# Calculating local climate regulation in Sweden

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## 2.1 Introduction

The work in this paper was carried out as part of Statistics Sweden's development of ecosystem accounts according to the revised European regulation 691/2011 on environmental accounts.

The project in which the work was carried out had the following specific objectives:

1. Investigate potential advanced data sources and methods to improve pilot tables according to the requirements in the guidelines at the time of carrying out the project.

2. Produce pilot tables for relevant indicators using advanced data sources and methods where applicable

The project investigated these aspects specifically for air filtration and local climate regulation. This paper focusses on the work carried out on local climate regulation.

The development of advanced modelling for the Swedish ecosystem service account for local climate regulation was carried out in two interrelated areas.

Firstly, the urban ecosystem area definition (as used in the in force version of the Nature Restoration Law) was applied to assess urban areas relevant for the local climate regulation service in Sweden. This is to contrast the urban definition that is used in the current version of the revised regulation, 691/2011 that still refers to the Local Administrative Unit (LAU) when defining urban areas for the local climate regulation ecosystem service.

Secondly, a custom detailed temporal and spatial dataset was obtained from the Swedish Meteorological and Hydrological Institute for the purpose of applying the dataset to assess the duration of the summer season for which the local climate regulation service would be relevant.

The outcomes from these analyses were used as input for the subsequent calculation of the mandatory indicator for local climate regulation, namely the average cooling. The methods used in these development areas and for the final indicator calculation are described in more detail below.

## 2.2 Background

### Urban ecosystem areas for calculating local climate regulation

Firstly, guidance in the area of local climate regulation notes the significance of identifying the service as it is made use of. For example –

> "Cooling that occurs in situations without people present does not constitute an ecosystem service. This is accounted for by requiring measurement of the cooling by vegetation in cities only." – p. 9 guidance note, local climate regulation.

However, this criterion is not really achieved according to the currently applied definition of cities. The recently published updated version of the European regulation on environmental accounts still applies the concept of local administrative unit when considering cities. The nature of local administrative units in Sweden (called "kommun" in Swedish) combined with the LAU definition of cities leads to large natural areas in Sweden being defined as belonging to built-up areas. This mismatch between Swedish administrative units and the local administrative unit definition has been raised in previous communications, for example reports submitted in other ecosystem-related EU Grant financed work. As these reports point out, the mismatch leads to the fact that data based on the LAU definition in Sweden is at best meaningless as a measure of ecosystem services in urban areas and potentially very misleading.

Meanwhile, the recently-published Regulation on Nature Restoration[1] provides a slightly different definition of urban areas that does not strictly follow the LAU definition –

> "4. Member States shall determine and map urban ecosystem areas as referred to in Article 8 for all their cities and towns and suburbs. The urban ecosystem area of a city or of a town and suburb shall include:
>
> (a) the entire city or town and suburb; or
>
> (b) parts of the city or of the town and suburb, including at least its urban centres, urban clusters and, if deemed appropriate by the Member State concerned, peri-urban areas.
>
> Member States may aggregate the urban ecosystem areas of two or more adjacent cities, or two or more adjacent towns and suburbs, or both, into one urban ecosystem area common to those cities, or towns and suburbs, respectively."

Accordingly, in this work, the urban ecosystem areas for Sweden have been calculated according to option (b) above with the aim of better capturing areas in the Swedish Local Administrative Units that are actually built-up. The procedure for so doing is described in subsequent sections of the paper.

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[1] Regulation (EU) 2024/1991 of the European Parliament and of the Council of 24 June 2024 on nature restoration and amending Regulation (EU) 2022/869 (Text with EEA relevance)

## Detailed spatial and temporal data to estimating the relevant cooling season in Sweden

The indicator according to the revised regulation on European Environmental Accounts is defined as "*the reduction of temperature in cities, due to the effect of urban vegetation, in degrees Celsius on days exceeding 25 degrees Celsius*" (see the guidance note on local climate regulation, p. 2). This identifies a need to assess the days on which the average temperature exceeds 25 ºC.

The guidance note gives further information about how the threshold of 25 ºC is to be interpreted:

> "The threshold of 25 degrees Celsius relates to the maximum temperature that is measured during a day." p. 3.
>
> "When applying the threshold, the spatial delineation of where the temperature is measured matters, for instance a city may include several forested hills and including or excluding them in the spatially averaged temperature calculation may make a large difference. To determine if the temperature in a city (defined through its city boundaries) exceeds 25 degrees, it is recommended to use either (i) the average of the maximum daily air temperatures of the local climate measurement stations per city ([2]); or (ii) the median of the LandSat land surface temperature (LST) data (see below). Air measurements (or air temperature models) should be considered first, because satellites provide the surface temperature, which is usually higher than air temperature. However, both approaches have limitations: air temperature is not spatially explicit, land surface temperature information represents a snapshot in time." p. 3.

Unfortunately, the current version of the INCA plug-in tool is not specifically able to calculate cooling effects only for those days where the temperature exceeds 25°C. However the INCA plug-in tool does allow for the user to select the months for which the cooling effect is calculated. In light of this, the guidance note recommends that the months selected for the analysis should be those where the maximum daily temperature exceeds the 25°C threshold for at least 10 days.

In addition to the mandatory indicator noted above, the guidance note identifies the number of days with a maximum temperature exceeding 25°C as a voluntary indicator. In light of these considerations, the aim of the work carried out here has been to apply highly disaggregated spatial and temporal data for the purpose of determining the length of the summer season according to definitions and interpretations relevant for the indicator for local climate regulation. In so doing it is intended to be able to produce data for the voluntary indicator noted above.

([2]) If there are insufficient measurement points per city, air temperature data from the Copernicus Programme: https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-cerra-single-levels?tab=overview) may also be used to pre-select the cities where maximum temperatures reached more than 25°C. Importantly, these data however are not suitable for the regression model.

