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GEOPORTAL FOR SEARCHING AND VISUALIZATION OF CADASTRAL DATA

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Abstract:

Geoportal is an indispensable part of the national spatial data infrastructure and a central point of access to spatial data. The paper presents the development of a geoportal based on the principles of service-oriented architecture. Open source frameworks and libraries were used to create geoportal. The aim of the paper is to present a partially different approach to the development of geoportals, based on the modern principles of web application development. The case study was conducted for the cadastral municipality of Brod, the municipality of Brod, Republika Srpska, Bosnia and Herzegovina.

Keywords: land administration, cadastral data, geoportal

ГЕОПОРТАЛ ЗА ПРЕТРАЖИВАЊЕ И ВИЗУЕЛИЗАЦИЈУ КАТАСТАРСКИХ ПОДАТАКА

Резиме:

Геопортал представља незаобилазан дио националне инфраструктуре геопросторних података и централну тачку приступа геопоросторним подацима. У раду је приказана израда геопортала за приказ катастарских података заснована на принципима сервисно-оријентисане архитектуре. За израду геопортала коришћена су развојна окружења и библиотеке отвореног кода. Циљ рада је приказ дјелимично другачијег приступа развоју геопортала, заснованог на савременим принципима развоја веб апликација. Студија случаја рађена је за катастарску општину Брод, општина Брод, Република Српска, Босна и Херцеговина..

Кључне ријечи: земљишна администрација, катастарски подаци, геопортал

1. INTRODUCTION

In order to integrate the land administration system in the Republic of Srpska and Bosnia and Herzegovina into European frameworks, it is necessary to implement the European recommendations and directives, primarily INSPIRE [1]. This Directive provides general rules for the establishment of national infrastructures for spatial information in Europe and obligates the institutions which are owners or who have the competence over spatial information defined in the 34 themes of INSPIRE Directive to make them publicly available. Accessibility is provided through geoportals, which represent the core of the geospatial data infrastructure and a central point for accessing and using data from the jurisdiction of different institutions. The paper presents a model of geoportal for the search and visualization of cadastral data, and a case study was conducted for the cadastral municipality of Brod, the municipality of Brod, Republika Srpska, Bosnia and Herzegovina. The displayed data were used exclusively for the purpose of research.

2. MATERIALS AND METHODS

As part of the research, the analysis and valorization of available literature in the field of research was carried out, and a special emphasis was placed on research carried out in the Balkans region. Methods of analysis, synthesis, comparisons were used, and through the case study by the method of modeling, a geoportal based on the principles of service-oriented architecture was realized.

2.1. RESEARCH AREA

In addition to the conducted case study, the paper gives an overview of the situation in the field that is the subject of research in the countries of the Western Balkans. Bearing in mind the European perspective of the countries of the region and the importance of adopting and implementing the INSPIRE Directive, all countries have made certain steps in order to make the geospatial data defined by this directive accessible (Figure 1). The solutions applied differ in the quantity and sources of available geospatial data, as well as the applied technological solutions. Different approaches have been used in the legal regulation of the field of national spatial data infrastructure. In some parts of the region, special laws have been adopted (Albania, Croatia, Macedonia), while in other countries this area has been regulated within the laws regulating the field of state survey and cadastre.

