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## **Publication of Energy Consumption Data of Scharnhauser Park via Web GIS**

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### **ABSTRACT:**

Most of the human activities are taken place inside buildings especially in urban areas. These activities are mainly supported by different forms of energies such as electricity, heating which makes the energy management very important especially in urban areas. This paper has made an approach on the analysis of the buildings energy consumption by using geoinformation systems (GIS). Energy consumption of the buildings can be visualized in different ways. Web GIS can address this issue very well over the Internet. This study was a part of a project namely POLYCITY, where the buildings are supplied with energy from biomass co-generation plant. The study area is located in Scharnhauser Park, very close to the city of Stuttgart, Germany. Buildings of the project area are provided with consumption data regarding heat and electricity which forms the basis for analysis and display. GIS can perform the task of visualization in a number of ways; thematic map is one of the best. A web portal is developed for displaying maps and attributes, which enables the residents of the area to evaluate the status of their energy consumption. Dissemination of this information will lead to an increasing awareness among the residents of the project area in terms of energy consumption and supply. The result of this study would support the energy management system to monitor and evaluate the building energy consumption in a very efficient way having a positive impact on power saving in the residential areas

## 1. Introduction

The Web GIS is comparatively a new but very fast growing sub-set of Geographic Information System. It is getting particular significance for spatial data handling over the web. In simple words this is for distributing and processing geographic information by the way of Internet and World Wide Web. It is getting increasing momentum and acceptability for different level of users such as geospatial data handler and producers as well as governmental and non-governmental agencies. It can provide GIS functionalities both on Intranet and Internet at the same time. As Internet GIS is platform independent it reduces the necessity of purchasing costly desktop GIS software.

Internet is a part and parcel in our everyday life. Useful information is available online regarding almost every sphere of life. Energy has played vitla role in order to attain the advancement of technologies and civilization. Very few things are possible without the magic touch of energy. Buildings support greater portions of human activities. Thus the management of energy inside buildings is worth stating. Particularly in urban areas, it is very important. Geo-information can be the right choice for this type of energy management. The objective of this study deals with structuring a system where building energy consumption data such as electricity and heating and renewable energy supply are to be managed with the help of geo-information systems. The users can have access to the building energy consumption data over the Internet and hereby they can evaluate the status of their respective energy consumption and supply. This will increase the awareness about energy consumption along with the efficiency of energy use among the users.

## 2. Background

POLYCITY is an urban conversion project. It is focused on the large-scale urban development. In this project working places and living areas are integrated in such a way that it would result in a sustainable city quarters with minimum tarvel distance and low energy consumption. The sustainable city quarters mean that these would be the best for the people and environment both for now and the future. The project handles a number of aspects related to urban conversion such as new construction at the city edges of Barcelona in Spain; the conversion of an old city quarters with poly-generation energy and grid based energy supply at Torino in Italy; new building construction and renovating old ones on a large former military ground near Stuttgart with biomass heat and electricity supply.

The part of the POLYCITY project in Stuttgart and its name is Scharnhauser Park. This is an urban conversion and development on an area of 150 hectares in the community of Ostfildern on the southern border of Stuttgart. Working places, residential areas and green park sections are integrated here to result a harmonious living and transportation environment with high comfort and low energy consumption. This one is also designed as an exemplary ecological community development where wood fired co-generation plants will deliver electricity and heat energy.



Figure 1: Residential area Scharnhäuser Park

The geo-information is one of the aspects of this project, which will be discussed in brief in the following sections.

### 3. Methodology

#### Available data

The energy consumption data of the buildings of Scharnhäuser Park reside in the archive of the municipal utility company Esslingen am Neckar GmbH. These data are comprised of annual heat and electricity consumption information for each building in form of Excel sheets. Then the collected data are stored in an Access database in tabular form. Additionally, the project POLYCITY is provided with a map of Scharnhäuser Park area from the city of Ostfildern. This map is a DXF-file, which contains all dimensions and object information for the study area, e.g. building construction, street name, etc.

#### GIS-Technology

The GIS-software used for this project is the program called GeoMedia Professional 6.0, which is powerful software for analyzing and managing spatial data. Additionally, further GeoMedia-Application, which is called GeoMedia WebMap Professional, is used for creating a Web application for publishing the project related data via Internet.

