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Title:
D4.2: Model Adaption and Parameterization for Applications 1-3

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Description of Work, D2.1, D3.2, D3.3, D4.1

Short Description:

The deliverable will give a summary of the efforts for application tool development for the different use cases. The parts of the deliverable describe the adaptation and parameterization explaining the activities to adapt the data sets, the functionality of the user interface and the related parameters as far as necessary.

Keywords:

Models, Applications., Adaptation, Parameterization

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About this Document

The document deals with Adaptation and Parameterization of the models and tools developed within urbanAPI to match the data structures and the characteristics of the cities with its use cases. It explains the activities to adapt data structure and to modify the parameters for each application in the four different cities.

1 Introduction

The project urbanAPI is summarised in Rix et al., 2010, Part A, pp. 3 as follows:

> *…… the urbanAPI approach will transpose elements of agile ICT development to the urban policy making process: Multiple activities can run in parallel, and all activities are kept synchronised. In such a process, risks are identified earlier, conflicts are understood better, and that knowledge gained in one activity can directly be used in all other activities.*

The urbanAPI tools will provide advanced ICT-based intelligence in three urban planning contexts.

- First, directly addressing the issue of stakeholder engagement in the planning process by the development of enhanced virtual reality visualization of neighbourhood development proposals.
- Second, at the city-wide scale, developing mobile (GSM) based applications that permit the analysis and visual representation of socio-economic activity across the territory of the city, and in relation to the various land-use elements of the city.
- Finally, developing simulation tool applications in the urban development context addressing multiple challenges in responding to the simultaneous demands of either expanding or declining city population.

The overall objective for work package 4 is to conduct city specific adaptations of the three applications developed in WP3 to enable these applications to be used in the case study cities.

The table below gives the overview of the applications to be carried out in the 4 cities.

The work package is divided into a task for each application describing them with their adaptation and parameterization needs to fulfill the user requirements as sub-tasks..

Finally the deliverable provides a summary of the results regarding application parameterization .

Table 1: City wise urbanAPI applications

	3D VR	Public Motion Explorer	Urban Growth Simulation
Vienna	√	√	
Bologna	√	√	
Vitoria-Gasteiz	√	√	
Ruse			√

2 Model adoption and parameterization for the 3D-VR application (IDG)

The first of urbanAPI applications is the 3DVR application. The description of work for the urbanAPI project outlines the application as follows:

> *Describing the general effects and the depicting the visual impact of urban development plans as realistically as possible with the help of 3D scenarios will support the negotiation process for urban development projects. Virtual reality visualizations depict the consequences of spatial planning processes in a virtual or real world environment. Interactive control of planning interventions and – on the fly – presentation of the new visual effects released through changes in zoning and finally building help the citizens to experience these impressions […]. Virtual representations of planning decisions seem to be the most convenient and understandable solution for presenting spatial planning alternatives to the public. Allowing interactive modifications of alternatives helps stakeholders to understand the proposed actions and to endorse the anticipated impacts. This deployment of the urbanAPI system will employ a relatively coarse client-side simulation model, but requires high-quality 3D geodata and rich interaction elements, especially to provide feedback on planning in various forms.*

The application is based on CityServer3D carried out by Fraunhofer IGD. In the urbanAPI project it is especially suited for the processing and maintenance of 3D City-Data and thus is used as a platform for data management in the 3DVR application.

2.1 Adapting input data for the 3D-VR for the 3 case study cities

3DVR application visualises 3D modelling of urban landscapes and enables users to perform constructive (i.e. inserting/adding some object in visual landscape) or destructive (i.e. removing some object from the visual landscape) operations e.g. building infrastructure, street furniture, green spaces, cycle routes, etc. for impact assessment for planning interventions.

Three cities (Vienna, Bologna and Vitoria-Gasteiz) are actively participating in this application.
The specific data requirements for the 3D-VR application were defined in a “hybrid” approach. This means that they were neither defined “bottom-up”, i.e. based solely on user needs, nor “top-down” based on application developer needs. Instead a mixture of both was chosen (“hybrid”).

This approach was selected because prototypes of the 3D-VR application had already been implemented by Fraunhofer IGD previous projects and therefore the developers of this application were well aware of basic data requirements. However, one has also to consider the system requirements specifications (Deliverable D2.1 – Requirements Definition) since the urbanAPI city partners and their cities have needs that are special for each city. For a more detailed description of the data requirements definition process the reader is referred to Deliverable D2.2 – Data Collection.

The sections below describe the adaptation needs for these data sets to integrate them into the 3DVR application.

2.1.1 Data adaptation – Bologna

For Bologna various data set have been provided for the entire city (See Deliverable D4.1). The data provision requires only little adaptation: most data sets have been delivered in formats where format conversion procedures have been already developed. Bologna had no 3D-Model to be converted or applied directly. As 3D information for terrain LiDAR data have been provided and shape files of footprint data along with the height of the building. Based on this information a basic 3D model was generated with CityServer3D and converted to X3D format which is directly usable in X3DOM.

Table2 data obtained and file formats

Dataset	Data / Format requested		Data / Format obtained – content	
Building Footprints	CityGML	Shapefile, GML2/GML3	Shapefile	--
3D Building Model	CityGML	VRML, X3D, 3ds, MAX	IMG	Digital Surface Model (LIDAR)
Transport Network	Shapefile	DXF/DWG	Shapefile	Streets Paths Railways Sidewalks Cycle Tracks
Orthophoto	GeoTIFF	JPG	GeoTIFF	--
Digital Terrain Model	GeoTIFF	DEM, XYZ/ASCII, ESRI TIN/Grid	GeoTIFF	LIDAR
Tree positions	Shapefile	DXF/DWG, GML2/GML3	Shapefile	
Zoning information	Shapefile	DXF/DWG, GML2/GML3	--	Not necessary (historic district)
Pollution	Shapefile	GeoTIFF	Shapefile	Noise pollution
Urban Lighting	Shapefile	GML2/GML3	Shapefile	--
Planning and Variants	Shapefile	GML2/GML3	--	Not necessary (historic district)
Biodiversity/ Biocapacity	Shapefile	GML2/GML3	--	Not necessary (historic district)
Colour Code:	**Identical format**		**Different format**	

2.1.2 Data adaptation – Vienna

The most geospatial datasets from Vienna are provided in standard GIS formats like shape files. Image data are provided as Geotiffs. Only for the 3D-information for buildings CityGrid solutions format from of UVM-Systems [5] is used. This commercial software is a closed solution as it only offers to export the data contained in the system into a proprietary XML-format that cannot be converted to a generic standard format with standard tools. As the dataset is XML-based it is possible to analyse the proprietary format and map it to the Metamodel. Based on this it is possible to create some component in the data access layer of CityServer3D, which seamlessly integrates the Vienna data into the CityServer3D software platform.

CityServer3D is already able to parse file formats from the computer graphics domain (VRML, X3D, etc.). Parsing CityGrid files have therefore been implemented by reusing existing components. CityServer3D has a modular architecture which allows for plugging in new data importers (described in detail in deliverable. The component is only used to import the Vienna data as the other city-partners in the project use standardised formats.