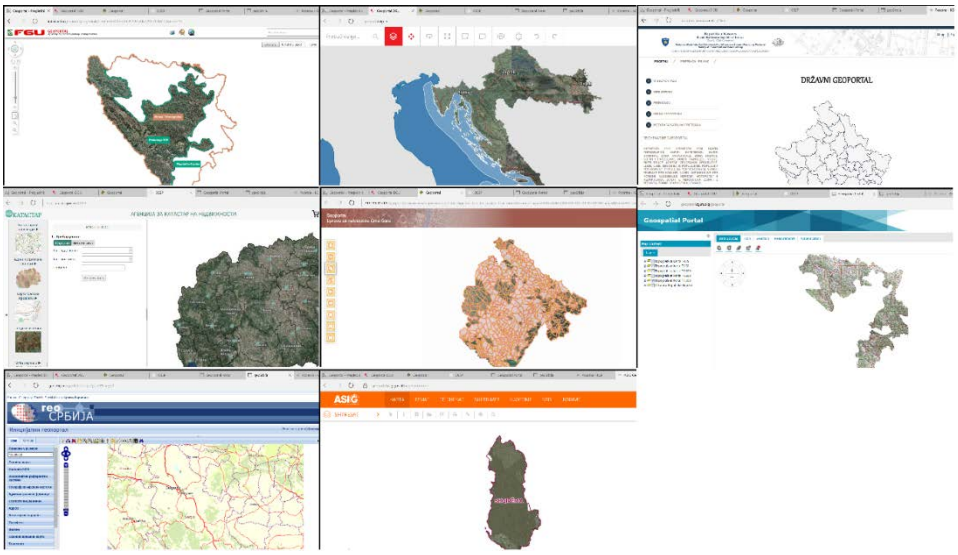


Figure 1.Geoportals of the countries of the Western Balkans

2.2. RECENT RESEARCH

In the countries of the European Union, as well as in the countries of the region, a considerable number of research have been carried out in the area of establishing spatial data infrastructure. A part of the research indicates the importance and role of the cadastre in the national spatial data infrastructure [2] [3]. There are also examples of web real estate cadastre application based on service-oriented architecture and GIS technology [4]. A part of the research carried out in the countries of the region is also relevant to the review of the establishment of spatial data infrastructure from the point of the strategy and the definition of the institutional framework [5], and an overview of the state and results of the implementation of the INSPIRE Directive [6].

3. TECHNICAL SOLUTION

The aim of presented technical solution for geoportal is to ensure modern aproach to web app development and simplicity of use. For the development of geoportal for the display of cadastral data, JavaScript programming language and MERN stack was used (Figure 2). MERN (MongoDB, Express.js, ReactJS, Node.js) is an acronym that is named after the solutions used to implement applications, from the database level (MongoDB), through the service level (Node.js and Express.js) to the user interface (ReactJS). This approach is particularly suitable for creating web applications with a high level of interaction. GeoServer was used to store, style and enable the availability of georeferenced graphic data. To get data from GeoServer, the JavaScript OpenLayers library was used.

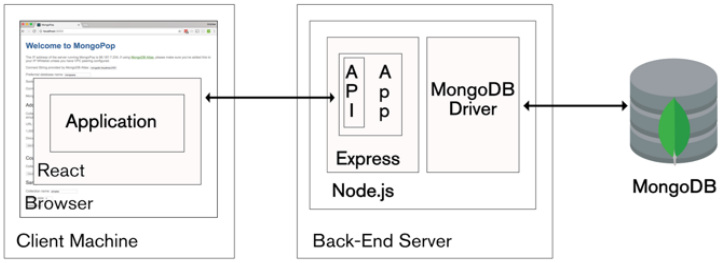


Figure 2. MERN architecture [7]

In the context of software design, components represent modular units with a defined interface [9]. The component diagram shows the organization and relationships between components. A diagram of components for a concrete case study is given in Figure 3.

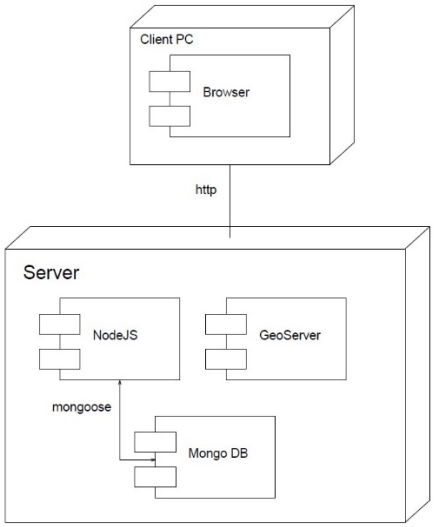


Figure 3. Diagram of components

The Use Case Diagram provides an overview of usage cases, actors, packages and so on. The UML (Unified Model Language) specification often describes the use case diagrams as a class diagram specialization, which are structural diagrams [8]. A diagram of use cases for this case study is given in Figure 4.

