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TEACHING OPEN SOURCE GIS SOFTWARE USING THE EXAMPLE OF SEISMIC DATA INVESTIGATION

Бул макала билим берүү процессиндеги, үстөлдүк жана веб Геомаалыматтык системаларынын (ГМС) ачык түрүндөгү программаларын колдонулушуна багытталган. КМКТАУ инженердик адистерди даярдаганына байланыштуу, республиканын сейсмикалык абалын аныктоодо, студенттерге ушул программаларды колдонууну окутуу абдан маанилүү болуп эсептелинет. Бул программалар коммерциялык программаларга салыштырмалуу бекер альтернатива, ошондой эле эгерде атайын өзгөчөлөнгөн жана жогору баадагы программанын зарылчылыгы болбогон учурда колдонууга ылайыкташтырылган. Бул макаланын негизги максаты ар түрдүү билим берүү жана илим изилдөө институттарындагы ГМС тармагындагы мугалимдерге жана илимпоздорго жардам көрсөтүү максатында жана аларды ГМС ачык түрүндөгү программаларын тааныштыруу болуп саналат.

Эта статья посвящена применению программного обеспечения с открытым кодом – настольных и веб ГИС в образовательном процессе. Поскольку КГУСТА осуществляет подготовку инженерных специалистов, очень важно обучать студентов использованию этих программных комплексов для изучения сейсмических данных по всей республике. Эти программные обеспечения являются бесплатной альтернативой коммерческим, а также хорошим решением, когда нет необходимости в специализированных и дорогих программных обеспечениях. Цель этой статьи заключается в оказании помощи преподавателям и ученым по геоинформационным системам из различных образовательных и научно-исследовательских институтов для ознакомления с потенциальной ролью программного обеспечения с открытым кодом в области ГИС.

This article focuses on implementation of open source desktop GIS and Web GIS software's in education process. As KSUCTA trains engineering specialists, it is important teach students to use of open source software's for the investigation of seismic data distribution over the country. This software's are free alternative to other commercial applications, and a good solution when highly customized applications are needed. The goal of this article is to assist GIS educators and scientists at various educational and research institutes towards understanding the potential role of open source software in GIS education.

1. Introduction

Open source software (OSS) is becoming popular and increasingly more reliable than in the past. OSS is a type of "free" software to be accessed, used or modified by their user groups and developers. One key feature to distinguish OSS from other types is their “free software licenses”, which explicitly define the legal rights to users with freedoms to run, study, change, redistribute, and access the source codes of the licensed software /1/.

As Kyrgyzstan is a high seismic zone country and the Kyrgyz state university of construction, transport and architecture (KSUCTA) makes its essential contribution in the preparation of the technical and engineering specialists to the solving the seismic tasks of the country. Since 2006, the application of GIS has been teaching for engineering specialists by teachers of the department of Geodesy and Geoinformatics. The teaching materials in GIS labs are fully based on the licensed ArcGIS software by ESRI. Regarding to the student’s questions for the installation of this software on their home computers, the implementation of open source GIS software is considered. The advantage is that students could directly to download from internet and to install themselves. Therefore, since 2009, number of open source desktop and Web GIS software have been used at KSUCTA, which are described in the next steps.

2. Study area and data acquisition tasks

The whole territory of Kyrgyzstan is the study area for this research. Therefore, the both raster and vector geographic data types are used with aiming to show the capabilities of open source GIS software. The raster data is a Landsat satellite image, taken by the National Aeronautics and Space Administration (NASA) /2/. We mostly use this data type as background images for our study area. The acquisition of vector data is slightly multipart task for our students where we use the data sources of the Digital Chart of the World (DCW) /3/ and the Institute of Seismology of the Kyrgyz Republic /4/.

Firstly, the set of vector data like country boundaries; cities; lakes; rivers; and roads have to be separately exported into GIS shape file format from the DCW database. Secondly, the seismic data in text format like seismic stations; catalog of earthquakes; and historical strong earthquakes have to be converted into GIS shape file format from the ASCII text files by use the coordinate systems information. Thirdly, for combining all these files on the same display, they must be in the same spatial reference system such as spatial data come from different sources and in a variety of formats. Therefore, all these spatial data have to be brought to the coordinate system WGS_1984_UTM_ZONE_43N. The satellite image of Landsat in TIFF format has been converted to PNG image format in order to efficiently display it on the internet. And this image has to be georeferenced in above mentioned projection system.

These spatial data sets have been investigated and visualized on the base of open source desktop and Web GIS software.

3. Open source desktop GIS software

Basic desktop open source GIS software can provide basic GIS functions in spatial data management, visualization, spatial analysis, and basic spatial and attribute queries. Most open source desktop GIS software runs on multiple operating systems, such as Windows, MacOS, and Linux. However, one common problem in open source desktop GIS software is the lack of advanced cartographic functions and symbolization.

