The design of the GIS application for the commune administration in Poland

Agnieszka CHOJKA, Poland

Key words: commune, GIS, GIServices, INSPIRE, MDA

SUMMARY

This paper relates to the adaptation of the modern software development technology – the MDA (Model Driven Architecture) to build the GIS (Geographical Information System) at the commune level in Poland. This technology, worked out by the OMG (Object Management Group), is a standard applied to build Spatial Data Infrastructures. Furthermore, this paper presents some practical examples of GIServices at the level of a commune. Providing users with integrated geographic services is one of the ESDI (European Spatial Data Infrastructure) tasks, and building ESDI is the general aim of the INSPIRE directive.

Using the MDA technology, the dedicated GIS was created. The system is designed for the commune administration and the property valuer to support spatial decisions making in the commune, especially in designing the local development project and its economic effects. The goal of the GIS is also an improvement of information flow among the commune administration, its partners (e.g. property valuer) and the citizens.

The built GIS was tested on the case study – the commune of Ujazd. A number of spatial and multi-criteria analyses were carried out and also a few GIServices were designed for: presenting, receiving and visualizing spatial data.

The performed tests of the system showed its full ability to substantially improve planning processes and land management at the commune level.

Design and realization of the GIS project for the commune administration led to a conclusion that: ability to carry out analyses of different scenarios of spatial development and their economic effects, 2D and 3D graphic visualization of analyses' results, improve significantly the spatial decisions making in the commune as well improve significantly the tasks of the property valuer in the range of preparing the economic forecast of passing the local development project. Furthermore, the used interactive form of the development project's presentation in the Internet gives a greater opportunity for community to participate in the processes of passing the planning documents. Moreover, common access in the commune to GIServices is the basis for building the Local Spatial Data Infrastructure.

The design of the GIS application for the commune administration in Poland

Agnieszka CHOJKA, Poland

1. INTRODUCTION

The public administration is the largest consumer of GIS solutions, in particular the commune administration. The majority of tasks realized by the units of the public administration have the spatial reference.

The GIS solutions accelerate considerably and facilitate the processes of making spatial decisions by the public administration (the possibility of working out the readable, graphic, interactive analyses) on the one hand, on the other hand they make possible the society participation in these processes, through the constant and easy access to every information connected with the terrain, e.g. GIServices, such as: presenting, receiving or 3D visualizing of spatial data.

Moreover, using GIS tools in communication between administration and citizens, not only improves significantly the exchange of data and information between them, but also improves the skills of the society in the range of utilization modern tools and IT services (so-called „digital literacy").

This paper is based on the author's PhD thesis with the title "The GIS project for the commune administration and the property valuer", defended on the Faculty of Geodesy and Land Management, at the University of Warmia and Mazury in Olsztyn, in 2008. The research was done within the realization of the research project No. N526 003 32/0687, funded by The Ministry of Science and Higher Education in 2007-2008.

The subject of research was the adaptation of the modern software development technology – the MDA (Model Driven Architecture) to build the GIS (Geographical Information System) at the commune level in Poland. Both the commune of Ujazd and the property valuer have been used as a case study to work out and test the GIS development technology.

2. CONCEPTION OF THE GIS

The system is designed for the commune administration and the property valuer to support spatial decisions making in the commune, especially in designing the local development project and its economic effects. The goal of the GIS is also an improvement of information flow among the commune administration, its partners (e.g. property valuer) and the citizens.

It was assumed that the system consists of two related modules (figure 2.1.), which fulfil following foundations:

– **commune-valuer module ("back-office" module):**

– GIS improving ”internal” administration process, accessible only for the commune office workers and the partners of the commune (e.g. property valuer),
– GIS supporting spatial decisions making in the commune – abilities to carry out analyses of different scenarios of spatial development and their economic, social and nature effects.

– **commune-citizens module (”front-office” module):**
  – GIS improving ”external” administration process, supporting the clerks in providing customers (not only citizens of the commune, but also investors, tourists and the others interested) with services,
  – GIS enabling citizens of the commune to participate in the processes of spatial decision making (GIS using PPGIS, Public Participation in the use of GIS).

