Human-in-the-loop: empowering urban environmental monitoring with flexible cloud-based satellite mapping workflows

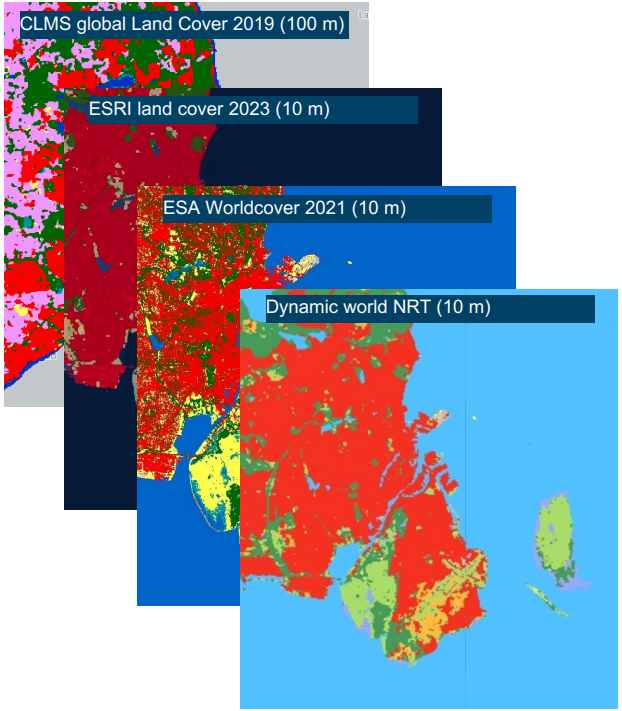
Session 9: Innovative downscaling and AI techniques (New emerging technologies -part 1)

URBIS24, September 18, 2024

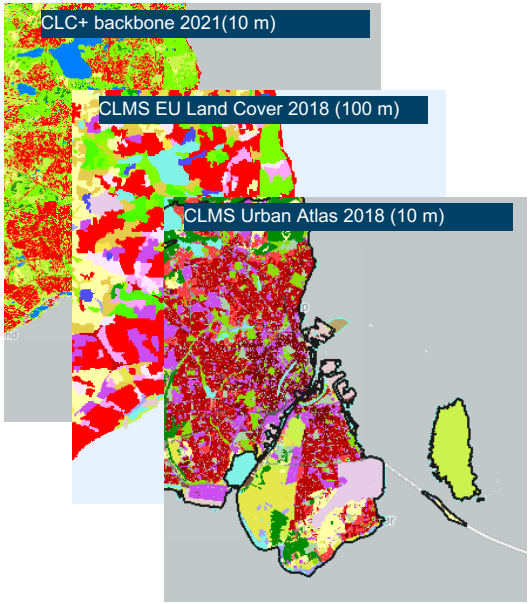
Nicklas Simonsen, Remote Sensing Specialist, DHI

Myriad of global and regional products

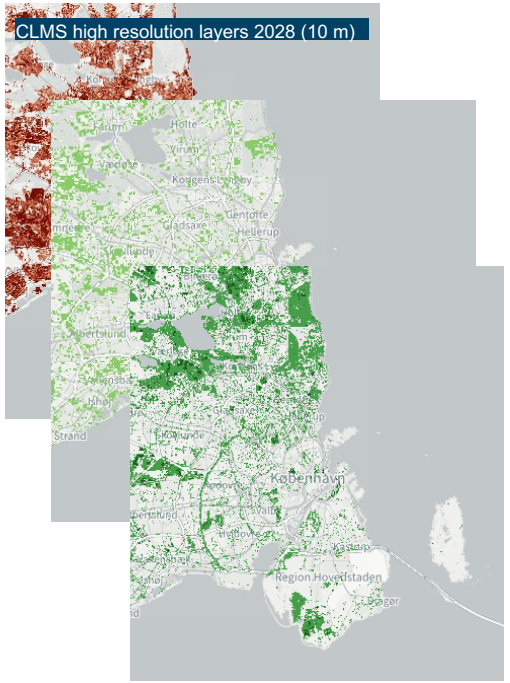
Global



European



Thematic



© DHI

Myriad of global and regional products

Global

European

Thematic

Pros:

