Application of GIS Technologies in maintenance and development of a Gas Transmission System

by **Iva Juretić and Vanja Skopljak Štulić**

The main role of GIS, in addition to providing spatial data, is to create analysis based on the spatial data and other input parameters for the purpose of the continuous monitoring and determination of the most suitable corridors and locations for the development of the gas transmission system. During the last ten years, Plinacro has been using and developing GIS on the ArcGIS platform, which serves to improve multiple business processes. This article will present all the benefits that GIS offers when integrated with other IT systems and included in the multiple business processes of the natural gas transmission company.

1. INTRODUCTION

Plinacro was founded by unbundling of the natural gas transmission activity from INA's former organizational structure into a separate daughter company on 19 January 2001, when the Croatian Government enacted the package of energy regulations necessary for further reform of the energy sector. According to those regulations, gas transmission became an energy activity performed as a public service, while on 11 March 2002, Plinacro became a 100% state-owned company. In April 2002, pursuant to the Gas Market Act, Plinacro prepared a Plan of Development, Construction and Modernisation of the Gas Transmission System in the Republic of Croatia from 2002 to 2011. The implementation of this Plan ensured 95% coverage of the Croatian territory with the gas transmission system **(Figure 1)**.

Today Plinacro manages approx. 2700 km of high-pressure gas pipelines (50–75 bar), 7 entry measuring stations and more than 450 overhead objects of the transmission system, including 157 exit measuring-reduction stations with 282 measuring lines. The total technical capacity of the transmission system entry amounts to 191,800,000 kWh/day.

In 2001 Plinacro took over spatial data from INA. It is important to realize that these data have not been systematized or organized and most of the data were analogue. In the meantime, the development and construction of a new gas transmission network began so the systematic monitoring of the construction and "right to use" registration was of great importance as well as daily reporting and visualization.

The challenge was to design and build a system that will enable unambiguous and quality spatial data management in a single database to make this information available to people of different professions and useful in different business processes.

For this purpose in 2006 Plinacro introduced GIS - Geographic Information System.

GIS is now used in various business processes for maintaining and developing the gas transmission system that will be discussed below.

2. GIS AND INTEGRATION WITH OTHER INFORMATION SYSTEMS

2.1 GIS – Geographic Information System

On the whole, GIS (Geographic Information System) is a natural part of IT technology which enables organization, presentation and analyses of spatial data. In Plinacro, it contains all spatial data about objects of gas transmission

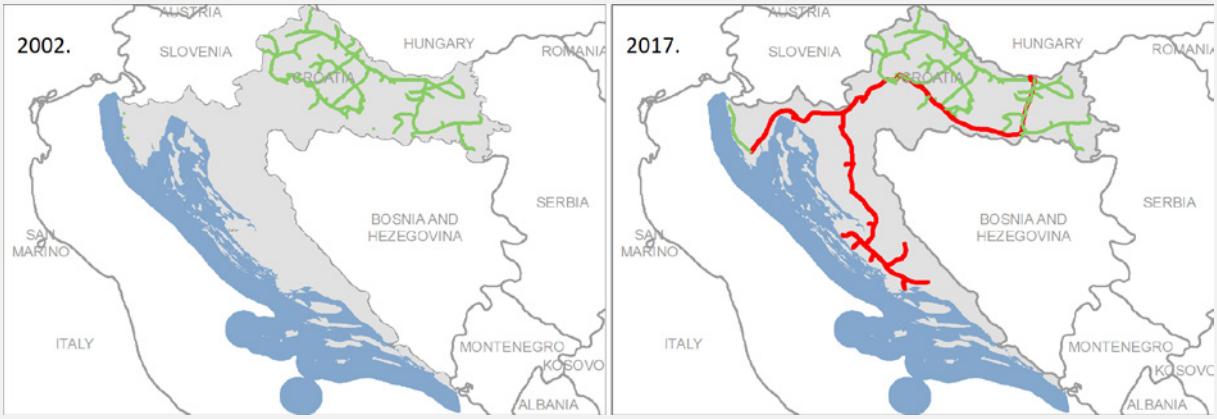

Figure 1: Development, Construction and Modernisation of the Gas Transmission System in the Republic of Croatia from 2002 to 2017

system as well as attribute data. Spatial data are organized into central GIS database of the company, making a unique data resource of technical statement of the entire infrastructure asset.