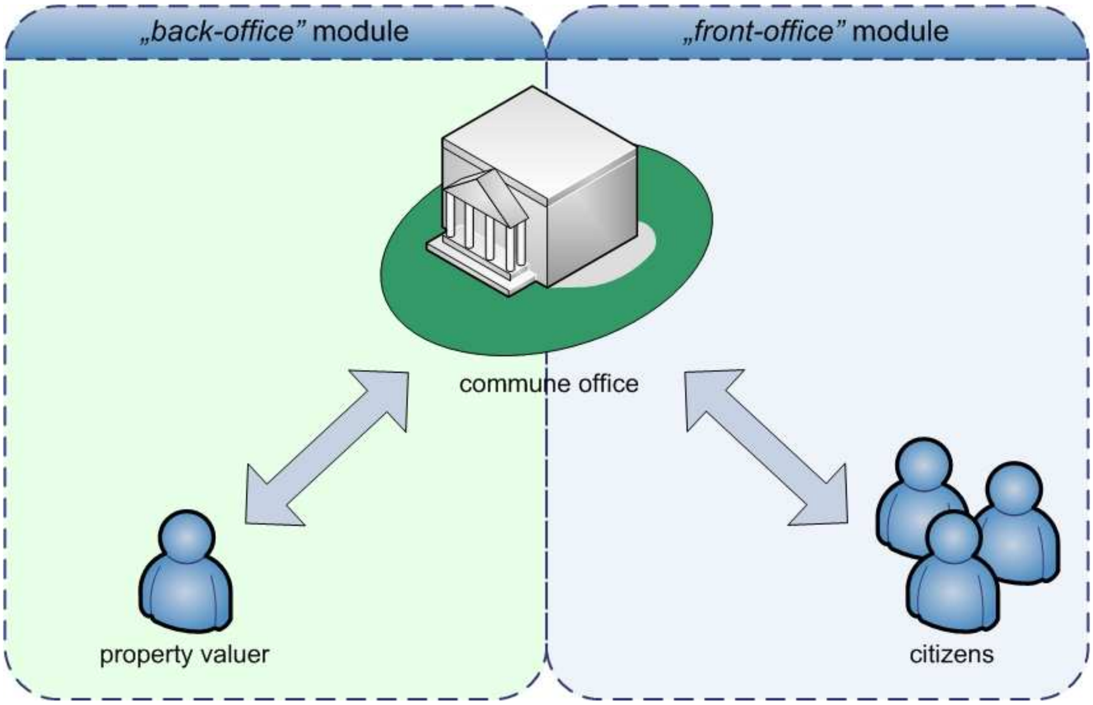

Figure. 2.1. Conception of the GIS.

3. TECHNOLOGY

The main factor, which determined the choice of the GIS development technology, was assuring:
– the quick production of the working system,
– the portability of the system when changing the hardware and software platform.

Realization of the GIS project was done with the use of the object-oriented technology, in this object-oriented analysis and design. Within the confines of the object technology, the following development techniques were used: MDA (Model Driven Architecture), UML (Unified Modeling Language) and Agile Software Development.

The “technological path” applied to build the discussed GIS, using aforementioned techniques and technologies (particularly MDA), is introduced in the figure 3.1.