#### Workflow

Once the data about energy consumption of each building is stored in the Access database, it is joined with spatial data from the DXF map within the geo-information system for its visualization. The energy consumption data are visualized in a number of thematic maps, which show the numeric values in color intensities. This gives the visual impression about the whole area, e.g. buildings with the darker color indicate more energy consumption. GeoMedia WebMap Professional is used to create a WMS (Web Map Service), which is implemented in the POLYCITY-Website for the dissemination of spatial information.

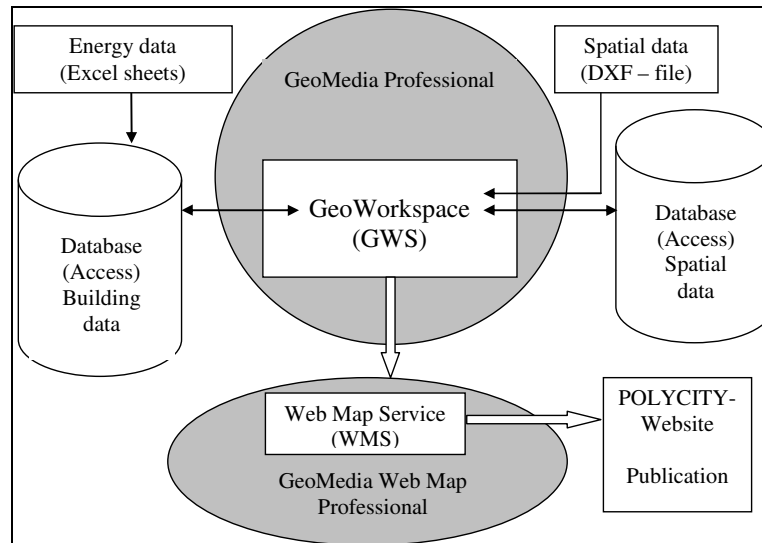


Figure 2: Flow diagram of methodology

## 4. Implementation

Implementation covers the working procedures in GeoMedia Professional for generating thematic maps, which enables the visualization and analysis of the energy consumption data and subsequently publishing the map with the help of GeoMedia WebMap. A concise description is provided in the following paragraphs.

The features with location data are in the GeoMedia warehouse and the most of the attribute data are stored in the Access database. The attribute data includes building information like building name, street name, house number and so on. The database also has information about electricity and heating energy consumption for each building. For visualization of these attributes data we had to establish a relationship between the database and the warehouse.

Once the connection is set up (joining by building ID) we can start processing data inside GeoMedia Professional. We are interested in energy consumption values per building. As we have already the data about heating per building we use the gross heating area to get the energy consumption data in desired unit of kWh/m<sup>2</sup>a.

A thematic map symbolizes geographic features according to non-graphic attribute data through the use of color and other user-defined display properties (Intergraph, 2005). It can give the visual impression of non-spatial attribute data over the maps. For making thematic maps customized ranges are used from 0 to 180 where the difference between two successive classes is 30. The number refers to the unit of kWh/m<sup>2</sup>a. Disclosure of individual's energy consumption data on the internet may lead to the violation of the privacy policy, therefore the buildings are divided into different types and groups, and the energy consumption data are presented as an average for each of the category.



Figure 3: Thematic map for average annual heating energy consumption (2005)

The visualization and interpretation of the energy consumption data within the GeoMedia Workspace show significant differences between the values of the energy consumption of buildings within one building type. Changing the users behavior could help to achieve a significant reduction of the building energy consumption.

