Application of GIS Analyzes with Cloud Computing

Sevket BEDIROGLU, Volkan YILDIRIM and Selcuk ERBAS (Turkey)

Key words: GIS, Cloud Computing, Spatial Cloud Computing

SUMMARY

Usage of Cloud Computing (CC) has been increasing day by day, due to the advantages at data store, data view and data processes. Common advantages of CC are, working regardless of place and offering economical solutions with the help of "pay as you go" model. Also ability of changing computer forces in a short time makes CC elastic. Although these advantages, CC has some disadvantages and these are about security, privacy and juristically problems. A new technology era occurred when CC and Desktop GIS integrated and this is called Spatial Cloud Computing (SCC). With the help of SCC, users may access their spatial data without any need of stationary operating system or devices. By this way, GIS analyses should be done via tablets, smart phones and other mobile devices on web browsers without requiring program installing. In SCC technology analyze operations are done in central servers and only results are sent to users so analyzes are too fast with the help of central parallel computers. In this work, the first aim is investigation of advantages of CC and SCC technologies. A sample geo database was designed at first step. Spatial data operations and GIS analyses has been done with the SCC technology. The performance compares of these two technology are researched in terms of, temporal compare, economic, time and ease of usage views. Turkey's situation at this technology is observed, the possible problems may occur in future are defined and solution of them are researched.

Application of GIS Analyzes with Cloud Computing

Sevket BEDIROGLU, Volkan YILDIRIM and Selcuk ERBAS (Turkey)

1. INTRODUCTION

Influence radius of Cloud Computing (CC) is increasing day by day in Information Sciences. CC is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (Mell and Grance, 2011). The main idea of CC is to build a virtualized computing resource pool by centralizing abundant computing resources connected with network and present the service of infrastructure, platform and software (Che et al., 2011)Like too many information systems Geographical Information System (GIS) has also been effecting from CC. A new era of geosciences has been occurred with the mix of CC and GIS, this is called Spatial Cloud Computing (SCC) or Cloud GIS. Spatial Cloud Computing (SCC) adds geography to the cloud computing paradigm.SC2 provides dynamically scalable geographic information technology, spatial data, and geo-applications as a web service (Williams, 2010). Cloud computing is a supercomputing paradigm based on Internet, which makes use of computer nodes in the cloud cluster through a network to complete a computing task in parallel (Wang et al., 2013; Buyya et al., 2009) The technology and architecture that cloud service and deployment models offer are the key areas of research and development for geographic information system (GIS) technology (Kouyomijian, 2011).). Cloud technology capabilities make it possible to combine data services from various data providers and distribute geospatial processing to other processing service providers (Evangalidis, 2014). This capability can be as simple as running a GIS on a cloud platform (Williams, 2009). Geographic Information Systems (GIS) have gained popularity in recent years because they provide spatial data management and access through the (Fustes et al., 2014). Web SCC brings too many adventageous criterias for GIS such as flexibility, cheapness, sustainability etc. SCC is useful and easily applicable in client or developer side. Through SCC, spatial data users can easily access their spatialdata from everywhere with their mobile phones, tablets, personel computers or another device regardless of installing any GIS programs.

In this paper SCC is used versus Desktop GIS. All the geodatabase were loaded to cloud and then common operations like query and analyze were done on cloud servers. Also symbology changes, layer controls were done. Some new tools was created through Java platform for enabling some operations to be done easily. At last step two different systems were compared in terms of, speed, accuracy, easiness. Advantageous and disadvantageous sides of SCC is derived compared to Desktop GIS. For case study Turkey country is chosen as en example. Spatial dataset was containing adminstative regions, hydrology layer (lake,river...), railways, auotoways and some other spatail data types. Some part of data was created at Desktop GIS and some were gathered from different sources. Finally future plans and abilities of SCC were contested.

2. RELATED WORK

2.1 Database Design

2.1.1 Study Area

Study area of this paper is Turkey country between the coordinates 36-42 North Latitudes and 26-45 East Longtitudes, position of Turkey can be seen clearly in Figure 1.