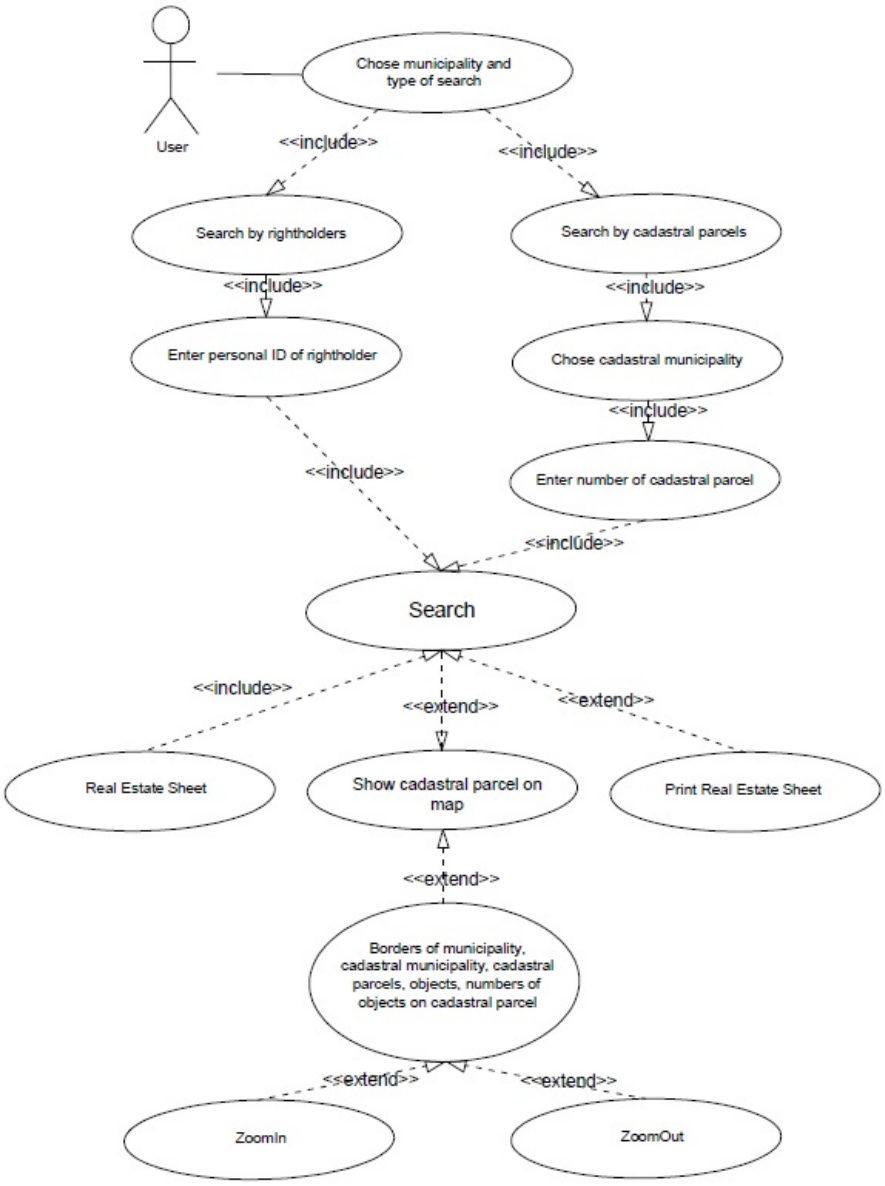


Figure 4. Use case diagram

3.1. DATABASE

For the purposes of the case study, the MongoDB database (NoSQL) was used. The basic characteristics of the MongoDB database are the lack of relationships and documentation based. In the example shown, each database instance represents a single sheet of real estate cadastre stored in a JSON (JavaScript Object Notation) format, or a binary variation of this format known as BSON (where B is a Binary tag) (Figure 5).