- **Broad Coverage**: Provide extensive geographical coverage, offering a global perspective on environmental dynamics.
- **Standardization**: Data is often standardized, allowing for comparability across different regions and time periods.
- **Accessibility**: Many datasets are freely available and easily accessible, supporting large-scale environmental research and policy-making.

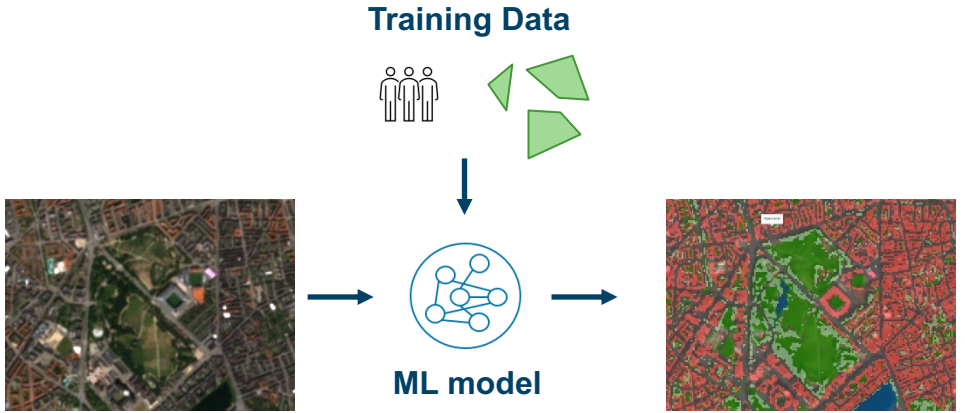
Cons:

- **Low Resolution**: Often lack the fine spatial resolution and disaggregation necessary for detailed urban analysis, missing critical local nuances.
- **Generalization**: May not account for specific local conditions, leading to less accurate or relevant data for urban stakeholders.
- **Latency**: Some products are updated infrequently, which can limit their usefulness in rapidly changing urban environments.

© DHI

New agile frameworks needed

Manual digitization vs **Machine learning**



High accuracy and flexible classification, but very time consuming and can often be subjective.

Typically trained using in-situ data or manual annotations.

Methods differ in terms of spatial awareness, the amount of training data and training required, the level of transferability and scalability.

© DHI

A human in the loop

A Base ML model has learned general land cover features through training on a large set of annotated images