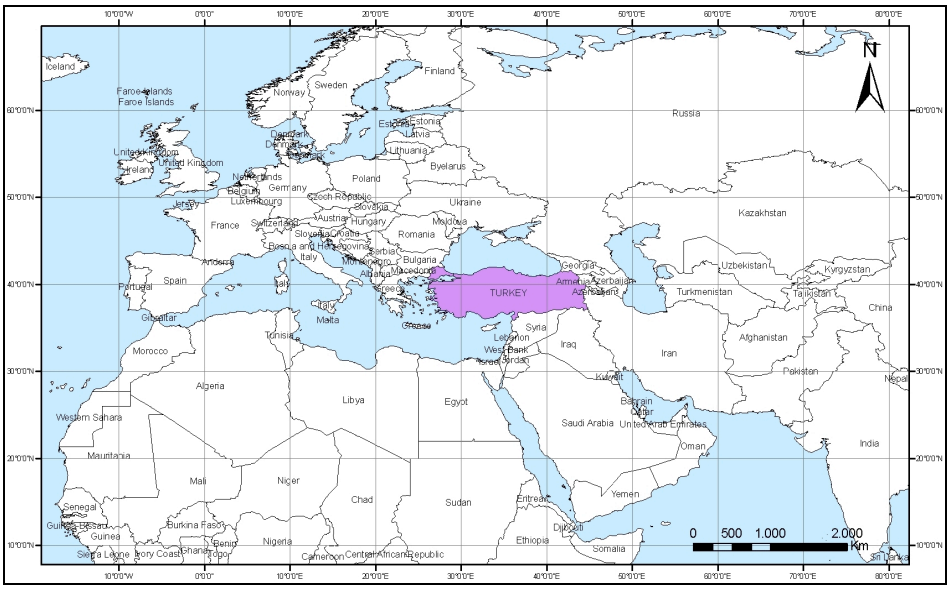

Figure 1: Study Area (Location of Turkey)

2.1.2 Database Design

Spatial dataset of Turkey was gathered in a geodatabase on the purpose of applying GIS analyzes and queries on cloud. This dataset contains adminstative regions, hydrology layer (lake,river...), railways, auotoways and some other spatail data types as it can be seen comprehensively in Figure 2 (schema) and Figure 3 (map view).