3.1 Quantum GIS (QGIS)

Initially Quantum GIS (QGIS) was originally developed as a GIS data viewer. QGIS has reached a more advanced state in its evolution that currently supports a number of vector and raster data formats. QGIS provides a very powerful integration with Python, a scripting language to customize or automate GIS functions. Two unique features of QGIS include the linkage (expendable) to GRASS functionalities and the support of DWG file formats. QGIS supports basic ESRI shapefiles and coverage formats, but not personal geodatabases. QGIS provides tools to download waypoints, tracks, routes from GPS receiver and import to xml files. It also includes good Web linkages, including WMS and WFS. There are many different versions of QGIS available for download /5/.

By use QGIS software our students learn the seismic data investigation and updating with new records of occurred earthquakes, to making spatial queries and spatial data visualization. The strong earthquake epicenters of Kyrgyzstan from historic period to 2010 are shown in Fig.1, where classified by the earthquake's energy classes. It represents the historical strong earthquake epicenters which are the strong Suusamyr earthquake (1992), where about 100 people died, at Kemin earthquake (1911) the greatest destructions were observed in settlements of Uital, Sazonovka, Djil-Aryk, where more than 450 people died. Except these were earthquakes of Chatkal (1948), Isfara-Batken (1977), Djalanash-Tjup (1978), Sarykamysh (1970), KochKor (2006), Nura (2008) and others which have incurred colossal material damages /6/.

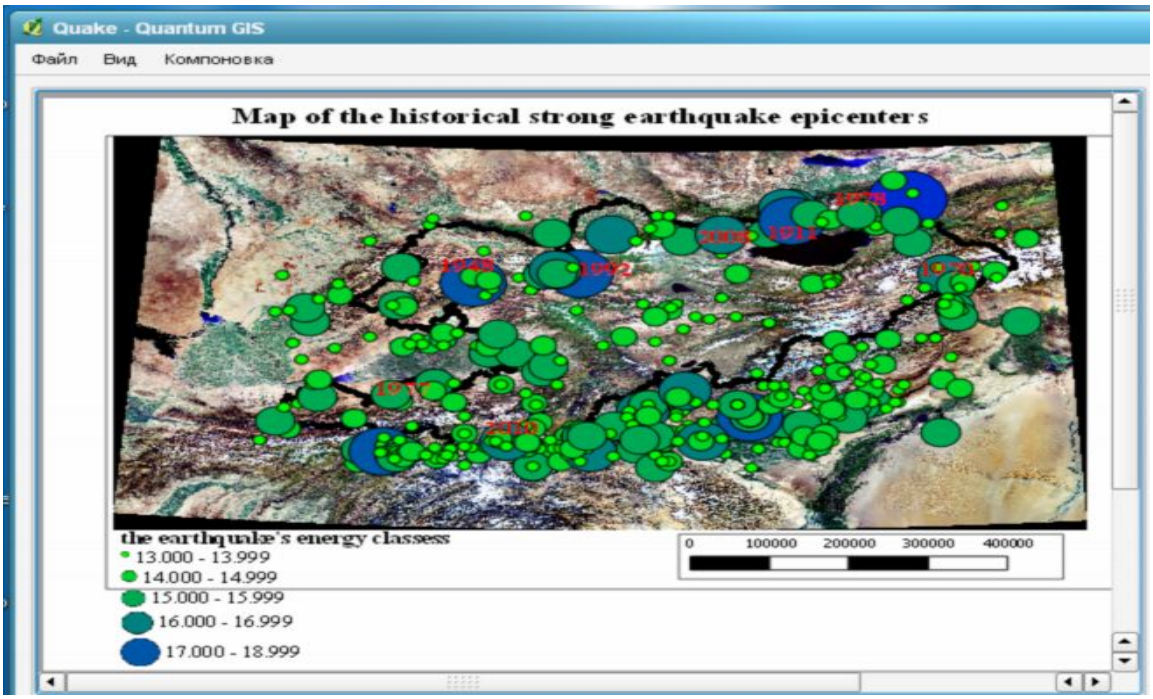

Figure 1. Map of the historical strong earthquake epicenters

3.2 KOSMO

KOSMO is one of the most popular open source desktop GIS, providing a nice Graphic User Interface, GIS data editing tools, and spatial analysis functions. KOSMO was developed based upon OpenJUMP, offering very limited graphic and symbol functions. KOSMO has improved cartographic and spatial analysis functions from OpenJUMP, providing a friendly and comprehensive GIS package for desktop computers /7,8/.

By use KOSMO software, the spatial distribution of occurred earthquake epicenters for 2009 year, lakes, seismic stations, fault lines and country boundary are represented in Fig.2.