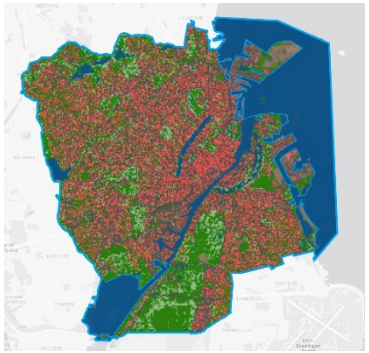
User annotations

The user annotations/data are used to fine tune the model to local conditions

Input data

ML Model

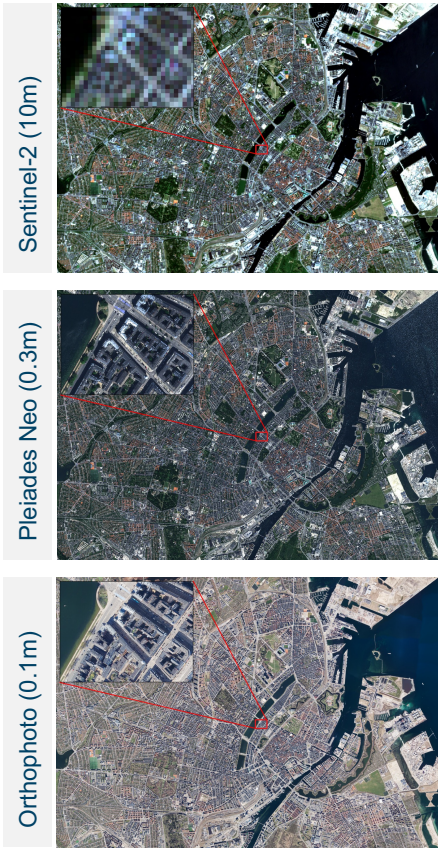
Output map



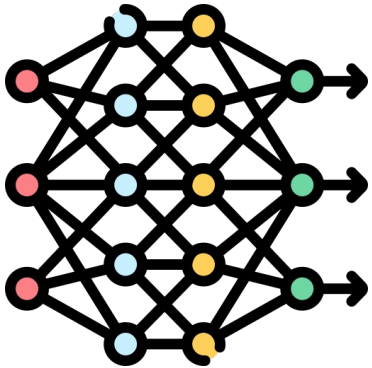
© DHI

Versatile platform

Models are trained for various problems at different resolutions



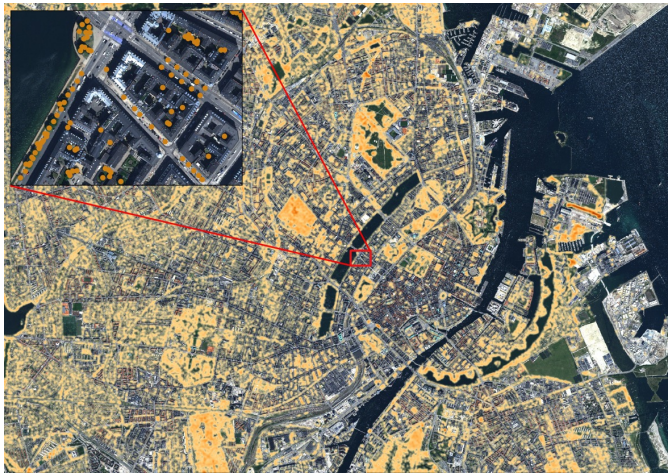
Pre-trained models



Choose from:

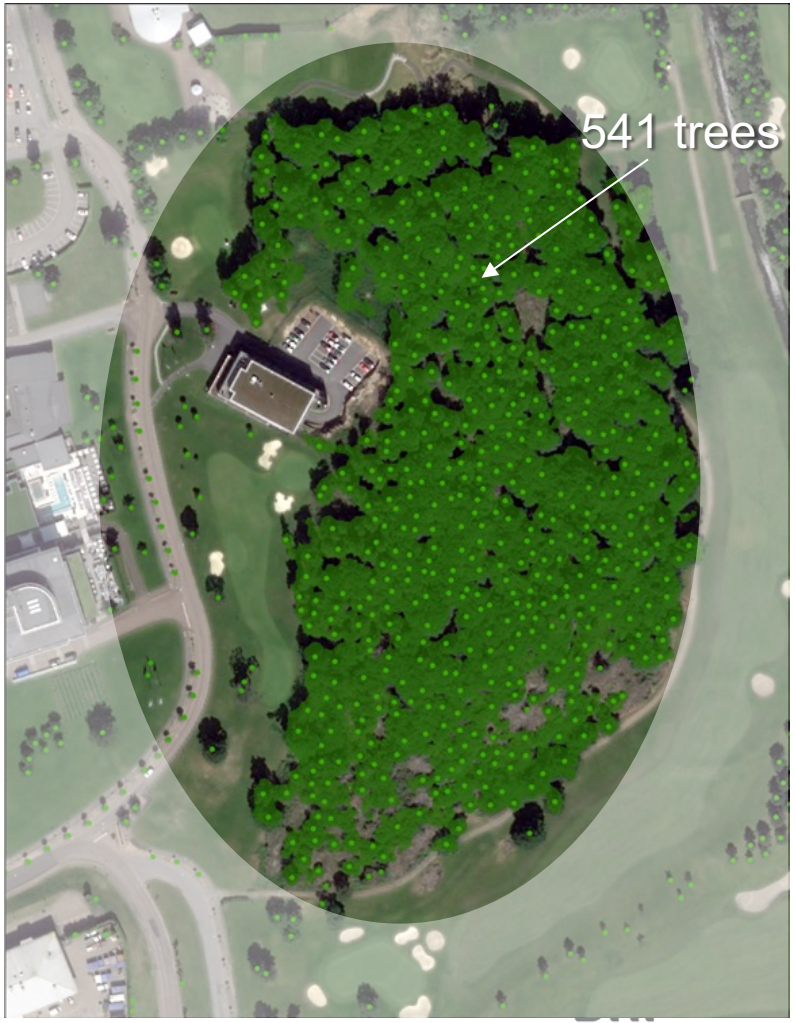
- land cover classification
- roof segmentation
- roof type classification
- tree inventory

