eMOTIONAL Cities

Mapping the cities through the senses of those who make them

DELIVERABLE 6.2

Open access geodatabase I, baseline scenario model development I and georeferenced model of the selected eMOTIONAL cities

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Main authors	Ata Chokhachian (CLIMA), ata@climateflux.com Paulo Morgado (IGOT), paulo@campus.ul.pt Bruno Miranda (FMUL), bruno.miranda@campus.ul.pt
Peer review	DTU – Technical University of Denmark
Contributors	Bishoy Kaleny (CLIMA), bishoy@climateflux.com Sevval Durmazbilek (CLIMA), sevval@climateflux.com
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Executive summary

This document aligns with the principles of open data within the project (refer to WP3) and presents a publicly accessible database for eMOTIONAL cities maps. The data contained in this database are geographically referenced, allowing users to contribute new datasets from different cities and locations, fostering mutual learning and collaboration. By examining these datasets, we aim to provide an overview of how cities, particularly artificial urban environments (including urban structures, elements, and overall design), impact the mental and physical well-being of individuals, as well as their travel behavior within a space-time framework.

The utilization of geovisualization techniques to map and depict urban design will play a crucial role in WP7. The creation of spatial representations and visualizations serves as a powerful tool to raise awareness about the subject matter and its profound influence. As a result, this project will compile all the gathered information (provided mainly by WP4, and WP5) within a georeferenced platform (as outlined in WP3). This platform will facilitate spatial analysis, mapping, and integration with existing datasets, allowing for a comprehensive examination of the collected information in a spatial context.

1. Introduction

1.1. Necessity

The development of a geovisualization dashboard is essential for harmonizing available datasets on spatial data infrastructure (SDI) and transforming raw data into valuable information that can be utilized by various stakeholders. In today's data-driven world, there is a vast amount of spatial data generated from diverse sources such as sensors (either wearable, mobile or static), satellites, and social media. However, this data is often fragmented, stored in different formats, and scattered across multiple systems. Without a unified platform like a geovisualization dashboard, it becomes challenging to access, analyze, and interpret this wealth of information effectively. One of the primary reasons for developing a geovisualization dashboard is to promote data harmonization. Datasets obtained from different sources may have variations in data formats, spatial and time scales, standards, and coordinate systems. By integrating these datasets within a single dashboard, the data can be standardized and transformed into a consistent representation. This harmonization process ensures that stakeholders can easily find and access, compare and analyze data seamlessly, facilitating decision-making and enabling a holistic understanding of the spatial relationships and patterns within the data.

Furthermore, a geovisualization dashboard serves as a bridge between raw data and meaningful information. Raw data, in its unprocessed form, can be overwhelming and challenging to interpret. However, by leveraging visual representations and interactive tools, a geovisualization dashboard transforms the raw data into visualizations, charts, and maps that are more easily comprehensible. This visual transformation helps stakeholders identify trends, correlations, and anomalies within the data, enabling them to derive actionable insights and make informed decisions.

Additionally, the availability of a geovisualization dashboard facilitates collaboration and knowledge sharing among different stakeholders. By providing a centralized platform to access and explore spatial data, the dashboard promotes transparency and enhances communication among researchers, policymakers, and the general public. It enables stakeholders with different levels of technical expertise to interact with and understand the data, fostering interdisciplinary collaboration and enabling collective problem-solving.

The dashboard aims to ultimately enhance decision-making processes, fosters data-driven initiatives, and promote a deeper understanding of the spatial environment for various stakeholders involved.

1.2. Objectives

The primary aim of this report is to propose a framework that allows the inference and assessment of various urban elements that have an impact on the physical and mental well-being of individuals, considering factors such as age, gender, and vulnerable groups (as outlined in WP5, D5.1). With this objective in mind, the open access geodata platform gives the opportunity to the users to analyze and categorize urban features and elements based on predefined metrics (see D6.1) to identify and spot specific zones that exhibit exemplary characteristics. The goal is to identify a set of properties that have an influence on health, not only considering demographic factors such as age, gender, socio-economic variables, and mobility patterns, but also focusing on individuals who belong to vulnerable groups, such as elderly and people with mild cognitive impairment, and therefore to contribute to a more inclusive urban planning and design.