## 2.3 Method

### Urban ecosystem areas for calculating local climate regulation

The European degree of urbanisation classification[3] defines two different levels for urban areas depending on population density and total population:

- High-density clusters, or urban centres have a higher density and higher total population
- Urban clusters have a lower density and lower population than high-density clusters/urban centres

Notably both high-density clusters and urban clusters are distinct in DEGURBA from rural (non-urban) areas.

To implement these area definitions in this work, the 2021 High-density clusters and Urban clusters raster datasets were downloaded from Eurostat, see Figure 1.

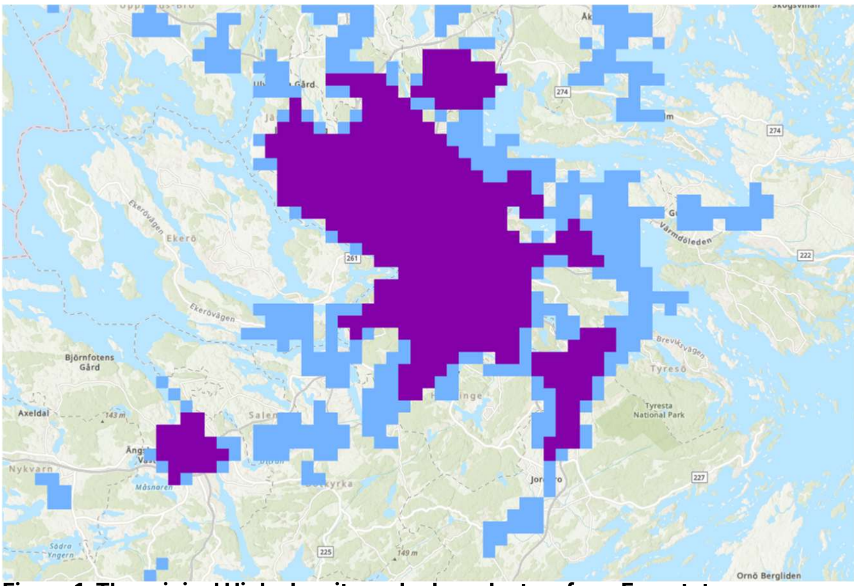


**Figure 1: The original High-density and urban clusters from Eurostat.**

The two raster data files were reclassified and merged into one single layer with pixels classified as High-density clusters, Urban clusters and non-urban. The raster file was then converted to vector format (polygons) with attributes for High-density clusters and Urban clusters, see also Figure 2.

[3] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Degree_of_urbanisation_classification_-_2011_revision

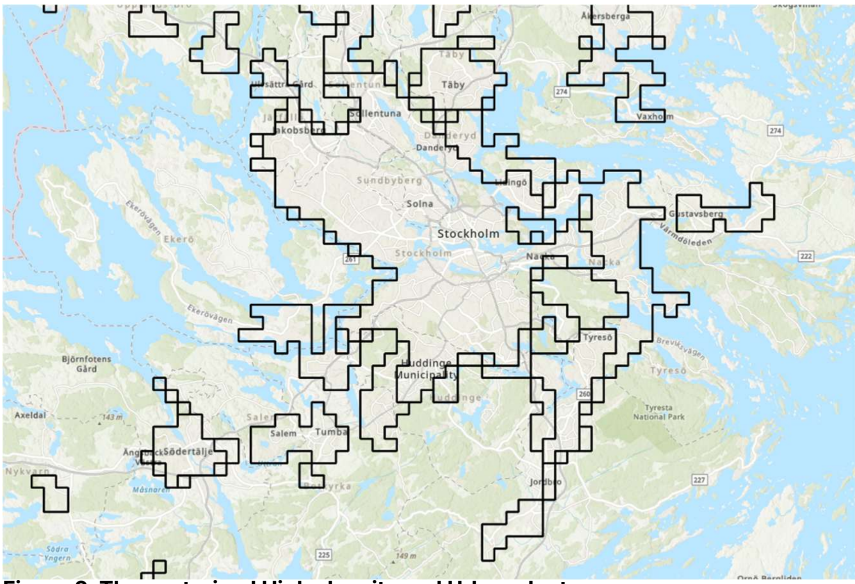

Figure 2: The vectorised High-density and Urban clusters.

The vector layer with High-density clusters and Urban clusters was buffered with 1 km. Minor gaps occurring inside buffered clusters were filled.

The DEGURBA code list was downloaded from Eurostat. The code list was joined onto the authoritative national LAU geography (municipalities with boundaries in reference scale 1:10 000).

The LAU geography was intersected with the vector layers containing the High-density clusters and Urban clusters (both the non-buffered and the buffered clusters, see Figure 3) to split urban polygons with municipality boundaries. Through the intersect, attributes from the DEGURBA code list were also transferred to the clusters.

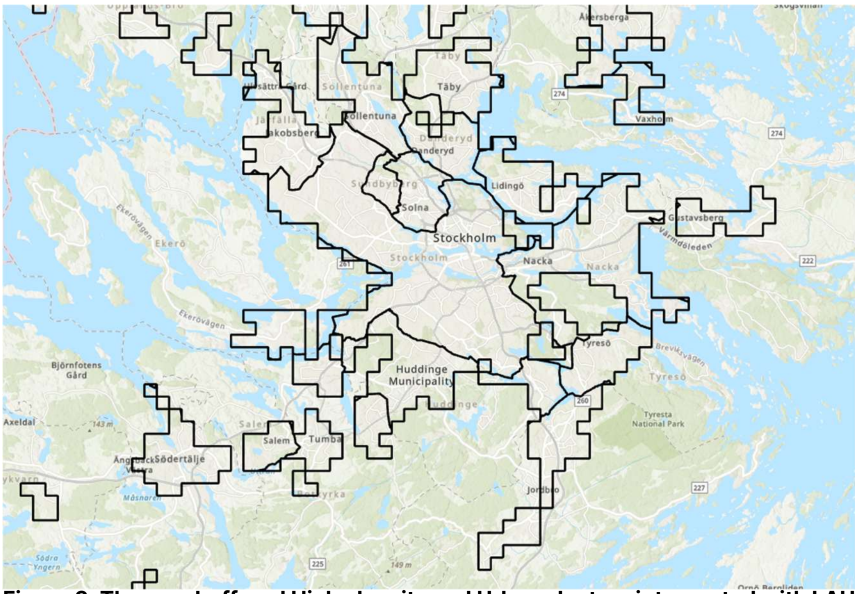

Figure 3: The non-buffered High-density and Urban clusters intersected with LAU geography.

