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Deliverable: 3.1

Title: Collation of Urban Spatial Data for GIS Database

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1. Introduction

The Deliverable 3.1 “Collation of Urban Spatial Data for GIS Database” is provided by the WP GIS-City, a key integrative WP for URGENCHE. This WP was tasked with being the central database holder, and producer of geographically referenced data, focused on each of the city work packages. With the Energy Balances, Health and Well-being, Urban Traffic (TNO) and GIS-Buildings WPs, the GIS-City WP needed to identify the data that was required and available for analysis. It will also support processing the data gathered in both WP Building Stock and Urban Traffic to estimate the exposures needed for health impact and well-being assessments. This will be performed in close collaboration with the WP Health and Well-Being. This deliverable, D3.1, focuses on the collation of the Urban and Spatial data for the GIS database.

During the course of the project, the initial approach that was suggested has been modified. Both the WPs Building Stock and Urban Traffic have developed, in close collaboration with WP GIS-City and the cities involved, GIS maps with relevant data for each city. Contrary to the original plan, the maps are managed by the cities and no central database is envisaged in URGENCHE. Also, the health impact assessment and evaluation of well-being will be performed at city level with support from the WP Health and Well-Being. This approach has been initiated by the cities and will be supported by URGENCHE as it better ensures sustainability of the implemented methods.

Consequently, provision of Deliverable 3.1 has been delayed and has been modified relative to the original plan. It now contains three elements: data collection by WP Building Stock, data collection by WP Urban Traffic, and requirements for WP Health Impact and Well-Being Assessments.

2. Data collection by WP Building Stock

Progress of Urgenche work related to building stock has been reported in detail in WP4 GIS Buildings Progress Report, including the Deliverable 4.1 on IEQ (indoor environment quality) factors. However, one of the tasks of the WP Building stock was to define the data requirements for building and urban structure assessment and prepare the database templates for all buildings related data to be collected in the cities. The data that had to be collected included spatial planning and city zoning data for buildings, transportation, industry, and open/green space; indoor environmental quality (IEQ) and building occupants; and information on building characteristics and energy supply. This document focuses on the data collection templates that have been produced.

The data collection templates are based on the project Wiki pages. There are four templates in total including:

1. Building stock data in URGENCHE (http://en.opasnet.org/w/Building_stock_data_in_Urgenche)
2. Baseline building stock (http://en.opasnet.org/w/Baseline_building_stock)
3. Land use in URGENCHE (http://en.opasnet.org/w/Land_use_in_Urgenche)

4. Ambient temperature in URGENCHE cities (http://en.opasnet.org/w/Ambient_temperature_in_Urgenche_cities)

Template 1 (building stock) contains theoretical considerations as well as guidance for data collection of buildings and land use. It was identified that each city should upload their data in the original format to the Heande file management system hosted by THL. It is important that all collected data is continuously available to the project partners including data that relates to city studies that a partner is not involved in. Once uploaded, the data is managed and manipulated to allow the necessary information to be extracted.

Each city is divided into blocks and time points. Blocks are based on a hierarchical structure that is deemed useful for that particular city; where possible, a structure that is used by the city itself is used. If necessary blocks can be split into sub-blocks if needed for a particular assessment. All data is bound to a particular time point, or more specifically a period with a start and an end, during which the data is valid. The length of time periods depends on the needs of the assessment. For example, some data may be specific for a season while some apply for a range of years.

A survey has identified that the following data is required for each block: land use, building stock, possible indoor environment quality indicators and additional data such as monthly temperature, monthly rainfall, average indoor temperature and population by age. All of this data should cover the whole city and the entire time period that is being considered. Data will be corrected and updated throughout the project until the project partners believe that the city case study produces reliable results for the questions asked.

Template 2 (baseline building stock) is the principal database template for collection of city-level building stock data. Currently uses the data of Kuopio, but can easily be adjusted to other cities. Examples of the data can be found in Figures 1 to 6. The full dataset is available to project partners on the project Wiki pages.

