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## Evaluation and planning of urban green structures Webinar

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[www.geografiskainformationsbyran.se](http://www.geografiskainformationsbyran.se)  
Stockholm, Sweden



### Content

- Introduction EO4GEO
- Poll 1
- Concepts
  - green infrastructure and
  - ecosystem services
- Ecosystem services from urban trees
- EO data and methodology supporting green infrastructure
- Case – planning challenges
- Case presentation
- Conclusions
- Poll 2
- Discussion, Q and A

## Learning outcomes

- Basic understanding of remote sensing data and vegetation indices
- Knowledge of different EO products and services
- Understand how to acquire data on urban greenery using remote sensing methods
- Understand how the data acquired can be used to improve urban greenery management, especially in the context of climate change adaption
- Understand how EO-data in combination with other remote sensing data can contribute to the assessment of ecosystem services



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The EO4GEO project



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## The Space/Geospatial Sector Skills Alliance

Towards an innovative strategy for skills development and capacity building in the space geo-information sector supporting Copernicus User Uptake



The EO4GEO project



## The VISION

To foster the growth of the European Earth Observation / Geographic Information (EO/GI) sector ensuring a workforce with the **right skills, in the right place, at the right time.**

## The MISSION

To ensure the strategic cooperation among stakeholders on skills development in the EO/GI sector.



The EO4GEO project



## THE STRATEGY

- Identifying the **supply** of GI and EO education and training at the academic and vocational levels.
- Identifying the current **demand** for GI and EO skills and occupational profiles.
- Assessing the skills shortages, gaps and mismatches between supply and demand.
- Analysing trends, challenges and opportunities in the GI and EO sector.
- Defining a GI and EO sector skills strategy for skills development.

## THE INSTRUMENTS

- An ontology-based **Body of Knowledge** (BoK) for the space/geospatial sector (extending the existing GI BoK with EO/Copernicus concepts).
- A set of BoK-based **innovative tools**.
- A series of **curricula and a portfolio of training modules** directly usable in the context of Copernicus and other relevant programs.
- A series of **learning actions** for a selected set of strategic scenario's in three sub-sectors to test the approach.
- A **Long-term Action Plan** to be endorsed to roll-out and sustain the proposed solutions.
- The support of a strong group of **Associated Partners** mostly consisting of associations or networks active in space/geospatial domain.

### An Ontology-based Body of Knowledge

A Body of Knowledge (BoK) is the complete set of **concepts and relations** between them, that make up a professional domain that can be used by members of a discipline to guide their education and work practice.



Describing the Geographic Information and Earth Observation domain is done by defining the underpinning inter-related concepts (theories, methods, technologies, etc.) that should be covered in education and training curricula.

<http://www.eo4geo.eu/bok/>



The EO4GEO project



## EO4GEO's open tools making use of the BoK

- **Curriculum Design tool:** Create, edit and find EO & GI Curriculum using concepts from the EO4GEO Body of Knowledge.
- **BoK visualisation and search:** Auxiliary tool to search terms in BoK concepts. The tool shows matching results, and allows navigating graphically and textually in the BoK.
- **Occupational Profile tool:** This tool allows to create occupational job profiles and connect them with BoK concepts (Knowledge) and ESCO (skills).
- **Job Offer tool:** This tool allows to create job offers based on occupational profiles.
- **BoK Matching tool:** This tool allows to compare two annotated BoK resources, as metadata "annotated" PDFs or a EO4GEO resource created in the other tools.
- **BoK Annotation Tool:** This tool allows to easily annotate (associate) any PDF document with EO4GEO BoK concepts.

The EO4GEO project



## EO4GEO IS MUCH MORE

- A series of **pre-defined curricula** in support of Copernicus.
- A portfolio of **training modules** directly usable in the context of Copernicus and other relevant programs.
- A series of **training actions** (webinars, academic courses, etc.) in three sub-sectors - integrated applications, smart cities and climate change.
- A **mobility program** to promote internships and on-the-job training.
- A **Long-term Action Plan** to sustain the proposed solutions.



The EO4GEO project



## FOLLOW US AND GET ENGAGED!

- Join the Sector Skills Alliance .
- Join as an expert to revise / feed the Body of Knowledge.
- Subscribe to our project Newsletter.
- Connect your project and establish synergies.

 [www.eo4geo.eu](http://www.eo4geo.eu)

 [@EO4GEOtalks](https://twitter.com/EO4GEOtalks)

Poll 1 – Use  
QR or link:  
[https://app.sli  
.do/event/nk  
-97xkpy](https://app.sli.do/event/nk-97xkpy)





## Concepts

- Green infrastructure
- Ecosystem services

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## Definitions

- **Green Infrastructure** - an ecologically functional network of habitats and structures, natural areas and landscaped elements that are designed, used and managed in such a way that biological diversity is preserved and ecosystem services that are important to society are promoted throughout the landscape. (Swedish environmental Protection Agency)
- **Ecosystems** are defined as "A dynamic complex of plant, animal and micro-organism communities and their non-living environment that interacts into a functional unit" (CBD – convention on Biological Diversity).
- **Ecosystem services** are defined as "The direct and indirect contribution of ecosystems to human well-being"  
(TEEB -Economics of Ecosystems and Biodiversity).