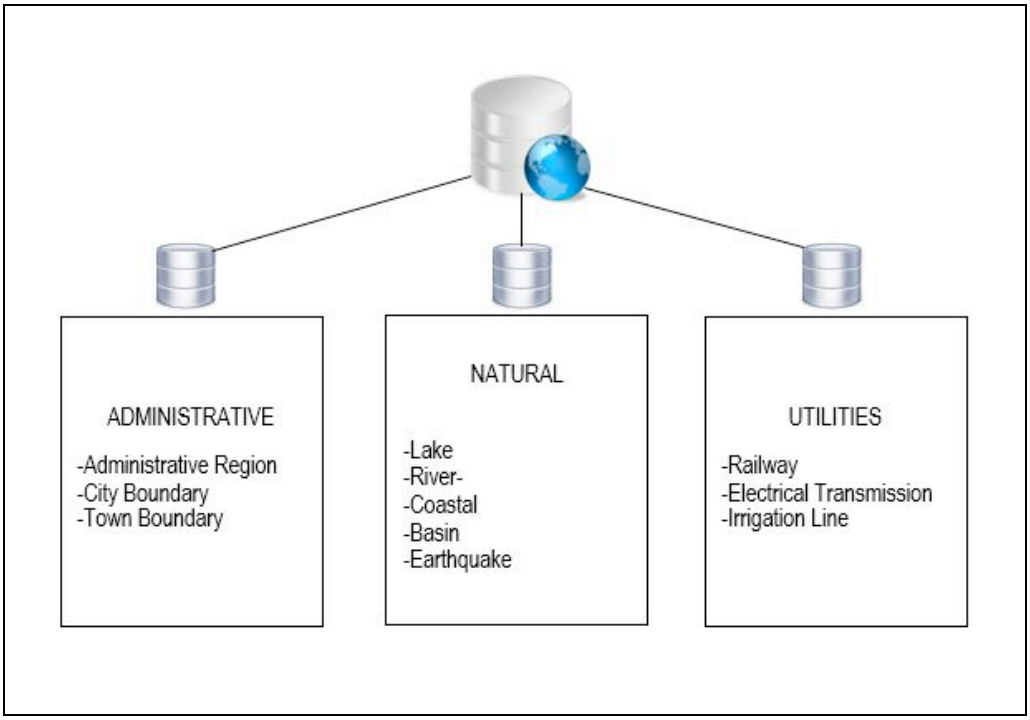

Figure 2: Used spatial dataset of Turkey

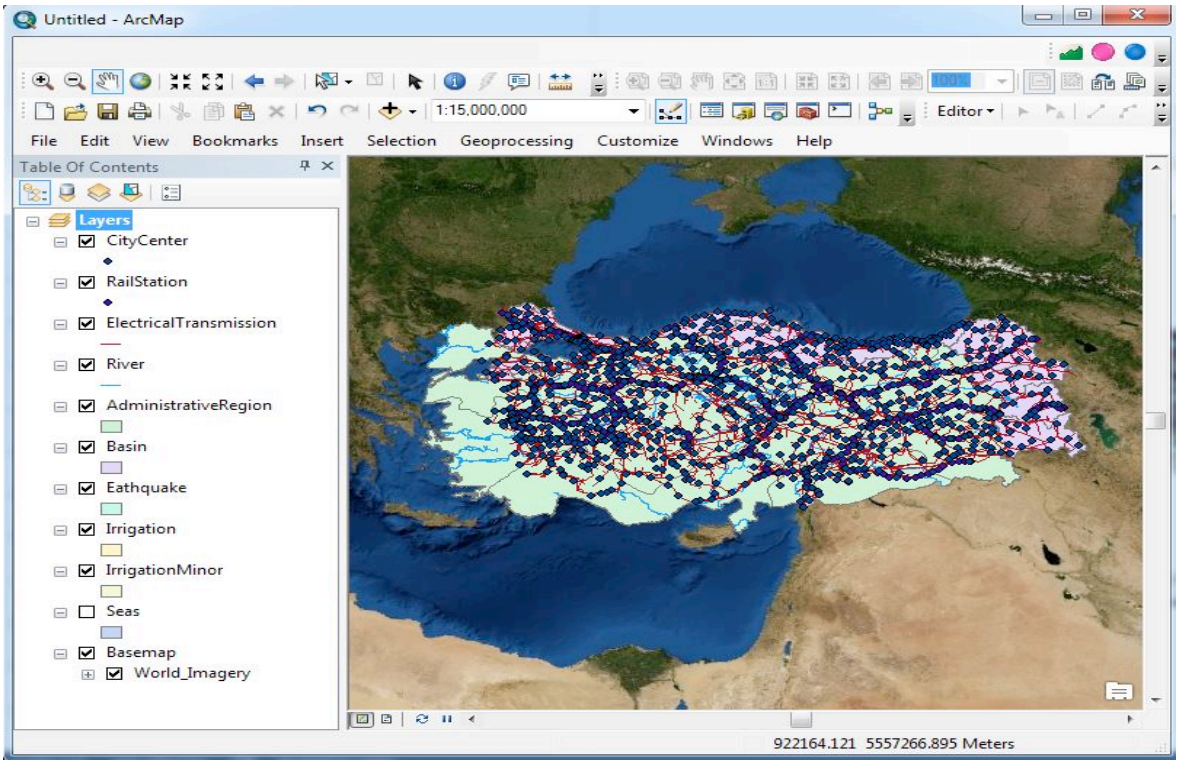

Figure 3: Map view of spatial database on Desktop GIS

2.2 Uploading to Cloud Servers

At the present time SCC directly enables creating spatial data via web browsers. This way has some advantages and disadvantages. No require of any installed GIS software, wide basemap functions such as satellite view, OSM (Open Street Map) or Demographic Layers etc., data loss assurance are some benefits but in another side there are disadvantageous objects like internet necessity, slow editing capabilities. In future may be these disadvantageous problems will be solved anyway but method of creating data in Desktop GIS was chosen whilst these problems exist. Some of these spatial data was gathered from different sources like government or private organizations collecting spatial data. Spatial data shouldn't be loaded to cloud servers before standardization, projection define and suitable format conversion. Some of spatial data was in local cad format (.Ncz) other was in shape (Esri) format. All local formatted data was converted to shape with FME (Feature Manipulation Engine) tool working on Arcgis 10.2 Desktop software. After format standardization attribute standardization was done. Local Turkish characters were changed with international characters. Finally projection standardization was applied. European Datum 50 was chosen because of most data was in that format. Unique format isn't an obligation for working on cloud, rule is loading true projected spatial data but a unique projection was chosen in terms of complete standardization. After all these steps all the dataset was loaded to cloud. Spatial data on cloud servers can be seen in Figure 4.