Obs	Building	Constructed	Number	AreaBR	VolumeBR	AreaHR	VolumeHR	Population	Description
1	Detached houses	2000-2010	756	386081	1633314	101479.9	324433.4		From building registry, except "AreaHR" and "VolumeHR" from heat registry
2	Detached houses	1990-1999	291	69238	244161	39061.7	124881.1		
3	Detached houses	1980-1989	1332	436466	1578407	178797.9	571620.7		

Figure 1: A sample of city specific data for Kuopio relating to building registry

Obs	Building	Number	Area	Volume	Year	Description
1	Detached houses	244-271	35137-40041	120728-141108	2010-2012	From city supervision of buildings
2	Row houses	26-39	13120-18408	44141-62721	2010-2012	From city supervision of buildings
3	Apartment houses	21-31	34815-55460	128154-209340	2010-2012	From city supervision of buildings
4	Commercial buildings	9-14	9742-87323	49576-651239	2010-2012	From city supervision of buildings

Figure 2: A sample of city specific data for Kuopio relating to New buildings per year

Obs	Building	Year	E-value	Description
1	Detached houses	2012 forward	204	Heated net area <120 m2; Finland´s Environmental Administration
2	Row houses	2012 forward	150	Finland´s Environmental Administration
3	Apartment houses	2012 forward	130	Finland´s Environmental Administration
4	Shops and other commercial buildings	2012 forward	240	Finland´s Environmental Administration
5	Offices	2012 forward	170	Finland´s Environmental Administration

Figure 3: A sample of city specific data for Kuopio relating to regulations regarding energy consumption of buildings

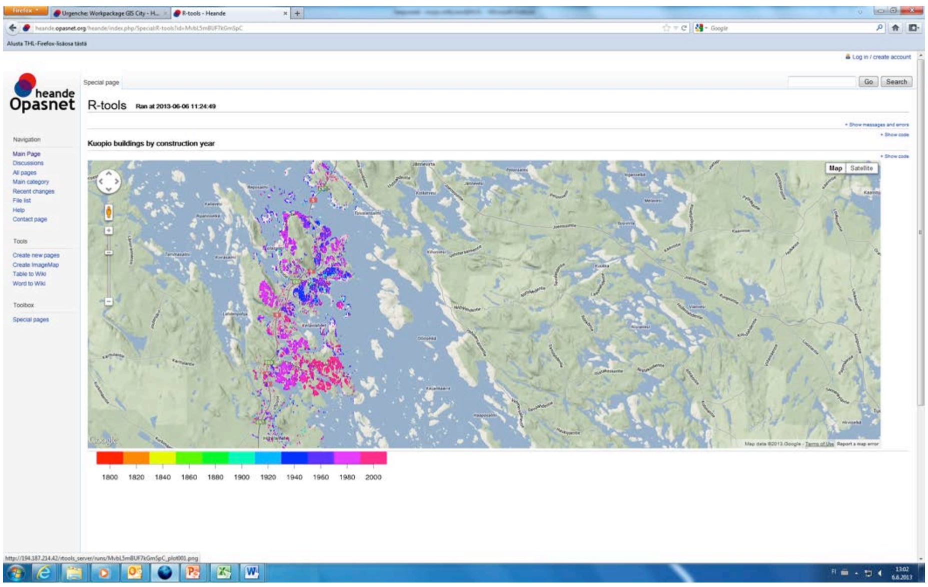

Figure 4: Kuopio buildings by construction year

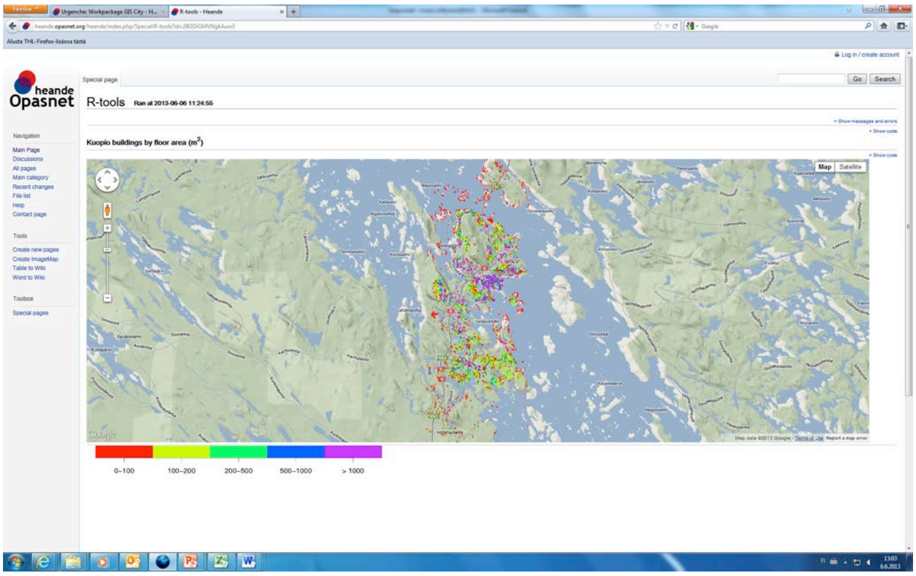

Figure 5: Kuopio buildings by floor area (m2)