From the Vienna planning authorities only a small part of the city's 3D-data sets have been provided for the application development and adaptation as listed in the table below:

Table 3 Vienna Data for the 3DVR application

Dataset	Data / Format requested		Data / Format obtained - content	
Building Footprints	CityGML	Shapefile, GML2/GML3		Included in the 3D Building Model
3D Building Model	CityGML	VRML, X3D, 3ds, MAX	XML/DTD XML/DTD XML/DTD GeoTIFF	Buildings Bridges Building block with and without texture FMZK (texture information)
Transport Network	Shapefile	DXF/DWG	Shapefile	Pedestrian Motorised private transport Cycle tracks
Orthophoto	GeoTIFF	JPG	GeoTIFF	--
Digital Terrain Model	GeoTIFF	DEM, XYZ/ASCII, ESRI TIN/Grid	XML/DTD	--
Land cover	Shapefile	DXF/DWG, GML2/GML3	Shapefile	Land cover/use
Tree positions	Shapefile	DXF/DWG, GML2/GML3	Shapefile	--
Zoning information	Shapefile	DXF/DWG, GML2/GML3	Shapefile	--
Water Permeability	GeoTIFF	Shapefile, GML2/GML3	Shapefile	--
Planning and Variants	Shapefile	GML2/GML3	Shapefile	Planned metro Planned tram
Colour Code:	**Identical format**		**Different format**	

The datasets have been converted from their original formats into CityCerver 3D format as mentioned above.

2.1.3 Data adaptation – Vitoria-Gasteiz

The city of Vitoria-Gasteiz supplied 2D footprints of the buildings in the city. Also laser-scan data of the area was supplied, which has been used to determine the height of an object on the ground. For every footprint a shape with the coordinates can be extracted and for each of the coordinates the height above ground could be found by a query on the laser-scan data. All these operations are directly supported by the CityServer3D.

Table 4 Vitoria-Gasteiz Data obtained and formats provided

Dataset	Data /Format requested		Data /Format obtained	
3D Building Model	CityGML	VRML, X3D, 3ds, MAX	GeoTIFF	Digital Elevation Model for Hydrography (LIDAR)
Transport Network	Shapefile	DXF/DWG	Shapefile	Municipality path/road/street network
Orthophoto	GeoTIFF	JPG	JPG	--
Digital Terrain Model	GeoTIFF	DEM, XYZ/ASCII, ESRI TIN/Grid	GeoTIFF	LIDAR
Land cover	Shapefile	DXF/DWG, GML2/GML3	Shapefile	Land cover/use
Tree positions	Shapefile	DXF/DWG, GML2/GML3	Shapefile	--
Zoning information	Shapefile	DXF/DWG, GML2/GML3	Shapefile	Superblocks Districts City Master Plan
Urban Lighting	Shapefile	GML2/GML3	DWG	--
Planning and Variants	Shapefile	GML2/GML3	DWG DWG	Cartography of the streets where the refurbishment will be done, at the present time. Cartography of the future situation
Colour Code:	**Identical format**		**Different format**	

2.2 Further model parameterization for the 3D-VR application

The model developed and applied here provides functionality for the visualization of different thematic contents for the 3 cities.

The application allows control and navigation for the presentation of a virtual reality. This has been carried out through menus, popups, toolbars and visual display in a web interface. The use cases of the 3 cities follow a common goal making use of a common set of visual elements. Therefore a common scheme for the layout of visual elements and features providing functionality have been defined.

The starting point of the application from an end-user perspective is the selection of a scenario. After the user selected a scenario he gets to the main page, where the scenario can be viewed or edited. Then control elements lead to the more specific functionalities, which lead to separate pages or popups.

The core of the application is the 3D display which is basically implemented through the X3DOM framework. Movement and interaction within the 3D scene is carried out via mouse of fingertips depending on the viewing device (laptop, pad). X3DOM has several movement modes, which are described in detail in the user interface documentation.

Between the different applications for the cities there is no difference in the viewing functions neither in the context to be views. For most scenarios the “Helicopter-mode”, is used by default allowing flying over the scenes experiencing a dynamic birds-eye view.. A further frequently used view mode is the pedestrian mode, where the perspective of a person walking through the scene is taken. One can switch between the modes with identical shortcuts for all use cases. The navigation mode is defined in the scenario.

The explorer view shows all objects in a scenario where an interaction is possible. The applied display stereotype is a list or tree (if a hierarchy is required) of objects for all cities. As city models tend to be very large and have a huge number of objects the objects to be displayed can be hidden.

2.2.1 Scenario definition, selection sharing

All scenarios available as tabs listed on top of the screen. The list is filtered according to the user's rights, e.g. a user can only see scenarios which have a group assigned he/she is belonging to.

Depending on the users’ rights, a user can view, annotate or create his own scenario based on the ones provided by cities and make his own change. Only owners are allowed to edit their own scenarios. To be able to track back, the origin of the scenario is displayed in the table. An alternative would be to filter for version of scenarios.

To share a scenario a dialog window pops up to assign groups that are allowed to view, change or comment on the scenario.

Object manipulation can be carried out for all use cases if this is allowed in the scenario, If yes corresponding buttons are visible on a button bar. To manipulate a (selected) object a set of buttons is provided: to move/ replace, to rotate, to re-size, to re-colour. All cities are “treated” with the same user interface providing the same functionality.

This means the parameterization is open to each city and to each scenario to be carried out for the city and can be set individually according to the preferences of the users.

The following table gives an overview regarding the important parameters to be set in the 3DVR application.

Table 5 Default parameter setting (graphic functionality) defined in the 3DVR applications

		Adapted parameter values		
Component	Parameter	Vienna	Vitoria-Gasteiz	Bologna
3D	URL of scene	/urbanapi.X3Drepository-portlet/fs/vienna3/scene.x3d	/urbanapi.X3Drepository-portlet/fs/VitoriaDemoX3D/ScenarioA.x3d	/urbanapi.X3Drepository-portlet/fs/bol2/scene.x3d
	Optional scenario qualifier			
	Canvas height	600px	400px	600px
	Viewport position	1320.49283 146.04051 1015.55545	0 0 0	1406.87368 161.25005 -738.97236
	Viewport orientation	-0.31467 0.88280 0.18662 1.15681	0 0 0 0	-0.02577 0.96933 0.20054 2.89901
	Scene height offset	0	0	-100
	Spatial reference system	EPSG:31256	EPSG:25830	EPSG:23032
	Northing	342500	4744110	
	Easting	2500	526025	
	Notification-email			
2D Map	Starting position: epsg3857north, epsg3857east	6143680.77, 1821828.78	5289141, 298486	5541970, 1263887
	Zoom level	14	14	15
3D Control	Reset-position	0 0 0	0 0 0	0 0 0
	Reset-orientation	0 0 0 0	0 0 0 0	0 0 0 0
XML Download	URL of scene	n/a	n/a	/urbanapi.X3Drepository-portlet/fs/bol2/scene.x3d
	Optional scenario qualifier	n/a	n/a	

The following figures 1 to 3 allow a comparison of the applications for Bologna, Vienna and Vitoria Gasteiz.