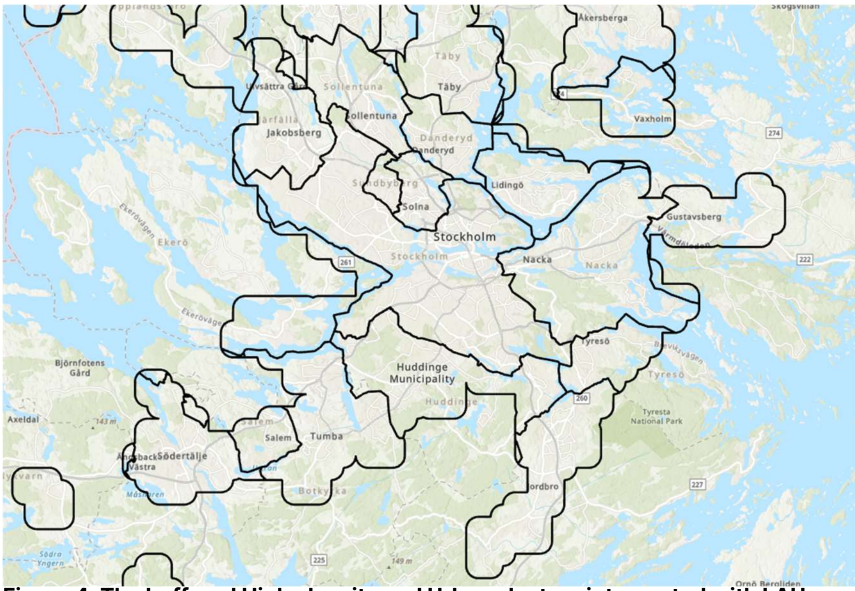

Figure 4: The buffered High-density and Urban clusters intersected with LAU geography.

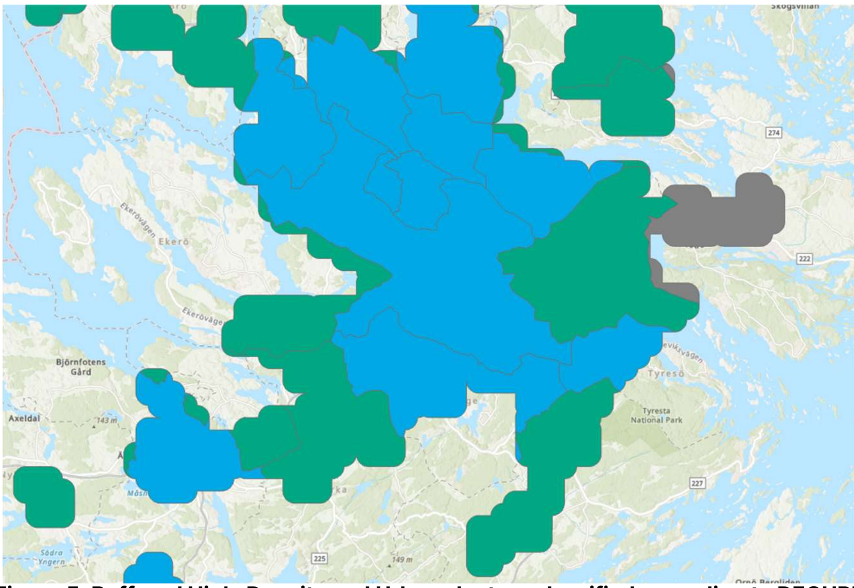

Figure 5: Buffered High-Density and Urban clusters classified according to DEGURBA. Blue=Cities, Green=Towns and Suburbs, Gray=Rural areas.

Once these urban ecosystem areas had been calculated, it was possible to calculate the tree cover density for each of the areas using QGIS.

The tree cover density was also calculated for the LAU definition of cities as it is applied in the INCA tool and recommended in the guideline for local climate regulation.

## Detailed spatial and temporal data to estimate the relevant cooling season in Sweden

The temperature data obtained from SMHI are modelled data using the MESAN model[4]. It gives air temperature at 2 m height, with a spatial resolution of 2.5 km x 2.5 km. The following data were produced:

[4] See SMHI - https://www.smhi.se/en/research/research-units/meteorology/method-and-models

- Maximum daily temperature (24 hour period)
- Minimum daily temperature (24 hour period)
- Mean daily temperature (24 hour period, mean of hourly data)
- For years 2015 through 2024
- All days for months April through September. Specified as all months where the maximum daily temperature can exceed the threshold of 25 ºC
- Degrees latitude and longitude for each square in the data

The data were provided by SMHI in NetCDF format (.nc files). In further data processing, the reference year 2018 was selected.

