Seventh Framework Programme

Call FP7-ICT-2009-6

Project: 247708 - SUDPLAN

Project full title:

Sustainable Urban Development Planner for Climate Change Adaptation

Deliverable D4.4.3

WP4 Common Services: Air Quality Downscaling Service V3

Due date of deliverable: 30/04/2012

Actual submission date: 30/04/2012

Document Control Page

Title	WP4 Common Services: Air Quality Downscaling Service V3	
Creator	SMHI	
Editor	Lars Gidhagen	
Description	Description of the V3 Air Quality Downscaling Service (deliverable added by the consortium, not in DoW)	
Publisher	SUDPLAN Consortium	
Contributors	SMHI, Apertum, cismet	
Type	Text	
Format	application/msword	
Language	EN-GB	
Creation date	25-04-2012	
Version number	1.0	
Version date	30-04-2012	
Last modified by	Lars Gidhagen	
Rights	Copyright "SUDPLAN Consortium". During the drafting process, access is generally limited to the SUDPLAN Partners.	
Audience	☐ internal ☒ public ☐ restricted, access granted to: EU Commission	
Review status	☐ Draft ☒ WP Manager accepted ☐ PMC quality controlled ☒ Co-ordinator accepted	Where applicable: ☐ Accepted by the PMC as public document
Action requested	☐ to be revised by Partners involved in the preparation of the deliverable ☐ to be revised by Technical reviewer ☐ for approval of the WP Manager ☐ for approval of the Quality Manager ☐ for approval of the Project Co-ordinator ☐ for approval of the PMC	
Requested deadline	30-04-2012	

Revision History

Version	Date	Modified by	Comments
0.5	25-04-2012	Lars Gidhagen, SMHI	Creating draft based on V2 document
0.6	26-04-2012	Magnuz Engardt, SMHI Lars Gidhagen, SMHI	Editing
0.7	27-04-2012	Lars Örtegren, APE Lars Gidhagen, SMHI	Editing
0.8	30-04-2012	Martin Scholl, cismet Lars Gidhagen, SMHI	Editing
1.0	30-04-2012	Lars Gidhagen	Co-ordinator approval

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1. Management summary

The SUDPLAN project develops a planning, decision support and training tool to assess how different environmental conditions and problems on the urban scale will evolve under a changing climate. Common Services offer urban downscaling services for intense rainfall, river flooding and air quality; accessible on the web through the Scenario Management System. The downscaling simulation results are improved by local input from the end user, i.e. Common Services can be described as interactive climate services.

The following downscaling functionality is implemented in Common Services:

- Intense rainfall: urban downscaling – generation of short-term precipitation data for urban hydrological climate change impact assessment
- Hydrological conditions: urban downscaling – local calibration of hydrological variables and generation of future runoff scenarios
- Air quality: urban downscaling – generation of local future air quality scenarios taking into account local emissions, long-range transport and climate change effects.

This report documents the air quality downscaling services, with a focus on the description of end user functionality, as a complement to the software itself. Some experiences gained during the experimentation of air quality downscaling are given. More IT related documentation can be found in the appendices of D4.1.2 Concerted Approach V2 and later in its final version V3 to be submitted M33.

The air quality downscaling in the Common Services is now (M28) fully operational, allowing both upload of gridded emissions with temporal variation and model execution for up to one year long periods at a time. Future air quality projections have been made for both Stockholm and Prague, of direct interest for those two pilots and external stakeholders linked to SULVF and CENIA.

The preparation of detailed emission inventories that reflect local urban planning, for present and future years, may require large efforts even for well-experienced users, as exemplified by the Stockholm pilot. A possible way to initiate the generation of emission scenarios for future years is to use GAINS model emission scenarios for the country/region of interest.

The air quality downscaling is computationally expensive and the downscaling procedure has been modified to reduce calculation times.

Experiences of how the Common Services air quality application is operated through the Scenario Management System user interface will be described in D5.3.3 Stockholm pilot report V3 and D8.3.3 Czech pilot report V3, both due M34.

This is a public document available at http://www.sudplan.eu/results.

2. Air Quality: Urban downscaling

The Air Quality (AQ) downscaling is performed by running the CS CTM[1] model over a specific city, using existing Europe scale model results for forcing and boundary conditions – a procedure also known as off-line nesting. This will yield a model result for part of the period of the Europe scale simulations, but with a much higher spatial resolution over the specific city (see Figure 1 example). The downscaling requires input of local emission with high spatial resolution, if the downscaling shall be meaningful.

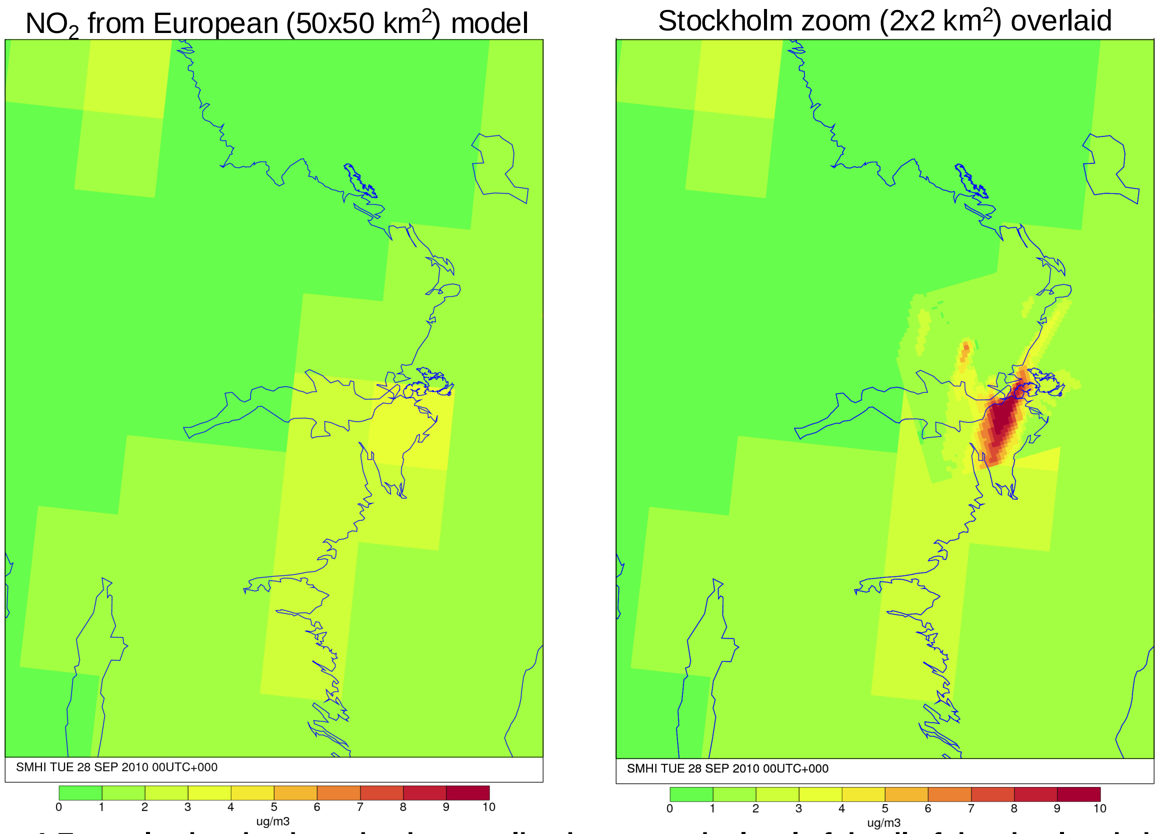


Figure 1 Example showing how the downscaling improves the level of detail of the simulated air pollution

