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Short Description:
The basic concepts of the tools used for visual analysis in urbanAPI are described along with some explanations of the problematic areas concerned. The scenario editor for the set up of the data to create analysable scenarios is introduced and tools for use in a web-portal environment. A special aspect is the integration of the mobile device movement data, so that it can also be analysed in a 3D environment.
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About this Document

This document deals with the software components in the UrbanAPI project for visual analysis. According to the description of work for UrbanAPI [1] it is the deliverable *D3.4 – Visual Analysis Documentation* of work package *WP3: Software Platform Development: Database, Integration, Visualisation and Simulation Tools*. The document will be superseded by an improved version if required at any time in the project life cycle. The finalized version of this document is planned for month 30.

1 Introduction

Today's decisions are often supported with bigger-than-ever amounts of data, condensed using sophisticated analysis techniques. Making the output of such processes fit for human consumption often is a challenging task, even for specially trained people. In the special case of 3D maps, for example of a modern city where ambiguous data has to support conflicting decisions, being able to outline a vision or highlight existing or potential problems is ever more important.

Suppose a major infrastructure project is being planned and early impact assessment is happening. The results of such endeavours are often (and increasingly) public, but drawing proper conclusions is hard except for relatively few people. One of the key reasons is that visualisations are hard and mostly done to highlight favourable aspects selected by a stakeholder.

In an environment where available information can be effectively communicated, this skew naturally decreases. As more parties get their views actually communicated, deeper inquiry into issues and more balanced outcomes are in reach.

For example, if a larger part of a city is to be rebuilt, different parties might highlight anticipated property price developments or the difference to the price people living there may afford. During the process an integrated view of both variables can be created to help resolve conflicts. Because the material is easily accessible and navigable by lay people, the resolution has a wider backing.

The information visualisation aspects mentioned above have led to the implementation of a scenario editor tool within the CityServer3D tool set, which is extended further according to the needs of the UrbanAPI project.

The concepts explained here improve the understandability of the scenarios modelled with the UrbanAPI-toolset. Some of use cases described in D2.1 [2] are visualisations of datasets directly within the 3D city-model, for example the impact assessment in Vitoria-Gasteiz regarding water drainage (volume, capacity) and vegetation analysis. The scenario editor will be the central point for the analysis e.g. the assembly of facts in the city model with special means to convey the facts to humans. The prepared scenarios can also be used within the urbanAPI portal or other devices such as touch tables.

In chapter 2 the basics of the Scenario Editor in CityServer3D's AdminTool are explained. The aspects that are new and directly related to or required by UrbanAPI are stressed.

Chapter 3 describes the measuring tools for 3D-scenes in the UrbanAPI-toolset. Chapter 4 deals with the shadow analysis features of the UrbanAPI-toolset.

Most of the aspects of visual analysis are naturally related to the 3DVR application use cases. In addition to this the results of the Public Motion Explorer application shall be integrated in the 3D city model and therefore can offer new ways of visual analysis. This is the main topic of chapter 5.

2 Information Visualisation for 3D Maps using the Scenario Editor

The concepts described in this section will be used to visualize additional, typically non visual, properties connected to the spatial entities or maps. For example

- resource consumption
- pollutants emissions
- carbon sequestration
- increasing of public space
- increasing biocapacity and biodiversity

The visualisation is basically two fold: First the set up of the scenarios and visualization with the AdminTool which is targeted for technical experts and second the visual analysis and parametrisation done by city planners, experts from different departments of the city or citizens. The AdminTool can also be used for visualisation purposes but there are also options for using the web portal as defined in D3.2 [3] or even special devices such as touch tables. The following chapter deals with the first part of the process: the scenario editor and the set up for analysis. The basic steps and elements for this are defined and explained.