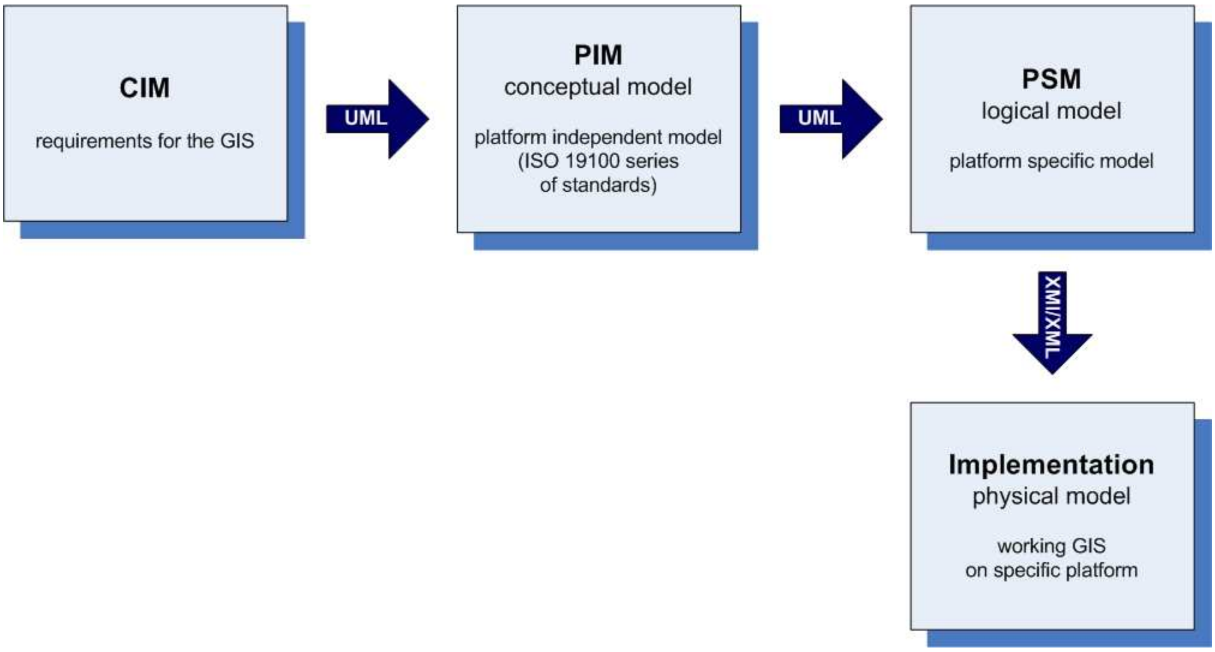

Figure 3.1. Technological path applied to build the GIS.

The MDA technology was worked out by the OMG (Object Management Group), and then in progress of standardization has been adapted to the ISO 19100 series of standards to build the Spatial Data Infrastructures. In this form, the MDA technology is included in the INSPIRE (Infrastructure for Spatial Information in Europe) directive and is recommended to build the ESDI (European Spatial Data Infrastructure).

The key role in the MDA technology plays modelling the system in the UML language.

Using the MDA technology, the dedicated GIS was created. In the progress of project realization, with the use of the UML language, four more and more detailed models of the system were designed: CIM (Computation Independent Model), PIM (Platform Independent Model), PSM (Platform Specific Model) and Implementation Model.

4. MODELS

According to MDA conception, four models of the GIS system were designed (CIM, PIM, PSM and Implementation). In each MDA model, three UML models were distinguished (architecture model, data structures model and behaviour model), in which different UML diagrams were used, among other things: class diagrams, deployment diagrams and activity diagrams (see figure 4.1.).

UML models \ MDA models	CIM	PIM	PSM	Implementation
architecture	dictionary	deployment diagram	deployment diagram component diagram	system architecture
data structures		package diagram class diagram	package diagram class diagram	data structures
behaviour	use case diagram	activity diagram	activity diagram sequence diagram	functions, algorithms

Figure 4.1. GIS models review.

4.1 CIM

Computation Independent Model is a model (or set of models) that presents the requirements for the system. This model shows the system in the environment in which it will operate, and thus it helps in presenting exactly what the system is expected to do. It may hide much or all information about the use of automated data processing systems. CIM is sometimes called a domain model or a business model. Typically such a model is independent of how the system is implemented.

In discussed GIS, CIM consists of functional requirements, where description of users of the system, use case diagram and dictionary of terms of the project were distinguished.

4.2 PIM

Platform Independent Model is a model (or set of models) that describes the system, but does not show details of its use of its platform. PIM is a counterpart of conceptual model of the system in the traditional software development.