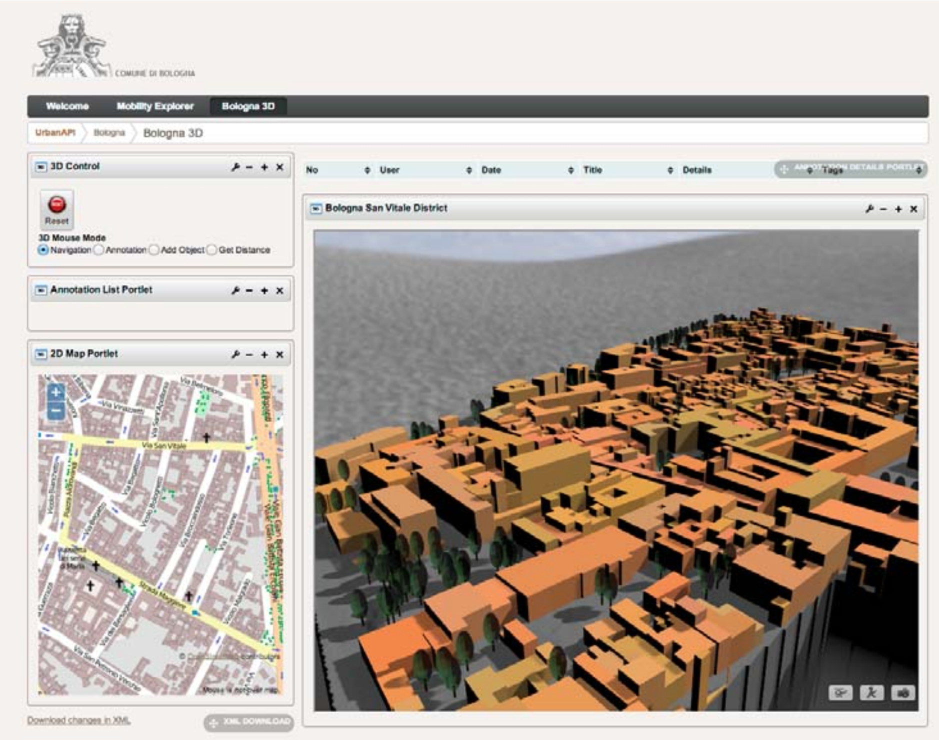

Figure 1: 3D-VR application layout for Bologna

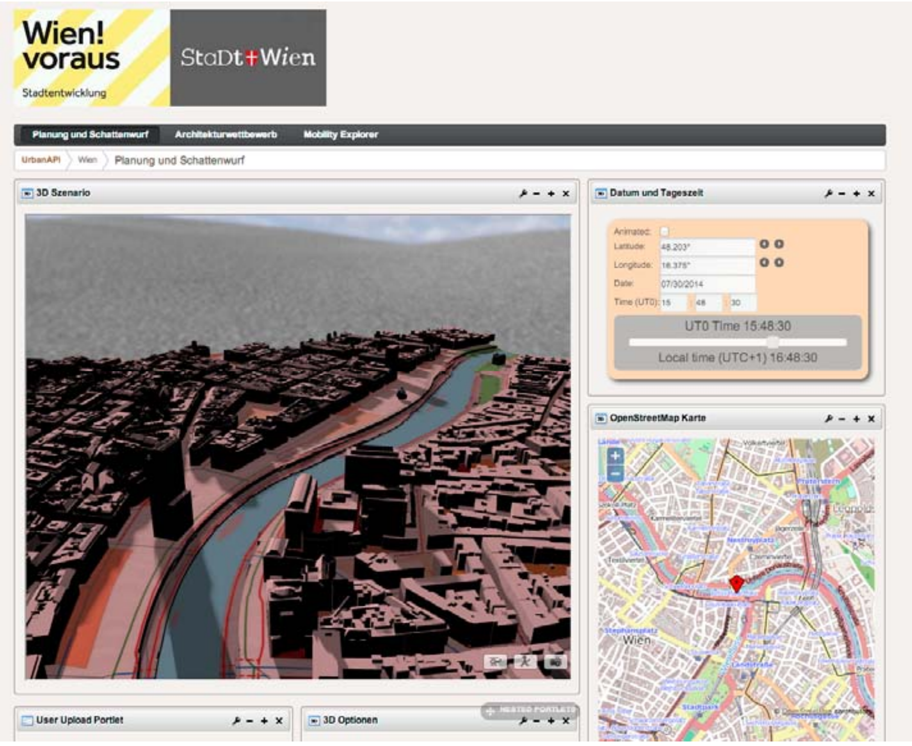

Figure 2: 3D-VR application layout for Vienna

Figure 3: 3D-VR application layout for Vitoria-Gasteiz

3 Model adoption and parameterization for the Mobility Explorer (AIT)

The objective of the Mobility Explorer (ME, originally named Public Motion Explorer, now renamed) is, to develop an interactively controllable application to make use of mobile device traffic data to explore diurnal movement patters as well as temporal population distribution pattern in the urban built environment and – to some extent- in open spaces. Mobile phone connection data will be explored regarding spatio-temporal distribution per GSM cell within the cities. The device volume geo-coded to the mobile phone cells is taken to generate maps and density surfaces to illustrate population and motion distribution.

> *The goal will be fulfilled by developing an easy to use tool which transforms the data delivered by mobile phone service providers into spatio-temporal representations by means of web-based dynamic maps linked with topographic and planning related information. Spatial joining of the mobile device distribution peaks and sinks with various urban characteristics allow planners as well as the public to explore the relationships between adoption of urban infrastructure and urban design or public space quality. Detecting correlations will help to improve the urban space, making it more attractive places for the population and allow more efficient usage of infrastructure. This will help stakeholders to explain their interests through action without verbal communication.*

The user interface cannot cope with "original – individual mobile phone user data but requires pre-processed mobile phone location data to take into account privacy concerns and error correction of input data.

The adaptation of the applications requires not only application of parameters and GUI but intensive pre-processing work with respect to data extraction, error exploration, data aggregation and reformatting, For Vienna also the identification of the users' "home raster cells" by exploring night and early morning cell occupation to be related to population numbers for extrapolation.

3.1 Adapting input data for the PME for the 3 case study cities

The Mobility Explorer application makes use of mobile device location data and to some extent to demographic data as well as background map data imported from proprietary file formats (e.g. ESRI shape files, mobile phone company files with individual file formats, tabular data (Excel files), image formats etc.). Mobile phone data requires to be heavily pre-processed and reformatted in order to be applied in the Mobility Explorer database.

From three telecommunication service providers data have been obtained:

Telecom provider A1 delivered for Austria where the data have been applied for Vienna and the Vienna Region A1.

Telecom provider Movistar Telefonica from Spain delivered data applied for Vitoria-Gasteiz.

Telecom provider TIM from Italy delivered data applied for Bologna.

3.1.1 Data adaptation for Vienna

The Vienna A1 data set was the first one used to develop the application. The data set contains all information which allows further explorations behind the objective for visualising the population

While the other telecom service companies provide preprocessed or even aggregated data, the A1 data sets have been provided a raw data in a compressed binary data format, requiring heavy data exploration, extraction and reformatting. The final data used are the location coordinates provided as geographic coordinates and the time stamps of these coordinates.

