CITYNEXUS - A novel urban digital twin application

DestinE in action – meet the first DESP use cases

Consortium

Solenix Engineering GmbH (DE)
Prime Contractor

MindEarth
Subcontractor

Solenix: Services & Expertise

The Company

- **International team of 70+ highly qualified staff in Germany, Switzerland and Italy**
- **19 years of experience, 8 MEUR turnover**
- **Flexible, solution-oriented work approach**

Operations Services

- **Spacecraft Operations**
- **Ground Segment Engineering**
- **Payload Data Ground Segment Engineering**
- **Data Processing**
- **EO Science and Applications Engineering Support**
- **EO Exploitation Platforms Engineering Support**
- **Research of Advanced Technologies Concepts**
- **AI/ML Specific Expertise & Consultancy**

Artificial Intelligence

- **Machine Learning**
- **Anomaly & novelty detection, Prediction**
- **Pattern matching, Trend analysis**
- **Planning & Scheduling, Optimization**
- **Automation & Autonomy**

SOLENIX

Operations Services

Software Products

Software Engineering
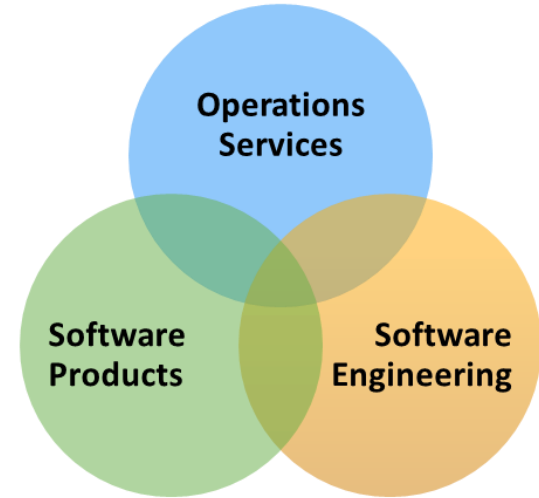
MindEarth   SOLENIX

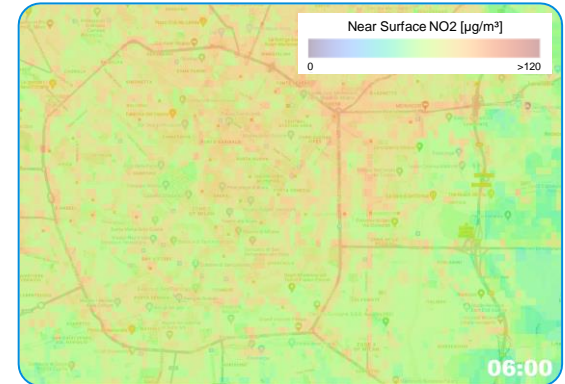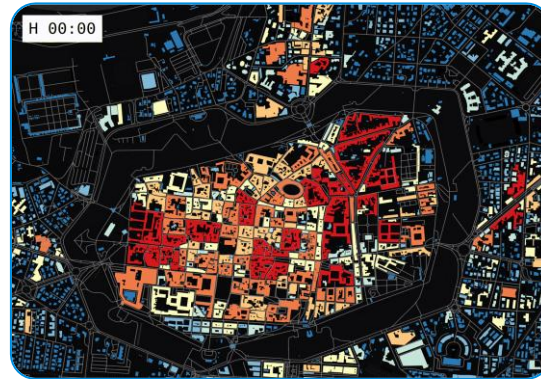# MindEarth: Location-driven Intelligence

local scale ⟷ regional scale ⟷ global scale

Mobile mapping and information extraction

Human flows and POIs from mobility data

Spatial inference from satellite data through ML/AI

CITYNEXUS: A novel urban digital twin application

Background and user requirements

- The City of Copenhagen aims to reduce traffic congestion, foster sustainable transportation and promote urban quality of life.

- A key proposal involves transforming high-speed roads in Ørestad (Amager Vest), a diverse area near the city center with about 25,000 residents and many commuters, to reduce traffic, improve air quality, and enhance living spaces.

- Inspire other districts and municipalities to prioritize mobility and economic needs with climate action and environmental health.