1. In the first data processing step, the files delivered from SMHI were processed in the following ways:
    a. Uploading of the .nc file in QGIS

    b. In QGIS data from the file were converted into a comma separated file with a python script written with the help of Microsoft Copilot

    c. The following variables were prepared for all data in the file:

        i. Maximum daily temperature
        ii. Minimum daily temperature
        iii. Mean daily temperature
        iv. Spatial disaggregation (degrees long. and lat.)
        v. Day and month

2. In order to provide input for the voluntary variables for the number of days when local climate regulation is relevant, representative pixels in the file were selected for the three largest urban areas in Sweden (Greater Gothenburg, Greater Stockholm and Greater Malmö) and the northernmost city in Sweden (according to the relevant standard for the degree of urbanisation), Umeå. These pixels were chosen to represent the temperature in those cities on those days.

    For each of the cities, two specific area concepts were applied:

    - the city core - a rectangular area comprising only the central built-up areas in the city in question

    - the greater urban area – also a rectangular area, but comprising the central core as well as all suburbs, and of course non-built-up areas adjacent to built-up areas

    For Umeå, a further area was identified incorporating the greater urban area of the city as well as a large part of the relevant local administrative unit for the city, Umeå municipality (Umeå kommun in Swedish).

Clearly the use of rectangular areas is a somewhat approximate method. Having said that, the temperature data in and of itself is limited spatially from an urban perspective given the resolution of 2.5 km x 2.5 km. The application of these different area concepts also offers an opportunity to evaluate the effect that the degree of spatial resolution can have on identifying the period for which the local climate regulation service is relevant.

Table 1 shows the number of pixels and total geographic areas included according to the urban definitions applied above. It shows a wide variation in the total area included. This is of course dependent on the definitions chosen, but also on the size of the cities in question and the 2.5 km x 2.5 km resolution of the original data.

**Table 1: The number of pixels and total area represented by the urban definitions as applied to determine the days when local climate regulation is relevant.**

| | Number of pixels | Area, $km^2$ |
|---|---|---|
| Greater Stockholm | 113 | 706 |
| Stockholm Core | 14 | 88 |
| Greater Gothenburg | 27 | 169 |
| Gothenburg Core | 2 | 13 |
| Greater Malmö | 30 | 188 |
| Malmö Core | 2 | 13 |
| Greater Umeå | 12 | 75 |
| Umeå Core | 1 | 6.3 |
| Umeå kommun | 163 | 1019 |

3. Based on these definitions, the average maximum daily temperature for each of the defined urban areas was calculated for all days in the months April to September. This made it possible to further calculate the number of days per month for which the temperature exceeded the 25 °C threshold.

4. The city areas chosen for the analysis were assumed to be representative of nearby cities (According to the DEGURBA definition) based Table 2.

**Table 2: Urban areas in this study assumed to be representative for the specific urban areas identified to produce the indicator for local climate regulation**

| Urban Area included for producing local climate indicator | Urban area in this study assumed to be representative |
|---|---|
| Järfälla | Stockholm |
| Huddinge | Stockholm |
| Botkyrka | Stockholm |
| Haninge | Stockholm |
| Tyresö | Stockholm |
| Täby | Stockholm |

| Urban Area included for producing local climate indicator | Urban area in this study assumed to be representative |
|---|---:|
| Danderyd | Stockholm |
| Sollentuna | Stockholm |
| Stockholm | Stockholm |
| Södertälje | Stockholm |
| Nacka | Stockholm |
| Sundbyberg | Stockholm |
| Solna | Stockholm |
| Lidingö | Stockholm |
| Uppsala | Stockholm |
| Linköping | Stockholm |
| Norrköping | Stockholm |
| Jönköping | Stockholm |
| Malmö | Malmö |
| Lund | Malmö |
| Helsingborg | Malmö |
| Partille | Göteborg |
| Göteborg | Göteborg |
| Borås | Göteborg |
| Örebro | Stockholm |
| Västerås | Stockholm |
| Umeå | Umeå |

## Calculating local climate regulation

Based on the output of the previously described methodological steps, the INCA tool was used to calculate local climate regulation for Sweden for the reference year 2018. The recommended default input data was used for the calculation. The length of the summer period chosen was based on the results of the analysis of SMHI data to determine the length of the cooling season in Sweden as described above.

The application in the INCA tool produced on the one hand the supply and use tables for the ecosystem services as required according to the revised European Regulation on Environmental Accounting (2011/691). The cooling according to this default method is calculated using the LAU definition of cities, for the entire area of the local administrative units. A further output from the INCA plug-in is a map in TIFF format containing data on the average cooling per pixel in the cities identified according to the LAU definition.

The mask developed to apply the urban ecosystem area definitions for Swedish cities was then applied to the INCA-output map with high resolution data on cooling per pixel. This was done with the zonal statistics function in QGIS to produce a table giving the average cooling for each city in Sweden according to the urban ecosystem area definitions of cities. This was done on the one hand for the urban ecosystem areas considering only the central urban cluster. It was also done for the urban ecosystem area concept including the central urban cluster and the periurban area.

The average cooling arising based on the different area definitions was then compared.

## 2.4 Results

### Detailed spatial and temporal data to estimating the relevant cooling season in Sweden

Table 3 and Figure 6 both show the number of days per month where the spatially averaged maximum temperature exceeds the 25 ºC in the Swedish cities selected.
The data here show that the indicator measured (number of days exceeding 25 ºC) is not very sensitive to which pixels or how many pixels are chosen to represent a given city. For example, Table 3 shows that the spatially averaged temperature in Greater Gothenburg exceeded 25 ºC for a total of 42 days. The equivalent number of days for Gothenburg Core is 44, barely 5 percent higher. The same analysis applies to the other cities.

It can be noted from Table 3 that the criterion for the summer season that at least 10 days in a given month have an average temperature exceeding 25 ºC is met for at least one of the cities considered for all months May through August. Having said that, the table also shows that there is some variation between the cities according to this measure. For Gothenburg, the criterion is met for example May through July. For Malmö and Stockholm the criterion is met for July and August. For Umeå the criterion is met in July only. A further observation is that in Gothenburg the criterion is met in June only for the Gothenburg Core, but falls short by one day based on the Greater Gothenburg area.