Various maps have been used during the development phase regarding data exploration, error check, data extrapolation. For the PME application as exploration and visualisation tool finally only a subset of data addressed in the beginning was required: besides the mobile phone data, background maps for orientation and demographic data for mobile phone user extrapolation for estimating the total population have been used. Only the image data could be used as they are for all other datasets a pre-processig and data reformatting step was necessary. The following table gives the summary regarding formats and size of the data volume.

Table 6 Vienna Data for the ME application

Content	Format	Scope (size, (n of entities)
Open street map	GEOTIFF	-
Wien –MZK (Mehrzweckkarte – multipurpose map)	GEOTIFF	-
Wien Flächenwidmung (zoning)	GEOTIFF	-
Mehrzweckkarte	Image	-
A1 mobile device log data for Austria, 2 Weeks	Binary sequential	(5 GB)
Statistik Austria Vector-Raster (1x1km), extent 100x 150 km	Esri Shape	15.000
Population Data Statistik Austria	Csv table	15.000
Colour Code:	Identical format	Different format

The details on data preparation work are described in D 4.1. – Data harmonization.

3.1.2 Data adaptation for Vitoria-Gasteiz

The exploration of the data sets from Bologna and Vitoria-Gasteiz provided by different mobile communicate providers give insights of the heterogeneous data structure and data provision restrictions for the different cities, which require individual data preparation steps. The Spanish

Telecom provider Movistar Telefonica provided data only for telephone call start and call end and for text messages within the city of Vitoria-Gasteiz. As only few data of the location for starting and stopping a call or sending a text message have been provided. The location coordinates have been provided as geographic coordinates with related time stamps. As the data provide somehow static information movement of the telephone users during the whole day could be extracted. So only the distribution of the active users but no motion patterns could be extracted from those data. To avoid double counting during data aggregation to grid cells only the positions of the telephone call starts have been used but not those of the telephone call ends.

To prepare the data for the visualization application only the image data could be used as they are. For the mobile phone location datasets a pre-processing and data reformatting step was necessary. The following table gives the summary regarding formats and size of the data volume.

Table 7 Vitoria-Gasteiz Data for the ME application

Content	Format	Scope (size, (n of entities)
Open street map	GEOTIFF	-
Mobitel telephone call starts & ends location data for the city for days of one week	CSV	few 100kb
Mobitel telephone text messaging event data for the city for days of one week	CSV	few 100kb
Mobitel mobile antenna location data for the city	CSV	few 100kb
Colour Code:	Identical format	Different format

The details on data preparation work are described in D 4.1. Data harmonization.

3.1.3 Data adaptation for Bologna

The datasets delivered by the Italian telecom provider TIM for Bologna Region have been provided only as aggregated data for defined time slices. The files per time slice contain the number of active users in each TIM network cell pre-aggregated to regular raster cells. So no aggregation was necessary and no further motion analysis was possible. The data have been provided as text files in a national coordinate system which requires re-projection as well as reformatting. The time stamp has been delivered too, which allows mapping of mobile device user densities for time slices after some spatio-temporal interpolation, which allows to shift locations according to pre-defined time steps.

Table 8 Bologna Data for the ME application

Content	Format	Scope (size, (n of entities)
Open street map	GEOTIFF	-
Aggregated mobile phone user for time slices	Gridded data for time steps	few 100kb
Colour Code:	Identical format	Different format

3.2 Further model parameterization for the ME application

3.2.1 Common framework conditions of the ME for output visualisation and the differences between the cities

The Mobility Explorer application uses PostgreSQL to integrate the spatial information on mobile phone location and movement. To load the datasets as tables into the Mobility Explorer database a command line tool like PostgreSQL's psql terminal or graphical tools like pgAdmin III has been used. To ensure good performance during application requests to the database PostgreSQL functions have been implemented to make use of the built-in Query Optimiser.

In order to have a best practice for future users of the urbanAPI Mobility Explorer application it is necessary to have a well-defined final data structure for the pre-processed and imported data.

Data sets depicting static user density for certain time slices consist of three attribute columns, where the time-stamp is divided into 15 minute slices for temporal data base queries and their visualization.

Time slice	Raster ID	User count (as anonymised identity)

Data sets on interaction (motion pattern of users between origin and destination raster) have been extended to 4 columns (available for Vienna):

Time slice	Origin- Raster ID	Destination Raster ID	User count of users from origin raster entering the destination raster within time slice

This simple sequential data structure allows a fast retrieval of the user totals per time slice and raster cell visualization of the data. The transfer of the content provided through the first data structure into a 3D-environment can be carried out which allows to integrate the mobile device density layer into

CityServer3D for 3D-visualisation within the urban layout. The transfer of interaction content provided through the second data structure needs an additional translation feature.

While the data structure, as stored in a PostGreSQL data base, is the same for every city, the temporal and the spatial aggregation is partly different for each city as shown in the next table. Here the data aggregated to grid cells and time slices (c.f. table 9) is linked via the Raster ID with the particular grid cells.

Table 9 Data spatially and temporally aggregated to city-specific grid cells for the ME application as customised for the 3 cities.

City	Spatial aggregation extent	Additional spatial aggregation extent for selected areas	Temporal aggregation
Vienna	1x1km	10 x10km for areas outside Vienna with low density of users and antennas aiming in large telecom cells	15min
Vitoria-Gasteiz	1x1km	500x500m for centre areas with high density of users and antennas aiming in small telecom cells.	15min
Bologna	No aggregation	Proprietary cell size provided by the telecom company See table 10	No aggregation – applying predefined time slices

3.2.2 ME User interface customization for the three cities

The database will be queried by the Mobility Explorer web-application and will view data exploration results according to the users' requests The following figures 4 to 6 show the graphical user interface of the ME for each of the 3 cities.

In general there is little difference regarding pre-definition of parameters. Just the spatial extent of the 3 applications has to be adjusted based on the coordinate lower left and upper right values. The Raster cell sizes for the 3 application are predefined and selected automatically, but are different for all the cities.

Figure 4 shows the large 10x10km target cell south of Vienna and the 1x1km destination cells inside Vienna. Figure 5 shows the smaller cells within the city centre of Vitoria-Gasteiz.

The presentation of the diurnal population density variation over a day shown as line chart of a cell to be selected shows a variable scale – the y-axis is adapted to the maximum of the population or user distribution automatically. The following screenshots give an impression of the look and feel of the applications.