MindEarth   SOLENIX

Aims and Objectives

- Evaluating baseline conditions for human mobility and other connected KPIs:
    - Dynamic Population Distribution,
    - Service Accessibility,
    - Air Quality and
    - Public Environmental Health;

- Enabling the interactive assessment of the impact of infrastructural and regulatory changes through live 'what-if' scenarios;

- Implementing data-driven, innovative approaches for urban planning and climate policy.

MindEarth   SOLENIX

'What if' scenarios simulation

Users are given the possibility to assess the effects of different interventions in a virtual space.

High-speed Road Redesign
simulate the tunneling of any existing road segment, while repurposing the reclaimed ground for other urban uses.

Low Emission Zones (LEZ) Creation
convert specific areas to LEZ, where motorized circulation is prohibited or limited to specific classes of vehicles.

Electric, Low-Emission Vehicles and Active Mobility
customize the proportion of these vehicles and modes within the traffic fleet.

Road Speed Adjustment
this scenario enables adjustments to speed limits for specific road segments or entire categories of roads.

MindEarth   SOLENIX

'What if' scenarios simulation

- Real intervention alternatives currently considered by the City of Copenhagen;

- KPIs relevant to assess fulfilment of existing policy goals and ambitions;

- Possibility to test diverse urban strategies in a risk-free environment;

- Interactive, participatory and data-driven approach to urban planning.

Data from DestinE Data Portfolio
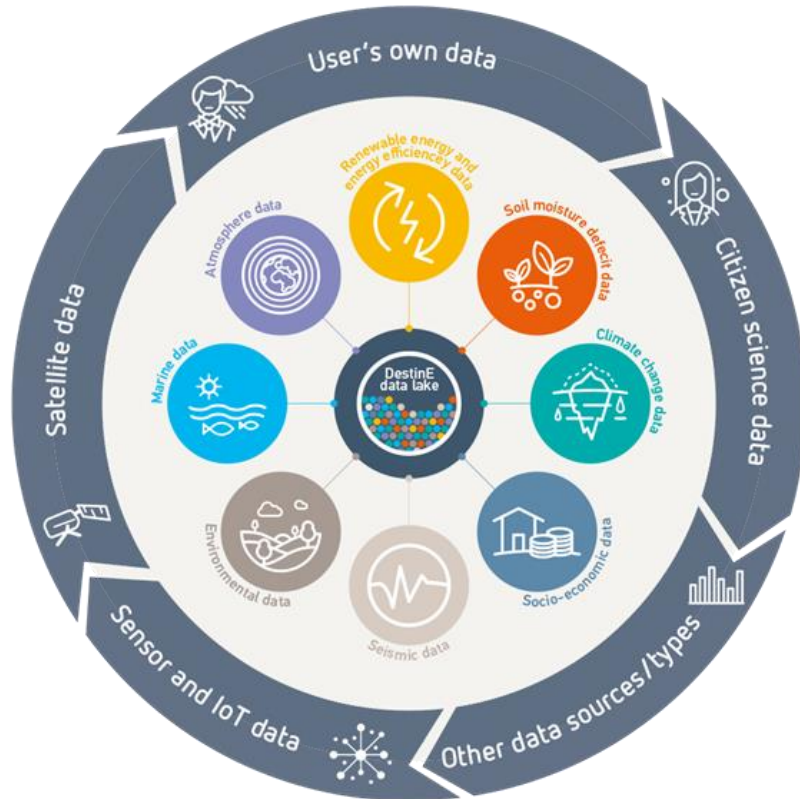
- **Sentinel-5P TROPOMI Level2** daily tropospheric NO2, SO2, CO, O3 vertical column densities;

- **Copernicus Digital Elevation Model** of Europe at 10m resolution;

- **ECMWF ERA5 hourly estimates** for different meteorological variables;

- **CORINE Land Cover** from the Copernicus Land Monitoring Service at 100m.

Human Mobility with HFLB Data

We rely on **commercial High-Frequency Location Based data (HFLB)** that is data precisely tracking the location of a GPS-enabled logging device in time.