GIS/TIS (where TIS stands for Technical Information System) was installed in 2006 within the SCADA (Supervisory Control and Data Acquisition) project. GIS is designed as a centralized system on a server - client architecture, using ESRI software and RDBMS - Oracle database.

Before the implementation of GIS, for technical engineering traditional IT technology was used based on CAD tools. By introducing GIS, it was possible to get a unique spatial database of the gas transmission system, which previously was impossible to achieve by using CAD tools. In addition, spatial data have become even more valuable since they have the ability to attach many attributes that describe them. A further advantage is that GIS offers numerous improvements in a visualization of data, complex spatial and statistical analysis, not only spatial relationships but also time events related to gas pipeline entities **(Figure 2)**.

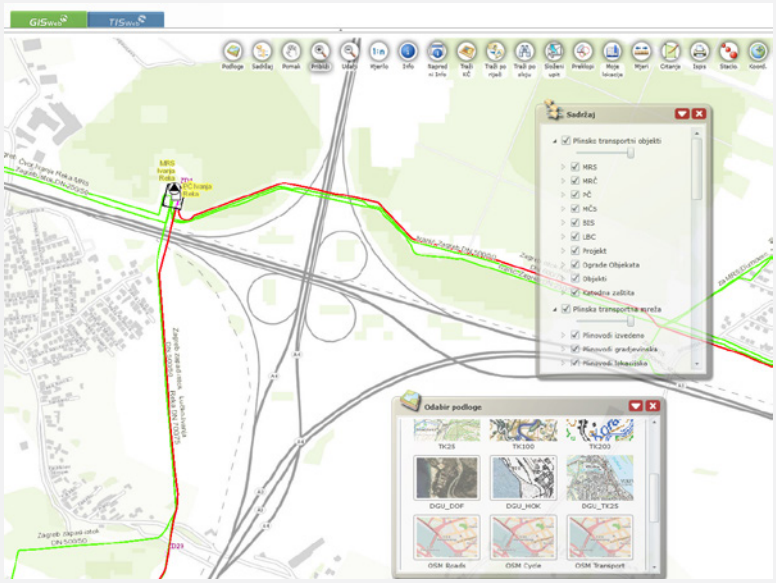

Figure 2: GIS/TIS application

As far as GIS data are concerned there are not only data about objects of the gas transmission system. There are also many other spatial data, for instance: Central registry of spatial units of Croatia, cadastre, raster maps of different scales and purposes, vector data of other users in space, spatial plans, etc.

Since GIS is intended for everyone in the company regardless of their workplace or skills, consequently, it is customized to be used at several user levels. For the largest number of employees, the Web GIS application is sufficient and it is accessible from all computers within the company's intranet via a link, while for the advanced users there are different levels of ArcGIS desktop applications.

Web GIS application is user-friendly and offers an easy access to data to a large number of users which implies browsing, retrieving required information, searching and creating cartographic views according to user's wishes and needs. In addition, through ArcGIS desktop applications advanced users maintain, update and administer a GIS database, create maps, create a variety of models for data visualization, make analyses, plan and design.

2.2 Integration of information systems

Besides this GIS is used in planning, designing and maintaining gas pipelines, GIS supports and collaborates with other IT systems by forming a consolidated technical-technological-financial management system of the company. Generally, in Plinacro are several important IT systems. Each of these systems supports business processes that take place across various departments. Here we are

focusing only on some of them that are closely related, i.e. integrated with GIS.

As stated earlier, GIS is the closest connected with TIS. TIS is the alpha-numeric system for managing data of technical/technological characteristics of the gas transmission system. As an essential resource, integrated GIS/TIS system enables continuous support in project development – beginning with planning and system design phase, through a construction phase up to commissioning as well as during the commercial operation of the pipeline.

The most significant contribution to improvement and acceleration of business processes during intense investment cycles was enabled by the integration of GIS with the Legal Property Rights Information System (LPRS) and Business and Financial Information System (ERP).

Fast pipeline network territorial expansion has resulted in the multiplication of handling information. This particularly applies to data on cadastral parcels, because the Croatian law provides an obligation to register "right to use" into Land Registry on every cadastral parcel which the pipeline crosses. Considering the fact that it is necessary to monitor status on thousands of cadastral parcels on daily basis it was essential to develop an "Automatic process control" to improve workflow. Thus, after establishing the LPRS containing textual data on cadastral parcels and other supporting documents as well as various contracts, began the process of integration with the ERP containing financial data and with the GIS that provided the spatial component. The most logical choice for a common identifier between all these systems was an ID of the cadastral municipality and ID of the cadastral parcel **(Figure 3)**.