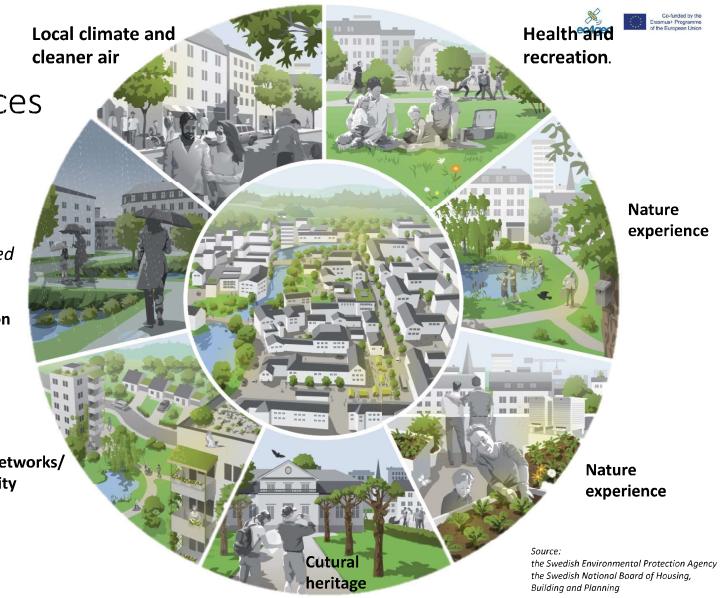
## Ecosystem services

<b>Supporting</b> <ul style="list-style-type: none"><li>-Soil formation</li><li>-Biodiversity</li><li>-Primary production</li><li>-Habitat</li></ul>	<b>Provisioning</b> <ul style="list-style-type: none"><li>-Food and fiber</li><li>-Wood</li><li>-Clean Water</li><li>-Medicinals</li></ul>	<b>Regulating</b> <ul style="list-style-type: none"><li>-Climate Regulation</li><li>-Pollination of crops</li><li>-Store carbon</li><li>-Control flooding</li></ul>	<b>Cultural</b> <ul style="list-style-type: none"><li>-Inspiration</li><li>-Recreation</li><li>-Education</li><li>-Aesthetic</li></ul>
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## Urban Ecosystem services

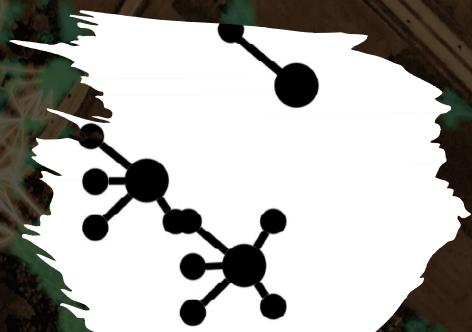
*for the sustainable development of cities and urban areas, it is important to interact with and develop nature's ecosystem services, which give humans benefits we often take for granted or do not see.*



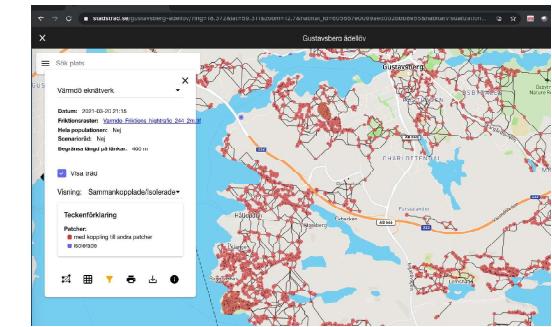
## Concept for habitat networks

### Trees are connected

- Forest areas large enough for reproduction
- Spreading links, short enough for the specie in question
- Connected or isolated?
- Stepping stones – important trees or small groups of trees



## Habitat networks



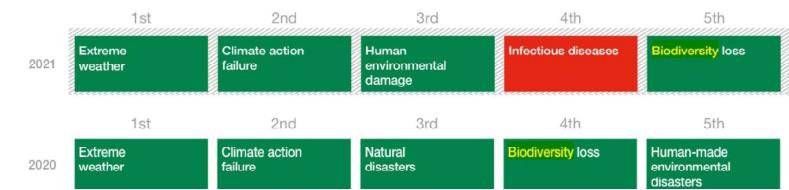
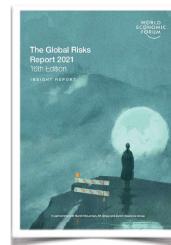
Red color for larger patches of forest that are connected via spreading links  
Blue patches are large enough, but not connected.  
Second image: Selected trees for an oak network

## Green Infrastructure

An ecologically functional network of habitats and structures, natural areas and landscaped elements that are designed, used and managed in such a way that biological diversity is preserved and ecosystem services that are important to society are promoted throughout the landscape.

- Green infrastructure - a prerequisite for ecosystem services
- For ecosystems to work, connections between different biotopes are required
- Isolated species are depleted, which means that the ecosystems in which they are included function less well
- The result will be a deterioration of the ecosystem services we want from the ecosystems.

## Global risks, 2021

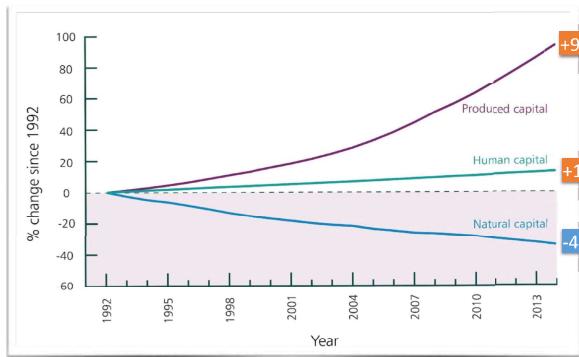


källa: The Global Risks Report 2021, 16th Edition, is published by the World Economic Forum.

## The Economics of Biodiversity: The Dasgupta Review, 2021



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of the European Union



A report on 610 pages with the message:

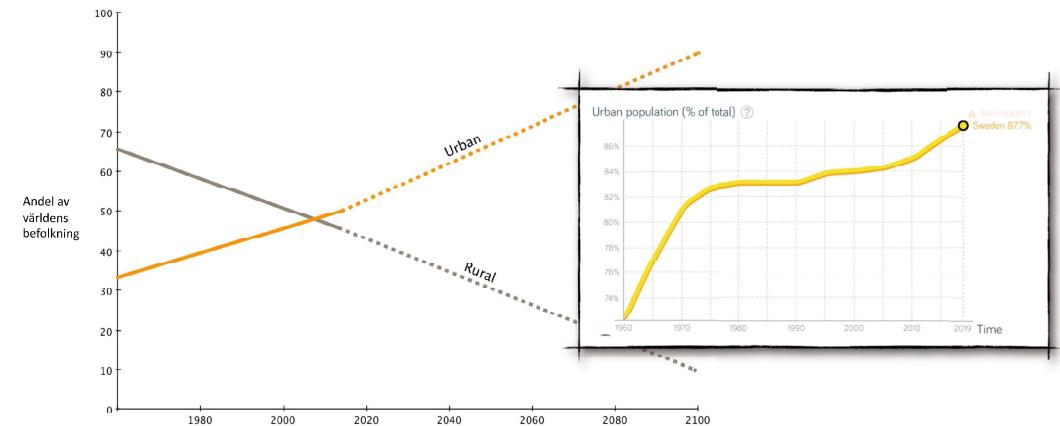
- 1) **We need to address the imbalance** of the demand from nature and the capacity for nature to satisfy demand (1,6 earths today)
- 2) **Need to change our measure of economic success.** From only GDP, that does not measure depreciation of natural capital.
- 3) **Must include nature as part of calculation in decisions.** A good economist should be arguing for nature on economical grounds.

källa: Dasgupta, P. (2021), The Economics of Biodiversity: The Dasgupta Review. (London: HM Treasury)  
<https://www.gov.uk/government/publications/final-report-the-economics-of-biodiversity-the-dasgupta-review>

It is costly to live in cities!  
 We need ecosystem services where people live



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Exosystem services - a value chain from ecological production to value for human.