This deliverable in the form of an open access dashboard will contribute new evidence to the concept of eMOTIONAL cities, emphasizing a universal design approach. This approach aims to create urban environments that can be accessed, understood, and utilized by all individuals, regardless of their age, size, ability, or disability. By identifying and understanding the impact of different urban elements on people's well-being, we can enhance the design of cities and promote inclusive environments that prioritize the health and needs of all individuals.

Through the comprehensive examination of urban artefacts and their effects on physical and mental health, this platform seeks to provide valuable insights and recommendations for urban planners, policymakers, and stakeholders. By characterizing and mapping these artefacts based on established metrics, we can gain a deeper understanding of their specific characteristics and identify zones that serve as exemplary models for health-conscious urban design. Furthermore, the focus on vulnerable groups within this study is of utmost importance. By considering the needs and experiences of individuals who face unique challenges, such as the elderly, individuals with disabilities, or those from economically disadvantaged backgrounds, we can develop targeted strategies to address health disparities and create more inclusive and equitable urban environments. The ultimate aim is to foster a sense of belonging and well-being for everyone, regardless of their circumstances or vulnerabilities.

2. Dashboard Development

2.1. SDI API

The development of the dashboard is mainly driven by the datasets that are available on the SDI. Since each dataset comes with its own spatiotemporal dimensions and resolutions, having the sample datasets in the initial steps of developing the dashboard is very important. In this case the main development has been based on WP4 datasets which are more present in the SDI lakehouse. The development follows a systematic approach. The first step was to understand the API structure and documentation to communicate with the endpoints, parameters, and data formats for the available data in the SDI. These tables typically store the processed and enriched data ready for visualization.

Table 1: Accessible dataset on SDI – Retrieved on 2023.06.30.

Pilot Cities	WP4 Data	Exp 1 Brain as predictor	Exp 2 Brain as predictor	Exp 3 App	Exp 3 Lab	Exp 4 Outdoor	Exp5 Clinical
Description	Meso scale datasets	Brain as predictor of emotional urban places (Flicker Images)	Understanding the neural processing of urban space through naturalistic stimuli (videos)	Mobile sensing of stress and emotional effects of daily urban experience		Outdoor neuroscience experiments	VR Clinical experiment
Lisbon	✓	✓	✓				
Copenhagen							
Lansing	✓						
London	✓						

Next step was to leverage appropriate querying mechanisms or APIs provided by the SDI to retrieve the required data from the lakehouse. We constructed queries or utilized APIs that allowed us to filter which data is needed to get mapped together. With the retrieved data, we utilized geospatial visualization libraries or frameworks to create the interactive geospatial maps for the dashboard. These tools allowed us to plot points, lines, polygons, or any other geospatial entities based on the retrieved data.

By consuming the data from the SDI lakehouse and building the geospatial map dashboard, we can enable users to explore, analyse, and gain insights from the geospatial data stored within the SDI. The dashboard provided an intuitive and visually appealing interface to interact with the data, empowering users to make informed decisions based on the geospatial information presented. Currently we have the pipeline for London and Lisbon where Lansing and Copenhagen are still work on progress with the project partners.

2.2. System Design

In the process of building the dashboard of geospatial maps, we encountered the need to retrieve metadata for the legends of the maps. However, we wanted to ensure flexibility in customizing the maps' colors and indexes in the future, as well as enabling users to personalize their maps. To achieve this, we made a conscious decision not to hardcode the metadata directly into the platform. To address this requirement, we designed and implemented a relational database specifically dedicated to storing the essential metadata for the maps. This approach allowed us to maintain a separate and centralized repository for the map legends, ensuring easy accessibility and modification of the metadata as needed.

Integrating this metadata database with the dashboard was a crucial step. By retrieving the necessary information from the database, we could dynamically adjust and customize the maps displayed in the dashboard. This integration enabled us to provide a user-friendly interface that allowed users to make changes to the maps, such as modifying colors or indexes, without the need for complex code modifications.