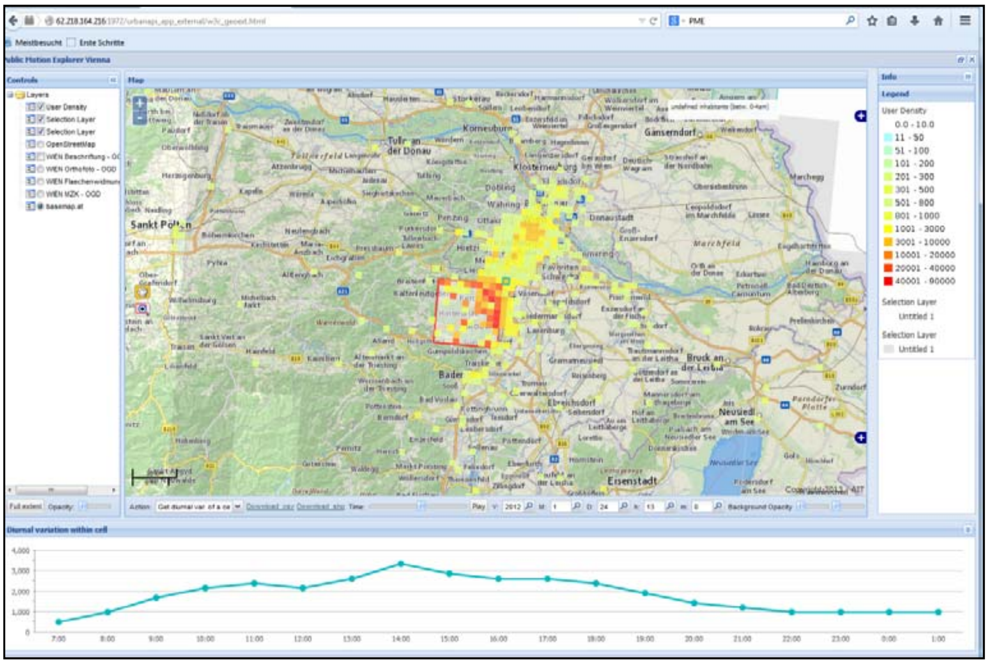

Figure 4: ME application layout for Vienna

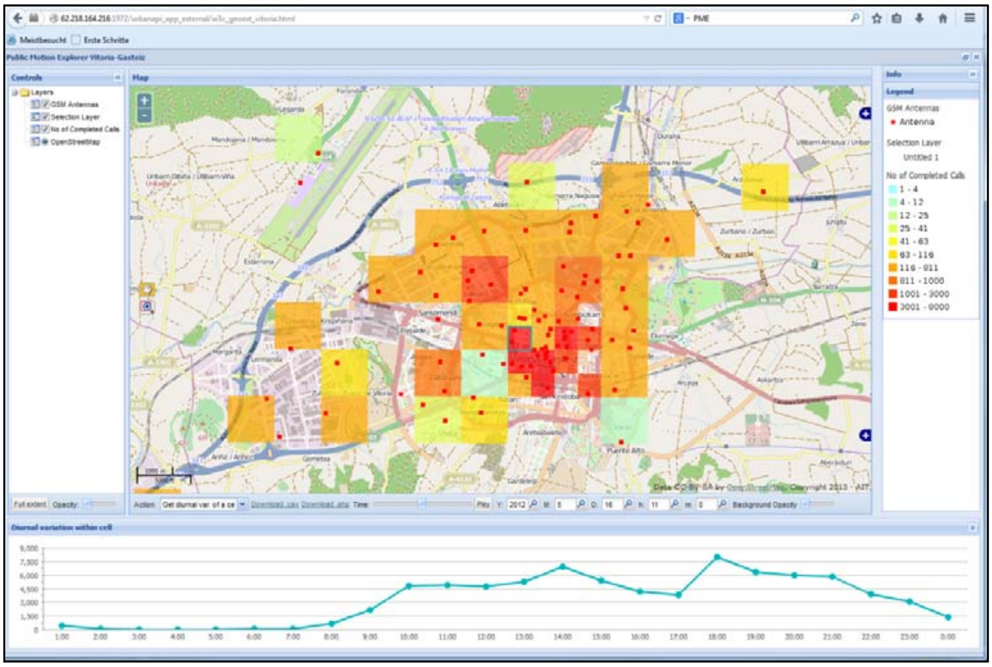

Figure 5: ME application layout for Vitoria-Gasteiz

Figure 6: ME application layout for Bologna

So, some parameters have to be pre-defined with default values for the application in the 3 cities:

- the grid cell resolution to show aggregated population or user distribution over time or motion patterns,
- the spatial extent for the 3 different cities.

Further map properties are defined on the fly:

- range of legend values,
- legend intervals based on the predefined class numbers and
- individual range of classes. related to predefined colours

The following table gives the overview.

Table 10 Default parameter setting (graphic functionality) defined for the ME applications

	Adapted parameter values		
Parameter	Vienna	Vitoria-Gasteiz	Bologna
URL	http://sbc1.ait.ac.at/projects/urbanapi/me/ Vienna)	http://sbc1.ait.ac.at/projects/urbanapi/me/ (Vitoria-Gasteiz)	http://sbc1.ait.ac.at/projects/urbanapi/me/ (Bologna)
Grid cell resolution	1000x1000m 10.000 x 10.000 m (outside Vienna)	1000 x 1000 m 500 x 500 m (in centre area)	500 x 250 m (entire area)
Spatial extent (Lat/Lon)	15.0,48.0 : 18.0,49.0	-2.87,42.77 : –2.52,42.94	11.20,44.43 : 11.47,44.56
Legend range, n of classes, colour code	Range and intervals automatically adapted based on value range of data set, n of classes and colours predefined	Range and intervals automatically adapted based on value range of data set, n of classes and colours predefined	Range and intervals automatically adapted based on value range of data set, n of classes and colours predefined
N of users – diagram: y-axis range and intervals	Automatically adapted based on value range of selected data subset of the particular grid cell	Automatically adapted based on value range of selected data subset of the particular grid cell	Automatically adapted based on value range of selected data subset of the particular grid cell

As the data formats for the input data is different for every city, as a consequence, the Mobility Explorer application cannot be used by any other city just by uploading a dataset to the application.

Regarding the output the user can select between images (i.e. a screen shot), animations (i.e. a video of a selected time range) or tabular data in spread sheet format, e.g. MS Excel or CSV file format .. Further format handling for open street map and google map content improves readability of the map content through provision of background layers.

4 Model adoption and parameterization for the Urban Development Simulator (AIT)

The third application is the Urban Development Simulator (UDS, formerly called Urban Growth Simulator, now renamed to make clear that the model is able to manage growth as well as intra-urban transition without extent growth or even decline):

> *City and urban region development simulation helps to understand the large scale consequences of spatial planning decisions in a complex urban system, including representation of socio-economic activity across the territory in relation to various land-use elements of the city. Interactive control of proposed planning interventions and associated impacts generated by these interventions assists the public interactively engaging in the planning processes and contributing to planning decisions. Detailed and easy understandable information about planning decisions and full transparency about the expected impacts will support the negotiation activities during a participatory planning process and will finally increase public commitment to these decisions.*

The model has been adapted for the needs of the city. As only one city has selected this tool for application. there was no need for adaptation to other cities. Nevertheless there were adaptation steps necessary – first to move from the city of Sofia (where initial data sets have been collected, explored, harmonised and integrated and a first GUI has been established) to Ruse and to change the focus from urban region development and urban growth to intra-urban transition of a recently shrinking city aiming in modelling different patterns of change, ranging from abandonment to re-occupation, to intra-urban growth and to densification.

4.1 Adapting model and input data for the UDS for Ruse

The core idea of the UDS applying an agent based model is to model urban development as effect of individual decisions of many actors resulting in a set of similar behaviour patterns related to the agent classes. The approach is usually to "extract" in advance behaviour patterns by analysing the past development and define rules for the agent-based simulation of the future on a local scale. But the data provided, and the spatial resolution, to analyse these trends was too weak and could not be improved during the project. Furthermore the known population trend was a significant decrease within the city (2001-2011) which is not expected to be the overall trend for the future.

