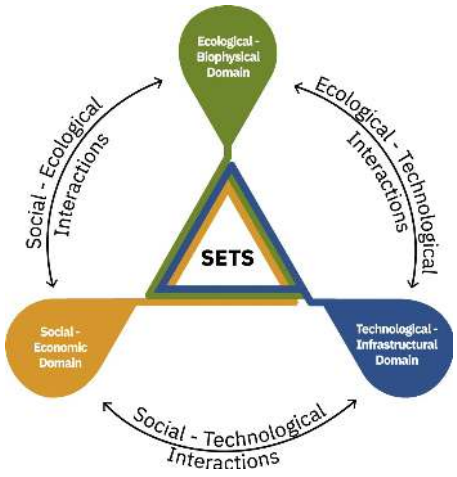
SMARTer Greener Cities: Making Smart Cities Smarter and More Liveable Through Nature-based Solutions

To be inclusive, equitable, resilient and fulfil their role as drivers of sustainability transformation, cities and towns need to be designed and governed as social-ecological-technical systems (SETS). This entails cutting across silos in disciplines and approaches by bringing technology, people, and nature together. Planning, designing, and managing urban spaces require a deeper understanding of how social, ecological and technological interact and the consequences of these relationships on biodiversity and human well-being.



Source: Depietri & McPhearson 2017

The SMARTer Greener Cities project (2020-2023) aims to develop and test novel tools and processes for explicitly converging social, ecological, and technological systems (SETS) approaches for improving life in cities. Within three case cities we analyse SETS couplings (Fig. 1). This is the second policy brief presenting the main findings of WP3 with some recommendations for urban planning and governance.

Read more about the project: https://smartergreenercities.com/

Project coordinator: Erik Andersson, Stockholm University, erik.andersson@su.se

Stockholm case contacts:
Artur Branny, Stockholm University, artur.branny@su.se

Stockholm case focuses on the ecological-technological (E-T) linkages. This refers to the different ways in which smart technologies can strengthen feedback between nature-based solutions, biodiversity, and people.

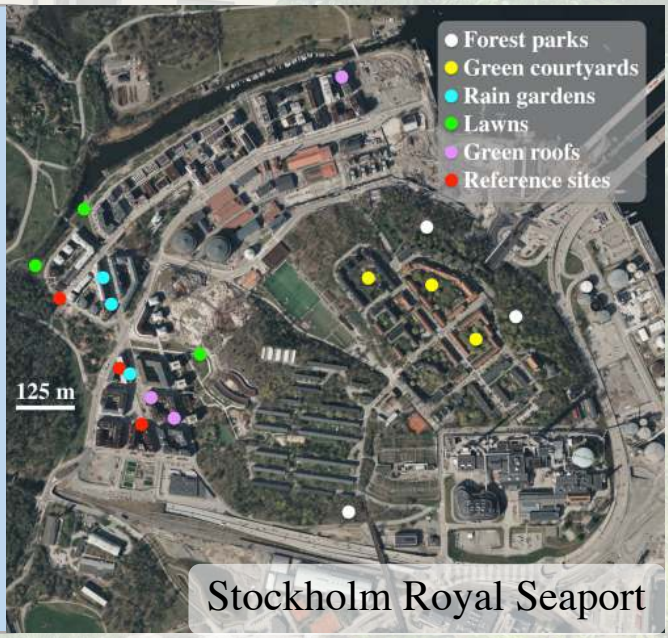
Copenhagen case focuses on social-technological (S-T) linkages and how technologies can help the inclusion of local residents' perspectives in the planning and evaluation of the landscape transformations.

Helsinki case focuses on social-ecological (S-E) interactions and how technology and nature can promote psychological restoration of daily living environments in fast growing neighbourhoods.