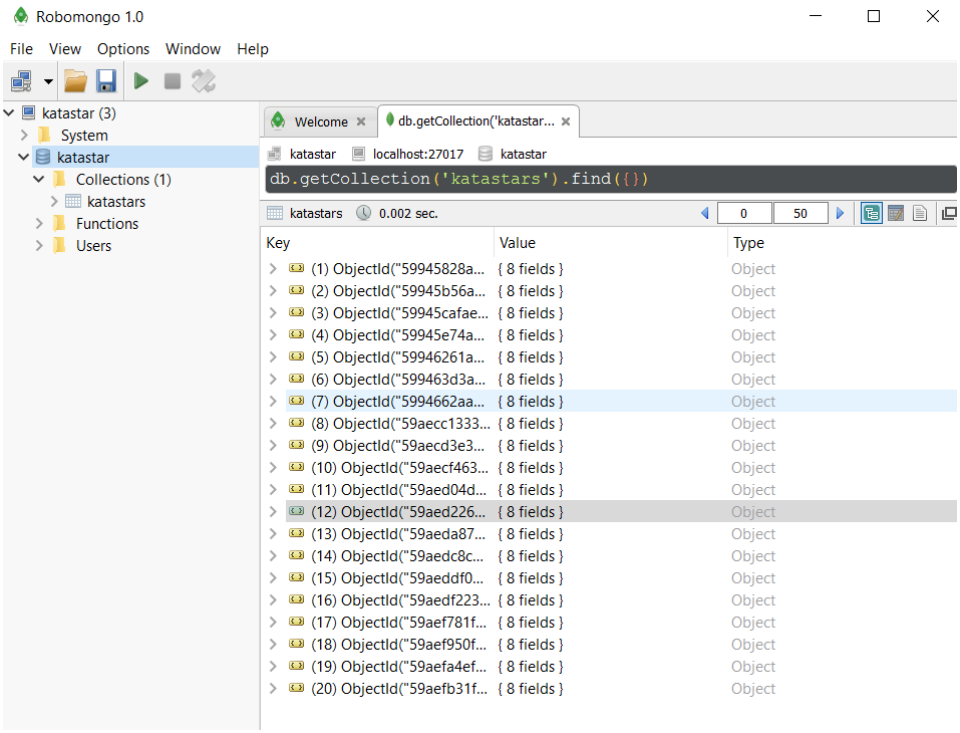


Figure 5. Instances of database

For each document, a unique identifier, ObjectId, is automatically generated, similar to the primary key in SQL databases, and there is the possibility of defining its own unique identifiers. The documents are made up of field-and-value pairs [10], and the structure of the document is given in Figure 6.