In Fraunhofer's CityServer3D tools and infrastructure for visualisation already exist and will be extended with the functionalities needed by the UrbanAPI project. The AdminTool offers various tools as Domain Specific Languages and rule-systems which will be applied for visualisation of data in a 3D city model context. Based on this a scenario editor is built, which gives the opportunity to visualize data by using symbolizers. These symbolizers modify or augment the scenario e.g. the 3D city model in our case for portrayal of special aspects. For example, in figure 2 the spheres corresponding to the energy consumption of a building are generated "on-the-fly" by a symbolizer. The information needed is the position of the building and the amount of energy consumed. With this input we know what is to be displayed and partly where, but not how it is done. This "how" is encapsulated in the symbolizer and can be changed as appropriate. In the example this is something as simple as "draw a sphere above the building with a diameter of X". It could be changed easily to something like "colourize the building in a shade of red in relation to X".

2.1 Integration of Data

The data will be integrated and made visually analysable with the AdminTool scenario editor.

The data for this is to be provided by the cities in a standard format for example as Shapefiles. This data is then imported in the CityServer3D AdminTool for further processing.

Typically this data has to be integrated as visual properties in the 3D city model.

2.2 Assignment of Symbolizers

In short, a symbolizer in the context of the scenario editor, replaces or amends some visualized entity visually by using additional information. For example the measured temperature of a thermo-scan of a house can be used to colourize the walls of the house in the 3D model. The temperatures can be represented by stereotypes of different colour gradients; relatively low to high temperatures can be represented by a gradient from blue to red.

A symbolizer modifies the 3D geometries to be displayed according to some defined rules. The rules themselves may in turn analyse additional data as is appropriate for the targeted scenario.

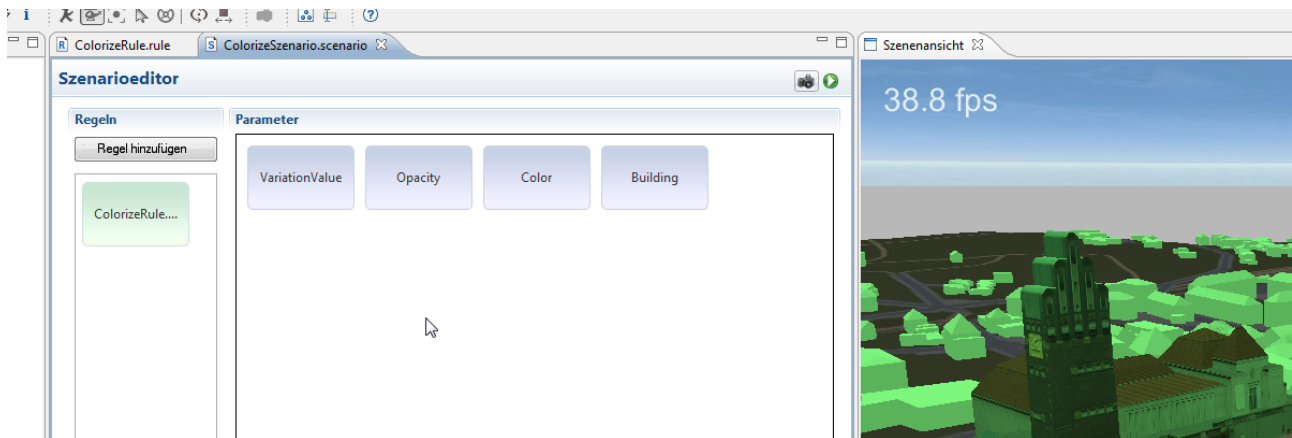


Figure 1: Screenshot of Scenario Editor

An example is the visualisation of energy consumption for different building occupancies as shown in Figure 2: A transparent sphere is drawn above a building which symbolizes two properties

- The colour indicates the occupancy (red - residential, yellow – public, blue – other)
- The size of the sphere is proportional to the amount of energy used

A third property which can be used interactively can be the time of the day, which may be selected by a time slider or any other widget appropriate. The visualisation of the spheres changes according to changes of the time and the changes of energy consumption. Therefore spheres may shrink and others may grow.

Of course, other graphical elements are available to address use cases with other requirements. For example, vertical 3D bars visually suggest some height and may be used to portray e.g. average precipitation.