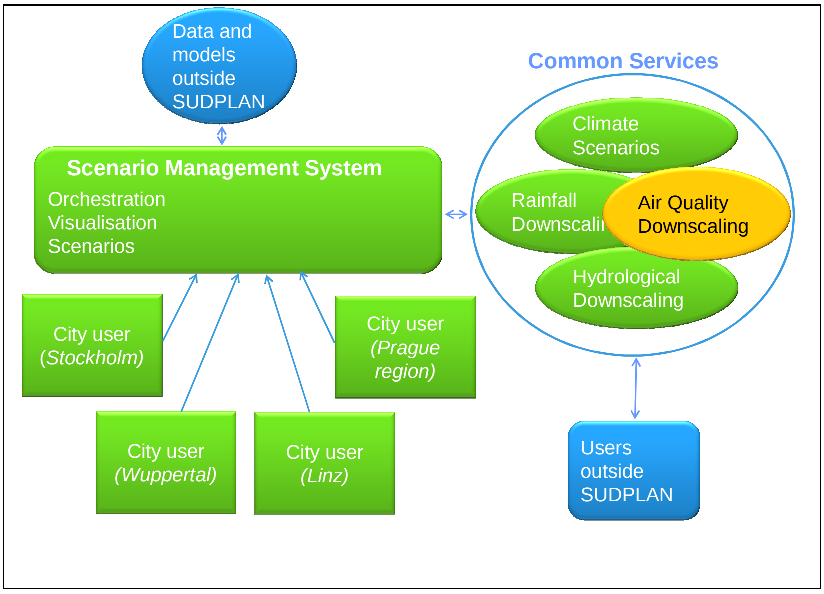
Common Services (CS) provides the climate and environmental information to end user through the Scenario Management System (SMS), which is a model control, visualisation and integration workbench for all SUDPLAN components (Figure 2). A standardized communication will assure an easy setup connection to the Common Services, also for other software which require climate services of this type.

The technical structure of Common Services is illustrated in Figure 3. The rainfall and air quality downscaling, together with the corresponding Pan-European climate and environmental information, have been implemented in an existing software, the Airviro system. Input (forcing and boundary conditions) and output data is either pointwise time series or gridded time series. The hydrological data is based on pointwise time series and irregular polygon data representing watersheds, managed through the existing HYPE model system. Therefore the back-back end

[1] Chemistry Transport Model

solutions are also splitted in two parts. The service layer does however streamline the communication to all Common Services, so that external user will only have to follow the OGC standards of four services SOS, SPS, WMS and WFS in order to establish communication.

Figure 2 Overview of SUDPLAN components. The communication between Common Services and the Scenario Management System uses standardized services (OGC).



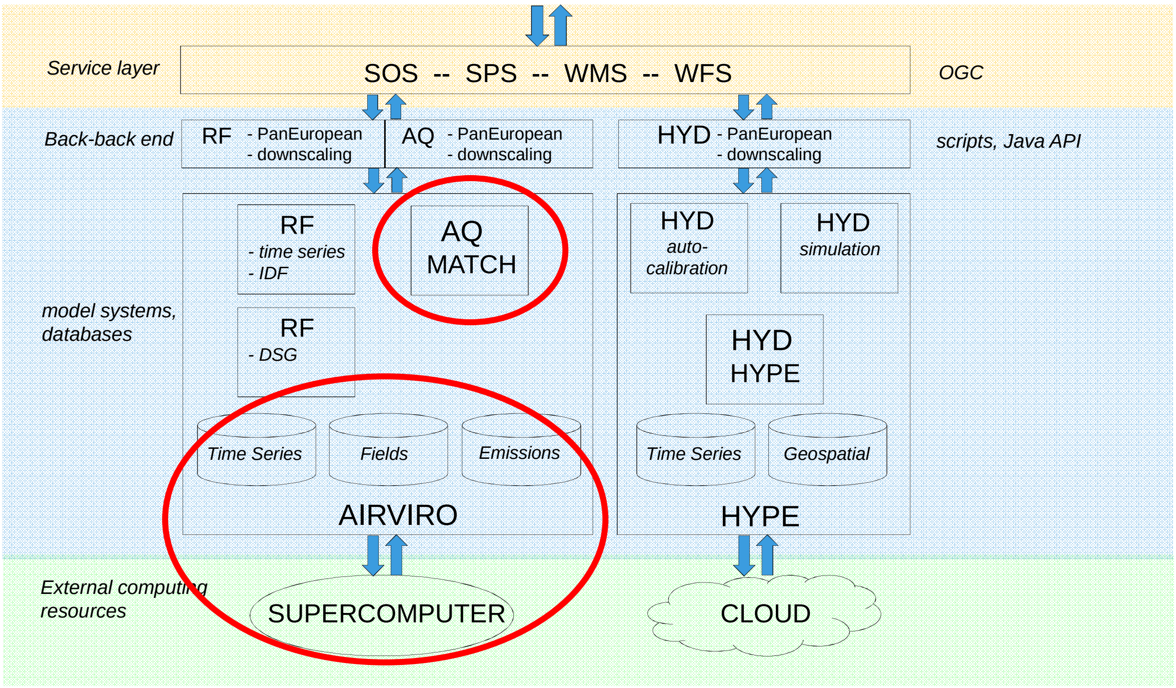


Figure 3 Technical solution of Common Services, with air quality downscaling components marked.

The air quality downscaling components (marked in Figure 3) forms part of the Airviro model system, which also supports the rainfall downscaling. This document describes how the downscaling is performed in SUDPLAN. Technical descriptions concerning the dispersion model MATCH and other components of the air quality part of Common Services environment is found in D4.1.2 Common Services concerted approach V2. A final update D4.1.3 Common

Services concerted approach V3 is scheduled to M33. The D4.1.2/D4.1.3 documents include appendices documenting the OGC communication[2] and also an appendix which documents the technical solution of the back-back end, i.e. how scripts can be used to communicate with the Common Services to upload emissions, select model domain and parameters, input data (emissions, forcing, boundary conditions), proceed to execution and then to access the output. The description given in the present document focuses more the user functionality (i.e. the functionality as developed in AQ model system marked in red in Figure 3), leaving the specific IT solutions for the D4.1.2 and D4.1.3 documents.