To facilitate this integration, we developed scripts that streamlined the workflow and collaboration between the individuals responsible for building the map legends and those working on the dashboard. These scripts ensured a smooth handover process, enabling the person responsible for creating the map legends to input the required metadata into the relational database. This integration bridged the gap between the map legend design process and the final implementation within the dashboard.

By adopting this approach, we achieved a flexible and adaptable system that empowers users to interact with the interface and customize their maps, and facilitates seamless updates to the legends. The integration of the relational database and the use of scripts ensured efficient collaboration and simplified the process of managing and modifying the metadata for the maps.

2.3. Backend Development

In developing the backend for the dashboard section that utilized Django with Folium, our aim was to create a powerful and efficient system for generating geospatial maps. Django, being a high-level Python web framework, formed the foundation of our backend infrastructure. To begin with, we designed the database schema to store the relevant geospatial data, including map configurations and associated attributes. We opted to use a relational database directly rather than Django's built-in ORM (Object-Relational Mapping) capabilities. This decision allowed us to have more control over the database design and interact with the data using SQL queries.

With the database structure established, we seamlessly integrated Folium, a Python library for interactive map creation, into the Django backend. Folium offered a rich set of functionalities for generating geospatial visualizations. Leveraging the library, we could plot various geospatial entities such as points, lines, polygons, and overlays on the maps. Folium's customization options enabled us to tailor the appearance of the maps, adjusting zoom levels, and applying custom styling.

To facilitate communication between the frontend and the backend, we utilized Django's views and RESTful APIs. These endpoints allowed the frontend to request the required map data and configurations from the backend. We designed the APIs to accept parameters for customization, such as selecting specific map layers, legends, or geographical boundaries. The backend processed these requests, retrieved the relevant data from the database using SQL queries, and dynamically generated the Folium maps accordingly.

In addition, we implemented backend logic to consume the data from the SDI in a flexible way that empowers users to make multiple API requests from the SDI. This flexibility would allow us in future development of the dashboard to perform spatial analysis, apply filters, or generate derived attributes before rendering the maps.

In summary, by combining Django's backend capabilities with the visualization power of Folium, we successfully developed an efficient system for generating geospatial maps within the dashboard. While we chose to directly use a relational database instead of Django's ORM, the integration between Django and Folium allowed us to create interactive and visually appealing maps. This cohesive integration empowered us to deliver a feature-rich geospatial mapping experience to users, leveraging the strengths of both Django and Folium libraries.

2.3. User Interface

The user interface of the dashboard plays a crucial role in effectively representing and analyzing spatial data, allowing users to explore and understand complex geographical information. These interfaces provide a visual platform for visualizing geographic data in the form of maps, charts, graphs, and other interactive visualizations. They enable users to interact with the data, gain insights, identify patterns, gain awareness, and make informed decisions based on the spatial context.

Developing a geovisualization interface involves several key steps. First, it is essential to define the objectives and target audience of the interface (D2.2 and D4.1), as this will influence the design and functionality. For this purpose, the project consortium decided to divide the users into 3 main categories, researchers, policy makers and citizens. Since the use cases of researchers can be very specific, for this purpose they will have access to the S3 buckets and the datasets on the SDI meaning the dashboard might not be suitable for research-oriented applications. Regarding policymakers, work done in WP2 (D2.2) and in WP4 (D4.2) were critical in identifying urban health determinants based on the policy reports, which in turn guided us to set up the technical requirements so that the dashboard can meet the needs of policymakers and be a decision support tool. The main target users of the dashboard will be focusing on policy makers and citizen with curiosity to observe and see straight forward visualization of different areas of the cities.

The logical process of the dashboard is based on the following steps:

- Selecting the desired city
- Selecting the data layers that the user is interested to map.
- Deriving evidence-based correlations from the selected layers

The following images visualize the platform which will be hosted on the eMOTIONAL Cities website.