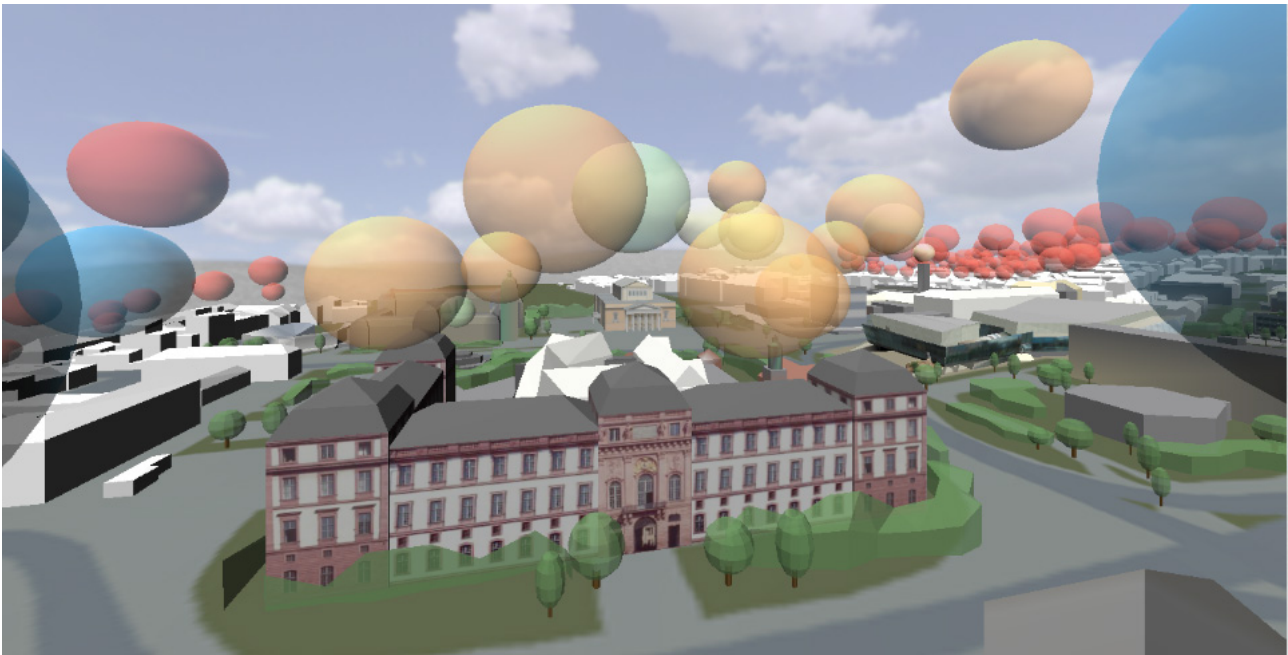


Figure 2: Visualisation of energy consumption of buildings

X3D, the ISO standard behind our visualization technologies, allows for arbitrary combination of its primitives. This makes it easy to adapt to changing visualization requirements, e.g. highlighting specific targets or making it easy for the viewer to inter compare certain aspects.

To be able to work on such subjects, we are creating what we call a scenario editor. It aims at capturing the steps required to build a visualisation and making them repeatable. This encompasses the following concepts:

2.3 Data Sources

These are pointers to the input data to be visualized, both geometric and tabular.

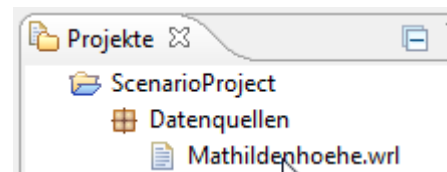


Figure 3: Data sources of scenarios

2.4 Integration Rules

Integration rules are repeatable processing instructions which facilitate integration of data from the specified data sources prior to visualization,

2.5 Portrayal Rules

Portrayal rules are parametrical analysis and visualization tools. They transform input data to symbolizers, i.e. symbolic descriptions of the target visualization. They can be created from pre-defined templates and adapted to the tasks at hand.