This is used to provide key insights into:
- commuting patterns,
- travel behaviour,
- traffic flows,
- congestion rates,
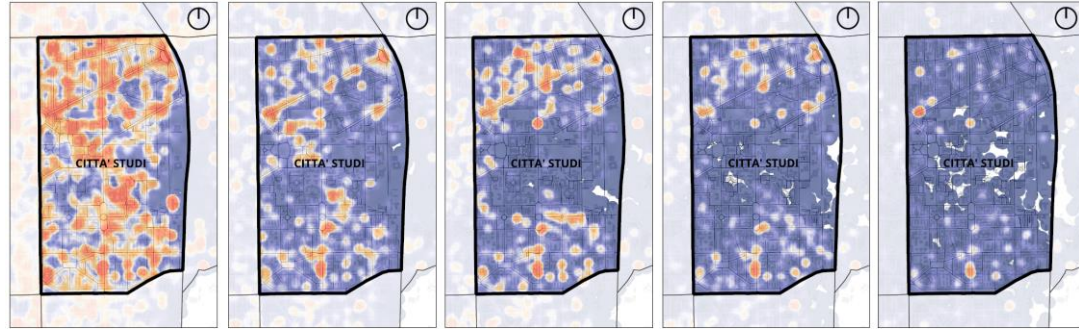- peak traffic hours,
- overall mobility dynamics.

Human Mobility with HFLB Data

Dynamic Population
We use HFLB data to dynamically track human presence in space and over time during weekdays and weekends with high degree of precision.

Accessibility to Services
We use HFLB data to map travel time to and from different types of urban services with different travel modes to identify gaps in accessibility to urban services.
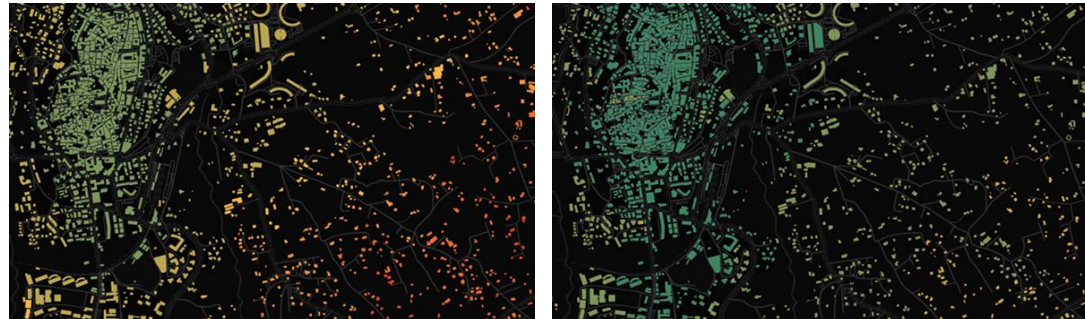
Area usage profile during a typical week day (top) and travel time to retail-based services on foot (bottom left) and bicycle (right)
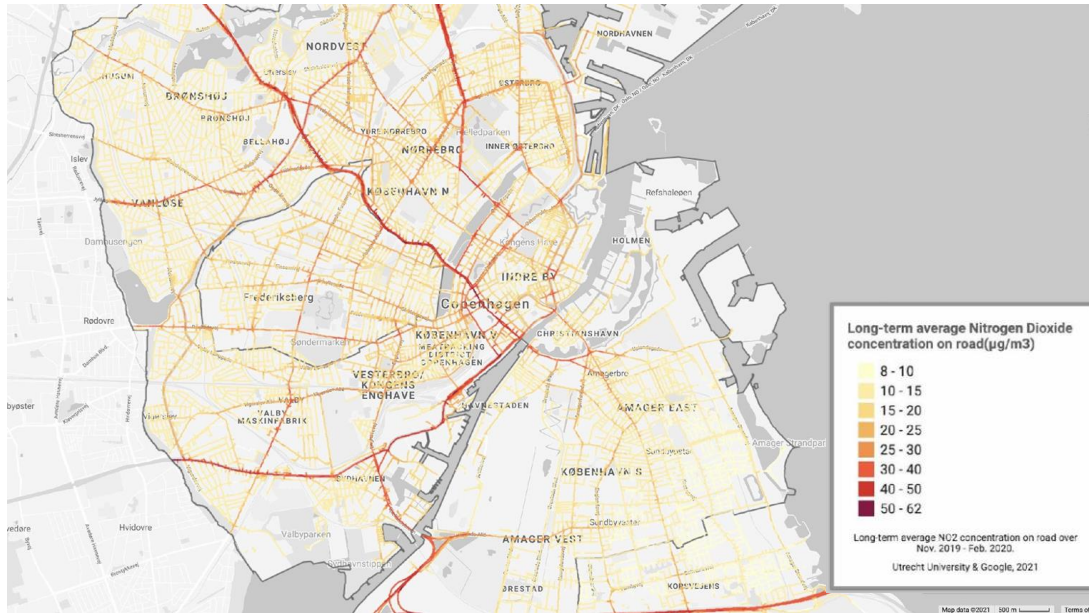
MindEarth   SOLENIX

Air quality estimation (NO2)

Exploiting data gathered from mobile mapping campaigns (Google Environmental Insight Explorer - Air Quality Labs data) and in-situ stations.