## Ecosystem services –

a value chain from ecological production to value for humans

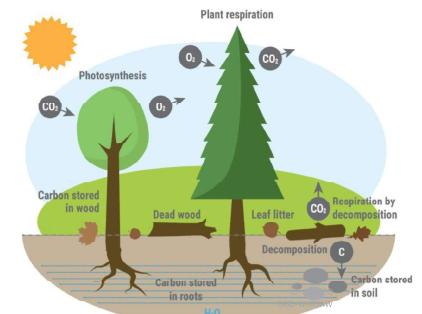


- Carbon control
- Local climate control
- Storm water control
- Pollution reduction
- Habitat networks



## EST – Carbon control

- 50% of dry weight of a tree comes from the carbon present in the atmosphere as carbon dioxide
  - When trees die the carbon goes back to the atmosphere
  - Urban trees act as "carbon sink"
- However, carbon sequestration (climate mitigation) is not the key ecosystem service of urban trees

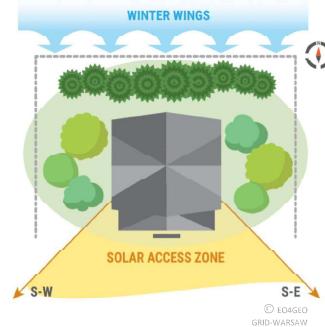


## EST – Energy conservation

Trees provide shade and block wind

Potential energy conservation results:

- Heat savings (Kwh)
- Cooling savings (Kwh)



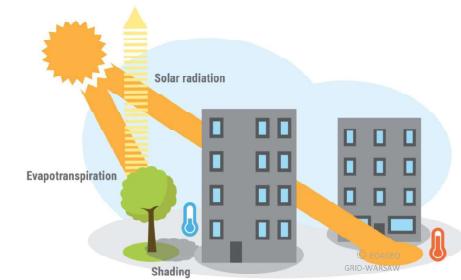
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## EST – Local climate control

Urban Heat Island (UHI) occurs when the city proper records are much higher temperatures than nearby rural areas

Trees reduce the UHI in the summer period by:

- Evapotranspiration
- Deflection of solar radiation

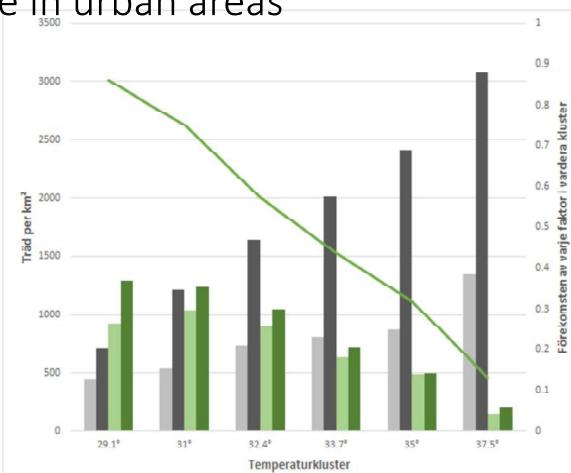


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## Trees and temperature in urban areas

The presence of temperature regulating factors and the presence of trees per square kilometer in each temperature cluster. The presence of tree-covered vegetation increases the lower the temperature in each temperature cluster. The number of trees per km<sup>2</sup> is also increasing in the cooler temperature clusters

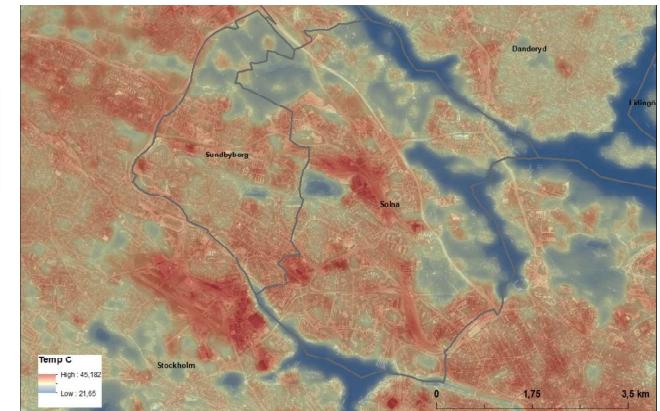
- Exploaterad mark
- Exploaterad mark 50m buffer
- Träbeklädd vegetation
- Träbeklädd vegetation 50m buffer
- Träd per km<sup>2</sup>



## Surface temperature from satellite

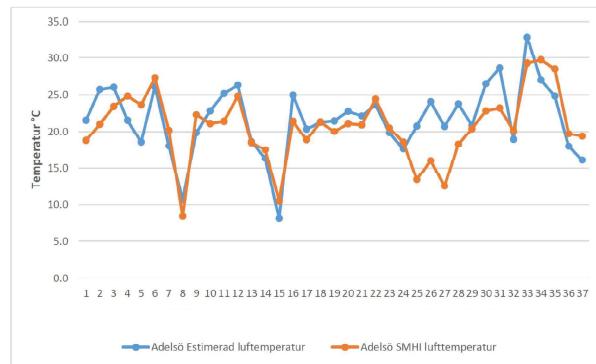
- Warm**
- Large black roofs
  - Impervious surfaces
  - Short-cut lawns

- Cool**
- Forest
  - Water
  - Leafy areas



# Satellite surface temperature vs measured air temperature

Mäststation	Differens	Standardavvikelse
Adelsö	2,7°	2,0°
Arlanda	6,3°	5,3°
Berga	2,3°	1,8°
Bromma	4,7°	3,3°
Landsort	4,3°	1,8°
Observatoriekullen	3,8°	2,8°
Skarpö	6,2°	4,3°
Svanberga	3,6°	4,2°
Tullinge	2,9°	1,9°
Medel:	4,1°	3,0°