2.6 Scenarios

A scenario, technically, is a collection of data sources, integration rules and portrayal rules. The scenario exposes selected input variables from the contained portrayal rules to the end-user. He may then tell the system to portray different variations of one or several scenarios.

The final scenario visualization may then be made available as a static 3D snapshot or as a repeatable visualisation process that will adapt to changing input data. This choice depends on available technology and the target audience. From these, more traditional products such as 3D renderings can be derived.

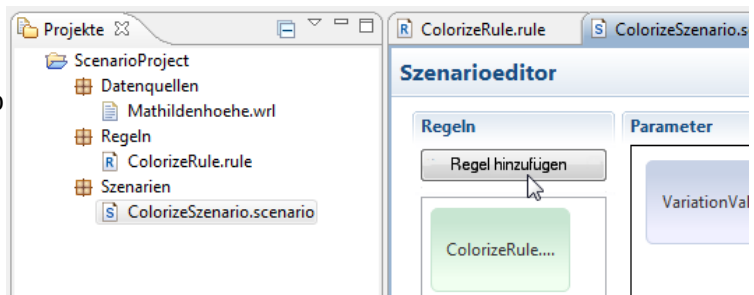


Figure 4: Scenarios, rules and data



Figure 5: Navigation without ground detail

3 Measuring Tool

For the UrbanAPI web-portal a distance measuring for the 3D display is implemented. In principle the distance between two selected 3D-points will be measured. To improve the handling of 3D measurement by using the mouse a dimension lock will be available. With this the two dimensional movement of the mouse can be mapped to 2 dimensions in the 3D display. For example when measuring the height of buildings the movement on the ground can be disabled so that only a vertical movement takes place. As visual indicator for the measurement a dimension arrow head along with the distance in meters will be drawn in the scene.

The arrow heads will stay in the scene until the scene is reloaded or otherwise cleaned. Image snapshots of the scene along with the arrow heads can be made for documentation and reporting purposes. A “clean measures” button will trigger a clean-up of all arrow heads manually.



Figure 6: Conceptual view of the measuring tool. The red arrows indicate the distance to measure of the 3D points selected. 3D spheres on those endpoints indicate the 3D perspective distortion. A point closer to the viewer will be surrounded by larger spheres as a point far away. With this a user can easily verify the expected results. This should assist the user as the points selected are not on a simple plane but in 3D space. As an example, the first measurement (left in image) shows the distance between 2 buildings where the second building is not as close to the viewer as the first one. Therefore the sphere is bigger on the first building. When using a frontal perspective, for example the measurement of a building's height, both spheres should be of the same size as shown in the measurement on the right side of the image.

4 Shadow Analysis

The impact especially of tall buildings is that they may cast a shadow on neighbouring buildings or facilities. The actual shadow changes depending on the daytime and the season of the year and therefore could not be assessed by using static images. The possibility to change those parameters together with a free choice of a point of view in a 3D scene provides an easy to use visual tool for the assessment.