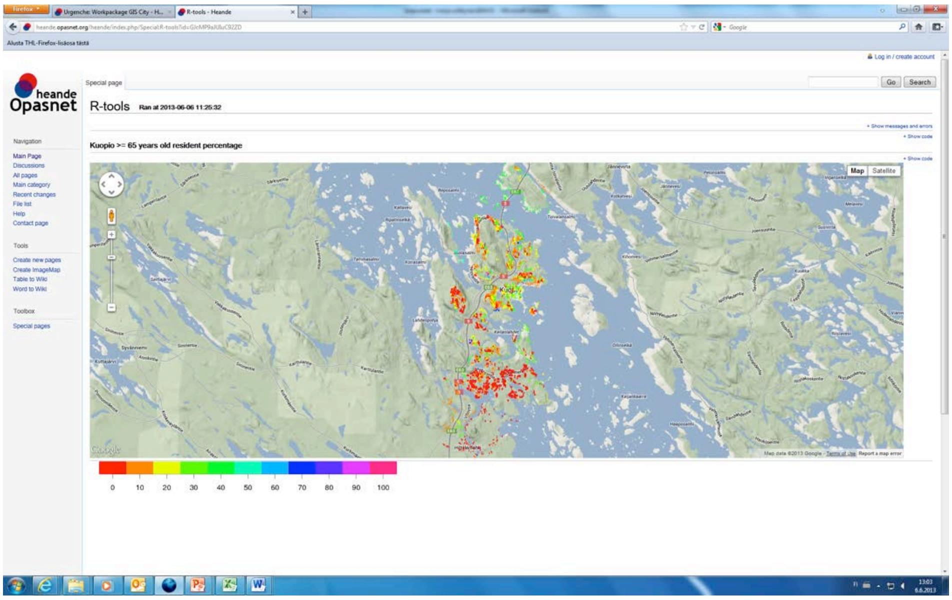

Figure 6: Percentage of residents over 65 years in Kuopio

Template 3 (land use) is a potential template for collection of data on land use in cities. An example of a subset of collected data using this template can be found in Figure 7. For developing the criteria for the land use, we decided to pick up 100 points as a random sampling from different cities in the URGENCHE project. As we have seven cities in this project, we agreed to evaluate 14 check points from each city. One of the challenges was to find a high resolution map. Google map is providing very valuable information but in some cases it is not enough. Another challenge was where to find out the actual boundary of each city. In the Google map there is slight differentiation between each city with pink boundary. However in one city (Kuopio) it is not visible. For Kuopio, we had some difficulties such as the Google map was not precise enough. So we used other database systems such as Karttapaikka website. Also we do not have the actual boundary of Kuopio. To overcome the city boundary of Kuopio we agreed to define some points as far as we got the actual boundary of Kuopio.

Furthermore using Google map and checking each city without any particular software may not be so precise. At the moment looking for kind of software to detect the green area, building and water will be helpful. Checking map information from different websites like infokartta might be useful as well.

Obs	City	Green area	Building area	Block of flats	Row house	Office	Industry	Detached house	Asphalt/paved area	Water area	Public, shops	Other land area
1	Kuopio	10%	50%	10%	5%				20%	5%		
2	Kuopio	50%	20%	2%					20%		8%	
3	Kuopio	25%	5%	40%					10%	15%		5%
4	Kuopio	30%	30%		19%				20%	1%		

Figure 7: A sample of city specific data for Kuopio for template 3 (land use)

Template 4 (ambient temperature) contains detailed data on ambient temperatures in URGENCHE cities. The ambient temperature and climate in Kuopio, Stuttgart, Thessaloniki, Basel, Rotterdam, Xi'an and Suzhou have been recorded. An example of a portion of the collected data can be found in Figure 8.