*Estimated air temperature (from satellite) compared with measured temperature from 37 dates at SMHI's weather station on Adelsö, Sweden.*

## EST – Storm water control

Impervious surfaces are the main contributor excess stormwater runoff  
The trees can help to manage the runoff by:

- Retention of precipitation water in canopies
  - Water interception and uptake by roots



## EST – Pollution reduction

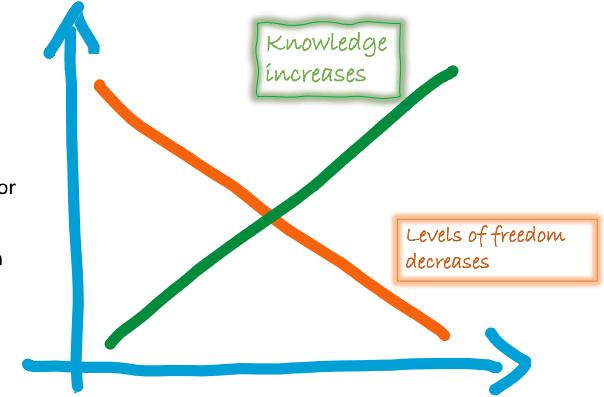
Trees clean the air from pollutants like micro particles

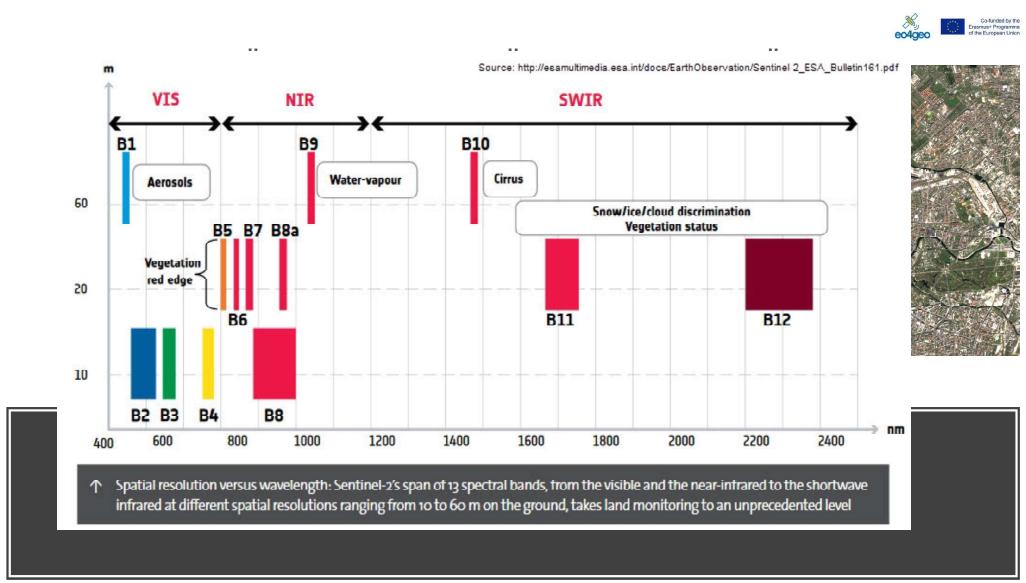


## A dilemma in planning

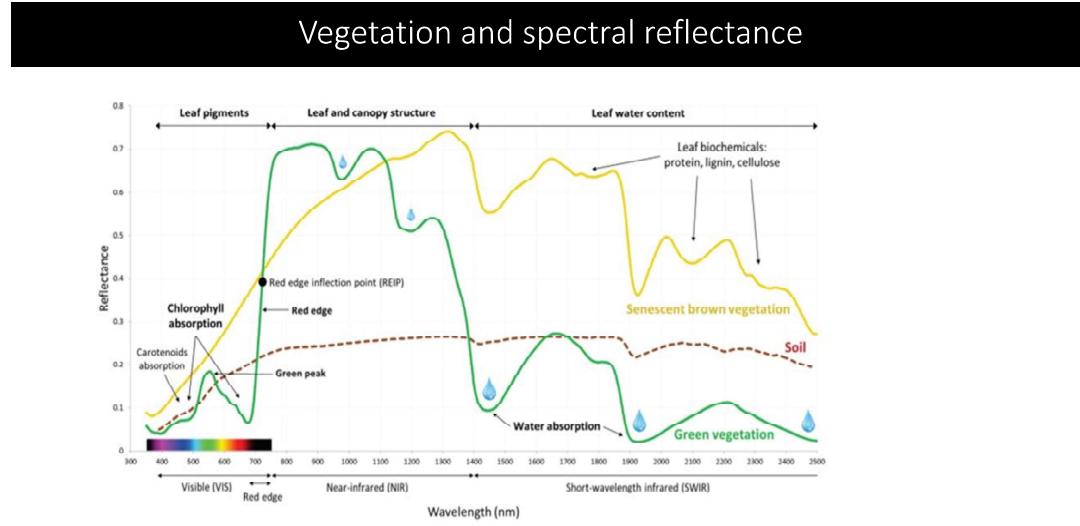
We know more as the project continues, but our opportunities for change are diminishing.

**Conclusion:** early knowledge has a great value for planning!



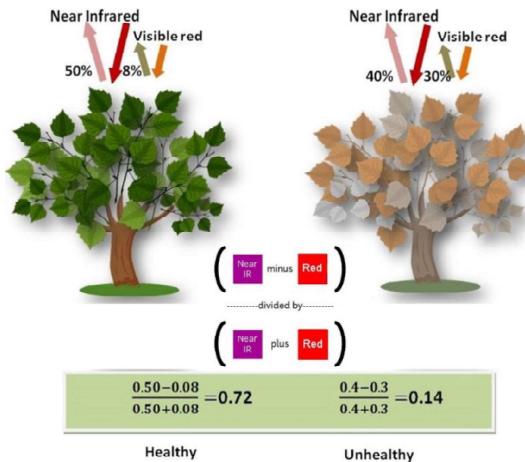


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## Vegetation indices

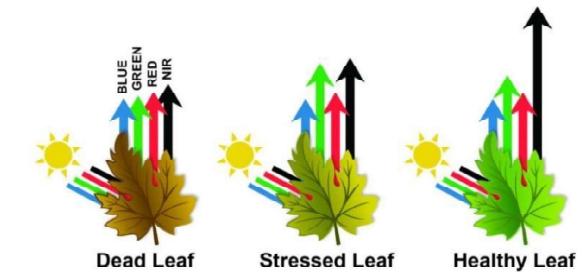
- Spectral indices dedicated to vegetation analysis are developed based on the principle that the healthy vegetation reflects strongly in the near-infrared (NIR) spectrum while absorbing strongly in the visible red.