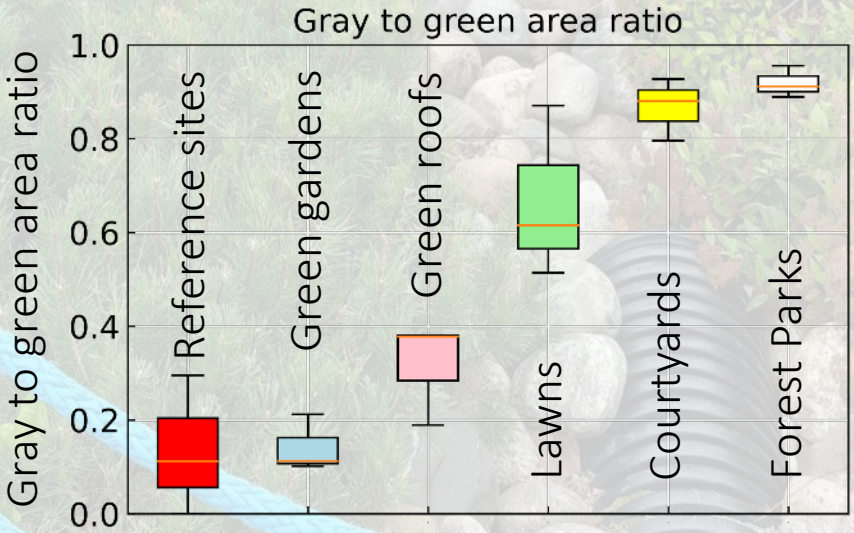
*The work was supported by NordForsk through the funding to SMARTer Greener Cities, project number 95377

In this case study we investigate the intersections between nature-based solutions and the smart cities agenda. We have selected **Stockholm Royal Seaport** because is the biggest flagship of sustainable urban development in Sweden. It features front-line usage of new technology and actively seek nature-based solutions to sustainability challenges. Planning work started in the early 2000s and the new city district will be fully developed around 2030. Read more at https://www.norradjurgardsstaden2030.se/en

Recent technological advances have made meteorological stations affordable and portable while preserving high measurement quality. We use this novel form of harnessing data to understand the performance of nature-based solutions across seasonal variation and under extreme weather conditions in terms of their direct impact on the local climate.



The map shows locations of 18 sensor locations. Colours indicate 6 site types under investigation. They are 5 green elements, forest parks, green courtyards, rain gardens, lawns, green roofs and 1 non-green reference site. The sites contain different proportion of green within a 50 m circle, spanning from low 0.1 to large 0.9, as presented in the figure below, also known as the green area factor or green space index.



- As nature-based solutions are high on the agenda it is crucial to evaluate their performance locally and in real-time.

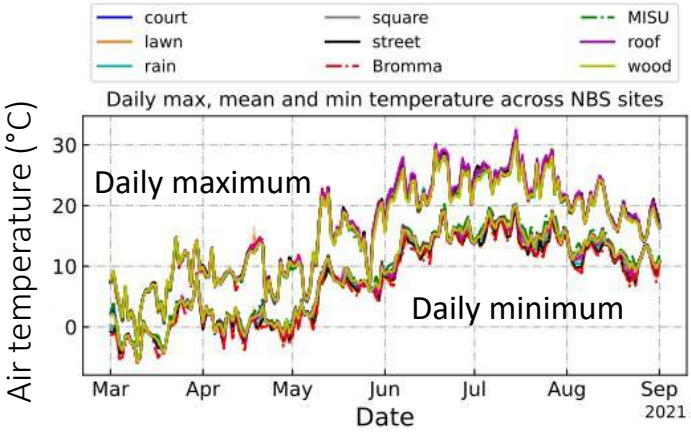
- Data below shows real-time data on air temperature from all the sites in the Stockholm Royal Seaport, indicated on the map during 2021.

- Despite large differences in green area cover, we do not observe a clear trend in the air temperature between sites.