Obs	City	Month	Average Temperature	Average high temperature	Average low temperature	Dew point	Relative humidity
14	Stuttgart	FEB	1	4	-2	-2	80
15	Stuttgart	MAR	5	9	0	0	73
16	Stuttgart	APR	7	12	2	1	70

Figure 8: A sample of data collected on ambient temperature

3. *Data collection By WP Urban Traffic*

The task of WP Urban Traffic (“Traffic”) is to provide air quality and noise data for each URGENCHE city. This refers to a recent (“reference”) year and a future year (2020/2025) for a business-as-usual (BAU) with and without traffic measures to reduce CO_2 emissions within a city. The air quality and noise data are used as input for Health and Well-Being Impact Assessments, respectively. These assessments are guided by the WP Health Impact and Well-Being. In order to model the spatial distribution of air quality and noise, input data are required on the road and motorway network in a city, the traffic on this network (i.e. volume, fleet composition and speed) and buildings near these roads and motorways. With these input data the contribution of emissions from road traffic to air quality and noise may be modelled.

A questionnaire was used to review existing GIS data on the road network, traffic and buildings in each city. In addition, available data on air quality and noise levels in each city was investigated. From the questionnaire it was concluded that in the Chinese cities Suzhou and Xian, the URGENCHE partners have limited access to GIS, air quality and noise data. In the Annual meeting in China in October 2012, it was decided to follow two different approaches in WP Traffic to collect data in European and Chinese cities:

- *European cities*; for the reference year in the European cities: Rotterdam, Stuttgart, Basel and Kuopio traffic and road data have been collected and stored by the WP Traffic lead partner TNO, while for Thessaloniki all related data have been collected and stored by the Greek city partner CERTH. The air quality for the regulatory pollutants and noise levels have been modelled by the cities and/or the city partner. For the year 2020 and the business-as-usual scenario, all cities have modelled air quality and noise with the following input data: similar road network and buildings as in the reference year, a 10-year average meteorology and city-specific traffic projections. The regional background of air quality in 2020 was provided by TNO from their regional model “LOTOS-EUROS”. TNO also performed for all cities the model calculations for elemental carbon (EC). The air quality was computed for each city as a population weighted average for each pollutant and each city, and spatially differentiated for people living along busy street canyons, near motorways and the rest of the population. An example of the air quality of EC in 2010 (reference year) in Stuttgart is presented in Figure 9, which illustrates the elevated EC concentrations along inner-urban roads and near motorways

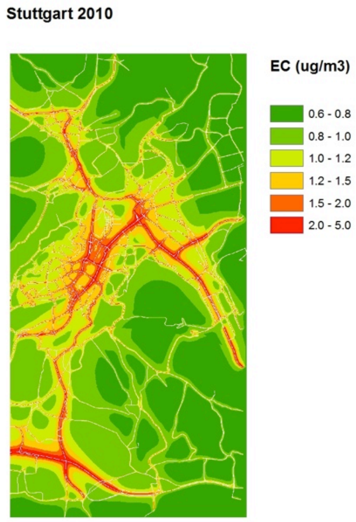

Figure 9: Annual average EC (µg.m^{-3}) in Stuttgart in 2010.

Analogous to the EC concentrations in Stuttgart, the air quality has been modelled in other cities for the reference and future years. The measures to reduce traffic-related CO_2 emissions in 2020 are related to more electric private vehicles (Rotterdam, Stuttgart and Basel), more biofuels (Kuopio and Rotterdam), more public transport (Thessaloniki), more cycling (Stuttgart) and a combination of these measures. An example of the noise levels in 2020 for a scenario with 50% electric private cars in the centre of Rotterdam is presented in Figure 10.

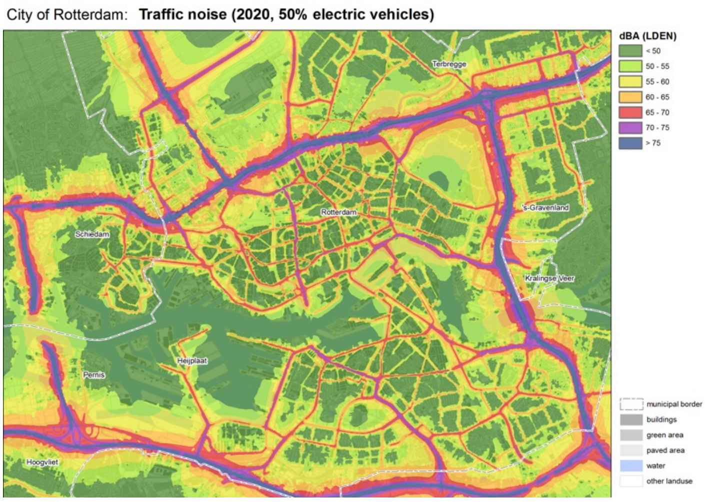

Figure 10: Annual average noise levels (dBA) during day and night ("LDEN") in Rotterdam in 2020 with 50% electric private cars.