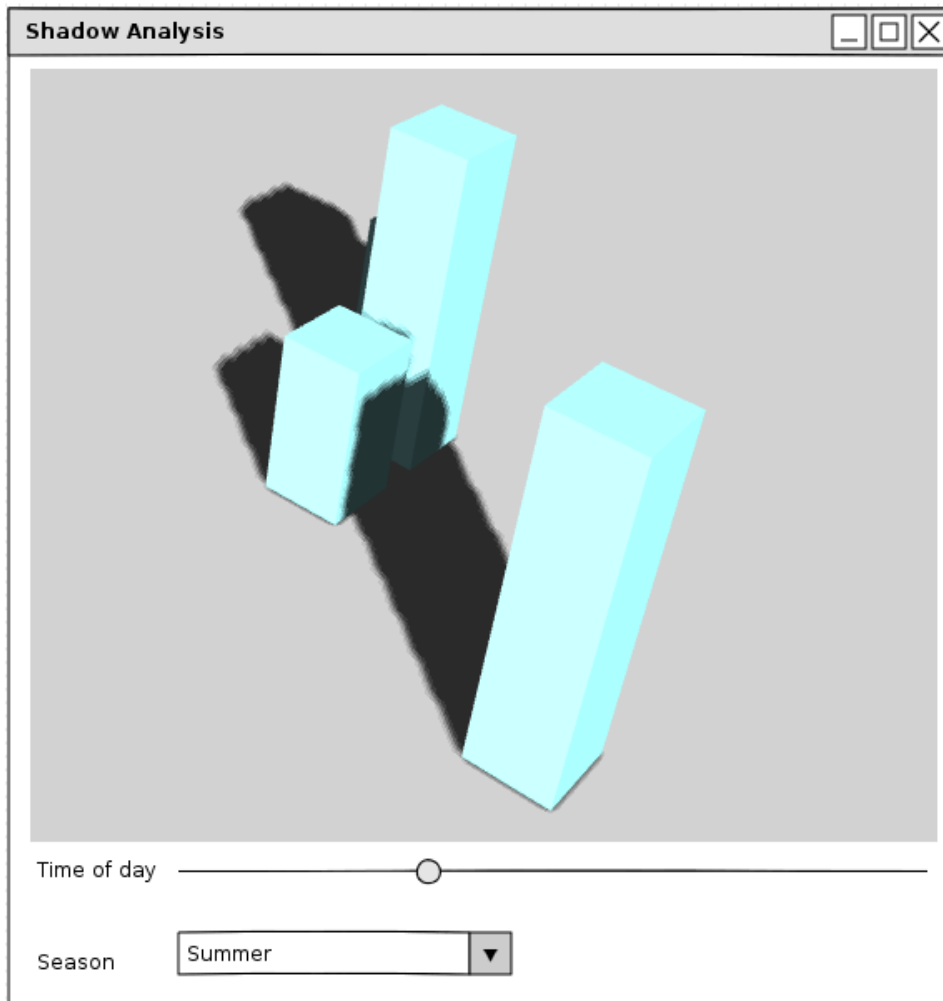
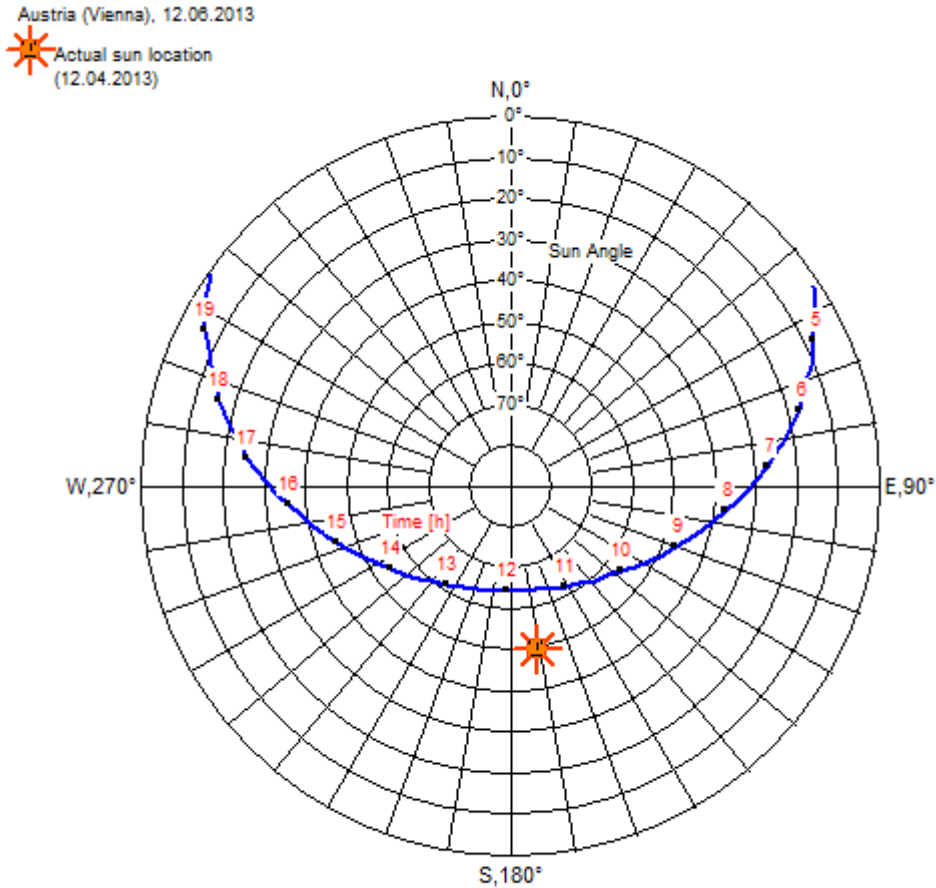