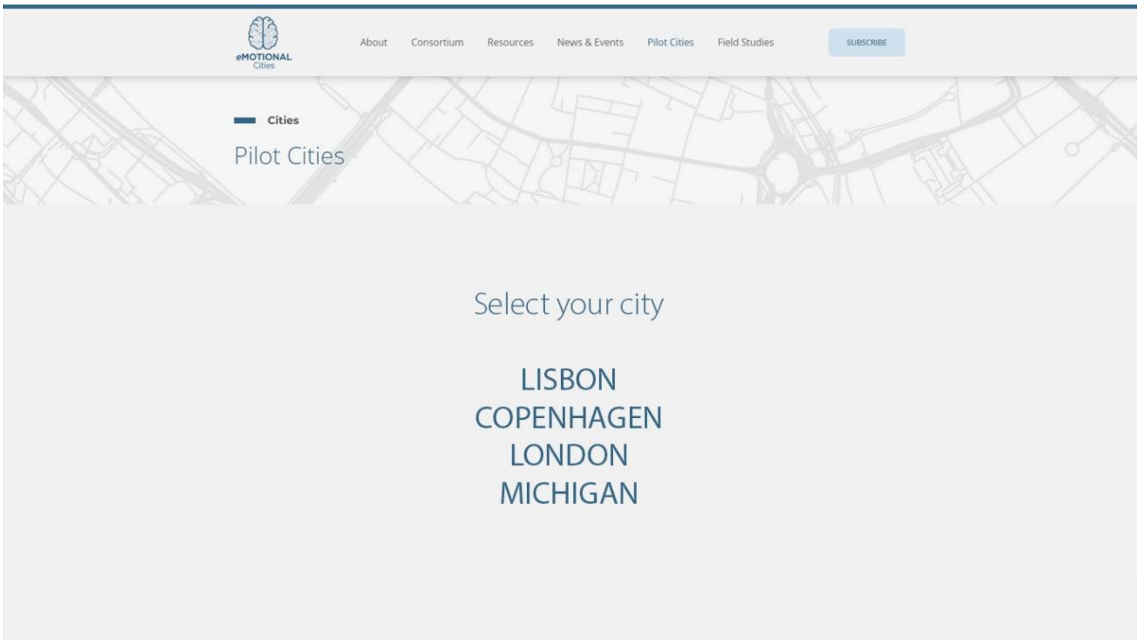

Figure 1: Page designed for selecting the desired pilot city.

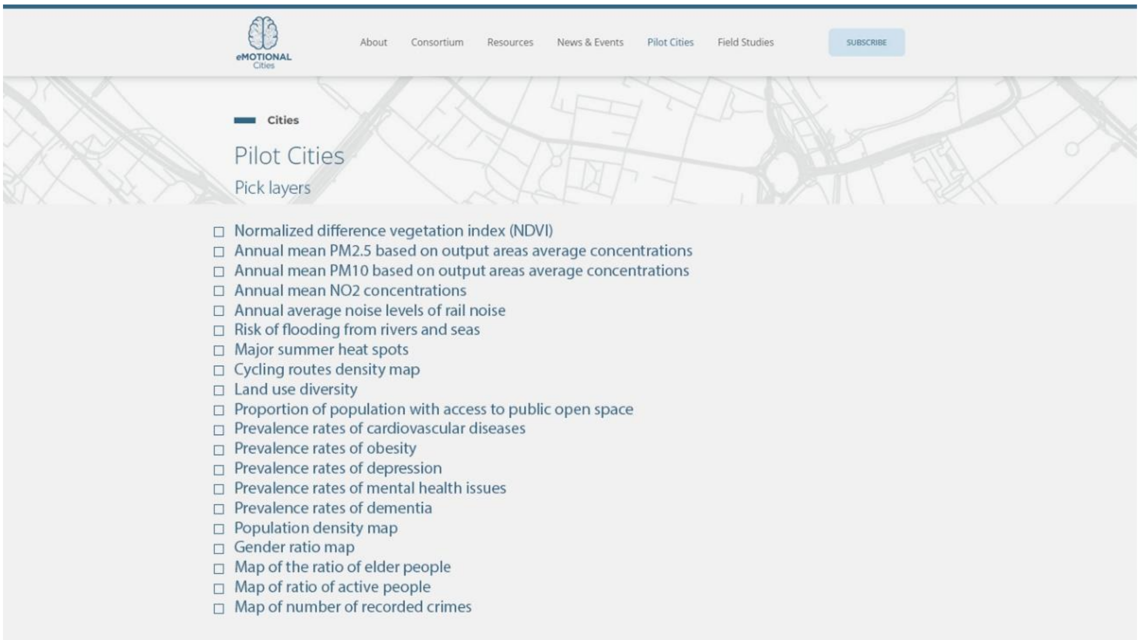

Figure 2: Example list of available datasets on the SDI for the city of London.

