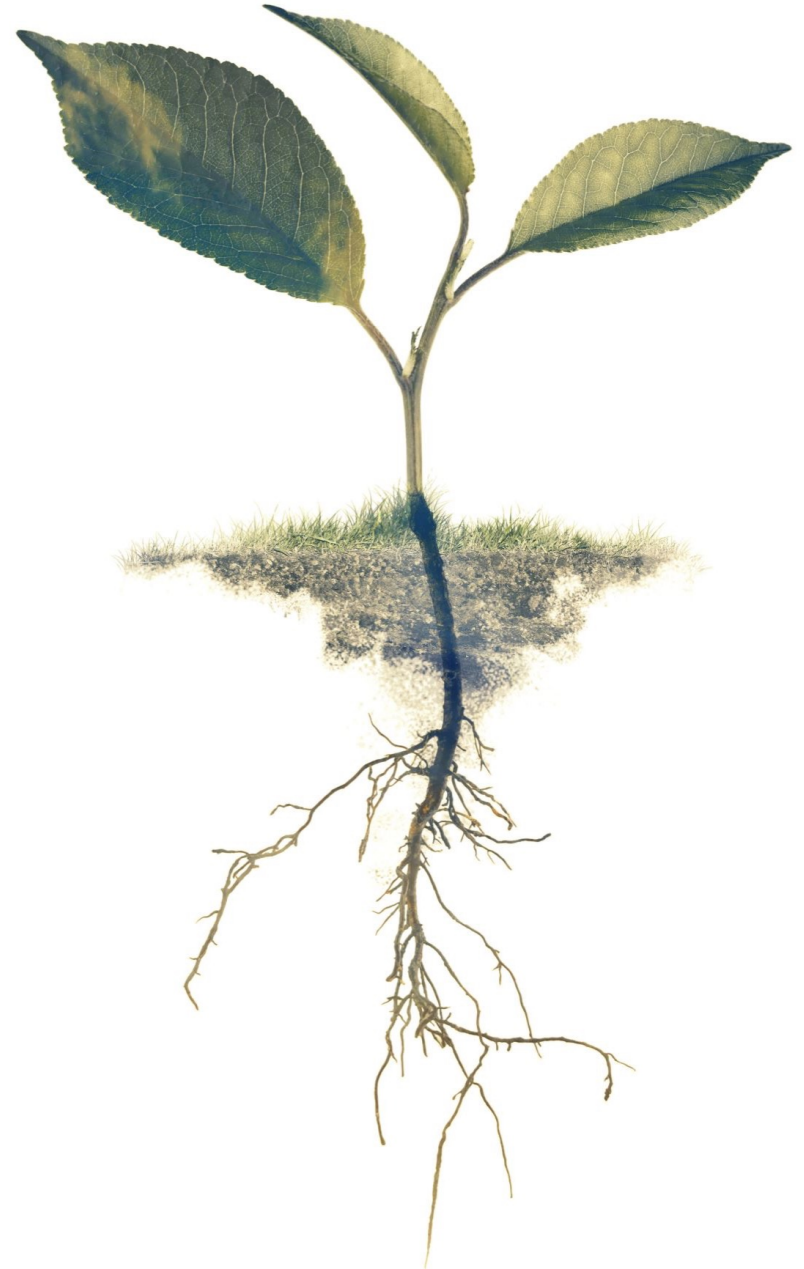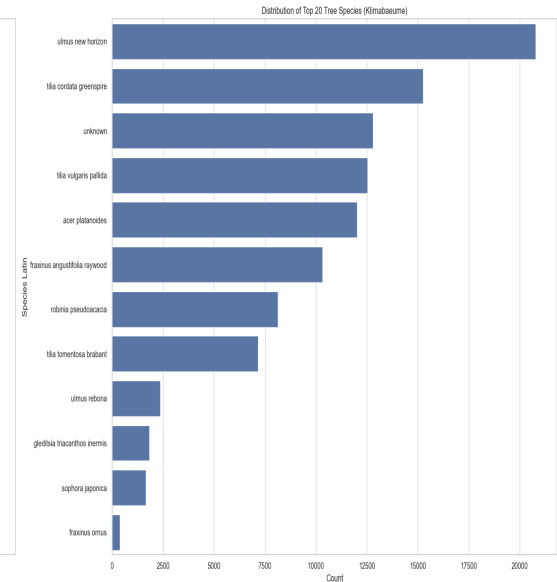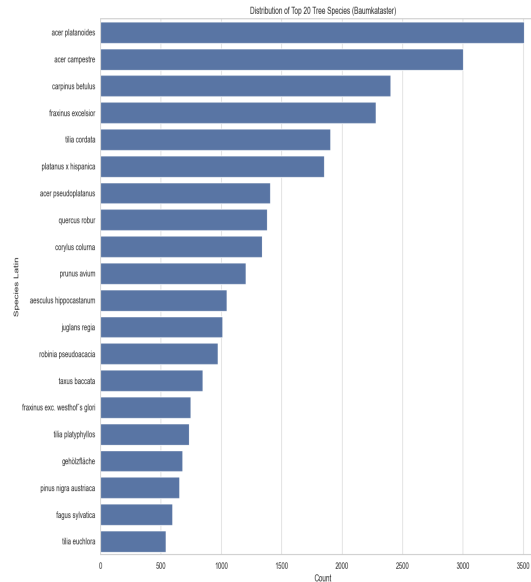
Analyses

- Distribution of tree species.
- Tree health and growth relationship.
- Tree characteristics relationship.