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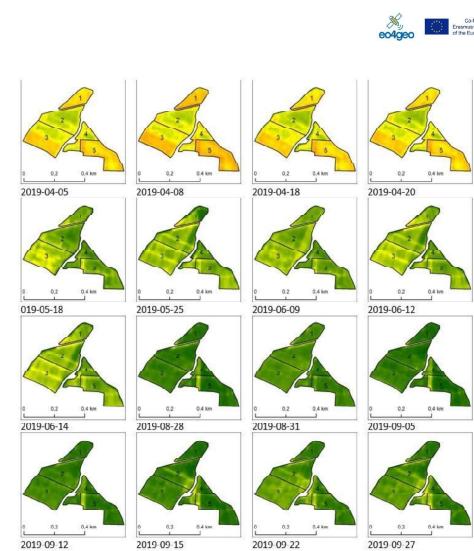
## Spectral signature

- In green healthy plant:
  - Chlorophyll absorbs large proportion of red and blue spectrum for photosynthesis and strongly reflects in green
  - strong reflectance in near infrared (NIR) due to leaf structure and condition
  - lower reflectance in shortwave infrared (SWIR) influenced by water content, which absorbs infrared energy.

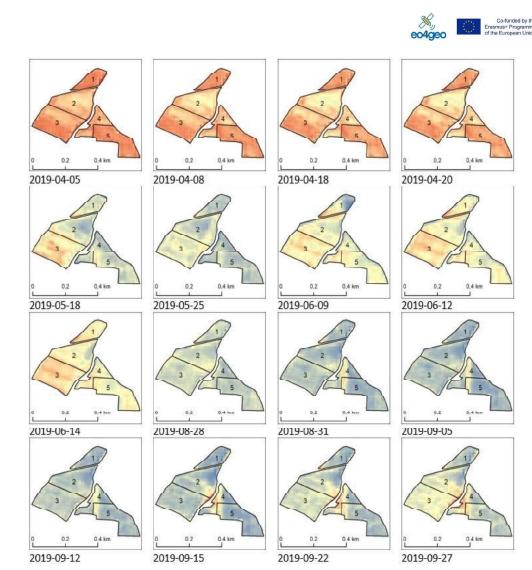


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## Multi-temporal NDVI (timeseries)



## Multi-temporal NDMI – Moisture index (timeseries)



More on vegetation indices

.....

And different EO topics

- <http://www.eo4geo.eu/training/sentinel-2-data-and-vegetation-indices/>
- <http://www.eo4geo.eu/training-material-catalogue/>



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Data services and access

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# COPERNICUS LAND MONITORING SERVICE (CLMS)

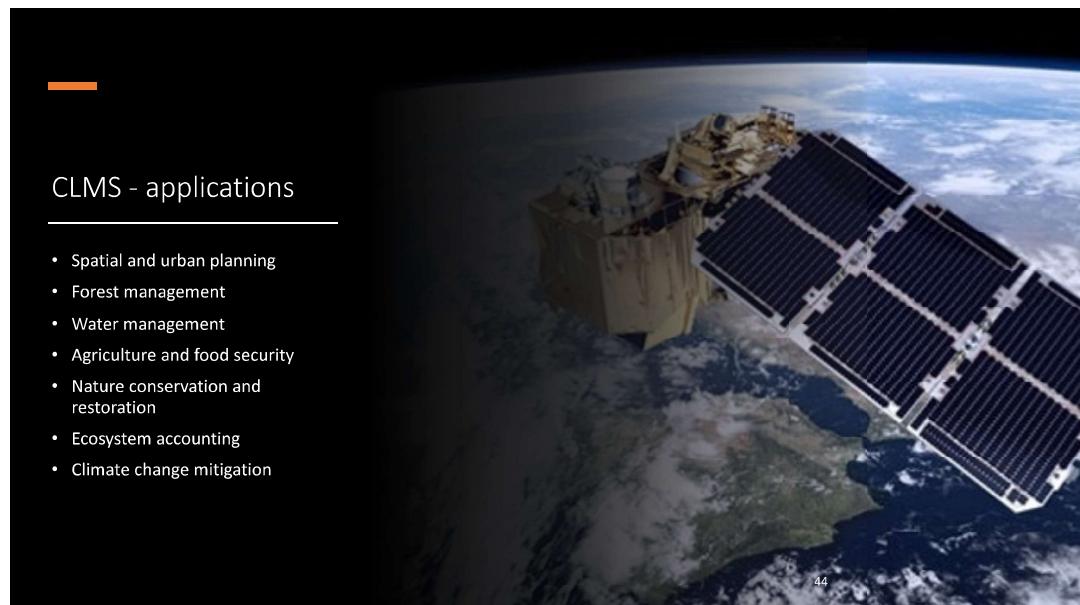
CLMS provides **geographical information** on land cover and its changes, land use, vegetation state, water cycle and earth surface energy variables **to a broad range of users** in Europe and across the World.

- It **supports applications** in a variety of domains such as spatial and urban planning, forest management, water management, agriculture, food,...
- CLMS is **jointly implemented** by the European Environment Agency (EEA) and the European Commission DG Joint Research Centre (JRC).
- The Land Monitoring Service has been in operational use since 2012 (<https://www.copernicus.eu/en/services/land> ).