Thus extracting rules for future population (and workplace) allocation and increase related to the available data (on prior state and development) do not lead to meaningful results. This is not only the case because of the poor demographic data describing prior trends but also because the intension to simulate changes in the transition process in contrast to the trend observed in the near past.

So a first adaptation was necessary regarding the model structure and the rule integration. In the beginning of the project the user requirements to integrate the citizen's preferences, was not the scope of the UDS. Finally it became one of the core features of the application. This also weakens the problem of missing data as the preferences from the online questionnaires can be used to estimate the attractiveness of certain areas of the city.

This new approach leaves the exploration of trends and refers to polling results of questionnaires on user preferences (through online questionnaire using LimeSurvey). The results allow generating new attractiveness layers based on recent preferences for residential target areas and further information.

The steps to customise the application by city are:

- Repeated data preparation of city data (statistical data and cellular landscape layers of current and future land use, actor distribution and density, attractiveness and repulsion and land use suitability criteria (e.g. share of open space cells, distance to industry, to road network, to highway exits) as well as land use zoning regulations.
- Repeated data acquisition to obtain data with improved data accuracy, quality and extended content. Repeated exploration and adaptation of behaviour rules to identify movement patterns in the respective city; quantification of the driver-pressure-attractiveness relations through regression models
- Adaptation of the graphical user interface to meet the changing needs over time
- Integration of the interactive policy decisions into the respective user interface.
- Adaptation of the online survey, e.g. translation to a different local language and integration of new local statistical data and a city base map, to add their preferences where they to want to live.

As there is only one city applied as case there is no replication of data adaptation and model parameterization necessary. Nevertheless we describe the elements that would require an adaptation and parameterization in case additional cities would be included as use cases.

The Urban Development Simulator (UDS) has been built using MASGISmo a (Multimethod Agent-based, System Dynamics and GIS modelling platform which has been developed as a basic generic simulation development tool at AIT during earlier projects. MASGISmo currently includes a database connection to a PostgreSQL database, where all tabular data are stored.

MASGISmo, making use of open source software such as PostgreSQL and PostGIS, enables to adapt to the user's needs in a wide range of cases. Programming of new interfaces will allow the import and export of new specific data formats if necessary

The following table gives an overview of the data included through geospatial layers and tabular data which allow geo-referencing.

As the UDS model has been developed with respect to the availability of geospatial data formats there was no reformatting necessary, as all data was provided through well-known formats. Nevertheless big effort was put on data acquisition, error correction and data improvement, as described on Deliverable D4.1. - Data harmonisation and integration as well as D3.7. - Processing Components Document, describing data processing requirements.

As mentioned above the UDS uses a PostgreSQL database to store tabular data. MASGISmo, the used modelling platform, can already import and export tables stored as CSV-files. These files can easily be extracted from Excel spread sheet files. MASGISmo uses a determined structure for these CSV- files to enable the user to store variable-specific metadata for each column in the DB as a separate table. During data import the meta information marked as UNIT and COMMENT is automatically stored in separate data table to each imported table . Thus the user can retrieve metadata information for each variable in a table in a simple but convenient way.

Data analysis has been carried out for all datasets provided by project partner ASDE and the municipality of Ruse. The data were delivered as a detailed collection of ESRI shape files, ArcGIS project files and maps. Datasets and maps were derived from the database collected for the ERGO[1] (Euroregion Ruse-Giurgiu Operations) Master-Plan in 2012. This is also the time stamp for all data collected and listed in the following table, since no metadata were delivered to determine the exact time stamp for the data.

First, it was necessary to get an overview of the received data. Since data requirements were specified rather general for flexibility reasons, the database collected includes more data than needed. A lot of datasets could be excluded from the harmonization activities because of their non-suitable content, their insufficient quality (e.g. coarse digitised data) or their redundancy. The defined whole area of interest is divided into two adjacent cities (Ruse and Giurgiu), but only the data of Ruse were provide, has been harmonised and is used for the simulation.

The following table 11 gives an overview of the integrated files including formats.

[1] http://www.territorialcooperation.eu/frontpage/show/5937

Table 11 Ruse data f or the Urban Development Simulator

Data set	Sub type	Data type
Base Maps Background	Open streetmap (OSM), Google maps (GM)	Via WMS service
Base Maps	Block to block clusters	Shape file
	Census units	Shape file
	Land use: CORINE landcover, Urban Audit, further	ASCII grids 5x5m
	Land use: merged	Shape files
	Public infrastructure	shape files /points
Census Data[2]	census data (1990, 2000, 2010)	NSI regions - shape file compiled
	census data (1990, 2000, 2010)	NSI regions - shape file compiled
	Population by age /gender	NSI regions - shape file compiled
	By social class /income	NSI regions - shape file compiled
	Households	NSI regions - shape file compiled
	Employment	NSI regions - shape file compiled
	Flats	NSI regions - shape file compiled
	Buildings, height, function, public vs. private ownership	NSI regions - shape file compiled
	Satellite / ortho-images	Shape file
	Road network	Shape file
City layout urban development	Cadastre building layer	Shape file
	Density / zoning	Shape file
All data formats follow the flexible model requirements: shape file, AsciiGrid, Geotiff, csv tables		

[2] The census data could only b e provided on a ver coarse spatial resolution which caused the main problems (for further details see D3.7)

The data shown in the list below have finally been used and integrated into the UDS database:

- Plots and Building footprints out of the cadastre (including height, ownership and function)
- Zoning plan
- Road and railroad network including stations
- NSI regions, including statistical data about[3]
  - population (age, economic activity and education, family size),
  - buildings (number, age and type),
  - dwellings and
  - households
- Polling-regions for temporal population series
- Manual edited layer with special points of interest for assessing local attractiveness
  - (e.g. schools, kindergartens, public transport stations, etc.)

4.2 Further model parameterization for the UDS application

The standard graphical user interface of MASGISmo has been developed during several years. The most important components of the UI are related to different main functionalities which are:

- spatial simulation features conducted through GIS functions,
- interactive control features,
- scenario simulation analysis.

For the UDS some features of the standard MASGISmo UI have been deactivated, as they are not necessary for the UDS and would reduce the usability by confusing the UDS user.
The online survey gathers information to be fed in the UDS simulation in two ways:

- 1st the citizens can vote for certain area in the city, which is result of all their preferences and background conditions.
- 2nd the survey asks for their preferences and this leads to an average preference distribution. This distribution can be classified by certain socio-economic parameters as e.g. age or education, unemployment or living standard.

The user of the UDS can use this information in the Agent behaviour settings (c.f. fig. 7 below). Currently five preferences are assumed to be important and can be quantified with the existing data retrieved from the online questionnaire. This number of Agent preference parameters can be changed. Some parameters are currently excluded by setting a zero value because no spatial information is available at the moment (e.g. property prices, rents).

[3] Derived for smaller entities of 500x500m (see D3.7)

4.2.1 Agent behaviour parameters

Agent behaviour through expectation definitions is required for Agent based model (ABM) applications to control the simulation and thus the transition of change. As described earlier above and in Deliverables (e.g. D3.2) online questionnaires can help to leave the trend scenarios where the model is forced to follow, if historical data are used to model future development. Below a “UDS control panel” is shown were the user is allowed or even has to move the sliders of each of the expectation parameters to trigger the agents to make decisions.