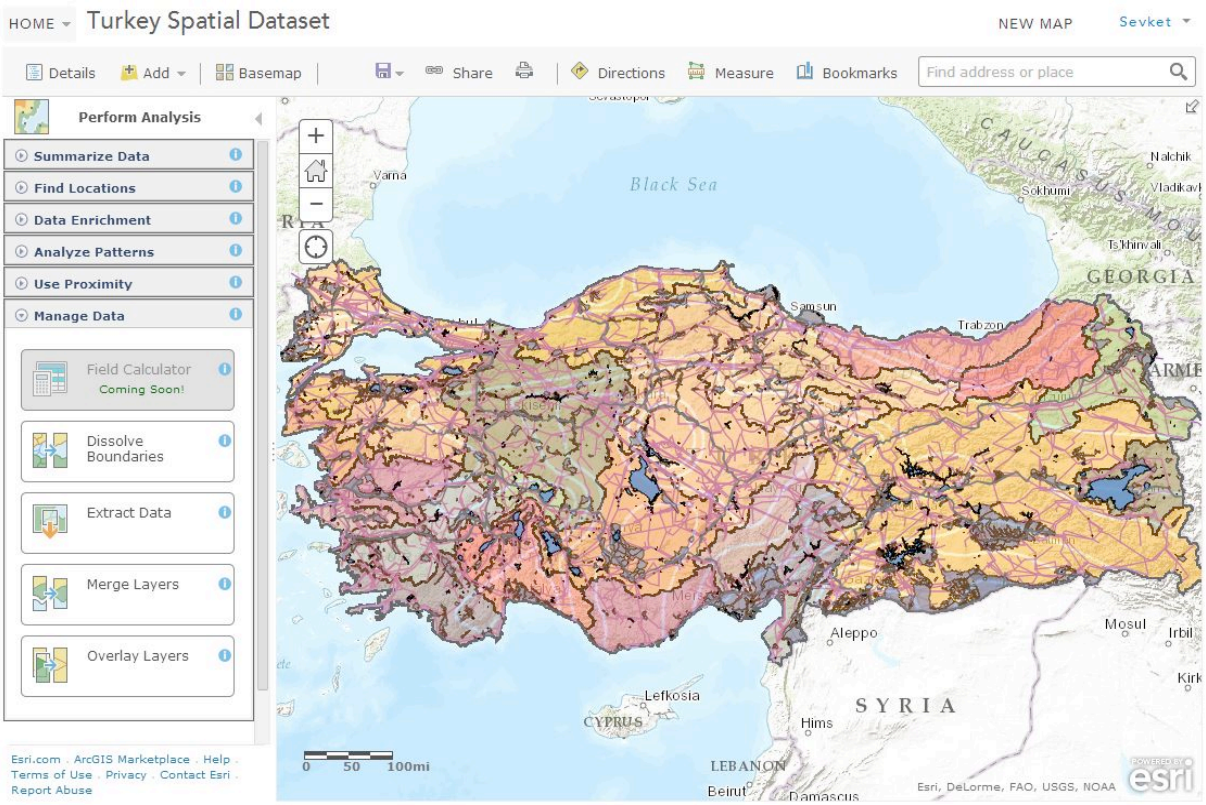

Figure 4: Map view of spatial dataset on cloud

There are some ready tools at Web interface of Arcgis Online, these are Measure Tool, Basemap Function, Share Tool, Add Data and some others. Conventional GIS users don't have any problem when using it. Client interface is easy and understandable in other respects developers can easily develop new interfaces or analyses tool through Java, Android or IOS environments. Following Url contains explains the ways to develop new applications and contains code library for small applications, https://developers.arcgis.com. Some analyzes like Geoprocessing, Navigating and Route, Generating Compare Maps and Creating Web Map Servers can be done via cloud. At following pages some GIS analyzes and queries will be done and shown how to. A simple attribute query is shown at Figure 5. In Figure attribute of Turkey basins can be seen.

It is possible to control layers on cloud. Applying symbology changes, migrating layer ranges, identifying any layers or details, adding map notes can be done. All these functions need internet connection, if acceleration of internet access speed worldwide is taken into effect it can be clearly seen that in future SCC will be easier to use. According to results if internet.org projects, Turkey's avarage internet connection speed 3.1 Mbps (Url-1). This speed may be slow if it is compared with well developed countries but internet sector of Turkey is growing day by day and connection speeds are increasing as it becomes worldwide. One of benefits of SCC is data loss assurance while working because changes are being saved in each periods. This makes SCC advantageous compared to Desktop GIS in terms of sudden electricity shuts or computer errors.

On the other hand many GIS users still have some troubles about security and privacy. Because they don't want any people to see their own data and they wary about what shall I do if my data is taken by third party people specially bad faith people. This is the biggest obstacle standing behind SCC consequently too many researches are working to solve this problem. Encryption of files on cloud or data insurance from service performer or third party firms.