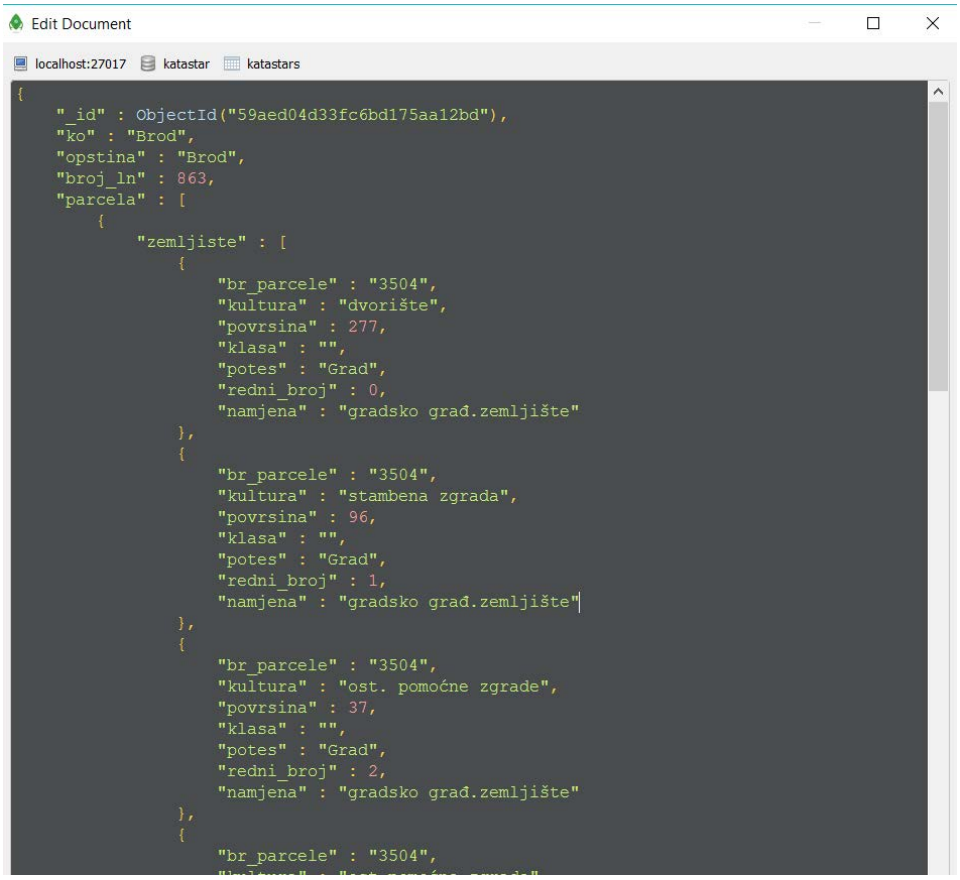


Figure 6. Structure of the real estate sheet No 863 CM Brod in database

3.2. SERVICES

The presented solution is based on the REST (Representational State Transfer) architecture model.

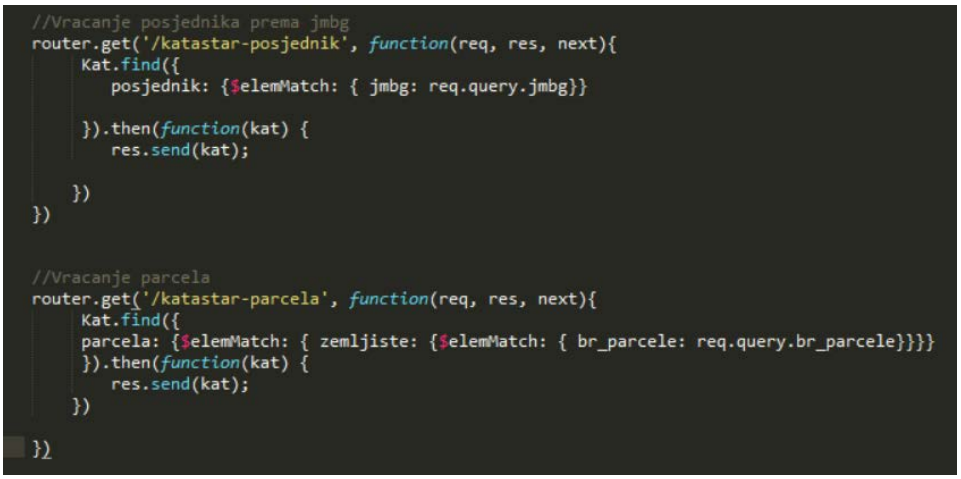
In this case study, two services were used:

- Service for serving alphanumeric data from the database (Express.js service that uses the data contained in the MongoDB database katastar, in the collection of objects katastars) and
- Graphic Data Service (GeoServer to which the graphic data in the .shp format is stored and where the data is styled).