The full use of the SUDPLAN platform to manage AQ downscaling will be presented by WP5 (Stockholm) and WP8 (CENIA).

2.1. Downscaling procedure

The Air Quality downscaling procedure involves two different actions: the upload of local emissions and the dispersion model execution. The uploaded emissions will be stored in Common Services, so when completed it is possible to perform series of dispersion model executions based on existing emission databases.

2.1.1 Emission upload

The concept of SUDPLAN downscaling is that an end user contributes with local input data that improve the quality of the model simulation output. For air quality this means emission data from a specific city.

SUDPLAN Common Services allow the user to perform a downscaling model simulation over the city region of interest, reaching a spatial resolution of about 1x1 km. For further refinement, user's own local models can be used. An urban air quality downscaling is only meaningful if the user can provide local emission data with sufficient spatial resolution.

The Common Services downscaling requires gridded emissions in the form of annual averages for six pollutants: NOx, NH3, PM, SO2, VOC and CO. The spatial resolution should preferably be 1x1 km or finer, so that the model simulation will not depend on the resolution of the emission input.

Minimum is to have one emission grid for each of the pollutants. If possible it is also desired to separate emissions at ground level from those coming out of point sources at certain height, typically 50 m or above. The model will then locate the emission grids at different heights.

There is a default (i.e. built into Common Services) time variation where ground level emissions vary according to a typical traffic pattern and where ground or elevated grid emissions are kept constant over time. However, the SUDPLAN user may also input simple tables that change the time variation to be specific for the city. Each set of emission grids are representing a particular year, e.g. 2010, 2030 or 2050.

[2] Note that the air quality specific part of the OGC documentation in D4.1.2 (submitted M24) is not complete, however the final D4.1.3 document will be submitted M33.

The upload of emission needs only be made once, since the grids and time variation tables are stored in the Common Services for future use.

The stepwise procedure to upload emissions is as follows (see Figure 4):

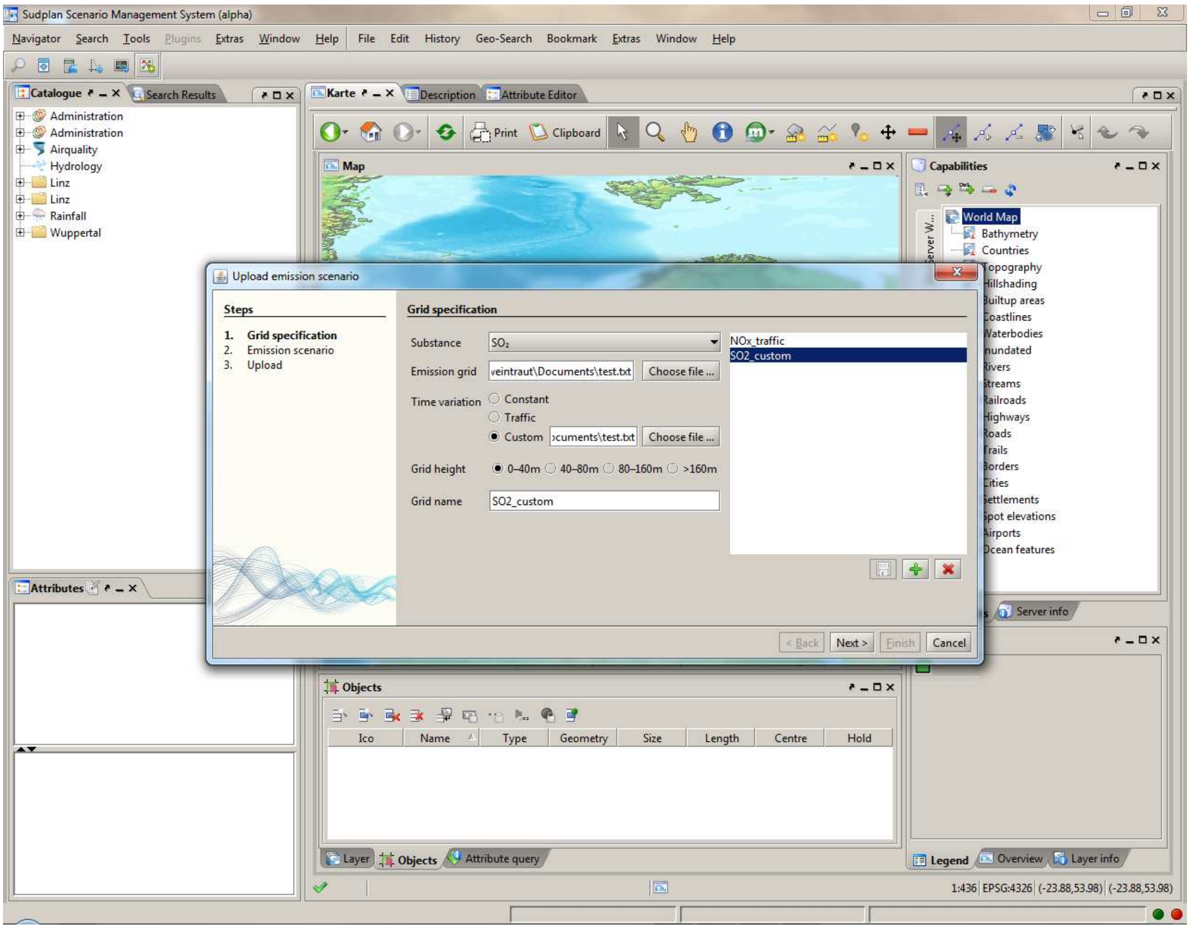


Figure 4. SMS wizard for emission upload to CS AQ database.

1. The substance is selected (among NOx, NH3, PM, SO2, VOC and CO).

2. The file with the annual average emission - in tons/year per each grid cell – is specified. The format is according to ESRI ASCII Raster format:

ncols *nx*
nrows *ny*
xllcorner *xb*
yllcorner *yb*
cellsize *dxy*
nodata_value *missvalue*
$val_{1,ny}$ $val_{2,ny}$ … $val_{nx,ny}$
$val_{1,ny-1}$ $val_{2,ny-1}$ … $val_{nx,ny-1}$
…
$val_{1,1}$ $val_{2,1}$ … $val_{nx,1}$

3. The time variation is given as Constant (no variation), Traffic (a SUDPLAN default variation profile taken from a European city) or Custom (the end user gives the variation by uploading a file).

   The Custom variation is given as a monthly variation and an hourly variation for four different day-types (Figure 5). Note that numbers given are relative, as they will be normalized in the database. This means that whatever direct readings from a traffic count can be put directly into the hourly variation table.