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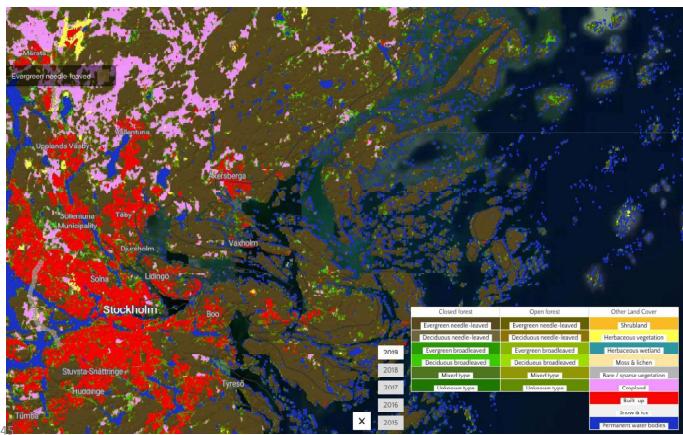
## CLMS - applications

- Spatial and urban planning
- Forest management
- Water management
- Agriculture and food security
- Nature conservation and restoration
- Ecosystem accounting
- Climate change mitigation



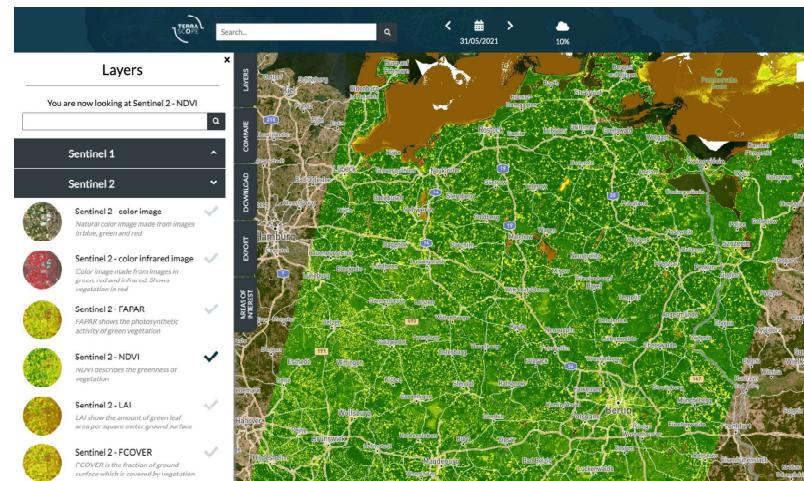
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## Viewing and downloading (<https://land.copernicus.eu/global/>)



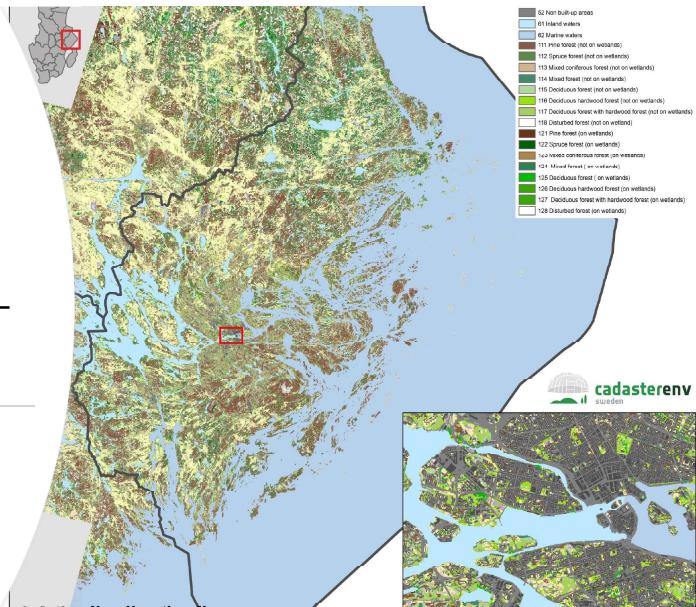
Developed by the  
European Programme  
of the European Union

Terrascope viewer <https://terrascope.be/en>

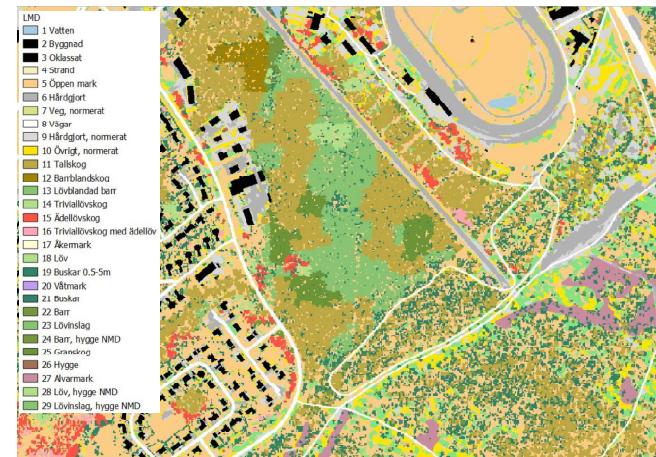


Developed by the  
European Programme  
of the European Union

NMD (Swedish landcover) 10m resolution satellite product—



## High-resolution landcover maps (1m)

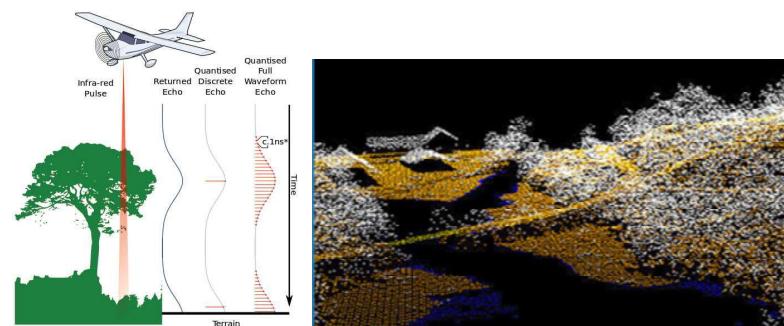


Comparison LMD (1m) vs NMD (10m)