Table 3 can be used to fulfil the requirements for voluntary reporting noted in the Guidance Note for local climate regulation. A similar method to that used to produce Table 3 can be used to produce further voluntary indicators noted in the guidance note, for example number of days with maximum temperature exceeding 30 and 35 °C respectively.

Although the method applied here applied area definitions without a high level of detail, the analysis showed that there was no great effect on the quantitative result, the area definitions applied provide very similar time series.

**Table 3: The number of days in 2018 with spatially-averaged maximum temperature above 25 ºC per month, and per Swedish City, according to different are concepts (see method section)**

| Month | APR | MAY | JUN | JUL | AUG | SEP |
|---|---|---|---|---|---|---|
| Greater Gothenburg | 0 | 12 | 9 | 18 | 3 | 0 |
| Gothenburg core | 0 | 13 | 10 | 18 | 3 | 0 |
| Greater Malmö | 0 | 6 | 9 | 19 | 10 | 0 |
| Malmö core | 0 | 6 | 8 | 19 | 10 | 1 |
| Stockholm core | 0 | 8 | 7 | 23 | 10 | 0 |
| Greater Stockholm | 0 | 8 | 7 | 23 | 10 | 0 |
| Umeå core | 0 | 2 | 1 | 21 | 5 | 0 |
| Umeå LAU | 0 | 2 | 1 | 22 | 5 | 0 |
| Greater Umeå | 0 | 2 | 1 | 21 | 5 | 0 |

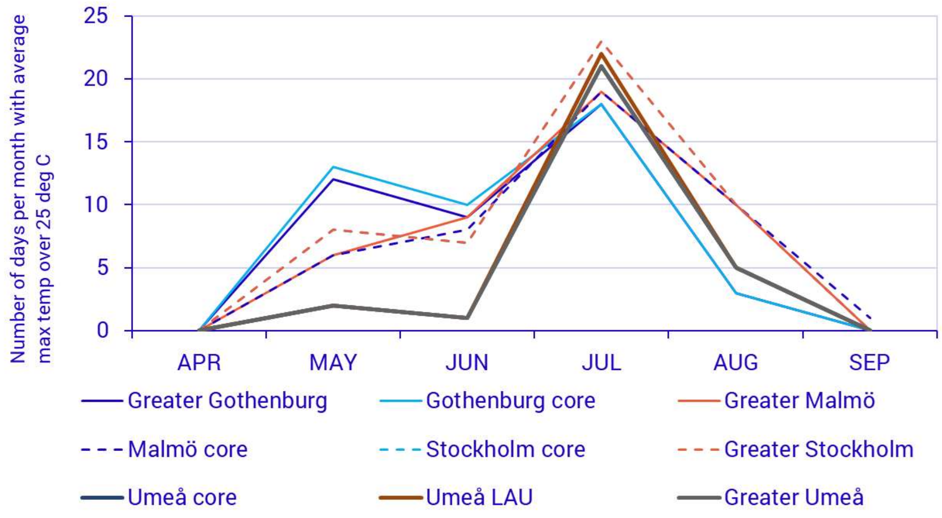


**Figure 6: The number of days in 2018 with spatially-averaged maximum temperature above 25 °C per month, and per Swedish City, according to different are concepts (see method section). Note the lines for "Stockholm Core" and "Greater Stockholm" have exactly the same values.**

## Calculating local climate regulation for the cooling season in Sweden using INCA

Table 4 and Table 5 show the supply table and use table for the local climate regulation service calculated using INCA. These data and the underlying maps were used in further analysis to calculate cooling using alternative area measures as described in the subsection below.

**Table 4: Average cooling between May and August (inclusive) 2018 in Sweden due to urban green space in degrees C. Supply table for the ecosystem service for local climate regulation for all of Sweden in 2018. Calculated using the INCA tool.**

| Ecosystem type | Average cooling |
|---|---:|
| Settlements and other artificial areas | 0.047 |
| Cropland | 0.181 |
| Grassland | 0.013 |
| Forest and woodland | 0.804 |
| Heathland and shrub | 0.000 |
| Sparsely vegetated ecosystems | 0.001 |
| Inland wetlands | 0.013 |
| Rivers and canals | 0.001 |
| Lakes and reservoirs | 0.017 |
| Marine inlets and transitional waters | 0.000 |
| Coastal beaches, dunes and wetlands | 0.000 |
| Marine ecosystems | 0.000 |
| **Total** | **1.077** |

**Table 5: Average cooling between May and August (inclusive) 2018 in Sweden due to urban green space in degrees C. Use table for the ecosystem service for local climate regulation for all of Sweden in 2018. Calculated using the INCA tool.**

| Sector | Average cooling |
|---|---|
| Intermediate consumption by industries | |
| Government final consumption | |
| Households final consumption | 1.08 |
| Gross capital formation | |
| Exports | |
| **Total** | **1.08** |

## Calculating tree cover density and local climate regulation according to urban ecosystem area and LAU

Figure 7, Figure 8 and Figure 9 show the comparison of tree cover density for Swedish cities (by DEGURBA definition) as calculated according to the different area definitions applied in the work, namely the entire local administrative unit (LAU – the area concept intended to be applied in the European ecosystem accounts according to regulation 2011/691), the high-density cluster and the high-density cluster plus a buffer of periurban area. The latter two concepts are applied according to the definition in the Nature Restoration regulation.

A few general points can be made. For a large number of cities shown, the tree cover densities are higher for the LAU area definition than the alternative area definitions. Västerås, Uppsala, Linköping, Norrköping and Umeå are relevant cases of this. All of these examples are cases where the total area included in the LAU is significantly greater than the areas included in the alternative area definitions. In addition, much of this extra area is covered in forest land (a very common ecosystem type in Sweden).