In discussed GIS project, PIM consists of architecture model (figure 4.2.), data structures model (figure 4.3. and 4.4.) and behaviour model, which presents the dynamic aspects of the system.

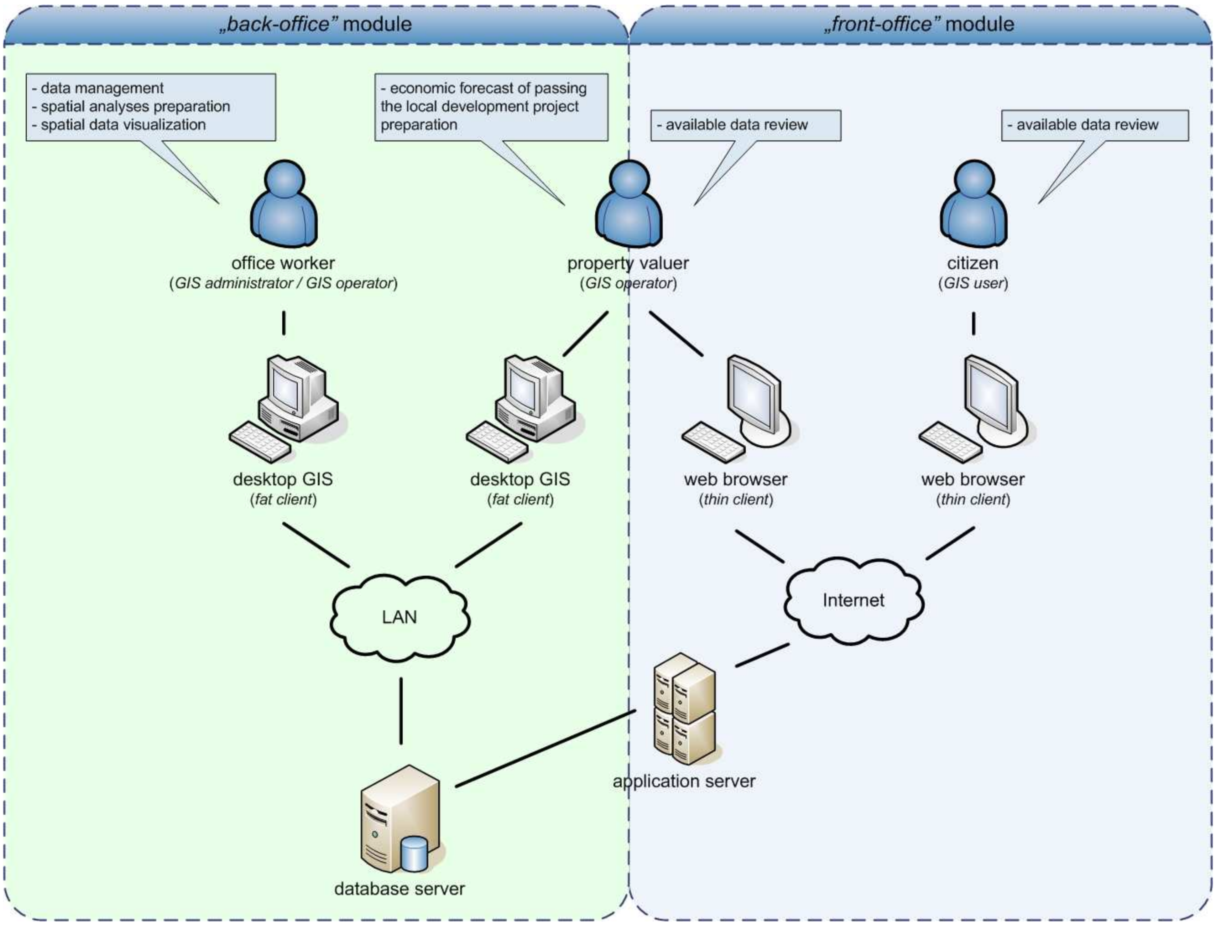

Figure 4.2. General GIS architecture – deployment diagram.