Long-term average Nitrogen Dioxide concentration on road(µg/m3)

- 8 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- 30 - 40
- 40 - 50
- 50 - 62

Long-term average NO2 concentration on road over Nov. 2019 - Feb. 2020.

Utrecht University & Google, 2021

Environmental Insights Explorer

Air quality estimation (NO2)

Downscaling **Sentinel-5P data to 100m spatial resolution** by means of a cutting-edge approach leveraging recent advances in artificial intelligence[1].

1. Kim, M., Brunner, D., & Kuhlmann, G. (2021). Importance of satellite observations for high-resolution mapping of near-surface NO2 by machine learning. *Remote Sensing of Environment*, *264*, 112573.

Near Surface NO2 [μg/m³]
0   >120

06:00
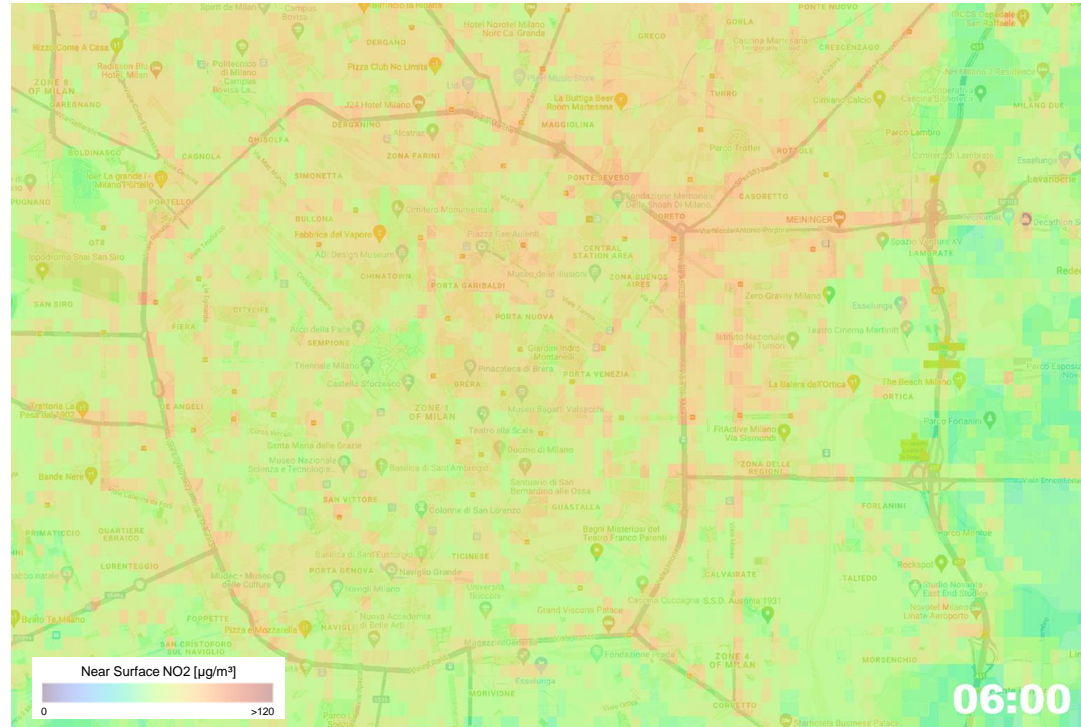
Community engagement and outreach

Objective: Establish a diverse, impactful user community for CityNexus, promoting sustainable urban development.

- **Local Engagement:** Present progress and findings to Local Councils of Amager Vest and and nearby districts and municipalities (Bispebjerg, Valby, and Gentofte);

- **Broader Impact:** Networking: Engage with networks like ICLEI-EUROPE, EUROCITIES, 100 Climate-Neutral and Smart Cities initiative and C40 Cities.

Thank you for your attention

Questions?

alessandra.feliciotti@mindearth.ch

www.mindearth.ai