There are nevertheless examples where the opposite is the case (e.g. Solna, Helsingborg), or where the tree cover density is actually higher than that for the LAU-defined are in one of the alternative definitions but lower in the other (e.g. Nacka, Sollentuna, Täby, Danderyd).

These cases can be subdivided into two further categories. In the first instances these cases arise in cities that belong to the Stockholm urban conurbation. That the differences are smaller in these cases is due to the fact that the total area of the city when the LAU concept is applied is actually very similar to the actual area calculated due to the alternative area definitions. This in turn is due to the fact that a very large proportion of the total area of the LAUs in question is subject to urban development.

The second subset of these cases arises for Malmö and Helsingborg, both in the Skåne region in southern Sweden. The smaller differences in these cases arise because the non-urbanized areas surrounding the urban cores in these cities is to a great extent made up of open arable land largely denuded of trees.

It can further be noted that the difference in tree cover density between the LAU defined areas and the alternative definition is generally greater for the area definition for the high-density cluster only, than for the urban high-density cluster plus the periurban area. This is of course due to the fact that the periurban area includes many areas that are not explicity subject to urban development but rather are covered with other ecosystem types, which in large parts of Sweden is predominantly forest.

Finally, it can be noted that the differences in tree cover density between the different area definitions is in some cases quite large (see Figure 9). More specifically this difference can be up to and even exceed 50 percent (see for example Linköping and Uppsala in the figure) for the comparison between the LAU definition and specifically the cluster.

The percentage differences between the LAU definition and the high-density cluster plus the urban periphery are in general smaller, but in certain cases can exceed 40 percent (Linköping and Uppsala for example). These differences are large enough to suggest that the LAU definition is unsatisfactory as a basis for the calculation of the local climate regulation service.

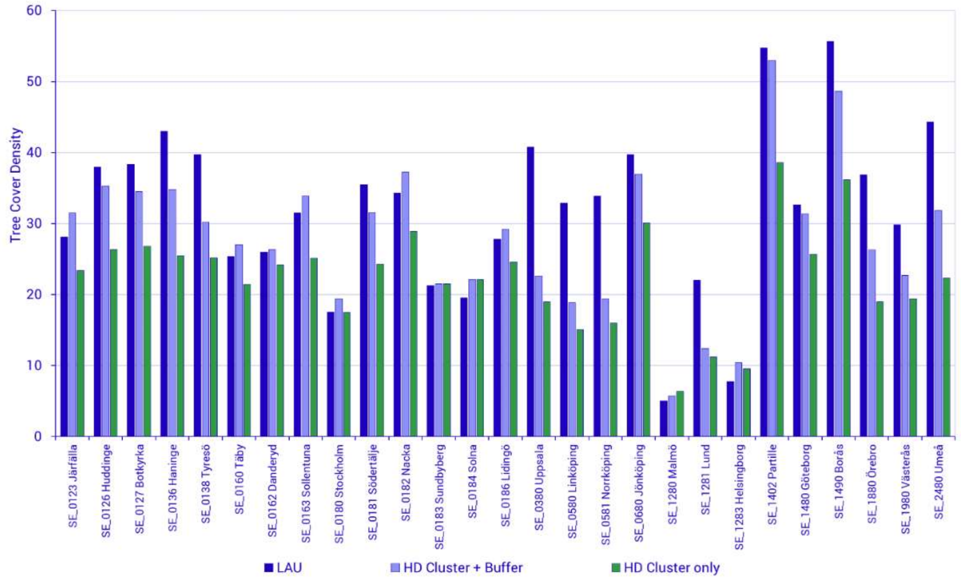


**Figure 7: Tree Cover Density (in percent) in Swedish cities (based on the DEGURBA definition) for different interpretations of the urban area – Entire area of the local administrative unit (LAU), only the high-density cluster and the high-density cluster plus the periurban buffer (high-density Cluster + buffer)**

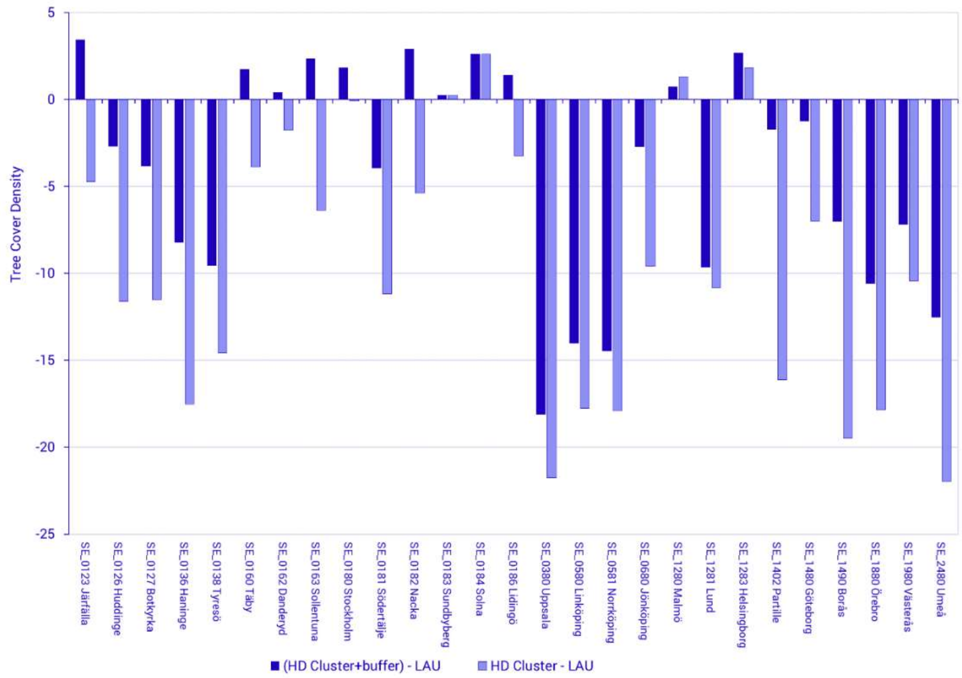


**Figure 8: Difference in tree cover density in Swedish cities (based on the DEGURBA definition) for (high density (HD) cluster + buffer) and high-density cluster, compared with the entire local administrative unit. HD Cluster – only the urban cluster, HD Cluster + buffer - the urban area plus the periurban buffer. Negative values show that the calculated tree cover density is higher for LAU than for the alternative area concepts.**