   The format for the time variation upload is simply an ASCII file with format:

   #TYPEDAY
   $freq_{1,1}$ $freq_{2,1}$ $freq_{3,1}$ $freq_{4,1}$
   $freq_{1,2}$ $freq_{2,2}$ $freq_{3,2}$ $freq_{4,2}$
   …
   $freq_{1,24}$ $freq_{2,24}$ $freq_{3,24}$ $freq_{4,24}$
   #MONTH
   $freq_{1}$ $freq_{2}$ … $freq_{12}$

	Mon-Fri	Fri	Sat	Sun
1	117	145	224	282
2	65	81	153	218
3	46	58	103	150
4	51	57	75	93
5	117	112	82	73
6	416	362	143	99
7	1197	1049	286	181
8	1626	1420	488	286
9	1423	1269	799	455
10	1240	1250	1312	765
11	1264	1430	1759	1224
12	1332	1578	1958	1568
13	1409	1747	1939	1803
14	1475	1962	1868	1931
15	1570	2137	1787	2007
16	1821	2366	1714	2076
17	2369	2608	1634	2096
18	1978	2270	1494	1984
19	1454	1761	1216	1712
20	976	1191	878	1369
21	782	842	667	1040
22	653	634	549	716
23	430	511	445	417
24	228	333	360	221

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
100	100	80	80	55	55	65	75	85	115	120	130

Figure 5. The time variation tables of the CS emission database

4. The height of the mission source is specified as one of four intervals:
   - Surface source, defined as between 0 and 40 m
   - Elevated point sources between 40-80 m
   - Elevated point sources between 80-160 m
   - Very high point sources above 160 m

   In the dispersion model, all surface sources will be enter as grid (or area) sources. For the three higher intervals, the model will treat the largest cell emissions as point sources, the rest will be introduced as grid/area sources.

5. A specific name is specified for the emission grid just introduced.

6. The 1-5 procedure is repeated for all pollutant grids. Note that there can be more than one grid for a particular pollutant and height, e.g. originating from different sources. Example: One PM10 grid from traffic and another from residential wood burning.

7. A name is given to the overall emission database (EDB) to be created in Common Services database. The name will appear in the list of EDBs available for model execution, see next section.

2.1.2 Model execution

The model execution has as a requisite that there is at least one emission database uploaded to Common Services database. The procedure to execute the downscaling is as follows:

1. The first steps are illustrated in Figure 6: CS receives from SMS the coordinates for the rectangle defined as downscaling area, together with some identification of the coordinate system and map projection[3]. The user has to specify which European scale air quality result - based either on a future climate scenario or on a historical period (hindcast) - to use as boundary conditions for the downscaling, this from a list of available European model results (Figure 6, bottom right).

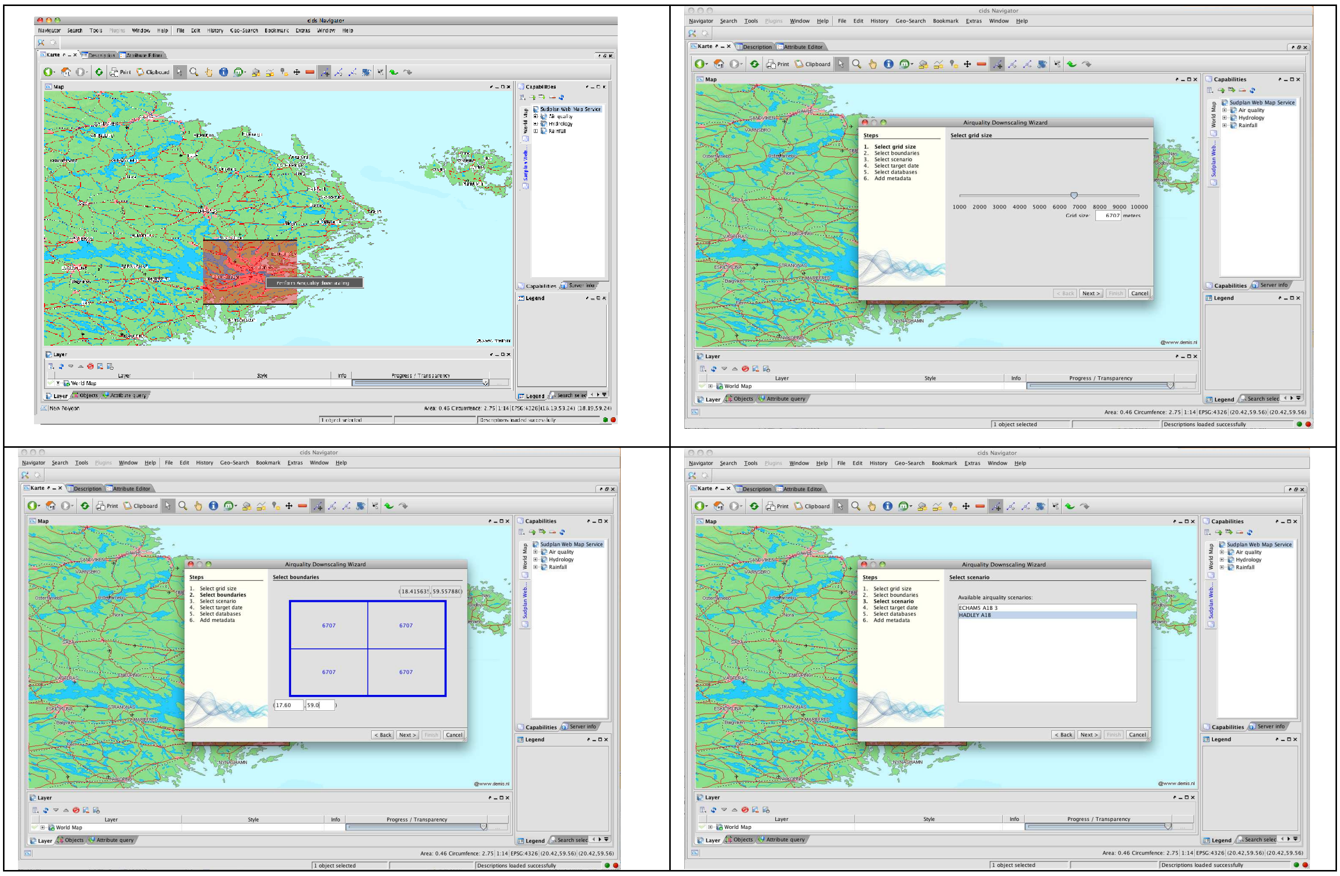


Figure 6. SMS user interface for air quality downscaling: Selecting city, defining grid resolution, refine coordinates of bounding box, selecting air quality/climate scenario as boundary condition.

2. As next step (not shown in Figure 6) the user has to specify the simulation period, which must be found inside the period covered by the European scale result used for boundary conditions. The simulation period is given as first and last day of the period.

3. A local emission database is specified from a list of available databases (see emission upload procedure which should be completed prior to model execution).

[3] For the European scale WGS84 is default, however end users may use their standard projections for their city.

4. The user adds metadata describing the simulation and launches the simulation which will be executed as a batch job. The system will notify when the results are available.