Architecture of the "front-office" module, meant for citizens of the commune, can be considered in the context of SOA (Service Oriented Architecture). The commune office can make various GIServices (e.g. presenting, receiving or visualizing spatial data) available to local community (not only citizens, but also investors, tourists, partners – e.g. property valuer).

Assumed structure for the designed GIS, especially for the "front-office" module, is also included in the INSPIRE directive worked out by the European Committee. This initiative leads to build the ESDI (European Spatial Data Infrastructure), which task is among other things providing users with integrated geographic services in the range of visualizing, linking information and carrying out spatial and temporal analyses.

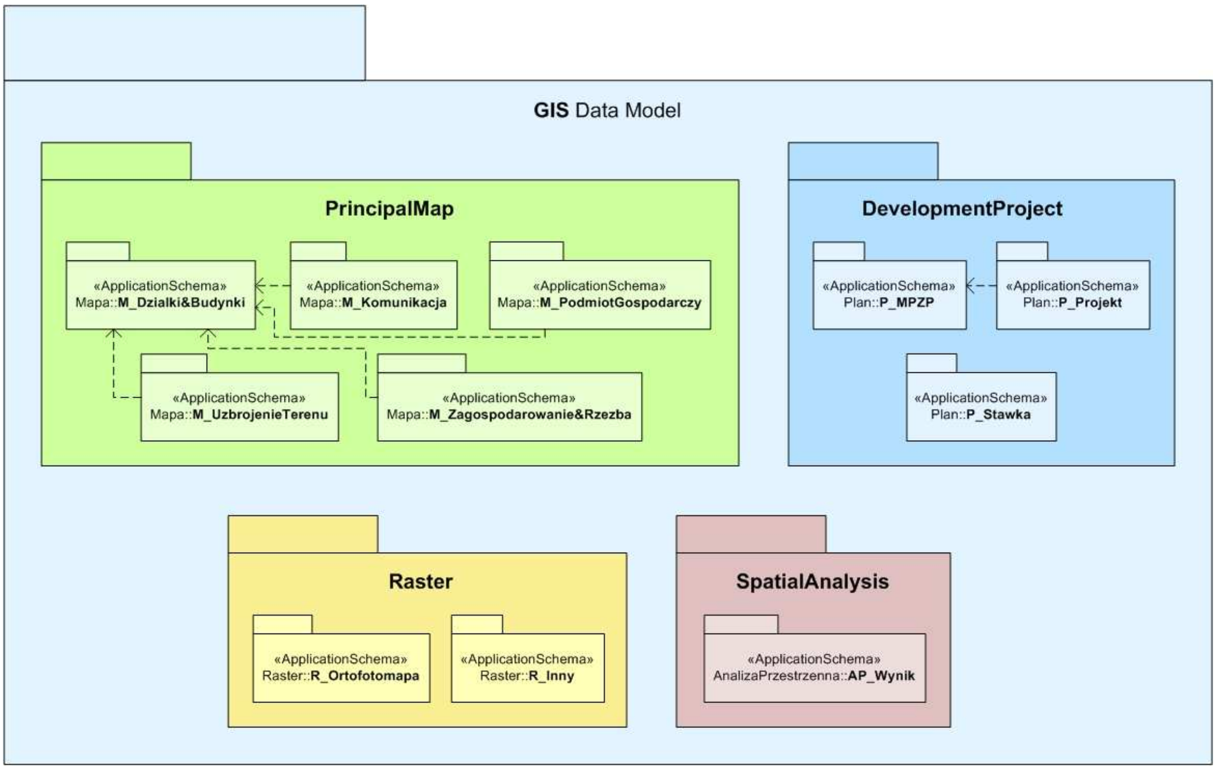

Figure 4.3. GIS Data Model with Application Schemas.