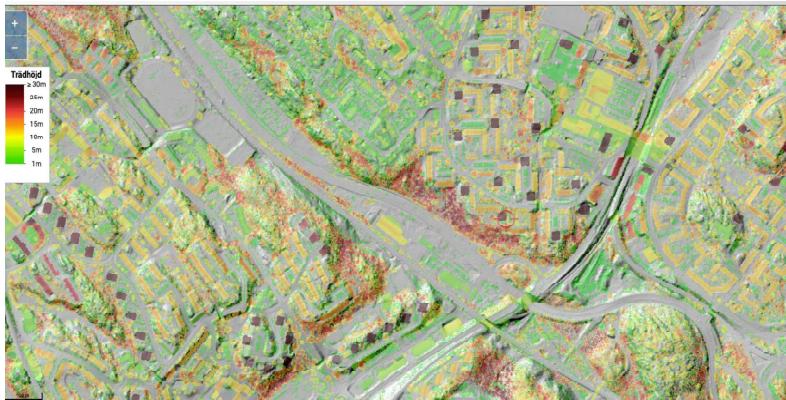
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Airborne LIDAR data



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Lidar-derived treeheight map  
(Skogsstyrelsen.se)



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Lidar-derived treemap (stadstrad.se)



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## Case – urban development

**Background:** In one of the municipality's urban development areas "Södra Häggvik", planning is now underway for a large area that will be converted from external trade with parking spaces to a residential area with school and parks. Today, the area is largely paved and contains a small proportion of green space. The area is located between the two major barriers E4 and the railway in an area where it is important to work on strengthening the green connections in the east-west direction.

### Contribution to the environmental quality goals in the municipality:

The project contributes to the environmental quality goals **a good built environment** and **a rich plant and wildlife**. By having the right tools and data to be able to plan for good conditions for functional ecological landscape connections, good living environments are also created for those who will live in the new district with much greenery and possible ecosystem services such as retention of water, air purification, noise reduction, climate control and more.

## Södra Häggvik - what is planned?

Extensive urban development is underway in Södra Häggvik, north of Stockholm Metropolitan area. The area has a unique location in the hub between the commuter train, E4, Häggviksleden and the upcoming Stockholm Bypass.

The area is today a distinct trade and business area with large parking areas. In current and future detailed plans for Södra Häggvik, it may be possible to build more than 5,000 new homes, develop trade, offices and services such as schools, preschools and sports halls, etc. In 2022, the first residents can move in, but the expansion will last for many years. . When Södra Häggvik is fully developed, more than 10,000 inhabitants are expected in the area.



## Södra Häggvik – planning challenges

Currently, Södra Häggvik is an external trading area with large parking spaces. Most of the land is covered and sealed by impermeable materials and a very small share is green / vegetated.

The area is surrounded by quite extensive barriers like roads and railway, but also single housing. Within a few hundred meters there are several forested and green areas.



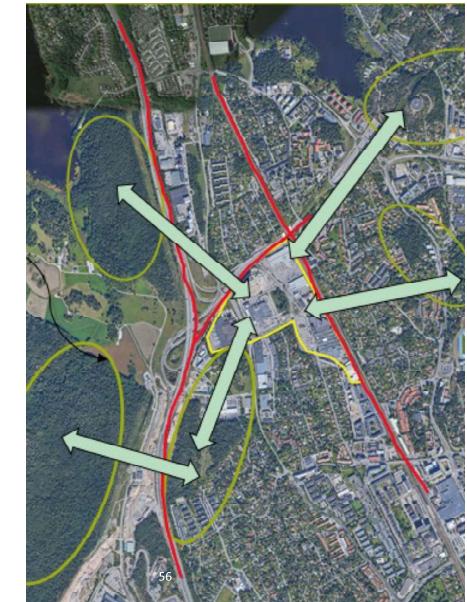
## Södra Häggvik – planning challenges

- **Strengthen** ecological networks and increase connectivity

- **Improve** stormwater management by enhancing the green infrastructure to support water retention

### - *Ecosystem services*

- Reduction of pollutants
- Water retention
- Reduction of CO<sub>2</sub>
- Climate control – temperature map





## Habitat networks

*Issue: How will the plan affect the ecological networks?*

### Data sources

- EO-derived landcover map
- Lidar- derived tree map
- Detailed plan of the development area

### Analysis

- Connectivity map
- Mapping isolated and connected green structure
- Measures to quantify the difference between different scenarios

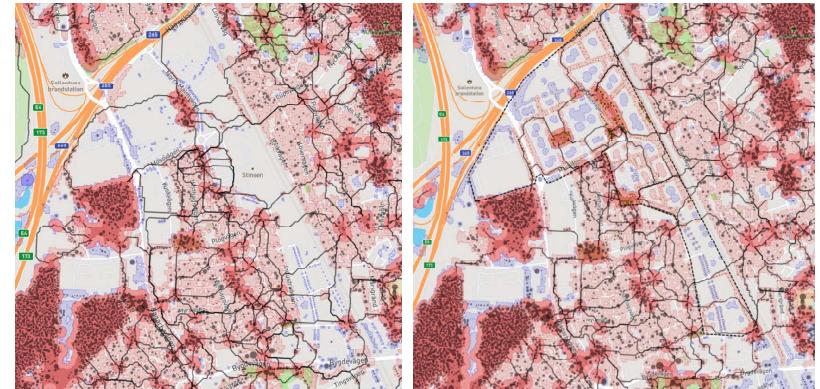
## Overview Sentinel-2 Land cover map



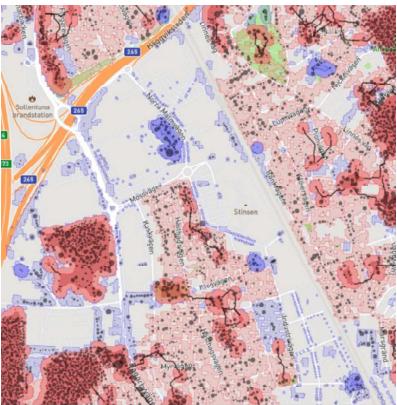
Tree points  
(Lidar)



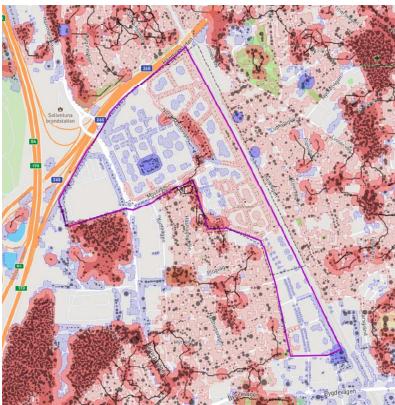
Green infrastructure – habitat network from trees



## Green infrastructure – strict connectivity



Today



Future plan



## Stormwater

### Issues

- Stormwater must be managed within the new development area.
- Management of cloudbursts and/or prolonged rain events