Sending request to the server for displaying the data from the real estate database based on the number of cadastral parcel and identification number of the right holder on immovable property is shown in Figure 7 and retrieving data from database and sending response to client side is shown in Figure 8. Retrieving graphic data in form of feature from GeoServer by using OpenLayers library is shown in Figure 9.

```
// PRETRAGA PO PARCELAMA
pretraziParcele(e) {
   e.preventDefault();
   var br_parcele = this.refs.parcela.value;

   fetch('/api/katastar-parcela?br_parcele='+ br_parcele).then(function(data) {
     return data.json();
   }).then(json => {
     this.setState({br_parcele: json})
   })
   }



 // PRETRAGA PO KORISNICIMA
 handleSubmit(e) {
   e.preventDefault();
   var jmbg = this.refs.posjednik.value;

   fetch('/api/katastar-posjednik?jmbg=' + jmbg).then(function(data) {
     return data.json();
   }).then(json => {
     this.setState({posjednik: json})

   })
   }
```

Figure 7. Request to the server for displaying the data from the real estate list based on the number of cadastral parcel and identification number of the right holder on immovable property



```
//Vracanje posjednika prema jmbg
router.get('/katastar-posjednik', function(req, res, next){
     Kat.find({
        posjednik: {$elemMatch: { jmbg: req.query.jmbg}}

     }).then(function(kat) {
        res.send(kat);

    })
})


//Vracanje parcela
router.get('/katastar-parcela', function(req, res, next){
     Kat.find({
     parcela: {$elemMatch: { zemljiste: {$elemMatch: { br_parcele: req.query.br_parcele}}}}
     }).then(function(kat) {
        res.send(kat);
    })

})
```

Figure 8. Retrieving data from the database and replying to the client side

```
var Opstine_RS = new Vector({
    source: new SourceVector({
        url: 'http://localhost:8080/geoserver/wfs?service=WFS&' +
        'version=2.11.1&request=GetFeature&typenames=brod:Opstine_RS&' +
        'outputFormat=application/json&srsname=EPSG:3857&' + 'Access-Control-Allow-Origin:*',
        format: new GeoJSON()
    }),
    style: new STYLE({
      stroke: new Stroke({
        color: 'rgba(0, 0, 255, 1.0)',
        width: 2,
       label: "${Opstina_RS}",

      }),
    }),
    visible : true,
});


var koRS = new Vector({
    source: new SourceVector({
        url: 'http://localhost:8080/geoserver/wfs?service=WFS&' +
        'version=2.11.1&request=GetFeature&typenames=brod:NM_RS&' +
        'outputFormat=application/json&srsname=EPSG:3857&' + 'Access-Control-Allow-Origin:*',
        format: new GeoJSON()
    }),
    style: new STYLE({
      stroke: new Stroke({
        color: ' #eeeeee',

        width: 2

      }),
    }),
    visible : true,
});
```

Figure 9. Retrieving vector data from GeoServer via WFS service

4. RESULTS AND DISCUSSION

The user interface is created to allow easy searching and display of alphanumeric and graphic data, and also offers the possibility of printing real estate cadastre sheets (Figure 10, Figure 11). The Javascript library of ReactJS was used for creation.
The display of the contents of the real estate sheet is divided into four groups:

- Rights holders,
- Parcels,
- Objects and rights holders on objects and lots and
- Restrictions and rules.