Analysis and Findings: Distribution of Tree Species

Distribution of Top 20 Tree Species (Baumkataster)

Distribution of Top 20 Tree Species (Klimabaeume)

- Analysis of the diversity and prevalence of different tree species in Würzburg.
- Crucial for biodiversity, identifying common and rare species, ecological balance, and urban forestry management.

# Analysis and Findings: Tree Health and Growth Relationship

- Examining the relationship between tree health metrics and growth patterns.

- Identifying key indicators affecting tree health, understanding their impact on growth, and improving maintenance and management practices.

Correlation Matrix - vol_water_content_30 and Tree Growth Metrics

Correlation Matrix - vol_water_content_100 and Tree Growth Metrics

Analysis and Findings: Tree Characteristics Relationship

- Investigating the relationships between various tree characteristics and overall health status.

- Determining the most influential characteristics on health, understanding dependencies between characteristics, and providing insights for improving tree care interventions.

Correlation Matrix of Soil Physical Properties and Tree Health Metrics
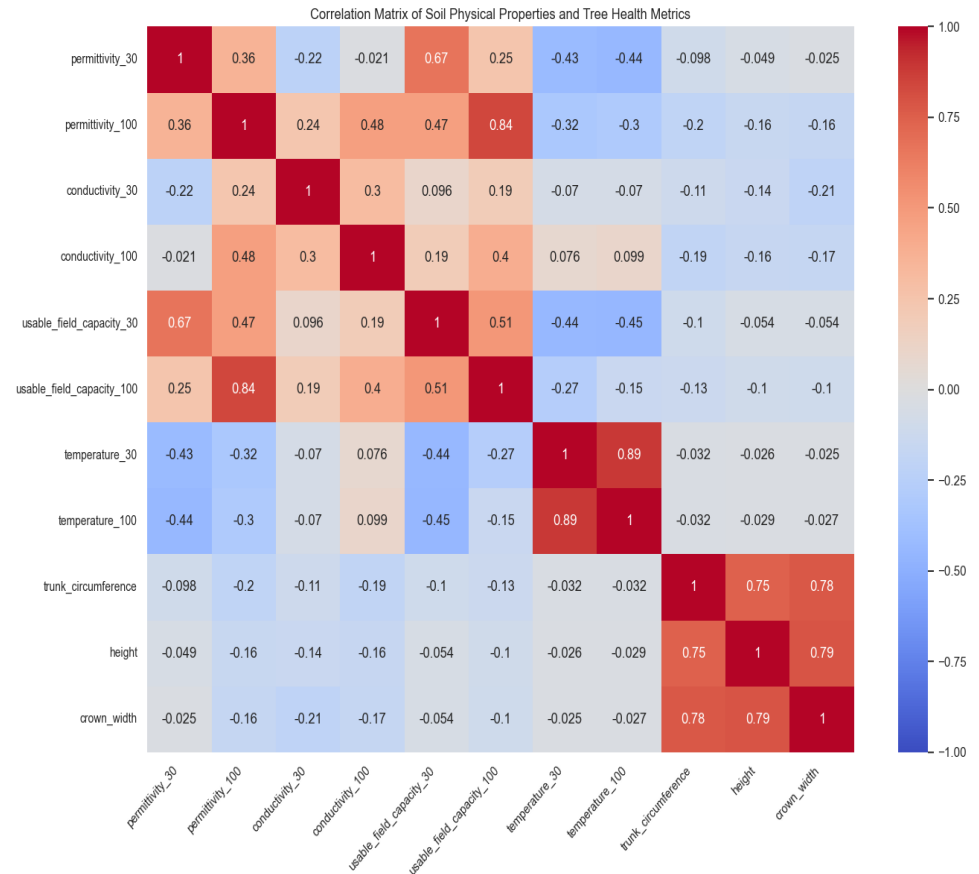
Discussions

- Tree Species Distribution

Importance of tree species diversity in Würzburg for ecological balance and resilience against diseases.

- Relationship between Tree Health and Growth

Examining the relationship between tree health metrics and growth, crucial for optimizing maintenance and management practices.

- Relationship between Tree Characteristics

Investigating the relationships between tree characteristics and health metrics, critical impact of soil temperature on tree health and growth.

Conclusion

- This study underscores the pivotal role of urban trees in bolstering climate resilience and enhancing urban living standards in Würzburg. Through thorough analysis of extensive tree and soil datasets, we have unearthed critical insights essential for refining urban tree management practices.

- Diverse species are integral to maintaining ecological stability and facilitating climate adaptation strategies. Looking ahead, the integration of these findings into urban planning frameworks will promote sustainable development and cultivate resilient cities.

Thank you for listening to me.