Example: Tree inventory (Pleiades Neo)



Urban green

© DHI



Urban infrastructure

© DHI

Urban infrastructure

© DHI

Key Benefits of Human-in-the-Loop approach

•**Enhanced Data Accuracy**: Combining human expertise with machine learning algorithms ensures more accurate and context-specific results, reducing errors that automated systems alone might overlook.

•**Tailored Solutions**: Stakeholders can customize the analysis and outputs to meet local needs, allowing for more relevant and actionable insights in specific urban environments.

•**Continuous Learning and Adaptation**: The system can improve over time by incorporating feedback from users, making it more adaptive to changing conditions and more aligned with stakeholder requirements.

•**Increased Stakeholder Engagement**: Involving local stakeholders in the data collection and analysis process fosters ownership, increasing the likelihood of the data being used effectively in decision-making.

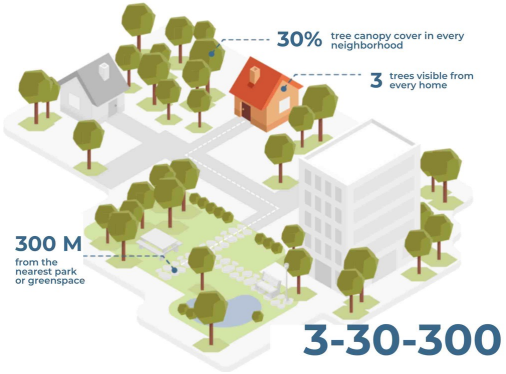
•**Scalable and Flexible**: The approach is scalable across different cities and regions, with the flexibility to accommodate varying levels of data availability and quality, making it suitable for diverse urban contexts.