5. As there likely exists a year-to-year variability due to meteorology, the typical procedure for air quality downscaling will be to make various (3-5) simulations with the same emission database but for different meteorological conditions. An example: first create three 1-year simulations representing “present” conditions, e.g. 2009-2010-2011 (they can all use the same emission database, since emissions will not have a strong year-to-year variation). Then a “future” time window of similar length is chosen, e.g. 2029-2030-2031, for which the model is executed three times. The time windows should be chosen within the limits of the Pan-European results, which for the two present scenarios is 1960-2100.

6. Model output are stored at CS server, accessible through SMS (Figure 7). The air quality downscaling in Common Services will output gridded concentrations of NO2, NOx, O3, SO2 and PM10 with hourly, daily, monthly and annual temporal resolution (seen in the SMS result list as four different results). The annual result file will only consist of one field, the annual average for that particular year. However, the hourly result file will, for a year-long simulation, include around 8760 hourly average gridded results

   The requirements for visualisation and further result processing have been defined by the Stockholm and Czech pilots, see their pilot definition plans V3 (D5.1.3 and D8.1.3). Common Services allow 2D visualisation of the downscaled concentration fields with colour settings defined by the user. For specific locations a time series graph can be displayed. Individual grids (i.e. the one displayed over the map) can be exported to some standard format (e.g. EXCEL). Also visualised time series may be exported e.g. in EXCEL or CSV format.

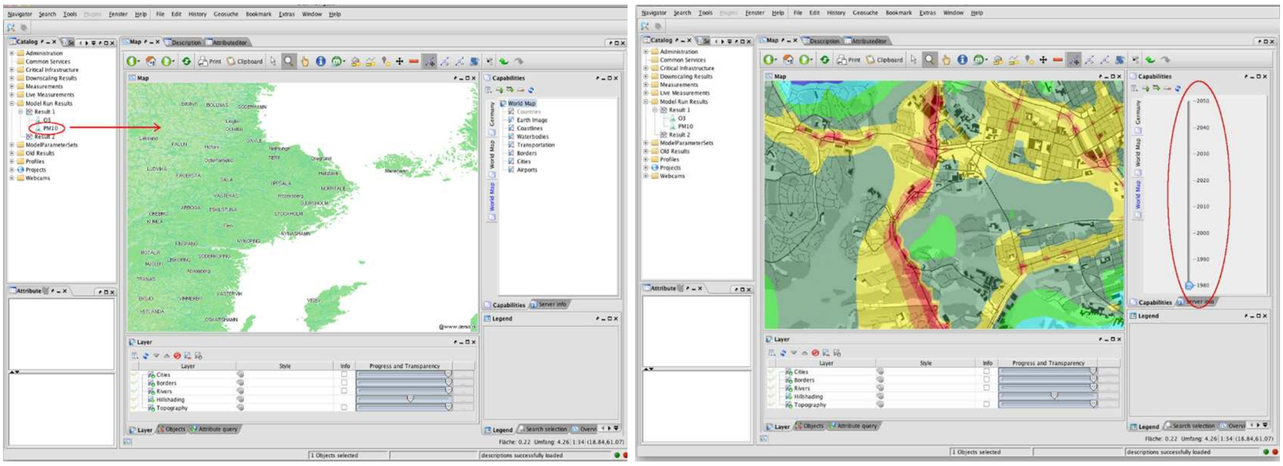


Figure 7. SMS user interface for air quality visualisation (prototype): Dragging downscaling result file into map (left) and 2D visualisation of air pollutant concentration (right).

2.2. Use of air quality downscaling results

Figure 8 gives an example of how the air quality downscaling can be used to project what will happen with NO2 levels in Stockholm up to 2030, taking into account various changes:

- Climate change
- Changed emissions over Europe
- Changed emissions in Stockholm (better vehicle technology, more traffic, new transit road etc).

More details on this type of application have been presented in the Stockholm pilot report V2 (D5.2.2) and the Czech pilot report V2 (D8.2.2).

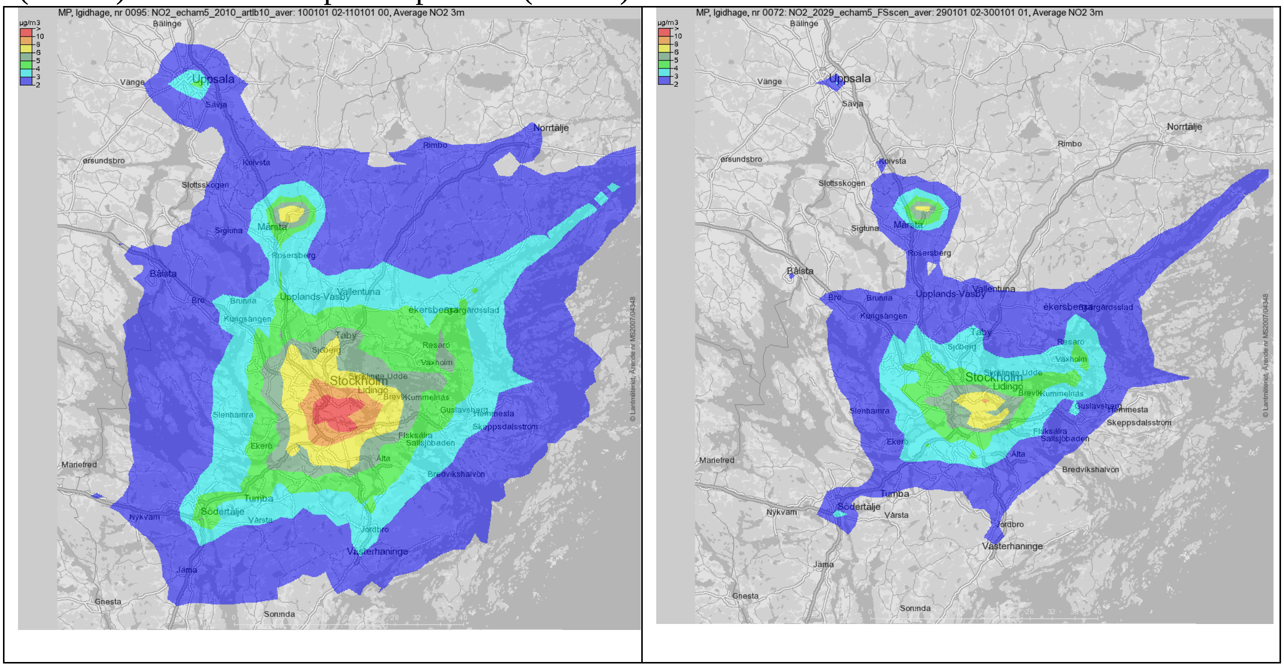


Figure 8. Annual average values for urban background concentrations of nitrogen dioxide: Year 2010 with present local emissions (left) and year 2029 with future emissions and new transit road (right), both using ECHAM5 A1B climate and RCP4.5 emission scenario for Europe (visualisations taken from Airviro user interface).

2.3. Overview of components and data flows

Figure 9 illustrates the components and data flows involved in the air quality downscaling procedure. More details to be found in D4.1.2 Concerted Approach V2 and later in its final update D4.1.3 Concerted Approach V3.