Figure 7: Mock-up of the Shadow Analysis component.

The component that provides this is based on the standard 3D display as described in the D3.2 User Interface Elements Documentation [3]. The position of the sun and therefore the ecliptic depends on several parameters that can be entered by some user interface elements. The season of the year (summer/winter) can be changed by a select box and a time slider is used to adjust for the time of the day (Figure 8).



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 Landeshauptstadt Stuttgart, Amt für Umweltschutz, Abt. Stadtklimatologie

Ver. 2.2 29.08.07 tf

Figure 8: Position of the sun for the day in vienna on the 12.06.2013.

Source: <http://cgi.stadtklima-stuttgart.de/mirror/sonneInt.exe>

The calculation of the ecliptic determines the position of the virtual sun in the 3D scene and is interactively adjusted when the time slider is changed. An example of such an ecliptic is shown in Figure 8. Two angles are shown, the horizontal orientation and the vertical orientation. For example at 12 o'clock the sun is located nearly in the south and about 65° above ground. With this information a trajectory for the virtual sun is computed.

5 Integration of Mobile Device Data with Geodata Visualisations and Analytic Tools

Since the mobile device data used within the use case of the Public Motion Explorer (PME) is complex in its content and structure (see e.g. D4.1[4] and D2.2[5]) ways have to be found to visualize the data and its content in a user friendly and structured way in order to enable a visual analysis via its web interface (Figure 9)