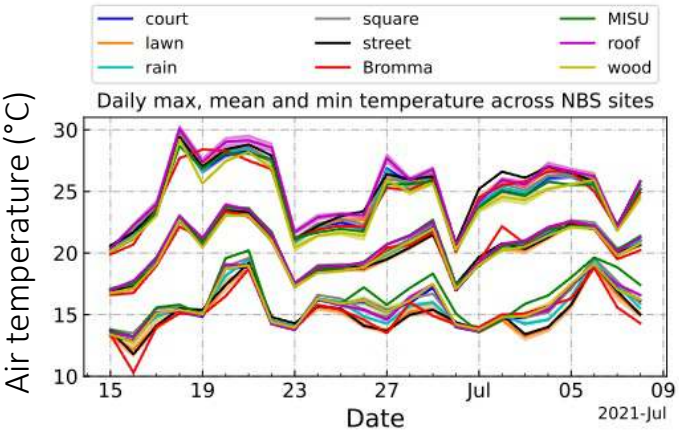
- But there are differences. The largest are up to 2°C in maximum daytime during the summer (June/July) and 5°C in minimum night time air temperatures. Forest parks are the coolest and the green roofs are the warmest green places.

Air temperature in Stockholm Royal Seaport 2021

March - September 2021



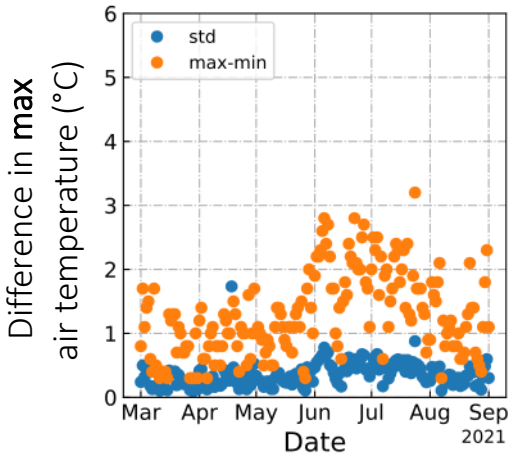
during two weeks in June/July 2021

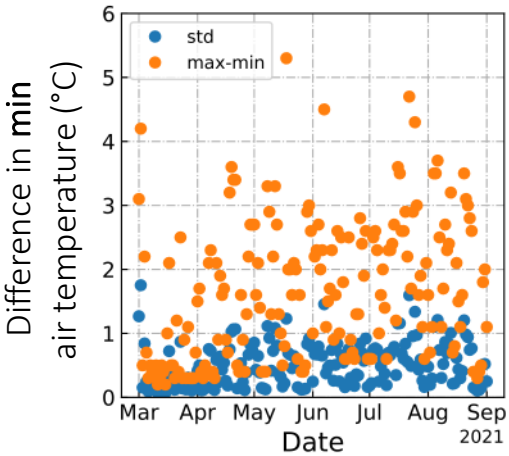


These 18 sites from Stockholm Royal Seaport are colour-coded together with Bromma airport and MISU weather stations

Differences between two extreme sites

in daytime maximum and night time minimum air temperatures





Recommendations for urban planners and researchers

How to be smarter and greener in your plans?

- We need up to date, real-time information about urban nature-based solutions (NbS).
- Local wireless sensors are an efficient, flexible and inexpensive way of tracking whether NbS perform as expected, e.g. by monitoring the impact of NbS on local climate.

Situated solutions – scale and context

- Do not take ecosystem functions and services for granted!
- **At the very local level**, only forest parks provide statistically different **air cooling up to 2° C**. Other types of NBS, like green courtyards, rain gardens, or lawns provide little and similar cooling. Green roofs are the warmest NbS.
- Cooling performance depends on circumstances. We observe the biggest differences during the hottest summer days, above 25° C.
- Interventions to improve local climate need to be considered at the district scale. **Local NbS, almost regardless of type, need to add up to a substantial total green cover** before they can be expected to have an impact.
- However, already at the local level urban NbS provide multiple functions beyond regulation of local climate which shouldn't overlooked, including facilitation of human-nature relations, providing habitat for biodiversity and supporting human mental and physical health.

Layers of resilience

- Many NbS are not self-sufficient, self-regulating ecosystems. They may require high maintenance, and management will be one of the factors determining their performance especially when under pressure.
- With climate change and other ongoing changes in the urban environment sensor information can provide real-time information input to support green space adaptive management.