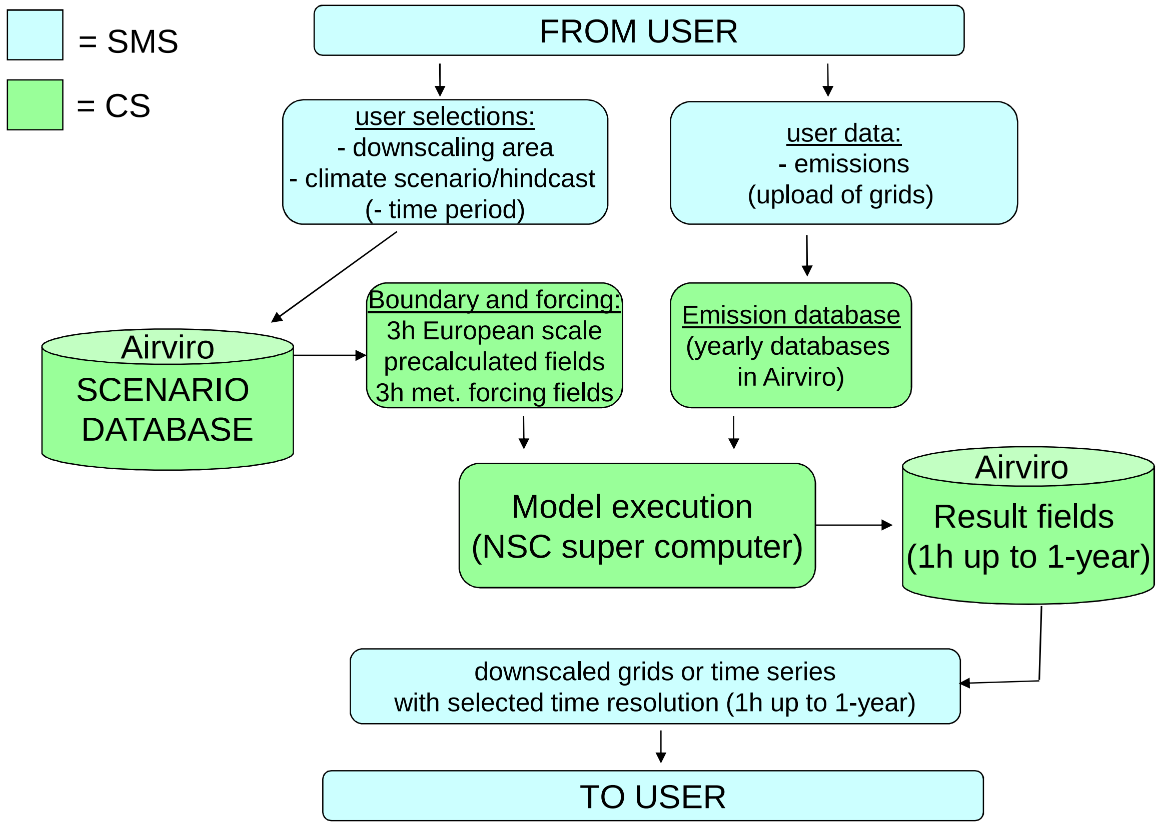


Figure 9. Components and data flows between SMS and CS for air quality downscaling.

The AQ downscaling performed and visualised in this document has been administrated through the Airviro web user interface.

2.4. Experiences gained during experimentation

The back-back end functionality of the Common Services air quality downscaling has been extensively used already during the second project year by both WP5 (Stockholm) and WP8 (Czech Republic) partners. This has been possible through the use of the Airviro web user interface, which permits emission uploads, model execution and result analysis in a similar way as the SMS user interface will do this third year (the Airviro user interface is more general but too complex for a typical SUDPLAN end user).

The air quality downscaling is the computationally most demanding application of the Common Services and it requires also huge amounts of input data. Here are some experiences from the WP5 and WP8 experimentation so far:

1. If emission databases of required quality (e.g. concerning spatial and temporal variability) are not available, a rather large preparatory effort is needed in order to be able to perform useful air quality downscaling simulations. For Stockholm a database describing present conditions was available from project start, but the built up of a future emission database of interest (for assessment of a planned transit road through Stockholm) was time consuming. This is partly due to the level of detail of the Stockholm database, which means that the entire road network – also new road links - are described as individual emission line sources. Such details are only possible for trained users that have access to the general Airviro EDB user interface.

   The Czech pilot staff, which had to build up databases both for present and future conditions, used a simpler approach so that the spatial distribution of emission sources were based on grids with identical spatial distribution for present and future databases. The difference was in the emission amplitude for different sectors, e.g. road traffic, large point source (energy, heavy industry) etc. The projected evolution of the those emissions were taken from a GAINS model scenario, an efficient and well documented way to create, in a top-down way[4], future emission scenarios. The Czech methodology can thus use the SUDPLAN emission upload and serves as an example for whatever other European city that wants to explore the CS air quality downscaling functionality.

   The importance of well-defined and documented emission scenarios is fundamental for discussing the validity of the air quality downscaling results.

2. The physical calculation times are huge. The first reason is the search and creation of emissions to send as input data to the supercomputer simulation. We found that the search of hourly emission grids, performed within the Airviro server at SMHI, takes 1-2 days for a one year simulation (8760 hourly grids of 6 pollutants). Although SUDPLAN users should benefit from shorter emission search times (a new server will be tested during the third year), the current duration is not critical as the model execution takes even more time, see next paragraph.

3. The second reason of long calculation times is the true CPU needed on the supercomputer system for the photochemical model simulation (MATCH model). SUDPLAN is currently working on 4 nodes, this can be extended to more nodes in the future. The spatial resolution (the total number of cells in the grid domain) is highly influencing calculation times. While a 2x2 km grid over the Stockholm domain (the one shown in Fig. 3) takes about one day for a year period, the completion of a 1x1 km grid will increase 4 times (to 4 days). Obviously the end user has to consider the need of spatial resolution and balance it with the need of doing multiple executions (e.g. with different years and with different climate scenarios as input).

   The long calculation times has forced the project to a revised procedure for air quality downscaling simulations. Instead of running continuously for the same period as the climate scenario used as forcing – presently 140 years - a revised procedure has been developed. The simulations are all made for one calendar year, but grouped three or five years together in “time windows”. Example: presentation conditions given by 2009-2010-2011 and future conditions by 2029-2030-2031. Note that it is important to have various

[4] Top down means that a global change of emissions are applied identically over a given spatial distribution, the latter e.g. created by the distribution of known “activities” such as population density and traffic volume.

years in the window, since there may be significant year-to-year variability in meteorological conditions. Emissions normally do not fluctuate between one year and another, so it will be enough with one emission database for each time window.