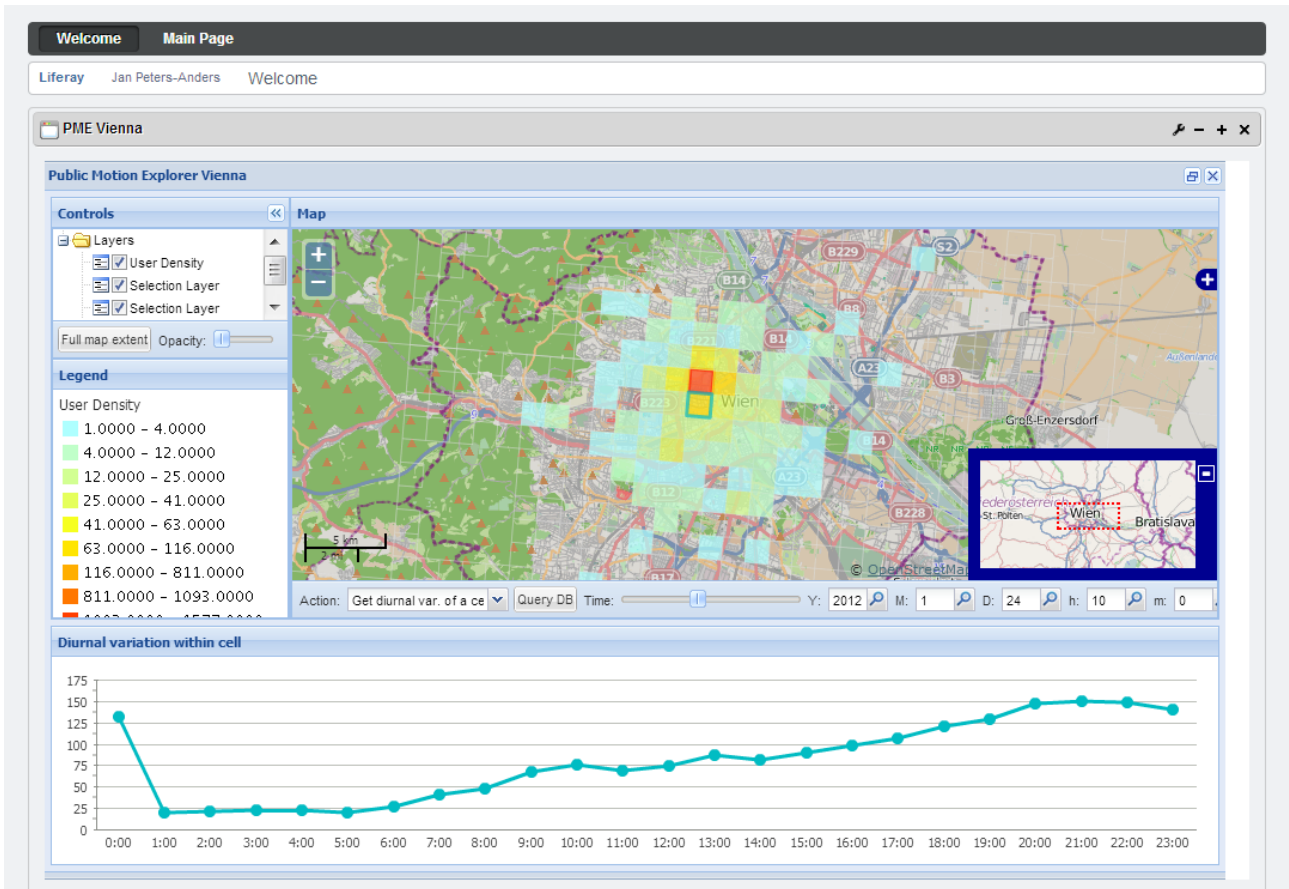


Figure 9: PME web interface within UrbanAPI portal

At the moment the user has the possibility to visualise a time series of mobile device densities over 24 hours, based on a selection of a so called source cell (red rectangle). The database responds to the user selection with a map of 1km raster cells which depict the densities for a certain time step. Additionally the user has the possibility to select one of the depicted raster cells to query the database (dark cyan rectangle) for a diurnal variation graph of the respective raster cell. In doing so, the user gets a visual impression of the user density variation of users coming from the source cell over the day. In this way it is possible to analyse the spatial 2D map's temporal dimension visually and the user gets an impression of the information contained in the motion data stored in the data base.

To enable an easier identification of the densities or to get a better orientation when having zoomed in very low, the layers' opacity can be adjusted to the user's needs (Figure 10)