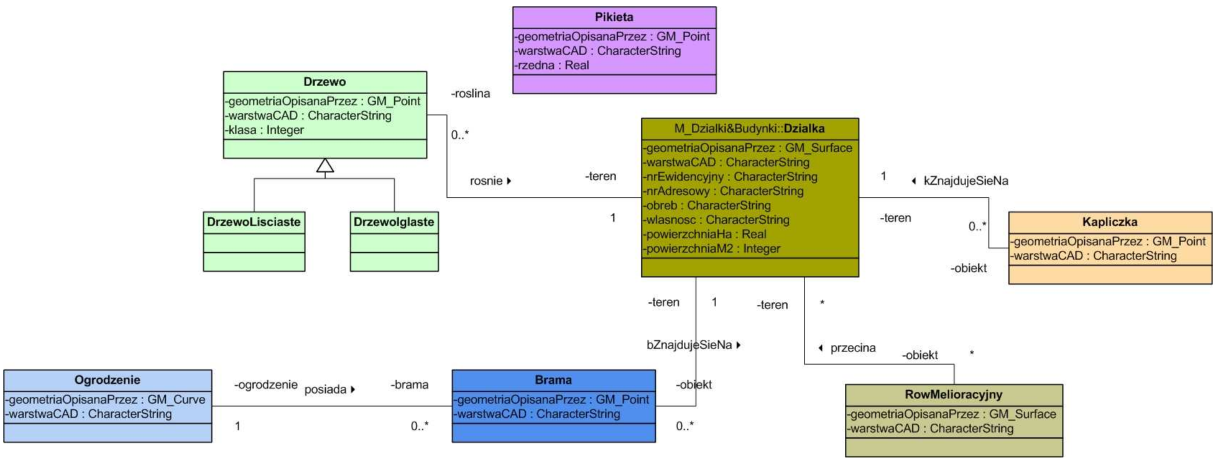

Figure 4.4. Class diagram in *M_Zagospodarowanie&Rzezba* Application Schema.

4.3 PSM

Platform Specific Model is a model (or set of models) of the same system specified by the PIM. It also specifies how that system makes use of the chosen platform. It may provide more or less detail, depending on its purpose. PSM is a counterpart of logical model of the system in the traditional software development.

In discussed GIS project, PSM was designed for the following platform:
– hardware: PC,
– operating system: Windows,
– GIS software: ESRI ArcGIS.

Similarly as in the case of the PIM, PSM consists of architecture model, data structures model and behaviour model.

4.4 Implementation Model

Implementation is a counterpart of physical model of the system in the traditional software development. It is physically working product.

Implementation of the discussed GIS proceeded in two stages: suitable hardware and software configuration and implementation of the geodatabase for GIS.

5. TESTING GIS

The built (designed and implemented) GIS was tested on the case study – the data for the commune of Ujazd. A number of spatial and multi-criteria analyses were carried out and also a few GIServices were designed for:
– presenting spatial data – WMS (Web Map Service), see figure 5.1.,
– receiving spatial data in the GML (Geography Markup Language) format – WFS (Web Feature Service), see figure 5.2.,
– carrying out simple spatial analyses (e.g. querying, buffering) – WebGIS (interactive GIS application accessible via Internet, operating by web browser), see figure 5.3.,
– 3D visualization of spatial data – interactive portable 3D visualizations and animations, see figure 5.4.

Above-mentioned services should be offered to all interested, e.g. local community, businesses or organizations. At the level of the commune the office of the commune can be and should be a provider of such services.