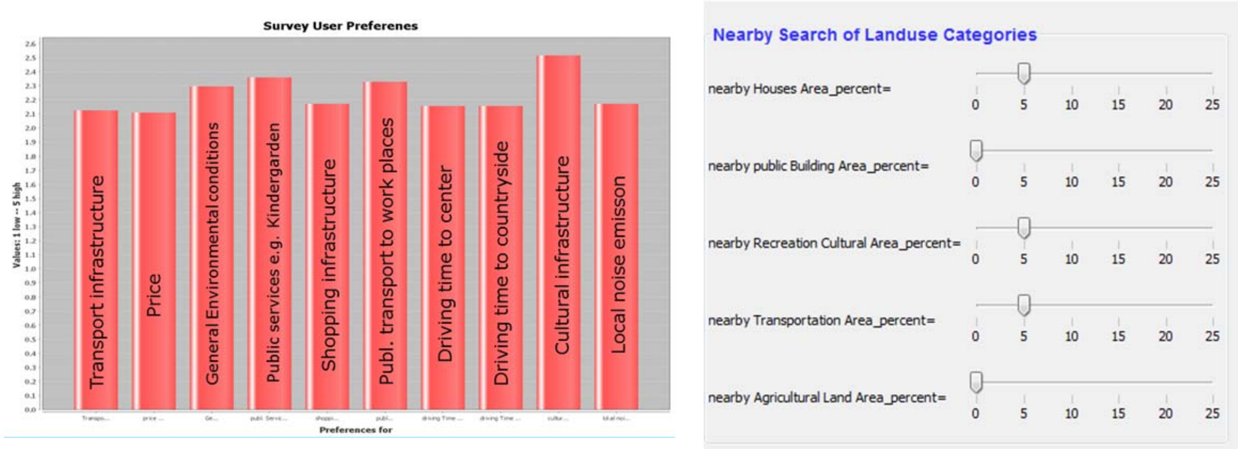

Figure 7: left: current results from online questionnaire for preferences; right: UI for Agent behaviour settings via sliders as part of the main management UI (see following fig.8).

Figure 7 above documents that no predefined parameterization is necessary, the application (in any city) and the weights or values can be defined individually as appropriate for the particular use case. Some information retrieved from the online questionnaire so far cannot be used in Ruse as e.g. price, indicating the preference value (5 of 0-5 -= high preference) to rent or buy an apartment. This is due to the fact that spatial data for this was not provided by the city. Nevertheless an adapted version of the UDS, if data are available, can be provided with little effort.

The figure 8 below presents the main control panel which allows additional interactive parameterization: population change, new buildings share (multi-family houses, family houses and villas), follow citizens vote results acceptance, etc. Some of these parameters are only valid for some simulation options (Scenarios A-D in figure 8). How to use the control panel is explained in Video tutorials provided online.

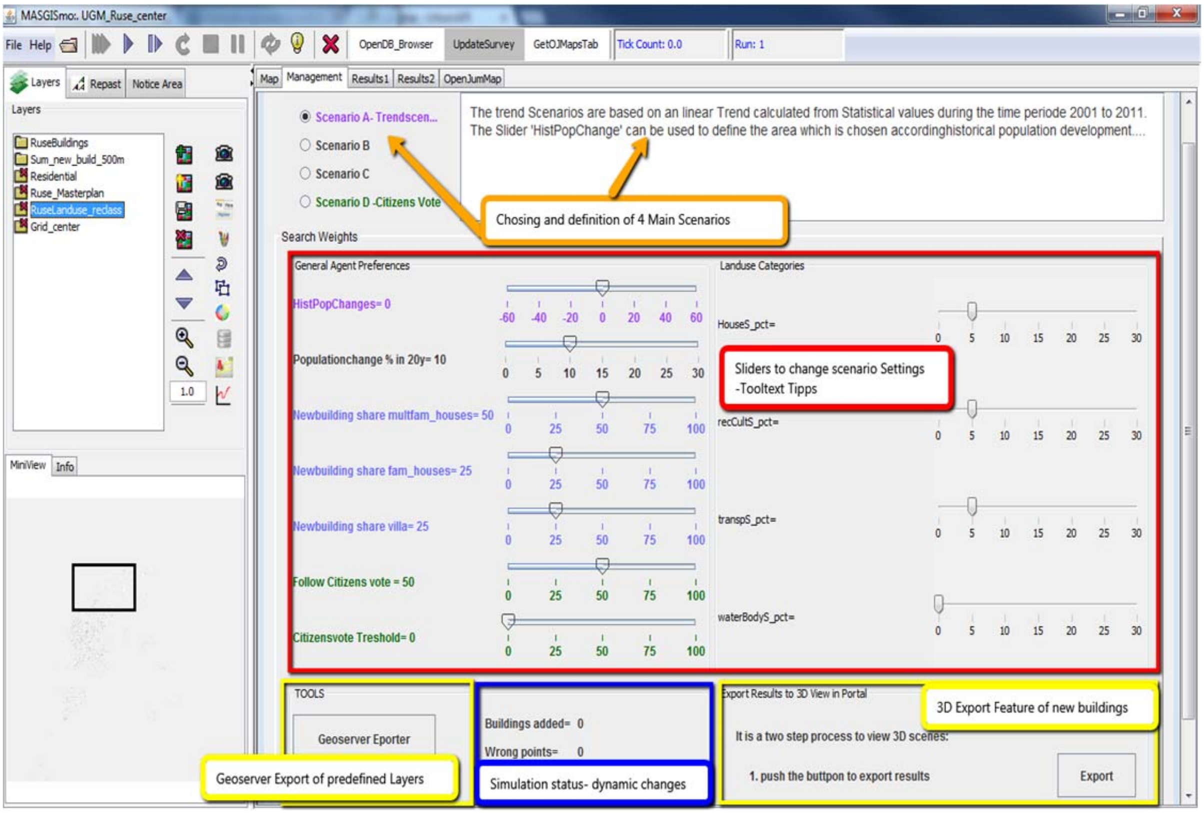

Figure 8: Control panel for agent behaviour setting via sliders

The following figure 9 presents the user interface with one of the output layers depicted, showing some results of a simulation.