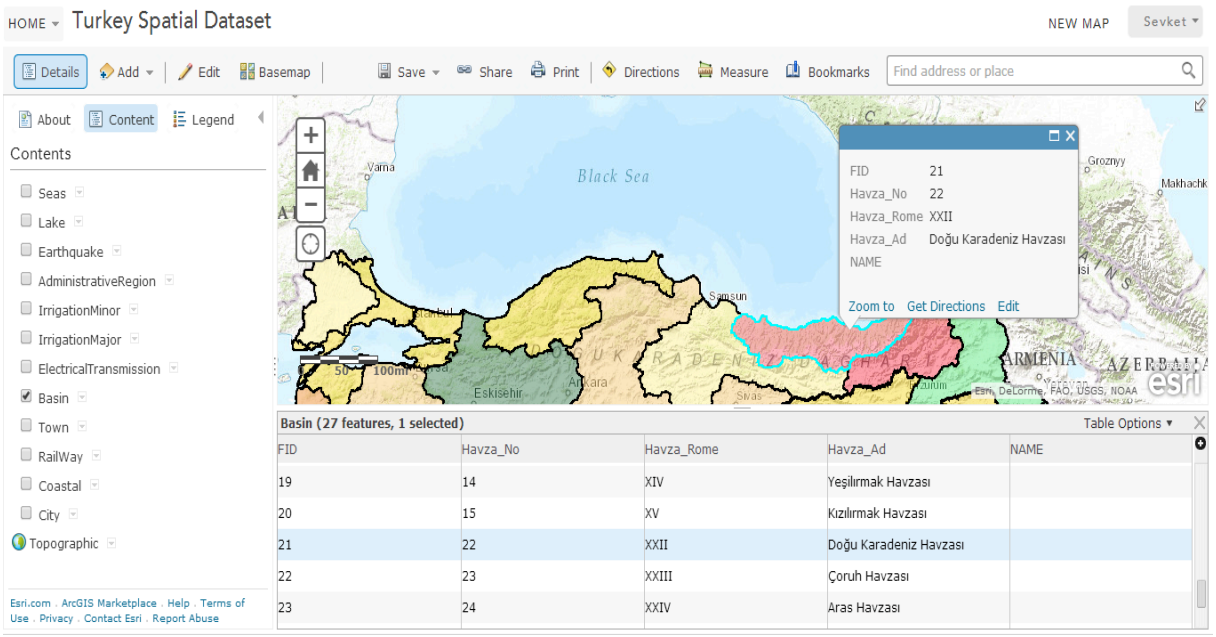

Figure 5: Attribute query on cloud

2.3 GIS Analyzes on Cloud

GIS Analyzes or queries are well known spatial analyzes using vector or raster formatted files. Till now analyzes are done on Desktop GIS systems or self GIS servers, but in our day all these can be done on cloud Figure 6. In this paper GIS analyzes are done and some compare results with Desktop GIS are derived. According to results SCC is as speed as Desktop GIS. Normally a buffer analyze with nearly 1000 arcs shapefile (Railway of Turkey) takes 9 seconds on i5 Intel processor. Other side it takes 10 second on SCC with a normal membership. This performance can be accelerated with paying more. In Figure 7 final view of Buffer analyze with Railway of Turkey can be seen. For case study common GIS analyses like Buffer, Intersect, Overlay, Hotpoint analyze and some network analyses are done on cloud. But only Buffer analyze is shown as an example. After analyses an accuracy test is applied to different final files and it is seen that analyze results are same and there is no graphic or metric difference between them.