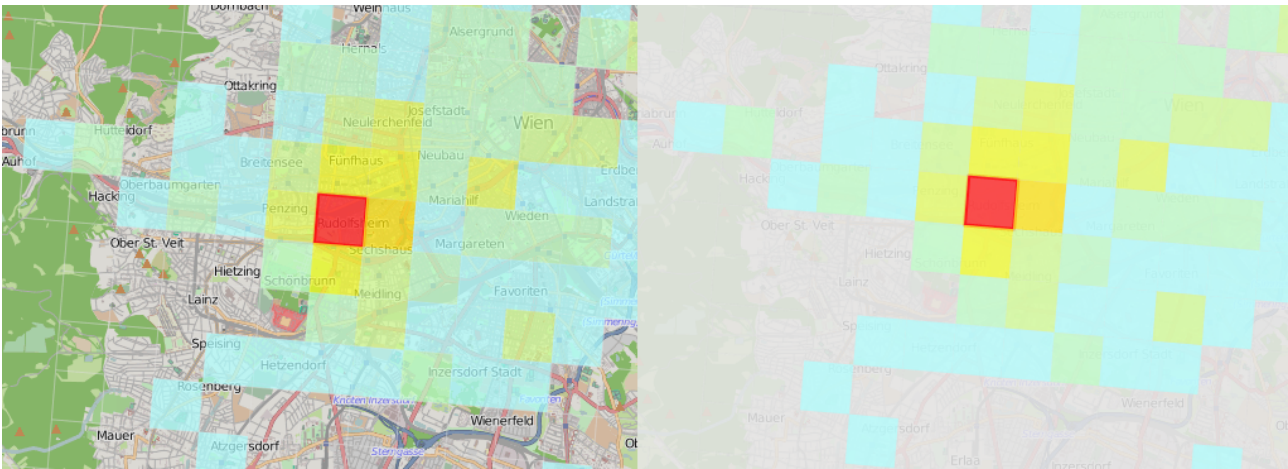


Figure 10: Adjusting opacity for better visual impression of the mobile device densities

In order to highlight different aspects of the data in the database it is planned to give the users the opportunity to choose between different colour schemes for the display of the data. Much like in a desktop GIS it will also be possible to choose different class limits and colour ramps to visually analyse the data even better. It is planned to have a menu holding “colour groups” so lay people will be supported in using meaningful colour schemes for their visualisations and analyses. The interface will also provide legends for different class numbers in order to highlight certain aspects of the data (via threshold adjustments for 2 class legends e.g.) and it will be possible to exclude number ranges to get a clearer picture in confusing situations (e.g. to many cells of the same class populating the display).

5.1 Visual Analysis: Chart Visualisation

The current version of the PME features the possibility to support the user’s visual analysis by drawing charts of diurnal variations for each raster cell. In doing so the user has the opportunity to analyse the data’s temporal dimension in two ways:

1. The user can have a look at a source cell and animate through the mobile device diurnal variations over the day (or a longer time period in future versions)
2. The user can have a look at a target cell and get the diurnal variation for this cell in a chart (Fehler: Referenz nicht gefunden)

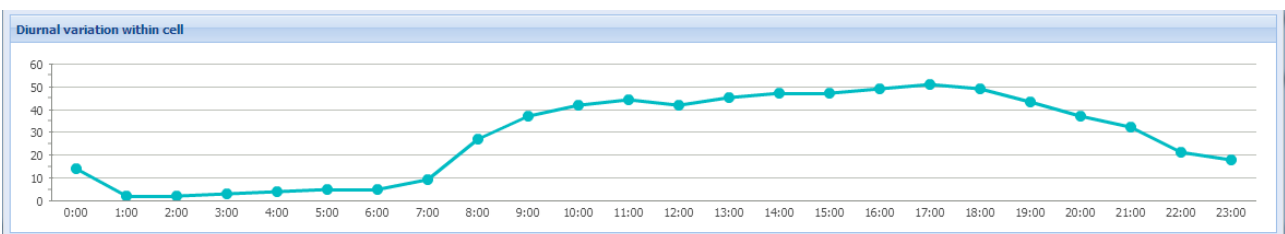


Figure 11: Diurnal variation for a selected target cell

5.2 Visual Analysis of PME data in CityServer3D

In order to move beyond state-of-the-art 2D mapping techniques the user's query result will be visualised in the CityServer3D 3D view, similar to Figure 2. These means of visualising data are a challenging task since ways have to be found to display the data and its variations over time in a meaningful way in order to be useful for the future users of the UrbanAPI tool set. The documentation of these developments will be part of future versions of this document.

6 Conclusion and new aspects beyond the State of the Art

Concerning beyond State-of-the-Art aspects the PME application provides direct user modifications (such as date/time and source region) in the analysis of -in the case of the city of Vienna- high resolution motion data compared to SOTA depictions of movements (e.g. animations/videos) that resemble only results of predefined analyses done by researchers/data managers beforehand (see e.g. <http://urbantick.blogspot.co.at/2011/11/vienna-resilience-and-taxi-tracks.html>). In this way also the way PME makes use of interactive web-mapping (click able map and time slider to identify movements) is quite unique.

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