3. APPLICATION OF GIS TECHNOLOGIES IN A GAS TRANSMISSION SYSTEM

Noting that the location is critical to almost every aspect of Plinacro pipeline business, the ability to know and communicate the exact location of any point or part of a pipeline and the events that happen on it is essential. Achieving this requires the GIS team to manage and maintain a vast amount of information about transmission system. Due to the amount of information it contains, the ability to manage, process, analyse, view and combine different types of data, both spatial and attribute, GIS supports different business processes. Here are some of the business processes that GIS supports on a daily basis **(Figure 4)**:

- Pipeline security corridors – according to the Ordinance on the technical conditions and standards for the safe transportation of the liquefied and gaseous hydrocarbons by the main pipelines and the pipelines for the international transport, (Official gazette no. 26/1985) Plinacro is obliged to protect corridor 30+30m around pipelines. This means that in this corridor construction is restricted and strictly defined by the applicable regulations. Therefore, Plinacro issues technical conditions for the construction of any project or activity within the protected corridor. By creating a map, GIS enables us to visualize, question, analyse, and interpret data on the project and pipeline to understand the relationships and influence that the project has on the relevant pipeline corridor so the technical conditions can be defined and issued **(Figure 5)**.

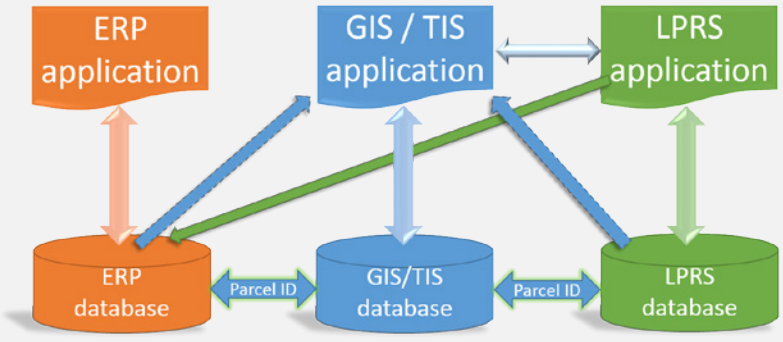

Figure 3: GIS integration with other IT systems

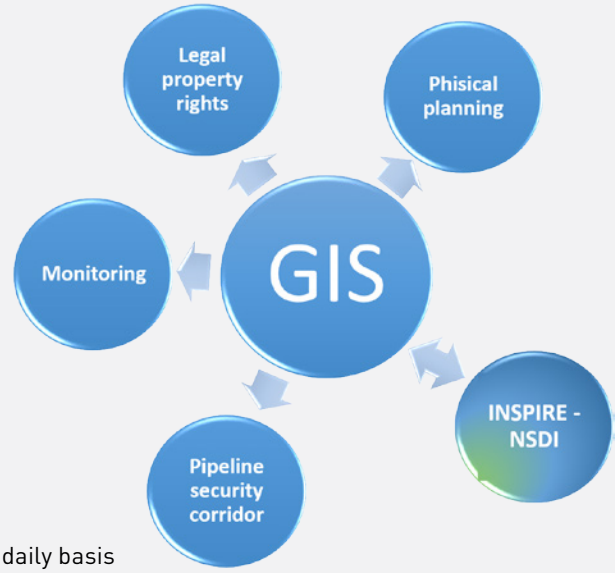

Figure 4: The business processes that GIS supports on a daily basis

- Monitoring – GIS allows us to track changes in a pipeline corridor based on overlapping and comparing different satellite imagery or digital orthophoto made in a different period of time. This way it is easy to monitor environmental changes especially if there is potentially hazardous activity within the pipeline corridor **(Figure 6)**.
- Legal property rights – as mentioned before, GIS enables preparation of graphical reports of "right to use" registration per parcel in a pipeline corridor by managing textual data stored in LPRS and graphical data from GIS. Equally important, every GIS web user can easily get the facts about any parcel in the pipeline corridor by a mouse – click on the relevant parcel in GIS web **(Figure 7)**.
- Physical planning – Plinacro is obliged by law to share its spatial data for the preparation of spatial plans of any kind. These data are prepared in GIS desktop application and delivered to spatial plan makers so they could import these data into their plans. On the other hand, the spatial data concerning the land use and some other infrastructure from spatial plans are imported into GIS for planning and designing routes for new pipelines.
- INSPIRE and NSDI – Infrastructure for Spatial Information (INSPIRE) is Directive 2007/2/EC of the European Parliament and the EU Council of March 14, 2007, which has a goal to integrate spatial data on the European level. INSPIRE is based on spatial data infrastructures of the Member States demanding harmonization of spatial data. So, INSPIRE makes the general framework for National spatial data infrastructure (NSDI) and Plinacro is obliged to participate in it. It means that Plinacro has to harmonize its spatial (GIS) data in accordance with the INSPIRE and NSDI regulations. As a result, spatial data of a gas transmission network will be possible to view, share and integrate with the European spatial data infrastructure both on a national and local level. Plinacro, as an NSDI subject is already registered in NSDI and is preparing spatial