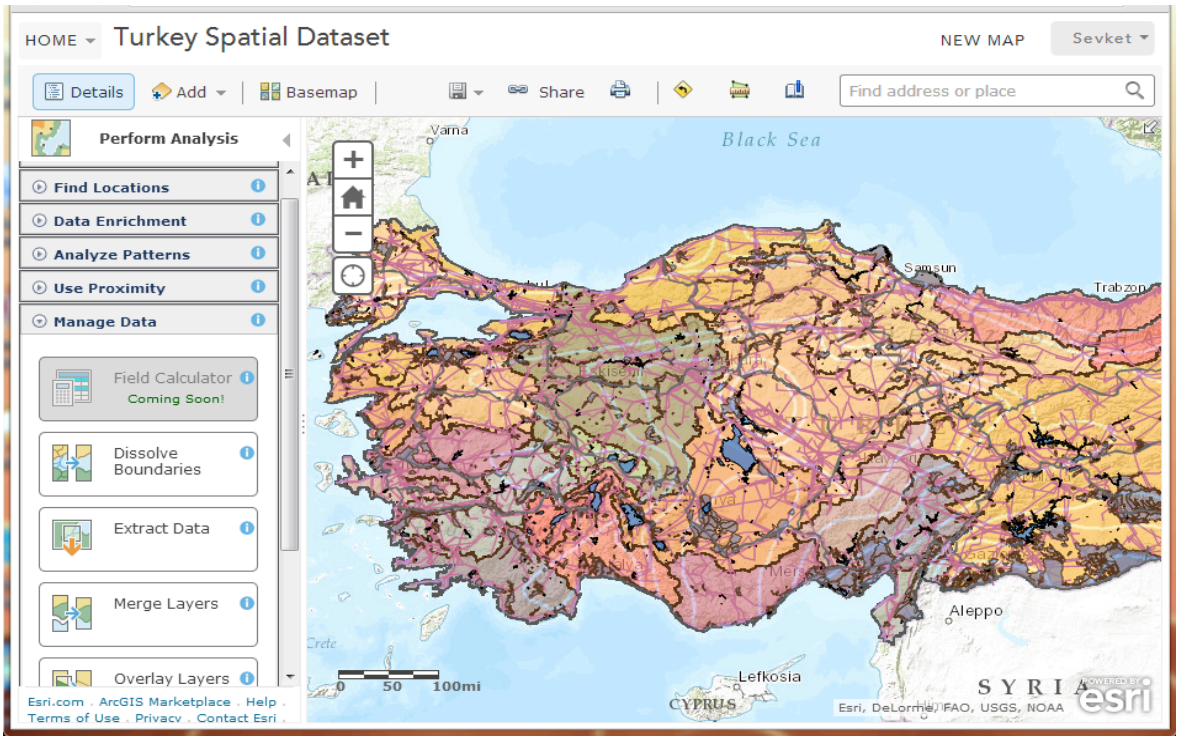

Figure 6: GIS Analyses on Cloud

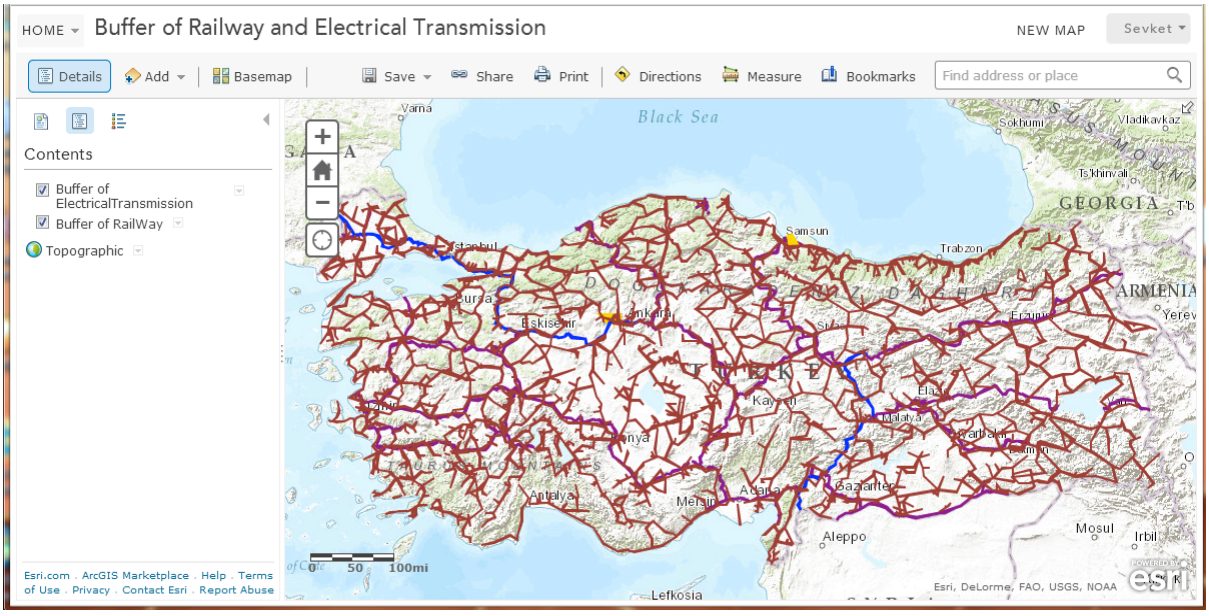

Figure 7: Final view of GIS analyze on cloud

3. CONCLUSIONS

The paper brings out SCC is likely to be a good alternative versus Desktop GIS. There are too many reasons for this, first of all results are same with Desktop GIS so there is no quality difference. Beside this SCC is advantageous in terms of economy, elasticity and accessibility. SCC is economic because initial costs of building an enterprise GIS system is too low. At first step you can build a normal performance system and then increase system capabilities according to requirements. This makes SCC economic and flexible. Other side using system regardless of installing software makes SCC accessible. Just a web browser and login info (user name-password) is enough if you have an internet connection. After these all GIS analyzes queries can be done quickly. If internet connection speeds will be better in future, strongly SCC will be more efficient with all of its capabilities. In SCC environment users can easily add basemaps under their spatial datasets published from cloud vendors or public datasets which were shared by other users. This functionality removes barriers in front of interoperability and sustainable work model. Every users can easily share spatial data easy and fast. Permission control about self-data makes SCC more functional, nominately data, map or an application can be open to one person (Private Cloud), a group (Community Cloud) or public. Access, edit, query and download controls can be manipulated cloud computing's deployment models.