Figure 5.1. Example of Web Map Service.


```
<?xml version="1.0" encoding="UTF-8" ?>
- <wfs:FeatureCollection xmlns:esri="http://www.esri.com/esri" xmlns:gml="http://www.opengis.net/gml" xmlns:wfs="http://www.opengis.net/wfs"
  xmlns:ogc="http://www.opengis.net/ogc" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://www.esri.com/esri
  http://ngis:80/wfsconnector/com.esri.wfs.Esrimap/Plan65_FSaxl?request=describefeaturetype&service=WFS&version=1.0.0
  http://www.opengis.net/wfs http://ngis:80/wfsconnector/schema/wfs/1.0.0/WFS-basic.xsd">
- <gml:boundedBy>
  - <gml:Box srsName="EPSG:4326">
      <gml:coordinates>4557195.85281482,5577620.42965324 4558352.65415903,5578933.43830007</gml:coordinates>
    </gml:Box>
  </gml:boundedBy>
- <gml:featureMember>
  - <esri:Teren-2 fid="Teren-2.1">
    - <gml:multiPolygonProperty>
      - <gml:MultiPolygon srsName="EPSG:4326">
        - <gml:polygonMember>
          - <gml:Polygon>
            - <gml:outerBoundaryIs>
              - <gml:LinearRing>
                  <gml:coordinates>4557488.27123147,5578933.43830007 4557554.08278355,5578929.18940344
                    4557615.53703861,5578925.09359191 4557677.62858877,5578921.06678007
                    4557687.85771406,5578918.8602909 4557720.44814252,5578915.45057973
                    4557765.87584291,5578912.94240562 4557805.98727453,5578910.13605787
                    4557815.10499449,5578908.53261413 4557894.90629745,5578902.82552326
                    4557944.0243407,5578899.38599331 4557956.9194933,5578898.24240688 4557982.64864359,5578896.02749992
                    4557980.56645189,5578883.30037475 4557979.75147972,5578878.31903463
                    4557978.77039054,5578872.32932213 4557977.15674167,5578862.4527438 4557974.9820344,5578850.61283867
                    4557974.20663666,5578845.60349143 4557887.22217154,5578853.7916707 4557885.14159032,5578840.5109488
                    4557885.06602095,5578840.51766176 4557603.14978126,5578865.56080117
                    4557483.47778385,5578874.56970289 4557474.16431949,5578875.27081999
                    4557476.09446777,5578883.59157468 4557488.27123147,5578933.43830007</gml:coordinates>
                </gml:LinearRing>
              </gml:outerBoundaryIs>
            </gml:Polygon>
          </gml:polygonMember>
        </gml:MultiPolygon>
      </gml:multiPolygonProperty>
      <esri:warstwa_ca>Linie rozgran MN PU NO</esri:warstwa_ca>
      <esri:przeznacze>MN</esri:przeznacze>
      <esri:opis>teren zabudowy mieszkaniowej jednorodzinnej</esri:opis>
      <esri:id_obszarp>1</esri:id_obszarp>
      <esri:shape_leng>1120.21784309</esri:shape_leng>
      <esri:shape_area>29394.2037248</esri:shape_area>
    </esri:Teren-2>
  </gml:featureMember>
```


Figure 5.2. Example of Web Feature Service.