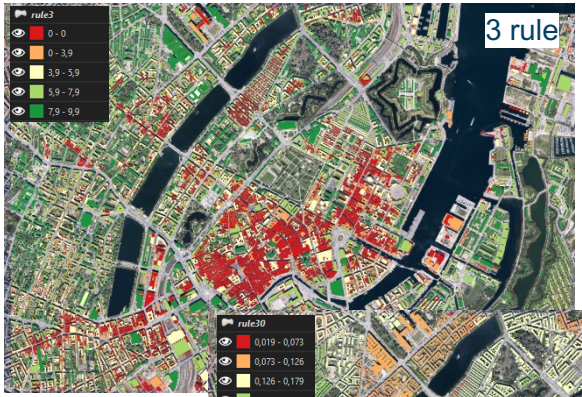
© DHI

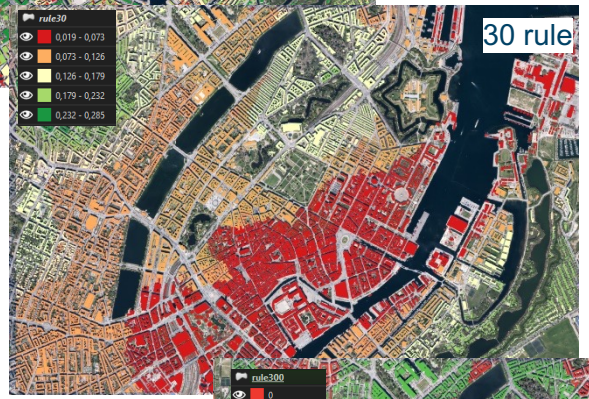
Other EO based initiatives to inform urban decision making

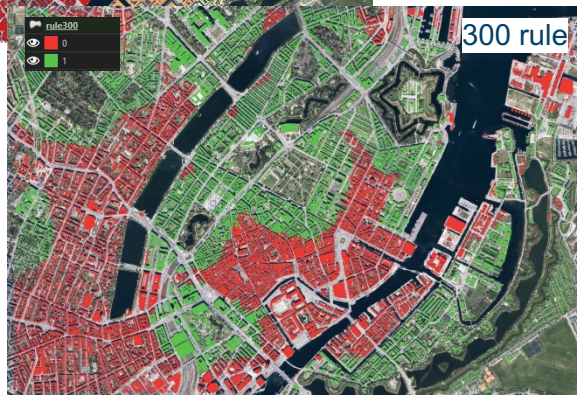
© DHI

Mapping the 3-30-300 rule



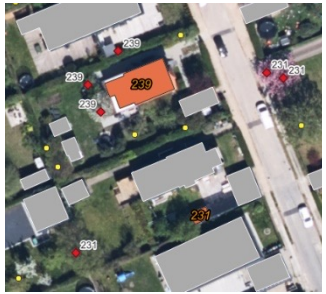






EO tree inventory

Building footprints



ML model

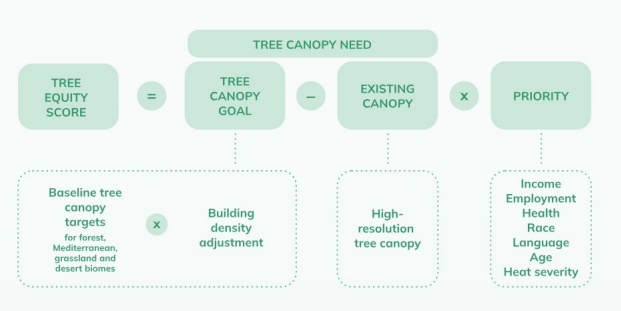
Geospatial operations

Mapping the tree equity score

The Tree Equity Score is a metric designed to ensure that all communities, especially those in underserved or disadvantaged areas, have equitable access to the benefits of urban trees.

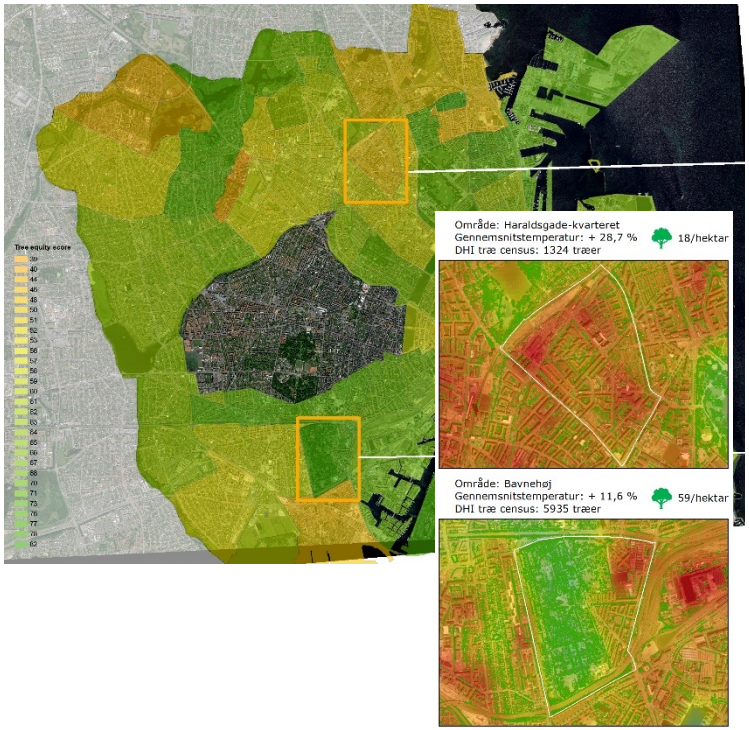
Components:

- **Tree Canopy Coverage**: Measures the percentage of tree cover in a specific area.
- **Demographic Factors**: Considers factors like income, race, and population density to assess disparities in tree coverage.
- **Environmental Benefits**: Evaluates how tree cover contributes to air quality, cooling, and overall environmental health in different neighborhoods.



https://www.treeequityscore.org/methodology

Adapted for Denmark and EU



In summary: Why should we use EO and AI for urban decision making

Human-in-the-Loop Approach:

- **Contextual Accuracy**: Incorporating human expertise ensures that AI-generated insights are relevant and tailored to specific local conditions and needs.
- **Stakeholder Engagement**: Actively involving local stakeholders in data collection and analysis fosters better alignment with community needs and enhances the acceptance and effectiveness of policies.
- **Continuous Improvement**: Feedback from users allows the system to evolve and adapt over time, improving accuracy and relevance based on real-world experience and changing conditions.

AI-Driven Insights:

- **Efficient Data Analysis**: AI processes large volumes of data quickly, providing actionable insights and identifying trends that might not be apparent through manual analysis.
- **Predictive Capabilities**: Machine learning models can forecast future urban challenges, such as traffic congestion or environmental impacts, aiding in proactive decision-making.
- **Data Integration**: AI can synthesize data from multiple sources, offering a comprehensive view of urban dynamics and facilitating holistic policy development (e.g. 3-30-300 and tree equity)

© DHI

Resources & Materials

EO and urban NBS

https://eo-labs.dhigroup.com/eo-clinic-nbs

https://urban.satlas.dk/

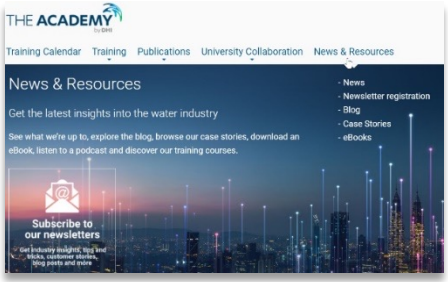
DHI Blog

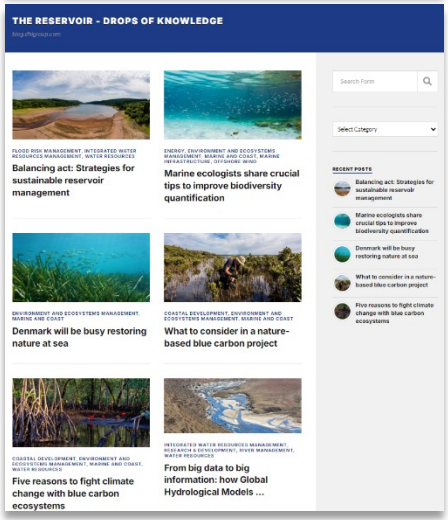
The Reservoir | Drops of Knowledge | DHI Blog (dhigroup.com)

DHI YouTube channel

https://www.youtube.com/@DHIGroup/videos

DHI's free on-demand webinars
https://wod.theacademybydhi.com/





Nicklas Simonsen (nisi@dhigroup.com)