SCC brings geospatial working ability for mobile devices. Normally GIS software doesn't run on mobile systems like Android, IOS or Windows Mobile. But with SCC, GIS is usable for mobile devices. Mobile clients can apply GIS analyzes with browsers or small applications but all these works are done on cloud servers. At developers side it is applicable to develop precious applications for working in SCC environment.

It is important to note that, the point CC and SCC arrived is well enough to use and other hand it can be clearly seen that future SCC will be more effective, functional, fast, economic and comprehensible.

REFERENCES

Che , J., Duan, Y., Zhang, T., Fan, J., 2011. Study on the security models and strategies of cloud computing, 2011 International Conference on Power Electronics and Engineering Application, pp. 586 – 593.

Evangelidis, K., Ntouros, K., Makridis, S., Papatheodorou, C.,2014. Geospatial services in the Cloud. Computers & Geosciences 63,116-122.

Kouyoumjian, V., 2010. GIS in the Cloud: The New Age of Cloud Computing and Geographic Information Systems, ArcNewsmagazine, pp. 1-31

Mell, P., Grance, T., 2010. The NIST definition of cloud computing, Communications of the Acm, pp. 50-50.

Williams H., 2010. A new paradigm for geographic information services, Spatial Cloud Computing (SC2) White Paper, pp 1-9.

YangJinnan;WuSheng; Key Lab. of Spatial DataMin. & Inf. Sharing, Fuzhou Univ., Fuzhou, China. "Studies on application of

cloud computing techniques in GIS" .Geoscience and Remote Sensing (IITA-GRS), 2010 Second IITA International Conference.
URL 1. http://www.webrazzi.com/2013/08/23/dunyada-en-hizli-internet-kullanan-ulkeleri-ve-turkiyenin-durumu/
URL 2: https://developers.arcgis.com

BIOGRAPHICAL NOTES

Sevket BEDIROGLU is a Research Assistant (PhD.) at Karadeniz Technical University (KTU), Turkey. He graduated from the Department of Geomatic Engineering at KTU in 2010. He received her master degree with thesis entitled "Publishing Web Maps With Cloud Computing: Trabzon City Sample" in December 2012. His research interests are Geographic Information Systems, Cloud Computing, 3D City and Urban Models and Data Interoperability.

Volkan YILDIRIM is an Assoc. Prof. Dr at Karadeniz Technical University (KTU), Turkey. He graduated from the Department of Geomatic Engineering at KTU in 1999. He had master degree in 2003. In 2009 he finished his PhD thesis dealt with Raster Based GIS Analyses and Optimum Route Analyses Using Multicriteria Decision Systems. He has many works and publications related with GIS and Land Managament.

Yasar Selcuk ERBAS is a Research Assistant at Black Sea Technical University (KTU), Turkey. He graduated from the Department of Geomatics Engineering at KTU in 2010. He received his Master's Degree at Black Sea Technical University / Geomatics Engineering in 2012. He is a PhD student now. His research interests are Geographic Information Systems and applications, Marine Areas (Cadastre) and HEP projects.

CONTACTS

Sevket BEDIROGLU
Karadeniz Technical University
Department of Geomatic Engineering
Trabzon
TURKEY
Tel: +90 (462) 3773654
Fax: +90 (462) 3280918
Email:sevketbediroglu@gmail.com
Web site: http://gislab.ktu.edu.tr/kadro/sbediroglu/

Volkan YILDIRIM
Karadeniz Technical University
Department of Geomatic Engineering
Trabzon
TURKEY
Tel: +09 0462 377 27 02
Fax: +09 0462 325 09 18
Email: yvolkan78@gmail.com
Web Site: gislab.ktu.edu.tr/kadro/yvolkan

Yasar Selcuk ERBAS
Karadeniz Technical University
Department of Geomatic Engineering
Trabzon
TURKEY
Tel: +09 0462 377 36 52
Fax: +09 0462 325 09 18
Email: yselcukerbas@hotmail.com, yselcukerbas@gmail.com
Web site: http://gislab.ktu.edu.tr/kadro/yserbas/