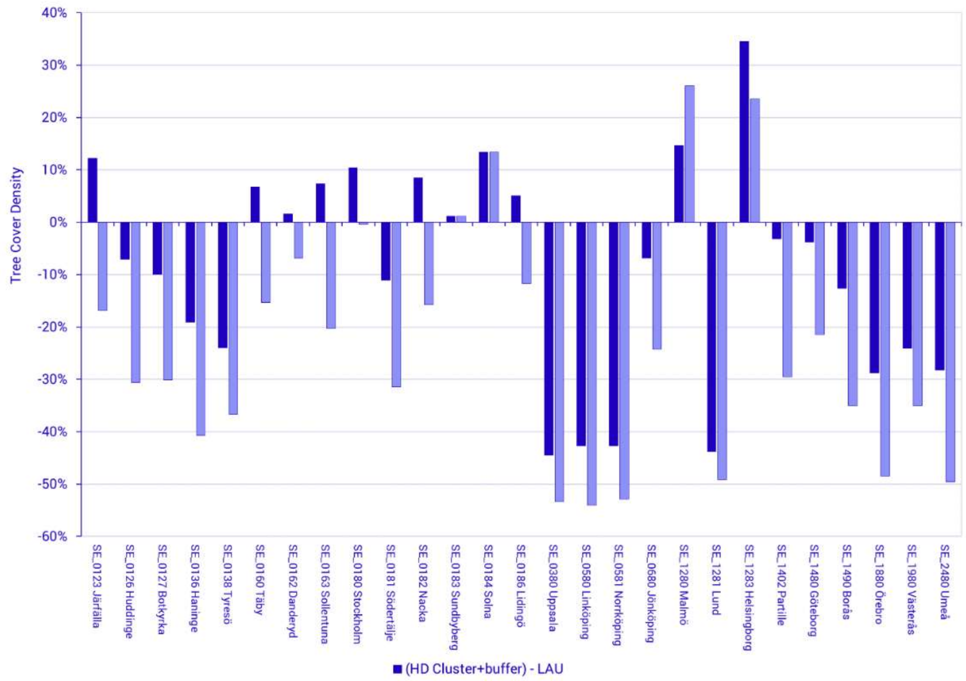


**Figure 9: Percentage difference in tree cover density in Swedish cities (based on the DEGURBA definition) for (cluster + buffer) and cluster, compared with the entire local administrative unit. HD Cluster – only high-density cluster as defined by DEGURBA, HD sluster + buffer - the urban area plus the periurban buffer. Negative values show that the calculated tree cover density is higher for LAU than for the alternative area concepts.**

Figure 10, Figure 11 and Figure 12 show and compare the calculated average cooling during summer months (May through August) in Swedish cities in 2018 based on the results of the INCA tool using the different city area definitions considered in the work.

The results here follow a very similar pattern to that demonstrated for the variation in tree cover density due to different area definitions (see Figure 7, Figure 8 and Figure 9). Firstly that the calculated cooling effect is predominantly greater when applying the LAU definition than either of the alternative definitions for many of the cities shown.

The differences are large in particular for cities where the LAU definition yields significantly larger total areas than the alternative definitions, for example, Uppsala, Linköping, Örebro and Västerås.

The differences are smaller for other cities, notably those that comprise the Greater Stockholm conurbation – Täby, Danderyd, the City of Stockholm itself (a subset of Greater Stockholm), Sollentuna, Sundbyberg. Again, the small differences noted for Helsingborg and Malmö arise because much of the area outside of the built-up areas included in the LAU for these cities is occupied by open arable land largely denuded of trees.

The differences between the assessed cooling for LAU and the other definitions are larger for the definition comprising only the built-up urban core (called “high-density cluster”) than for the definition comprising the periurban area as well (called “high-density cluster plus buffer”) in the figures.

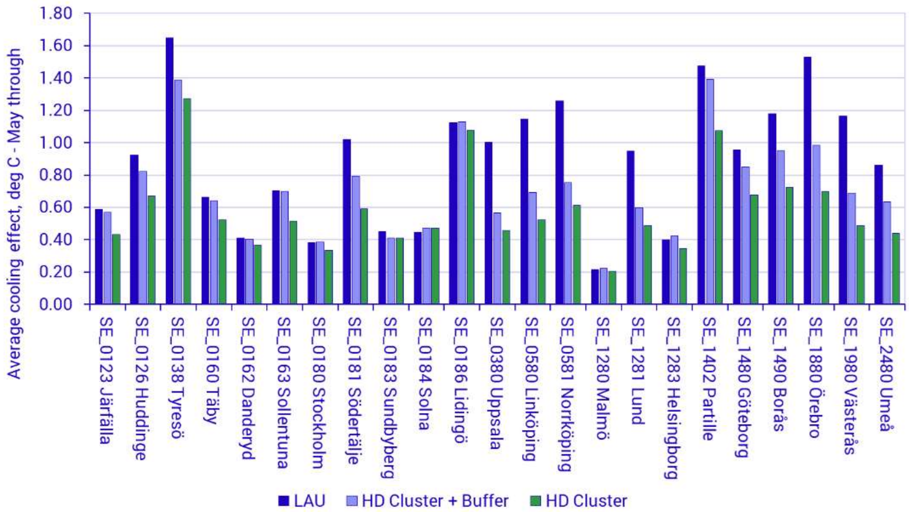


**Figure 10: Average cooling during summer months for cities in Sweden due to tree cover for 2018. Based on results from the INCA tool. Three different area definitions for cities – Entire local administrative unit (LAU, according to specifications in updated regulation on environmental accounts 2011/691), high-density cluster and high-density cluster plus buffer (including periurban areas). Last 2 definitions according to specifications in the nature restoration law.**