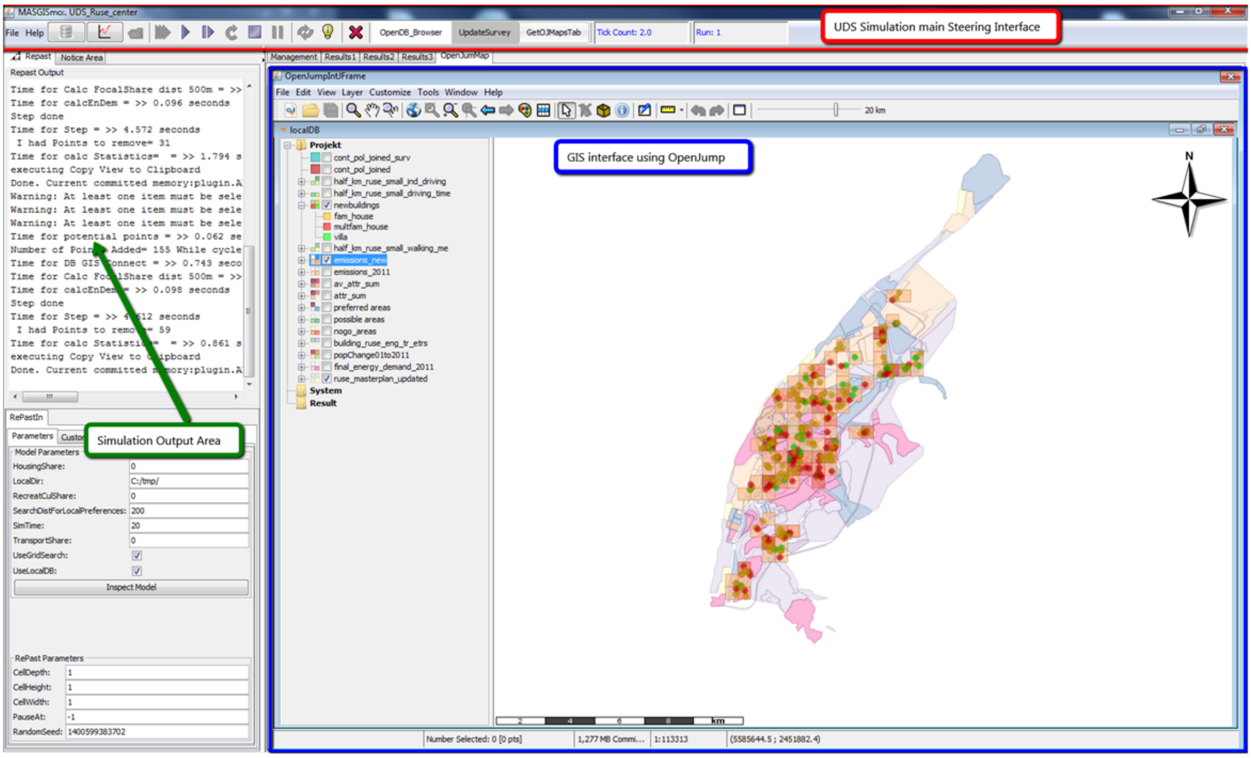

Figure 9: MASGISmo UDS application layout for Ruse coloured points show area occupation by erected/ used house type,

4.2.2 Additional parameters used for the City of Ruse

Here additional modelling on energy consumption has been provided tailored for the City of Ruse. The following tables list additional parameters to calculate the energy demand and emission as part of the environmental impact assessment for Ruse[4]. This data was extracted from different sources and checked with local expert opinions, whereas the UDS is made flexible that the city can easily change these parameters in the future if improved data are available.

4.2.2.1 Specific heating demand for different building-age classes

(Table name in DB: spez_heatdem)

Line number of first data row:	**5**		
const_period	**From**	**To**	**new_en_type_pct**
Text	Integer	integer	integer
building age class	min energy demand in kWh/m2,yr	max energy demand in kWh/m2,yr	Percent of newbuildings in 'standard/low(ne)/passiv' type (total must be 100)
till49	300	500	0
f50to59	250	300	0
f60to69	200	250	0
f70to79	150	200	0
f80to89	100	150	0
f90to99	75	100	0
f00to11	70	75	0
new_st	47	70	**70**
new_ne	16	47	**20**
new_ps	0	16	**10**

[4] The format of the tables depictes the above described special format developed to inlcude meta data into the UDS (PostgreSQL) database.

4.2.2.2 Emission factors related to final energy carrier use

(Table name in DB: endem)

Line number of first data row:	**5**			
item_description	**carrier**	**Emission-factor**	**emf_source**	**endem_distr**
text	**text**	**float**	**text**	**float**
short definition of energy use and carrier	name	G CO2/kWh	dmnl	heating percentage from final_en_demand
heating_gas	gas	198	http://www.ago.ag/files/deeagt-services-emissionadvice-list-document.pdf	0,6[5]
heating_oel	oil	266,4	http://www.ago.ag/files/deeagt-services-emissionadvice-list-document.pdf	0,2
heating_wood	wood	0	CO2 neutral	34,1
heating_district	dhcp	50	estimation	16,4
transport_public	publ	0	estimation	0
heating_other	other	177	estimation	0,3
heating_coal	coal	450	http://www.iwu.de/fileadmin/user_upload/dateien/energie/werkzeuge/kea.pdf	19,8
heating_el	el	300	estimation	28,6
transport_dies	diesel	260	http://www.ago.ag/files/deeagt-services-emissionadvice-list-document.pdf	0
heating_newbuild	newbuild	100	estimation	0

The following table is not only important to calculate the final energy demand of new buildings (depending on the floor space) but also addressing the number of new buildings required within a simulation run to attract new population moving into the city.

[5] This distribution is for all building types the same to reduce the complexity. The used data was found within the TABULAR project http://www.episcope.eu/building-typology/country/bg/

4.2.2.3 New buildings matrix

(Table name in DB: matrix_buildtype)

Line number of first data row:	**5**				
type	**area**	**Pop**	**pct_newbuild_type**	**et_min**	**et_max**
text	integer	Integer	integer	integer	integer
new building type	average floorspace	average number of people per building	percentage of building type (total must be 100)	min number of floors	max number of floors
multfam_house	1000	30	**30**	4	10
fam_house	400	10	**60**	1	4
villa	200	3	**10**	1	2

5 Conclusion

The three applications require specific parameterization, as the models are fully generic and can be applied to all cities as far as data are available, nevertheless the necessary data preprocessing need distinct workload.

The 3DVR application needs settings addressing graphic properties for the visualisation activity but do, besides the spatial extent of the scenes, not require content specific parameter setting for the cities.

The ME application needs settings regarding graphic properties like grid cell size and spatial extent. All other data sets to be applied must follow a certain structure. Legend ranges or y-axis ranges for the map and graph presentations are extracted automatically, based on the range of the values in the particular data sets (number of population, users, mobile phone events).

The UDS application requires extensive parameter setting to be tailored for the cities where the application shall be applied. Most of these parameters are not predefined. They have to be adapted on the fly before the simulation starts to describe a certain policy or achieve a certain future population target within a certain time range.

Regarding future developments following topics would be of interest:

The 3DVR application represents the basis for further developments either for the web-based 3D components but also for the data server and administrative tools. In the future the application will be extended beyond visual representation of objects in a city. This means that a lot of additional semantic information available will contribute to enhancements of the model and in particular to interaction for users.

A performance optimization for the ME could be carried out, by exchanging the standard data base with an improved data structure and exchanging SQL filtering statements by more advanced search and aggregation functionality. The application could be more adapted to market needs in a way to address commercial customers instead of public ones – e.g. to explore not so much mobility but origin destination traces to identify customer catchments, and further visitor distribution and occupation over time to identify customer volumes.

For the UDS the application can be extended by adding functionality e.g. to estimate infrastructure needs for the expanded areas. An opposite way would be to provide a tool with higher simplification which allows more coarse input data and less attractiveness layers to ensure tool application in cities with less sophisticated geo data availability.