4. The storage of Pan-European air quality results is highly demanding in disk space, since the 140 year simulations (of which we now have two scenarios based on different GCMs) must have all level data stored over the entire Europe and with a temporal resolution of at least 6 or better 3 hours. We found out that all this data can not be stored on the Airviro server at SMHI, instead they are stored on disc at the supercomputer centre. Only daily average data for the lowest (ground) level and for a few of all chemical species handled by the MATCH model, have been transferred to the Airviro server and are available for the PE visualisation of time series.

5. End user reactions on the results so far are promising. We can see that actions taken to reduce pollution emissions will be the most important factor for future air pollution levels in European cities. We have seen that the climate change effect on e.g. ozone levels is typically smaller than the effect of expected reductions of precursor emissions. For some pollutants like NO2, local action in each city will be decisive if compliance with EU directive will be achieved. This means that future air quality can evolve very differently from one city to another or from one country to another, therefor scenario modelling will be important for planning purposes in many cities.

   During the final project year, the CENIA partner will integrate CS air quality results into the CENIA public information system (GEOPORTAL). With this integration, there is a possibility to reach many potential users of future air quality levels. These external users will not be able to execute the CS downscaling by themselves, but they will able to download scenarios that CENIA has prepared in advance. CENIA has designed three types of scenarios to be assessed during the final project year (see D8.1.3 Czech pilot definition plan V3 revised).

   Experiences of how the CS air quality application is operated through the SMS user interface will be described in D5.3.3 Stockholm pilot report V3 and D8.3.3 Czech pilot report V3, both due M34.

3. Conclusions

The air quality downscaling in the Common Services is now (M28) fully operational, allowing both upload of gridded emissions with temporal variation and model execution for up to one year long periods at a time. Future air quality projections have been made for both Stockholm and Prague, of direct interest for those two pilots and external stakeholders linked to SULVF and CENIA.

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4. References

D4.1.2 Common Services concerted approach V2.pdf

D5.1.2 Stockholm Pilot Definition Plan V2.pdf

D8.1.2 Czech Pilot Definition Plan V2.pdf

D5.2.2 Stockholm Pilot report V2.pdf

D8.2.2 Czech Pilot report V2.pdf

D5.1.3 Stockholm Pilot Definition Plan V3.pdf

D8.1.3 Czech Pilot Definition Plan V3 revised.pdf

5. Glossary

2D	Two-dimensional, typically a field that varies in east-west and north-south direction. The field may also vary in time –this is typical for e.g. air pollution and population density. The former varies from one hour to another while the latter maybe varies from one year to another.
3D	Three-dimensional, typically a field that varies in east-west and north-south direction as well as vertically. The field may also vary in time.
4D	Four-dimensional. Most often 3D field that explicitly also varies in time. It could also be when a certain 3D parameter (e.g. a particular air pollutant) also varies according to another 3D parameter (e.g. temperature). It will then be possible to study the variation of the first 3D parameter as a function of space (x,y,z) and the second parameter.
Airviro	Air quality management system consisting of databases, dispersion models and utilities to facilitate data collection, emission inventories etc, see http://www.Airviro.smhi.se/
Climate scenario	*Climate scenarios* means the resulting climate evolution over time, as simulated by global (GCMs) and regional (RCMs) climate models. Climate scenarios are products of certain emission scenarios that reflect different economic growth and emission mitigation agreements.
Common Services	*Common Services* is the climate downscaling services for rainfall, river flooding and air quality, developed in the SUDPLAN project and accessed through the SUDPLAN platform (Scenario Management System)
Common Services server	*Common Services* models will be executed at a SMHI server, accessible through OGC communication.
Emission scenario	These are of three types, of which the first one is behind the climate scenarios used in all SUDPLAN Common Services. The two remaining emission scenario types are only relevant for air quality downscaling.

IPCC emission scenarios	*IPCC emission scenarios* are estimates of future global greenhouse gas concentrations based on assumptions about global development (economic growth, technical development, mitigation agreements, etc). During the first two years of the SUDPLAN projects, the climates scenarios based on SRES (Special Report on Emission Scenarios) A1B scenario from the 4th assessment have been used. The SRES emission scenarios do not include emissions of the pollutants of interest for air quality. If available the climate scenarios based on the 5th assessment RCP (Representative Concentration Pathways) emissions scenarios will also be used within the SUDPLAN project. They include emissions of air pollutants.
European tracer gas emissions (air pollutants)	*European tracer gas emissions (air pollutants)* thus may or may not be included in IPCC emission scenarios. For creating Pan-European air quality fields under climate scenarios driven by the SRES A1B emission scenario, SUDPLAN uses tracer gas emissions from the more recent RCP emission scenarios. This inconsistency will be solved when climate scenarios based on RCP emission scenarios are available.
Local emission scenarios	*Local emission scenarios* (to the atmosphere) are those of a particular European city. These will to a large extent influence future air quality in the city, but have little influence on global climate, nor do they influence air pollution concentrations in incoming long-range transported air. SUDPLAN will typically need gridded emissions with 1x1 km or finer spatial resolution as input to its urban air quality downscaling model.
Hind cast	A simulation of a historical period. Often done to compare model simulations with data which is available during that period.
Hot spot	Point (or small area) which is very different from its surroundings. In the present context, most often high concentrations of air pollutants, or extreme meteorological conditions.

Information product	Raw data, such as the results of mathematical modelling, and the analysis thereof, will often need to be packaged in such a way as to be accessible to the various stakeholders of an analysis. The medium can be one of a wide variety, such as print, photo, video, slides, or web pages. The term *information product* refers to such an entity.
Mockup	A model of a design used for demonstrating the functionality of a system.
Model	A *model* is a simplified representation of a system, usually intended to facilitate analysis of the system through manipulation of the model. In the SUDPLAN context the term can be used to refer to mathematical models of processes or spatial models of geographical entities.
PM_{10}	'PM10' shall mean particulate matter which passes through a size-selective inlet as defined in the reference method for the sampling and measurement of PM10, EN 12341, with a 50 % efficiency cut-off at 10 μm aerodynamic diameter;
$PM_{2.5}$	'PM2,5' shall mean particulate matter which passes through a size-selective inlet as defined in the reference method for the sampling and measurement of PM2,5, EN 14907, with a 50 % efficiency cut-off at 2,5 μm aerodynamic diameter;
Profile	Within SUDPLAN a *profile* is a set of configuration parameters which are associated with an individual or group, and which are remembered in order to facilitate repeated use of the system.
Regional downscaling	A climate scenario may be downscaled to a higher spatial resolution, typically 25-50 km, by a Regional Climate Model (RCM). The regional downscaling in SUDPLAN will be performed by SMHI's RCM (RCA, see below) and will generate climate scenarios at 44 or 22 km resolution.
Report	A *report* is a particular type of information product which is usually static and might integrate still images, static data representations, mathematical expressions, and narrative to communicate an analytical result to others.