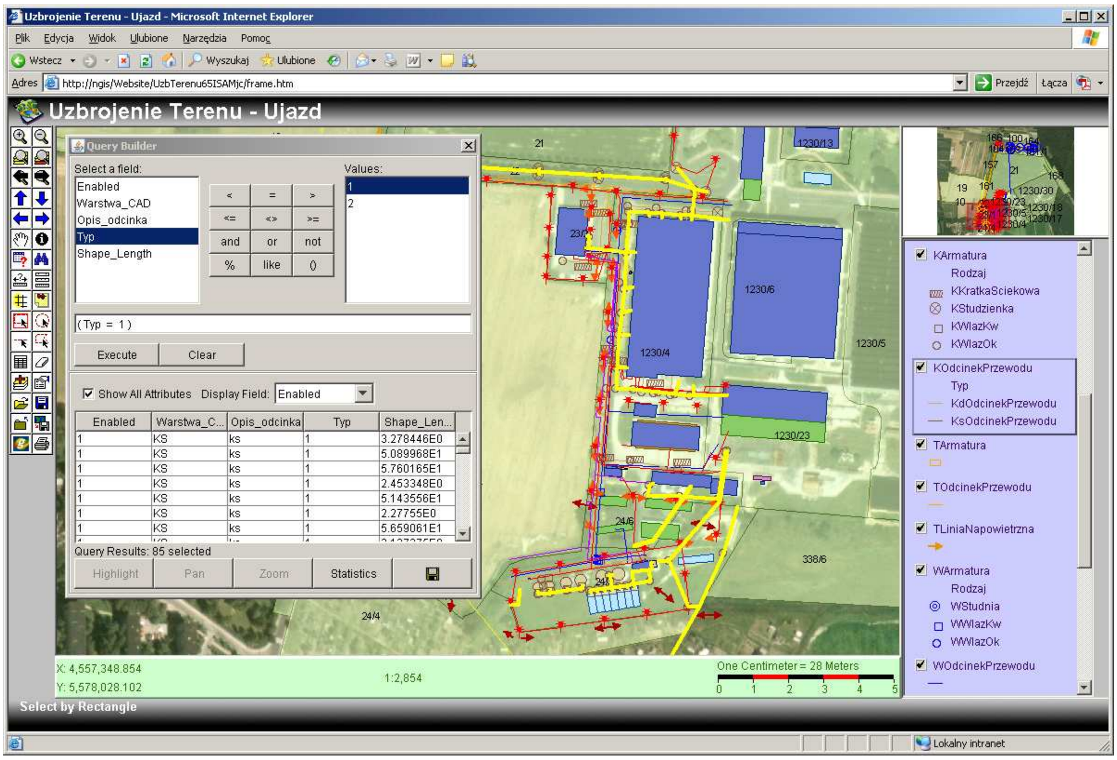

Figure 5.3. Example of WebGIS.

Figure 5.4. Example of 3D visualization of spatial data (SiteBuilder 3D – sharable and portable 3D scenes).

6. CONCLUSIONS

The performed tests of the system showed its full ability to substantially improve planning processes and land management at the commune level.

Design and realization of the GIS project for the commune administration and the property valuer, led to a conclusion that:
- ability to carry out analyses of different scenarios of spatial development and their economic, social and nature effects,
- 2D and 3D graphic visualization of analyses' results,

improve significantly the spatial decisions making in the commune as well improve significantly the tasks of the property valuer in the range of preparing the economic forecast of passing the local development project.

Furthermore, the used of interactive form of the development project's presentation in the Internet gives a greater opportunity for community to participate in the processes of passing the planning documents. Moreover, common access in the commune to GIServices is the basis for building the Local Spatial Data Infrastructure.

The presented technology can be implemented by any commune in Poland to build a system according to own requirements.

REFERENCES

Ambler S. W. 2004. *The Object Primer, Third Edition. Agile Model-Driven Development with UML 2.0*. Cambridge, UK, Cambridge University Press.

Chojka A. 2008. *The GIS project for the commune administration and the property valuer*. PhD thesis. University of Warmia and Mazury in Olsztyn.

Cockburn A. 2002. *Agile Software Development*. USA, Addison Wesley.

Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE).

ISO 19128 : 2005 *Geographic information – Web map server interface*.

ISO/CD 19136 : 2004 *Geographic information – Geography Markup Language*.

ISO/CD 19142 : 2006 *Geographic information – Web feature service*.

MDA Guide Version 1.0.1. 2003. www.omg.org/mda

BIOGRAPHICAL NOTES

Agnieszka Chojka, born in 1979, in Tomaszów Mazowiecki, Poland. Since 2003 MSc – computer science engineer, Technical University of Lodz (Poland), Faculty of Physics, Computer Science and Mathematics, major in Computer Science with specialization in Computer Graphics. Since 2004 research worker and academic teacher at the University of

Warmia and Mazury in Olsztyn (Poland), Faculty of Geodesy and Land Management, Department of Surveying. In 2008 defended PhD thesis on the Faculty of Geodesy and Land Management, at the University of Warmia and Mazury in Olsztyn.

CONTACTS

PhD Agnieszka Chojka
University of Warmia and Mazury in Olsztyn, Faculty of Geodesy and Land Management, Department of Surveying
ul. Heweliusza 12, 10-724 Olsztyn
Olsztyn
POLAND
Tel. +48 089 523 35 86
Fax +48 089 523 48 78
Email: agnieszka.chojka@uwm.edu.pl
Web site: www.uwm.edu.pl, www.geo.kortowo.pl