## 5. Publication via Web GIS

In order to publish the average energy consumption data of the buildings in Scharnhäuser Park the Web Map Service (WMS) is created by using the GeoMedia WebMap Professional. WMS is a specification that produces maps of spatially referenced data dynamically from geographic information [LI Hui, 2006].

```

<?xml version="1.0" encoding="UTF-8" ?>
<schema targetNamespace="http://www.opengis.net/gml" xmlns="http://www.w3.org/2001/XMLSchema" xmlns:gml="http://www.opengis.net/gml"
xmlns:xlink="http://www.w3.org/1999/xlink" elementFormDefault="qualified" version="2.1.2">
- <annotation>
<appinfo>feature.xsd v2.1.2 2002-07</appinfo>
<documentation xml:lang="en">GML Feature schema. Copyright (c) 2002 OGC, All Rights Reserved.</documentation>
</annotation>
<!-- include constructs from the GML Geometry schema -->
<include schemaLocation="geometry.xsd" />
<!-- bring in the XLink namespace -->
<import namespace="http://www.w3.org/1999/xlink" schemaLocation="xlinks.xsd" />
- <!--
=====
global declarations
=====
-->
<!--
<element name="_Feature" type="gml:AbstractFeatureType" abstract="true" />
<element name="_FeatureCollection" type="gml:AbstractFeatureCollectionType" abstract="true" substitutionGroup="gml:_Feature" />
<element name="FeatureMember" type="gml:FeatureAssociationType" />
<!-- some basic geometric properties of features -->
<element name="_geometryProperty" type="gml:GeometryAssociationType" abstract="true" />
<element name="geometryProperty" type="gml:GeometryAssociationType" />
<element name="boundedBy" type="gml:BoundingShapeType" />
<element name="pointProperty" type="gml:PointPropertyType" substitutionGroup="gml:_geometryProperty" />
<element name="polygonProperty" type="gml:PolygonPropertyType" substitutionGroup="gml:_geometryProperty" />
<element name="lineStringProperty" type="gml:LineStringPropertyType" substitutionGroup="gml:_geometryProperty" />
<element name="multiPointProperty" type="gml:MultiPointPropertyType" substitutionGroup="gml:_geometryProperty" />
<element name="multiLineStringProperty" type="gml:MultiLineStringPropertyType" substitutionGroup="gml:_geometryProperty" />
<element name="multiPolygonProperty" type="gml:MultiPolygonPropertyType" substitutionGroup="gml:_geometryProperty" />
<element name="multiGeometryProperty" type="gml:MultiGeometryPropertyType" substitutionGroup="gml:_geometryProperty" />

```

Figure 4: Declarations of the WMS

This WMS is then implemented into the Website of the project POLYCITY, what is shown in the following picture:

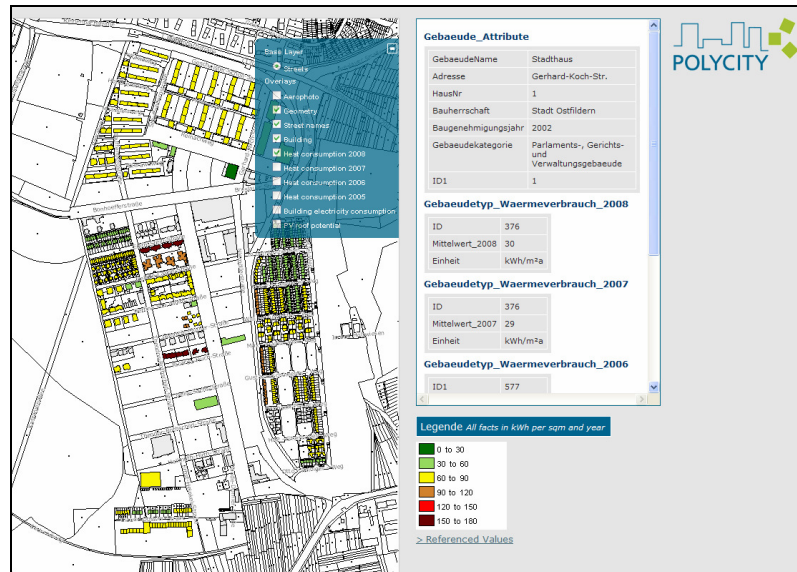


Figure 5: POLYCITY-Web GIS Application (Heating energy consumption 2008)

## 6. Conclusions

This paper makes an attempt to describe the visualization and publication of the energy consumption data of the buildings in Scharnhäuser Park. This work is carried out within the project called POLYCITY funded by European Union. A web portal is designed having furnished with the maps and non-spatial attribute data regarding building energy consumption. This portal provides a certain level of interactivity for the users like viewing the attributes. The thematic maps show the annual average values of heating and electricity consumption for different building types. Other available specific information can also be provide through password protected system Analysis shows significant differences between the energy consumption of the individual buildings and the category to which the building belong to. The reduction of energy consumption could be achieved by changing the user's behavior as the web portal would make an increasing awareness about the status of consumption.

The outcome of this paper will be integrated into the POLYCITY project to make the city of Ostfildern as energy efficient and susatinable for urban dwellers. Later this idea can be replicated for other cities in European countries. The result can also be interesting for urban planners, managers from utility supply companies, architects and engineers and so on.

## REFERENCES

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