Scenario	A *scenario* is a set of parameters, variables and other conditions which represent a hypothetical situation, and which can be analysed through the use of models in order to produce hypothetical outcomes. In SUDPLAN a scenario is an individual model simulation outcome to be used in urban planning. The model simulation may or may not include Common Services downscaling (with specific input) and may or may not include a local model simulation (with specific input and parameters).
Scenario Management System	*Scenario Management System* is synonymous with SUDPLAN platform
Scenario Management System Framework	The *Scenario Management System Framework* is the main Building Block of the Scenario Management System. It provides the Scenario Management System core functionalities and integration support for the other Building Blocks.
Scenario Management System Building Block	Scenario Management System Framework is composed of three distinct *Building Blocks*: The Scenario Management System Framework, the Model as a Service Building Block and the Advanced Visualisation Building Block.
Street canyon	Volume between high buildings in cities. Due to poor circulation (and high emissions) prone to poor air quality. Street canyons have unexpected circulation patterns, thus dedicated models are needed to study air pollution here.
SUDPLAN application	A *SUDPLAN application* is a decision support system crafted by using the SUDPLAN platform and integrating models, data, sensors, and other services to meet the requirements of the particular application.
SUDPLAN platform	The *SUDPLAN platform* is an ensemble of software components which support the development of SUDPLAN applications.
SUDPLAN system	*SUDPLAN system* is synonymous with SUDPLAN application

Urban downscaling	This refers to further downscaling of the regional climate scenarios for Europe to the urban scale within SUDPLAN. This will be possible for a) *rainfall/precipitation* where the temporal resolution will be 30 minutes or less. The spatial resolution will be that of a precipitation gauge, i.e. representative for a point rather than a certain area. b) *hydrological variables (river runoff, soil moisture etc*) where the temporal resolution is daily and the spatial resolution linked to catchment areas which presently count approximately 35000 and with average size 240 km^2. *c) air quality (PM, NO2/NOx, SO2, O3, CO).* The temporal resolution will be hourly for gridded output fields and the spatial resolution typically 1x1 kilometres.
User	The term *user* refers to people who have a more or less direct involvement with a system. Primary users are directly and frequently involved, while secondary users may interact with the system only occasionally or through an intermediary. Tertiary users may not interact with the system but have a direct interest in the performance of the system.
Web-based	Computer applications are said to be *web-based* if they rely on or take advantage of data and/or services which are accessible via the World Wide Web using the Internet.

6. Acronyms and Abbreviations

Acronym	Description
A1B	Emission scenario used for global climate modelling in IPCCs Fourth Assessment Report (AR4)
Airviro	Air quality management system to facilitate data collection, emission inventories etc, see http://www.airviro.smhi.se/
CS	Common Services
AVDB	Airviro Time Series database (used for storage in Common Services)
AR4, AR5	Fourth and Fifth Assessment Report of IPCC
AQ	Air Quality
C API	Application Programming Interface written in C
CMIP5	Coupled Model Intercomparison Project, phase 5 (coordinated model exercise in support to AR5)
CS	Common Services (SUDPLAN functionality)
CTM	Chemistry Transport Model
CTREE	FairCom CTREE database (Index database, core of AVDB)
DBS	Distribution-Based Scaling, a method to bias-correct (i.e. remove systematic errors in) the temperature and precipitation of the RCM output
DoW	SUDPLAN Description of Work
DSS	Decision Support Systems
ECHAM5	GCM developed at Max Planck Institute for Meteorology, DE
ECMWF	The European Centre for Medium-Range Weather Forecasts (also co-ordinating FP7-SPACE project MACC)
EDB	Airviro Emission database
EEA	European Economic Association
E-HYPE	HYdrological Predictions for the Environment (European set-up), hydrological rainfall-runoff model developed and used by SMHI
EM&S	Environmental Modelling and Software
ESA	European Space Agency
ESDI	European Spatial Data Infrastructure
EU	European Union
GCM	Global Climate Model or, equivalently, General Circulation Model. Physically based computer model that simulates the global climate on a 200-300 km resolution. Can be used both to reproduce historical climate and estimate future climate, e.g. in response to changes in greenhouse gas concentrations.
GHG	GreenHouse Gases
GTE	Georeferenced Time-series Editor
GIS	Geographic Information System
HadCM3	GCM developed at Met Office Hadley Centre, UK

HIRLAM	HIgh Resolution Limited Area Model, numerical weather prediction model developed and used operationally by SMHI
ICT	Information and Communication Technologies
ID	Identifier
IDF-curve	Intensity Duration Frequency-curve, a curve (or a table of values) showing the rainfall intensity associated with a certain duration (i.e. time period) and frequency (i.e. probability, generally expressed as a return period). Calculated from short-term rainfall observations and widely used in design of urban drainage systems.
iEMSs	International Environmental Modelling & Software Society
IFIP	International Federation for Information Processing
IPCC	The Intergovernmental Panel on Climate Change, the leading body for the assessment of climate change
IPR	Intellectual Property Rights
ISAM	Indexed Sequential Access Method, a method for indexing data for fast retrieval
ISO	International Standardization Organisation
ISESS	International Symposium on Environmental Software Systems
IST	Information Society Technology
MATCH	Multiple-scale Atmospheric Transport and Chemistry modelling system, a CTM developed and used by SMHI.
MODSIM	International Congress on Modelling and Simulation
OASIS	Organization for the Advancement of Structured Information Standards Open Advanced System for Disaster and Emergency Management (FP6 project)
OGC	Open Geospatial Consortium
O&M	Observation and Measurements
ORCHESTRA	Open Architecture and Spatial Data Infrastructure in Europe (FP6 IST-511678)
OSGeo	Open Source Geospatial Foundation
OSIRIS	Open architecture for Smart and Interoperable networks in Risk management based on In-situ Sensors (FP6 IST-33799)
PMC	Project Management Committee
RC	Rossby Centre, climate research unit at SMHI
RCA	Rossby Centre Atmospheric model, RCM developed by SMHI and used in SUDPLAN
RCM	Regional Climate Model, commonly used to increase the spatial resolution of climate scenarios to 25-50 km in a specific region.
RCP4.5	Radiative Concentration Pathways: A set of four emission scenarios to be used for the AR5 simulations. The scenarios are named according to their radiative forcing at 2100, e.g. 4.5 W/m^2.
RNB	Airviro Field database
SANY	Sensors Anywhere (FP6 IST-033654)
SDI	Spatial Data Infrastructure

SISE	Single Information Space in Europe for the Environment
SISE	Single Information Space in Europe for the Environment
SMHI	Swedish Meteorological and Hydrological Institute
SMS	Scenario Management System
SOA	Service Oriented Architecture
SOS	Sensor Observation Service
SPS	Sensor Planning Service
SWE	Sensor Web Enablement
SUDPLAN	Sustainable Urban Development PLANner for climate change adaptation
SWE	Sensor Web Enablement
Tbd	To be determined
UWEDAT	AIT environmental data management and monitoring system
WCC	World Computer Congress
WCS	Web Coverage Service
WFS	Web Feature Service
WP	Work Package
WPS	Web Processing Service
WMS	Web Map Service