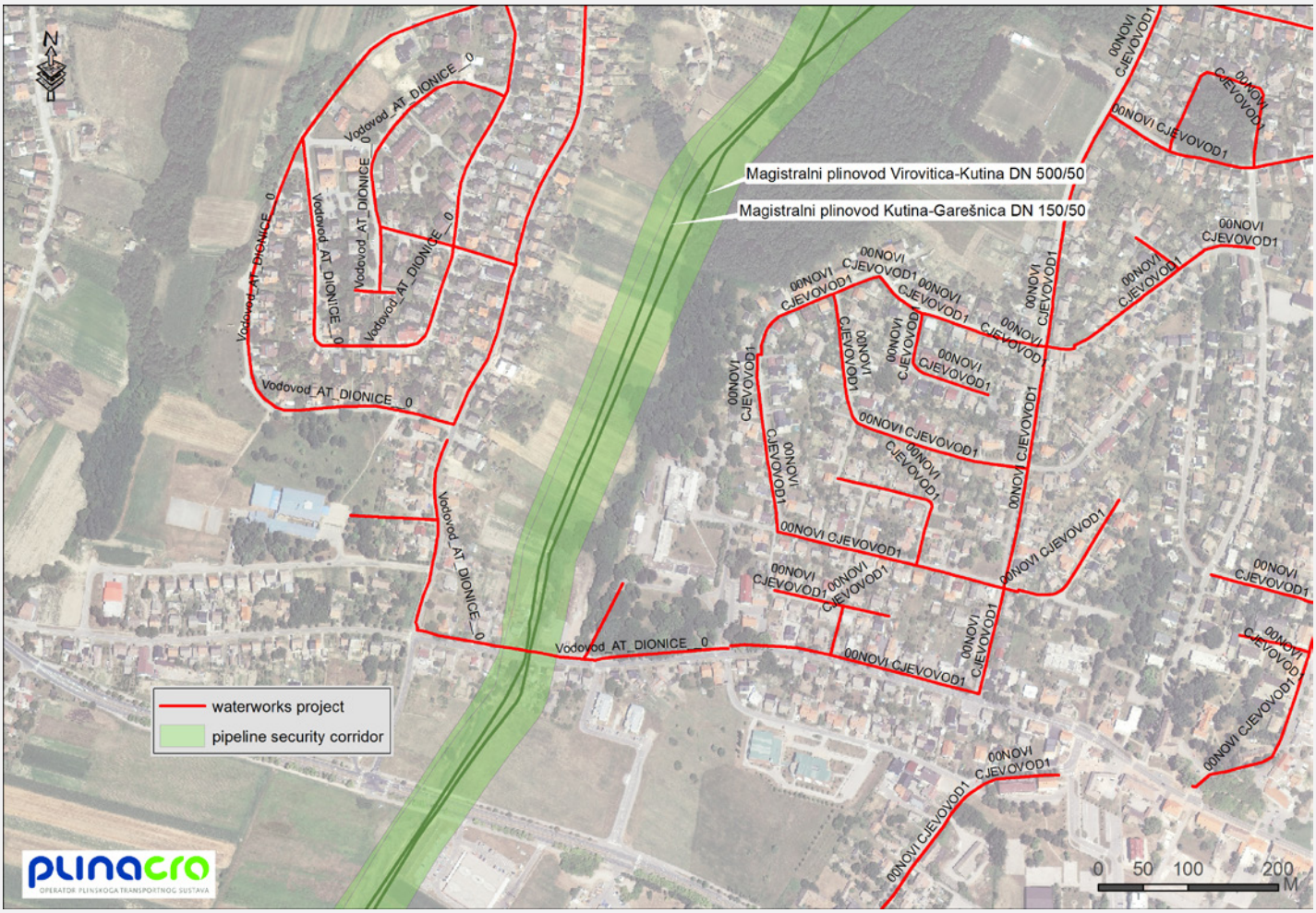

Figure 5: Map of waterworks construction in pipeline security corridor

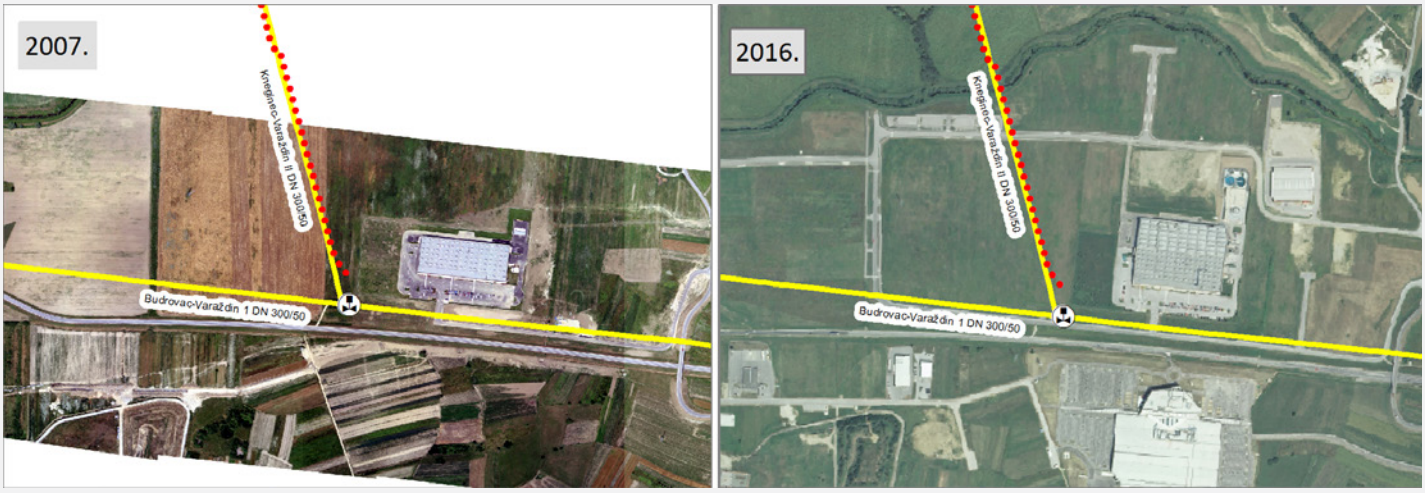

Figure 6: The same location recorded in 2007 and 2016

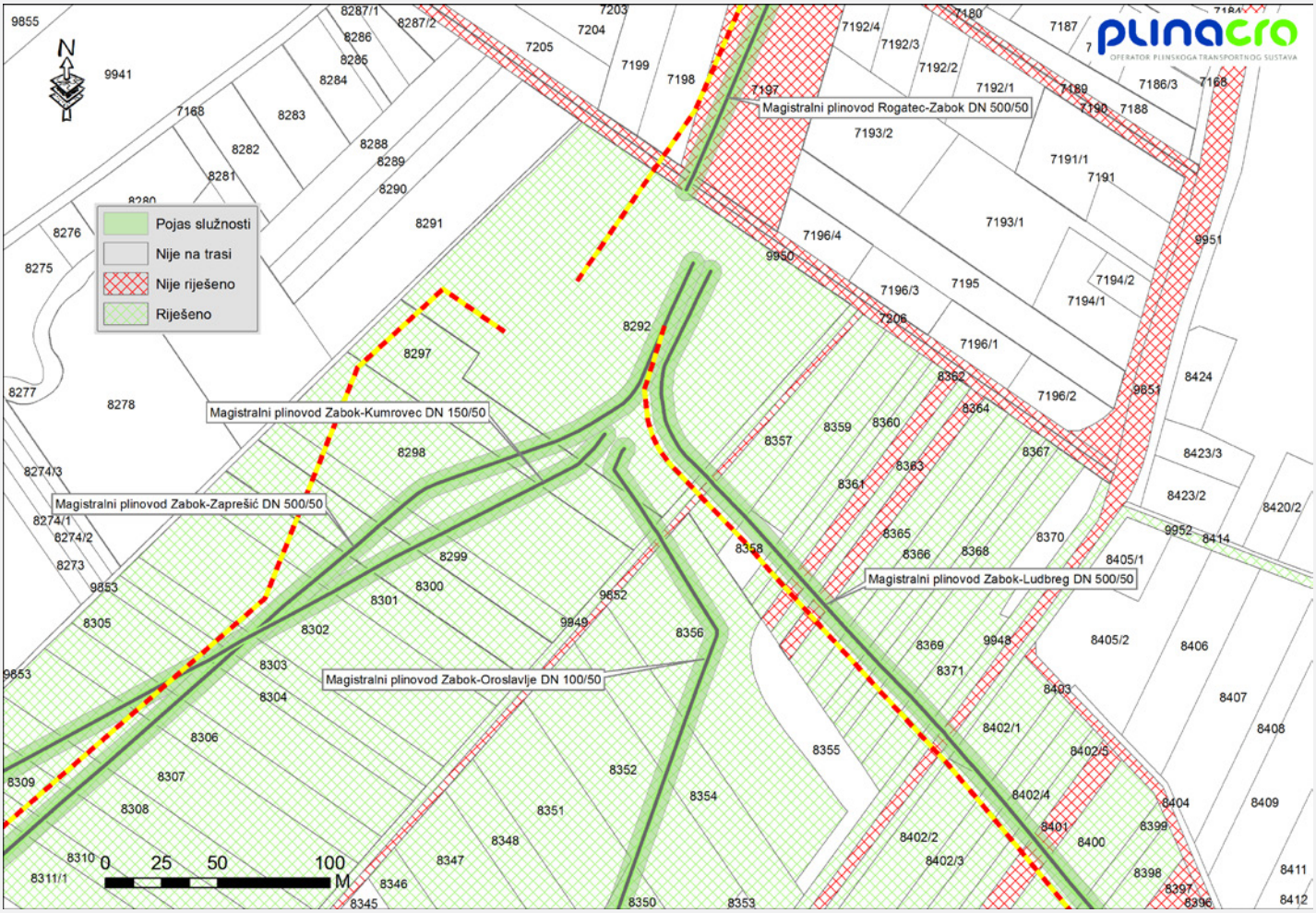

Figure 7: Graphical reports of "right to use" registration per parcel in a pipeline corridor

data using the GIS tools and applications to fulfill INSPIRE and NSDI requirements.

4. GIS PORTAL

Portal for ArcGIS is a component of ArcGIS Enterprise that allows sharing maps, scenes, apps, and other geographic information with other people in the organization through a website. GIS Portal in Plinacro has been introduced recently and is still being examined for the use in everyday business.

Plinacro GIS Portal is more than a tool for environmental planning and regulatory compliance. It is a customizable, out-of-the-box platform that allows the GIS team to build diagrams and dashboards, maps and apps from a single source of data retrieved from the entire systems. It is easy to create user-friendly workflows, executive dashboards, and online or offline field apps that meet specific needs, such as asset inspection on the field. Due to integration of all geospatial data from various data sources (such as pipelines, cadastre, spatial plans, land cover, data on various infrastructure such as road infrastructure, railway infrastructure, infrastructure of other energy companies, topographic maps, satellite imagery and other), the GIS Portal is an easy and fast way to produce shareable, focused and meaningful maps. This makes it easier and quicker to make decisions in day-to-day processes through the visualization of data in space, as well as web data update (graphical and attribute).

With the help of GIS Portal, internal users can plan the safest, the most profitable, and the most environmentally friendly routes when Plinacro expands its network. By using the asset dashboard from GIS Portal, users are able to see what is happening in real time. The GIS team is controlling who has an access to GIS Portal and is able to keep decision makers, regulators, and customers informed **(Figure 8)**.