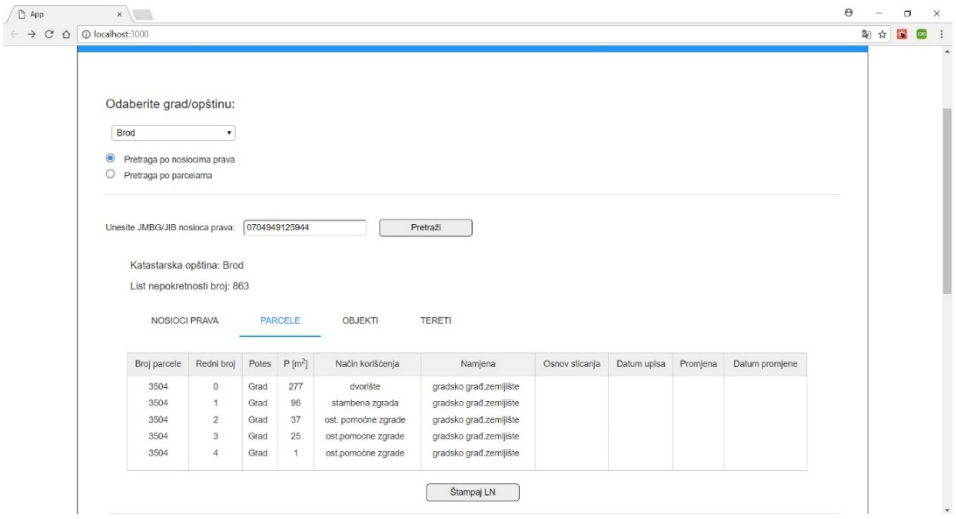


Figure 10. Search result based on identification number of real estate right holder

For each of the above data groups, the values of the following fields from the database, analogue B, A, A1, B1 and V sheet of the real estate sheet are shown:

Table 1. Content of real estate cadastre sheet splitted in categories

Right holders	Parcels	Buildings	Right holders on objects and lots	Restrictions and Rules
Name/Title	Parcel number	Parcel number	Name/Title	Parcel number
Scope of right	Number	Building	Scope of right	Number of restriction
Type of right	Division	Sub-sheet	Type of right	Registration number
Type of property	Area	Use	Sub-sheet	Restriction/rule description
Type of scope	Use	Area	Type of property	Registration date
	Allocation	Address	Type of scope	
	Legal ground for aquisition	Legal ground for aquisition		
	Registration date	Floor		
	Number of amendment	Number of floors		
	Date of amendment	Registration date		
		Number of amendment		

		Date of amendment		

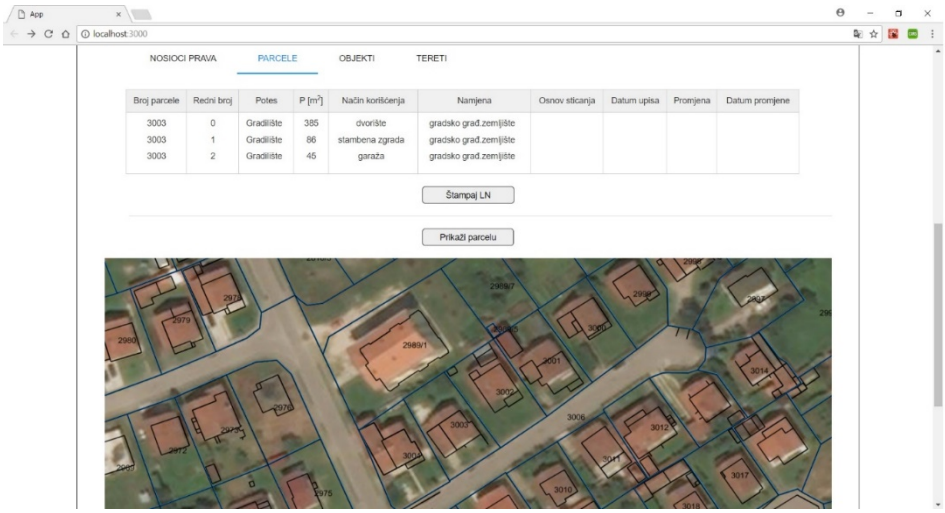


Figure 11. Display of cadastral parcel in the real estate sheet and on the digital cadastral plan

Based on rendered data from GeoServer, there is possibility of displaying the boundaries of political and cadastral municipalities, settlements, cadastral plots and facilities.

5. CONCLUSION

Bearing in mind the rapid development of information and communication technologies and their impact on the field of land administration, it can be concluded that investing in the development of modern services that enable the availability of data from public records through the Internet has complete justification. In the field of geospatial data, special and even primary importance is given to data on real estate, which are under the jurisdiction of state institutions for geodetic and property-legal affairs. Benefits from the implementation of such technologies are multiple, both for users of geospatial data, as well as for different entities within the jurisdiction of a particular type of geospatial data. The solution applied is characterized by a modern approach in terms of used development environments and libraries (Express.js, ReactJS) and ease of user interface.

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