### Data sources

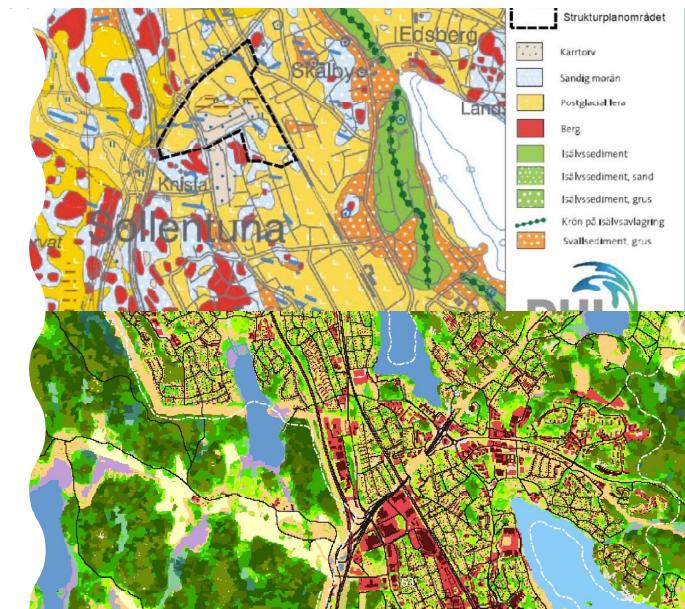
- Geological maps, Land cover maps
- Lidar-derived DTM model
- Detailed plans

### Analysis

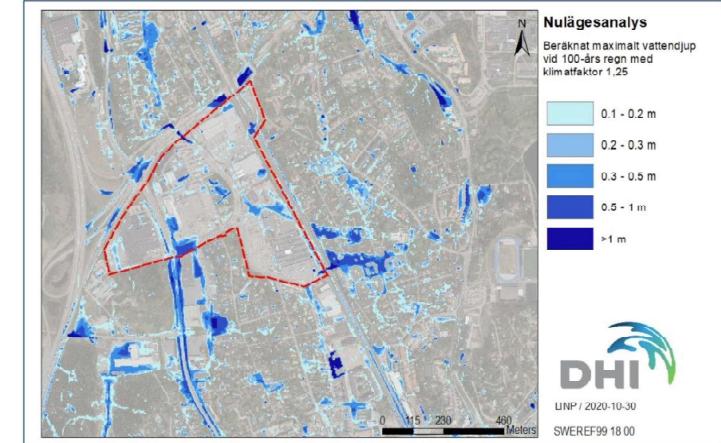
- Depression mapping
- Infiltration mapping
- Hydraulic modelling
- Flowpaths

## Input data for storm water modelling

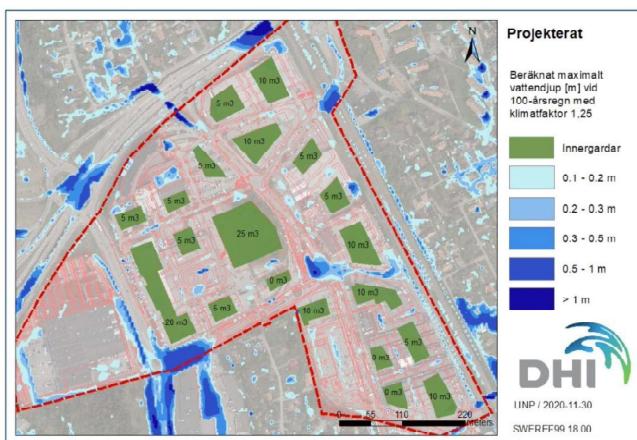
- Geological map – soil infiltration
- Landcover, surface runoff modelling



## Hydraulic modelling (prec. 100 y return), today



Future plan



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## Ecosystem services from trees and landcover data

### Data sources

- Lidar derived tree maps
- Inventory of tree species
- Detailed plans – New buildings, planting of new trees

### Analysis

- Scenario analysis
- Water retention
- Carbon storage and sequestration
- Reduction of pollution



## Today



## Future



## Example of Ecosystem service calculations (iTTree eco)

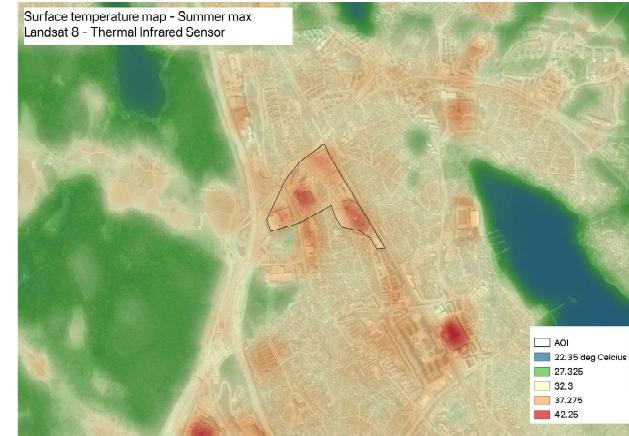
	Today	Development			
		Trees removed	New trees	Total EST	
<b>Trees</b>	503	200	851		
<b>Water retention</b>	227	90	384	521	m <sup>3</sup> per year
<b>Carbon storage</b>	96016	38177	162445	220284	kg
<b>Carbon sequestration</b>	3366	1338	5695	7723	kg per year
<b>Pollution removal</b>	71638	28484	121200	164353	g per year
<b>Cost of replacement</b>	5690	2263	9627	13055	kkr

©Source: stadstrad.se  
iTTree Eco v6



Developed by the  
European Programme  
of the European Union

## Temperature mapping from satellite (2015-2019)



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Poll 2 – Use  
QR or link:  
[https://app.sli.  
.do/event/nk  
— 97xkpy](https://app.sli.do/event/nk-97xkpy)



## Conclusion

- Urban greenery need to be involved in early planning stages
- a well-planned and developed green infrastructure in urban areas is necessary to achieve ecosystem services
- Ecosystem services is the value that nature creates for humans and need to be accounted for on economical terms
- EO data can be used for estimation and mapping of green infrastructure and ecosystem services
- For further questions, please contact us:  
[www.geografiskainformationsbyran.se](http://www.geografiskainformationsbyran.se)