For the dashboard platform we've been looking for different options based on the complexity of the development, availability of resources and the efforts and user friendliness. Since this process is dependent on different datasets which come with varying formats and collected for specific applications, the development of the dashboard will continue to evolve as more datasets are available on the SDI.

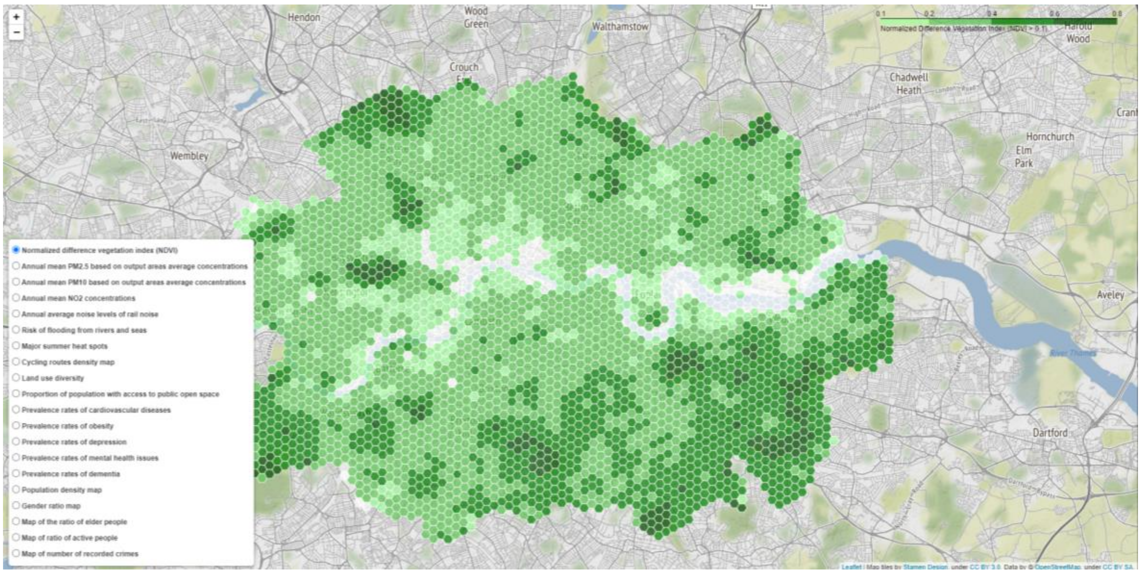

Figure 3: Image of an interactive map to characterize and cluster the urban features and artefacts based on previously identified metrics to identify exemplary zones due to their specific characteristics.