In all cities, traffic-related CO_2 measures will be quantified the coming period in order to assess the impact on air quality and noise;

- *Chinese cities;* due to the lack of access to data in Chinese cities , it was decided *not* to perform noise calculations in Suzhou and Xi'an. Also, no traffic-related CO_2 reduction measures are envisaged in the Chines cities. Hence, the WP Traffic calculations for the Chinese cities are limited to regulatory pollutants (i.e. NO_2, $PM_{2.5}$ and PM_{10}) and EC for a reference year (2010) and a future year (2020). The required input data such as GIS data for the road network was collected via "open street map" and meteorological data via "open source airport data". Subsequently, the required traffic data was collected from the literature and from the Chinese city partners the University of Nanjing (Suzhou) and the University of Peking (Xi'an). The road network in Xi'an is presented in Figure 11.

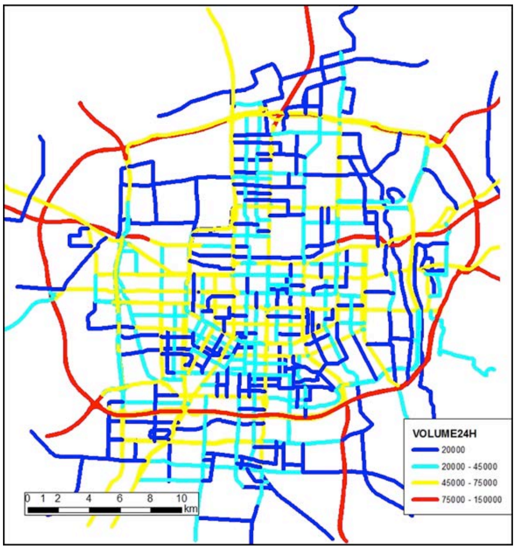

Figure 11: Road network and traffic volume (#/24-h) in Xi'an in 2010 based on "open street map".

The road network is distinguished in tertiary, secondary, primary roads, and motorways with a range of the traffic volume per 24 hours. Based on literature data, it was assumed that emission factors for road traffic in China are comparable with EURO-3 emissions in Europe. The main difference is that private cars in China are fuelled for more than 95% by petrol while in Europe the contribution of diesel fuel is in general considerable higher. The regional background concentrations have been collected for Xi'an from the literature. Based on these inputs, the air quality in Xi'an was modelled. The results for EC in Xi'an in 2010 are presented in Figure 12.

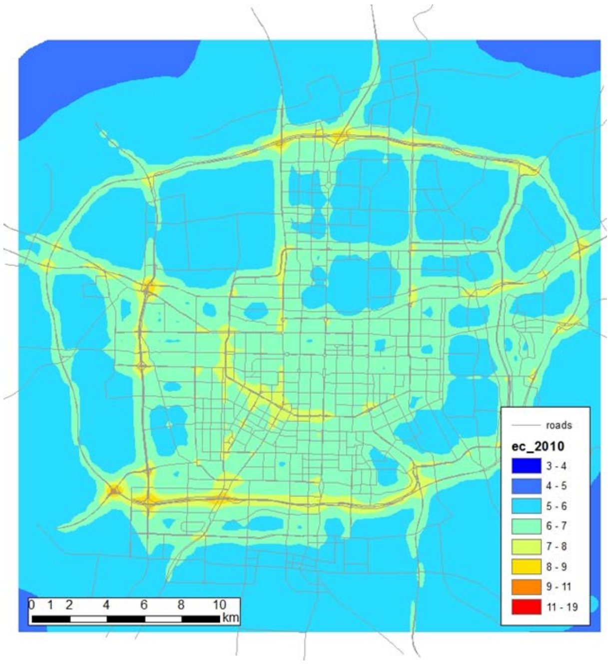

Figure 12: Annual average EC (µg.m^{-3}) in Xi'an in 2010.

The figure shows (probable) the first map with the spatial distribution of elemental carbon in a Chinese city. The results will be validated with monitoring data in Xi'an collaboration with the University of Peking. The traffic volume increased with more than 25% per year the last decade in Xi'an. Extrapolation of this trend to 2020 would result in more than four times more vehicles as compared to 2010. This amount of traffic does not comply with current road capacity. Therefore, the traffic volume in 2020 is maximised to the current road network, which results in doubling the traffic volume as compared to 2010. Emission factors are projected to be similar for the Chinese car fleet as for the European car fleet in 2020. This method has been developed in Xi'an will also be applied in the city of Suzhou in collaboration with the University of Nanjing.