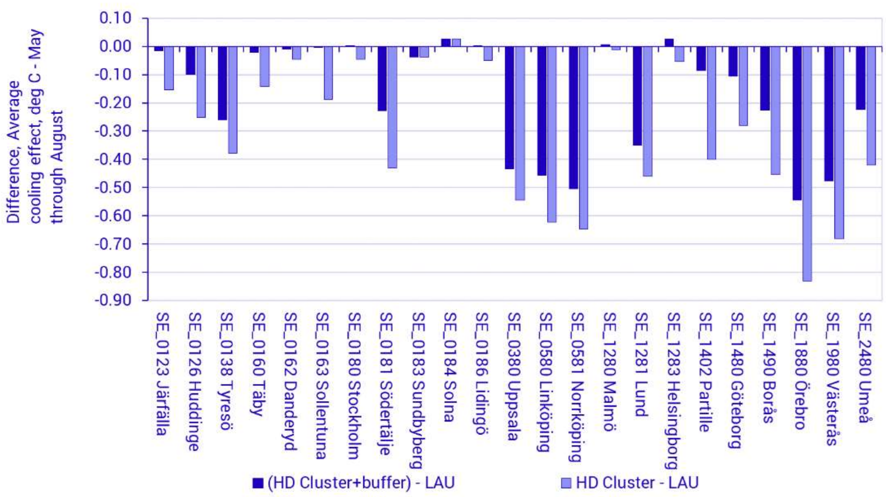


**Figure 11: Difference in average cooling during summer months for cities in Sweden due to tree cover for 2018 depending on the area definition applied. Bars represent the difference between cooling based on local administrative unit definition and the high-density urban cluster on the one hand and the local administrative unit and the high-density urban cluster including periurban areas on the other. Negative values indicate that the LAU definition overestimates compared to other definitions to which it is compared and vice versa.**

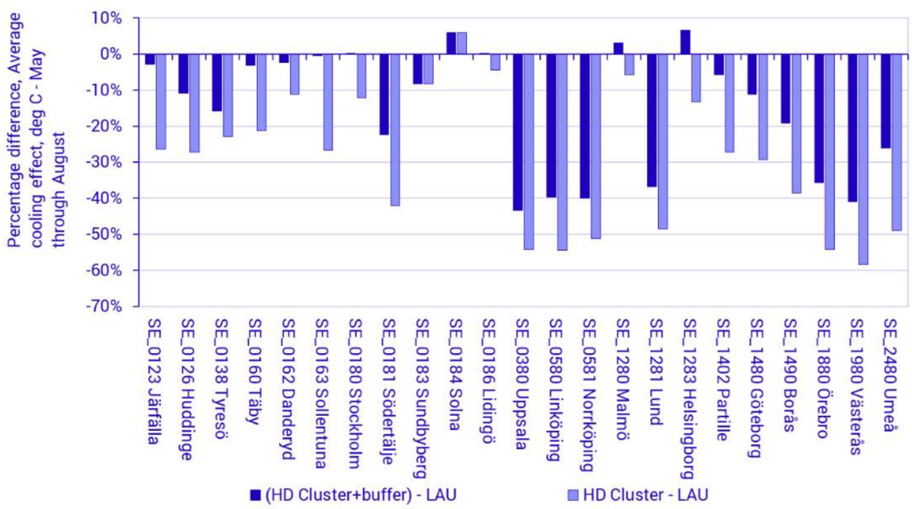

**Figure 12: Difference in average cooling during summer months for cities in Sweden due to tree cover for 2018 depending on the area definition applied. Bars represent the difference between cooling based on local administrative unit definition and the high density cluster on the one hand and the local administrative unit and the high-density cluster including periurban areas on the other. Negative values indicate that the LAU definition overestimates compared to other definitions to which it is compared and vice versa.**

## 2.5 Concluding discussion

The comparison of the average cooling indicator based on LAU and urban ecosystem areas showed that for many urban areas in Sweden significant differences in the calculated average cooling arise when changing the area definition for cities.

Going forward, it is recommended that in national reporting and communication with national users (for example the Swedish Environmental Protection Agency, the Swedish Board of Housing, Building and Planning, local authorities) that urban ecosystem areas are used exclusively. In reporting condition indicators required according to the Nature Restoration Regulation, the urban ecosystem areas will also be used. It is also strongly recommended that urban ecosystem areas are used for reporting local climate regulation to Eurostat in conjunction with the revised regulation on European Environmental accounts.

The analysis in this work also showed that the temperature datasets are a valuable source to be able to determine the time period for which the ecosystem service local climate regulation is relevant. The analysis showed that it is possible to apply for each identified urban area in Sweden. The data and analysis have produced tables that can be used for the voluntary reporting of the length of the cooling season for each city in Sweden.

Going forward it is recommended that the same method be applied for all urban areas in Sweden, and it can be applied for all years for which we have data (2015 through 2024). It is also possible to develop analysis to be able to report further voluntary indicators noted in the current guidance, namely the number of days that average maximum temperatures in a city exceed 30 and 35 degrees C respectively. These data also make it possible in the future to calculate the mandatory average cooling indicator for different time periods for different cities, given that other analysis in this work has shown that local climate regulation is relevant for different parts of the year in different parts of Sweden.


## Acknowledgement

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