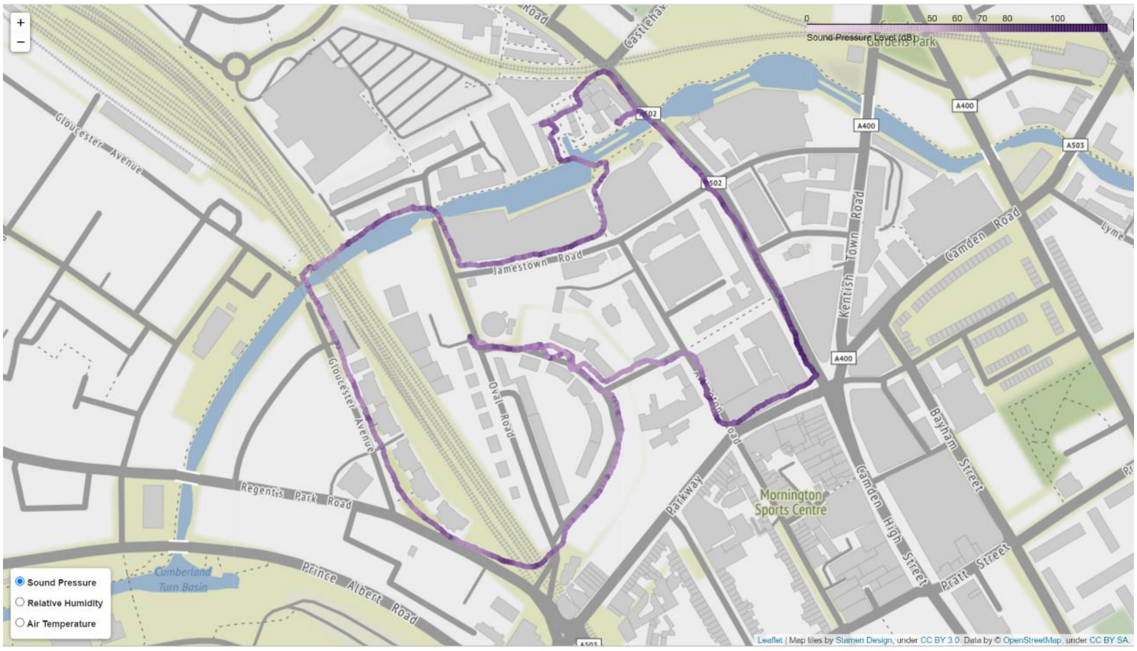

Figure 4: Interactive map of the walking experiments for the case of London showing the Sound Pressure exposure.

3. Final Remarks

This report presents the development process of the geovisualization dashboard that will serve as the platform to present the datasets and outcomes of the eMOTIONAL Cities project. The work effort outlined in this report is a work in progress which evolves based on the incoming datasets to the SDI to accommodate different types, resolutions (temporal and spatial) and user preferences.

The development process of the geovisualization dashboard also included a robust data management and integration strategy. Given the diverse nature of the datasets involved in the eMOTIONAL Cities project, ranging from health and wellbeing to urban infrastructure information, careful attention was paid to ensure seamless integration and harmonization of these datasets. This involved implementing data processing techniques, standardizing data formats, comparable legends and establishing data pipelines to handle the continuous influx of data in future. By ensuring data quality and accessibility, the geovisualization dashboard becomes a reliable resource for researchers, policymakers, and the general public. In summary, the development process of the geovisualization dashboard for the eMOTIONAL Cities project embraces a user-centric approach, robust data management strategies, and adaptability to accommodate evolving datasets and user preferences. By leveraging advanced visualization techniques and user-friendly functionalities, the dashboard aims to facilitate data exploration, analysis, and decision-making, ultimately contributing to the overarching goal of creating emotionally informed cities.

4. Prototype

The Emotion Dashboard is not yet available online, but interested individuals can implement it locally by following the instructions provided on the public GitHub page of the project (https://github.com/emotional-cities/GeoDatabase1).

The primary objective of the project is to ensure seamless compatibility between the datasets and the dashboard's framework. This involves uploading the datasets to the Spatial Data Infrastructure (SDI) and implementing them into the dashboard's functionality. The datasets being integrated into the dashboard are sourced from different experiments conducted in various cities. Each dataset comes with its own unique requirements, necessitating careful data preprocessing, validation, and optimization. These steps are crucial to ensure accurate and meaningful visualizations of the emotional data.

To maintain transparency and allow stakeholders to track the project's progress, a public GitHub repository has been established. This repository serves as a central hub for sharing updates, code, and relevant documentation. The ultimate goal of the open access geodatabase in this project is to deliver a comprehensive and user-friendly online platform. The successful integration of all datasets into the SDI and their subsequent implementation into the dashboard's framework are critical milestones that need to be achieved before the dashboard can be made available online.

The dashboard development is progressing steadily, with ongoing efforts focused on dataset integration and dashboard development. The team is dedicated to delivering an intuitive and informative platform for exploring and understanding urban environments. Stakeholders can follow the project's progress through the public GitHub repository.