Benefits of GIS Portal:

- Pipeline data are easily accessed and simple to view via browsers and mobile devices offering visualization to a variety of users anytime, anywhere.
- Interdepartmental communication is drastically improved with easily consumable and visible data for entire Plinacro.
- Departments can identify redundancy and can implement simplified solutions to enable improved productivity.
- The analysis anchored in data management best practices and visualization technology provides insights and business intelligence that enables management to make intelligent and informed decisions in real time.
- GIS Portal is a key tool for any kind of preparation and planning of future development of Plinacro pipelines as well as their day-to-day maintenance.

5. CONCLUSION

From all the aforementioned, it can be concluded that GIS technologies have multiple and varied applications in

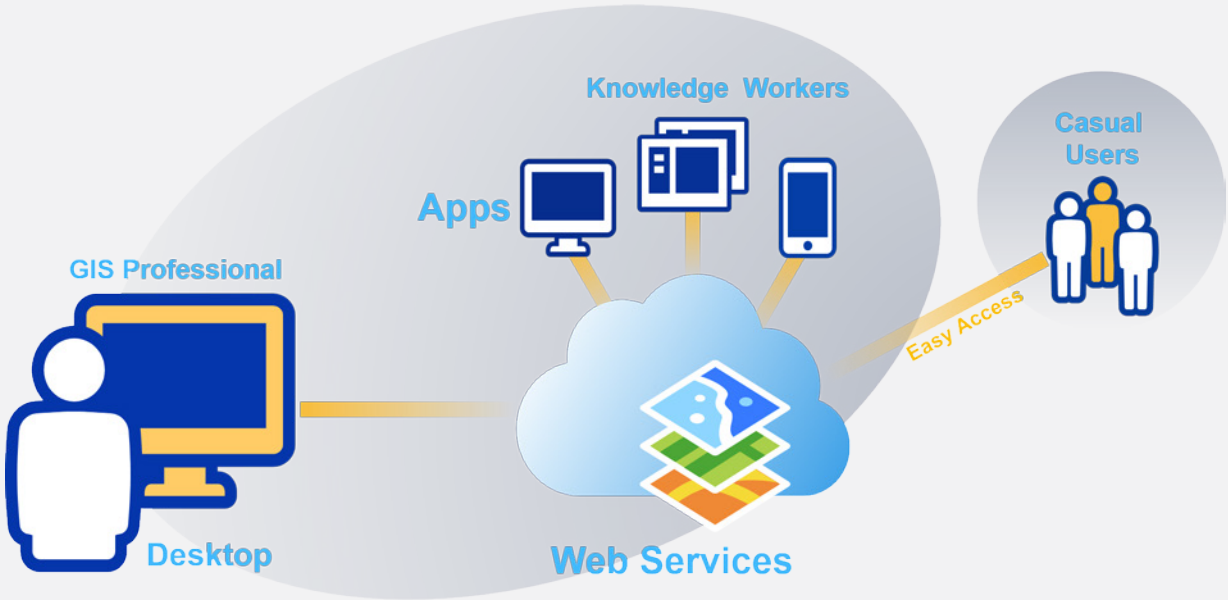

Figure 8: GIS integrates organization by sharing information and supporting collaborative approach

the maintenance and development of the gas transmission system.

GIS offers detailed information, improves collaboration, efficiency, and performance in the planning and design phase, during construction and for the ongoing operational management. In fact, the main task of GIS is spatial analytics which is used for finding the best location for pipeline corridors, making better decisions and preparing or responding faster in crucial situations. It is possible to make decisions in real time through direct insight in the field using out-of-the-box and easy-to-use GIS tools. Consequently, more work is done for less money, while preserving the same quality level of the projects and the gas transmission system maintenance.

In addition, geospatial technology itself is witnessing a lot of innovations that are scaling up their potential from the basic positioning information to offering the ability to integrate with many different IT systems, giving intelligent, connected workflows that help improve productivity and profitability of the gas transmission company.

REFERENCES

[1] http://www.plinacro.hr/
[2] Plinacro company profile 2014
[3] Ordinance on the technical conditions and standards for the safe transportation of the liquefied and gaseous hydrocarbons by the main pipelines and the pipelines for the international transport, (Official gazette no. 26/1985)
[4] http://www.nipp.hr/

AUTHORS

Iva Juretić
Plinacro Ltd., Zagreb, Croatia
Phone: +385 1 6301 760
Email: iva.juretic@plinacro.hr

Vanja Skopljak Štulić
Plinacro Ltd., Zagreb, Croatia
Phone: +385 1 6301 707
Email: vanja.skopljak@plinacro.hr