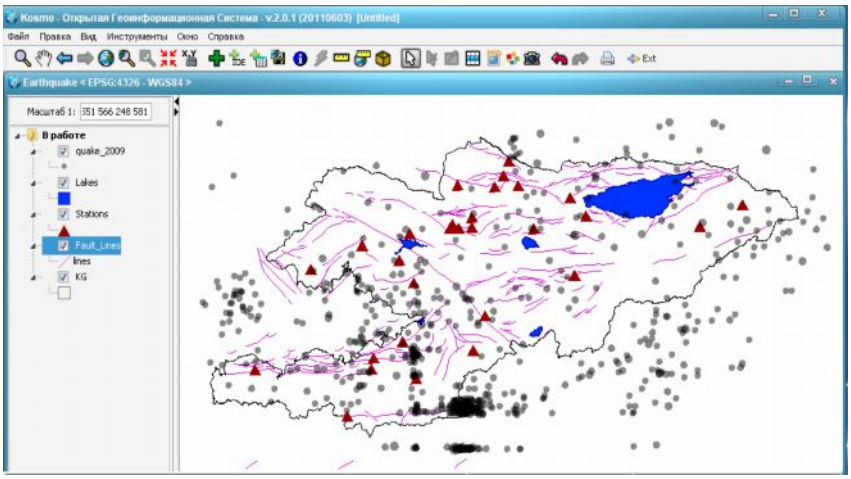

Figure 2. Spatial seismic data distribution

In Fig.2, we can see the locations of seismic stations as brown triangles that cover the entire country. These stations register annually about 3000 earthquakes and among them 10-15 are sensitive. Unfortunately, the dissemination of seismicity information and disaster risk reduction activities are poor developed in the country. For this reason Kyrgyzstan needs broad policies based on science and technology to be enacted and implemented before earthquakes strikes. Only in this way it will be possible to protect the people, the infrastructure and the economy. Therefore, the web mapping service - Web GIS is urgently needed in order to provide public access to information about earthquakes and to make other spatial information available over the Internet.

4. Open source Web GIS software

Today Web GIS becomes a powerful solution for distributing spatial data. It combines the advantages of both GIS and the internet where geographic information can be explored, visualized and disseminated through the internet. WebGIS simplifies the exchange of geographical data, provides structured information for users and to access GIS applications without using any specific software.

The teaching of WebGIS is concentrated to creating of dynamic map browser which is designed for interacting with the seismicity information of Kyrgyzstan. It would provide easy access on the Internet for users to available spatial data - seismic hazard map; national earthquake catalogues; settlement areas; roads; rivers and etc. As Kyrgyzstan is a high seismic zone country and the preparation of high qualified

WebGIS specialists among our students is very important. The further published seismic data on the Internet would be very helpful for increasing the natural hazard awareness of the relevant population.

The teaching of open source Web GIS software is based on UMN MapServer. This software originally was developed by the University of Minnesota through a NASA sponsored project in the mid-1990s. UMN MapServer is a popular open source project, whose purpose is to display dynamic spatial maps over the Internet /8/.

By use this UMN MapServer our students will learn of creating dynamic web page which is consisted of two files; a map file (.map) and a template file (.phtml). The map file is created in text format which is the basic configuration file for data access and the parameters to each layer for displaying on the internet. The created map file's code in text format (HTML) and as an example of the codes from the beginning part for bringing to the same spatial reference system is shown in below.

```
MAP
  NAME SEISMIC MAP
  STATUS ON
  SIZE 800 500
  IMAGETYPE PNG
  IMAGECOLOR 240 240 240
  SHAPEPATH "seismodata"
  EXTENT -10000 4300000 960000 4830000
  UNITS METERS

  PROJECTION
    "proj=utm"
    "ellps=GRS80"
    "zone=43"
    "north"
```

The template file is created in PHP format that provides a scripting interface for the construction of web and stand-alone applications. When a request is sent to UMN MapServer, it uses information passed in the request URL and creates an image of the requested map through these files. The created template file's code in PHP scripting language and as an example of the codes from the beginning part for loading of the spatial seismic data and displaying them on web page is shown in below.

```
<?php
dl("php_mapscript.dll");
$map_file="./seismap.map";
$map = ms_newMapObj($map_file);
```

```
$check_pan="CHECKED"; // default value
if ( isset($_POST["up"]) )
  {
   $y1new = $_POST["y1"] + ($_POST["y2"] - $_POST["y1"])/3;
   $y2new = $_POST["y2"] + ($_POST["y2"] - $_POST["y1"])/3;
   $map->setextent($_POST["x1"],$y1new,$_POST["x2"],$y2new);
  }
```

The developed of the Web GIS application on the base of UMN MapServer is shown in Figure 3. There are different functions implemented in this application such as to select layers through switch boxes for displaying in a map that updates after clicking the Redraw button. The viewing perspective of web maps can be changed by the user, such as with a Zoom-In/Out Tool for viewing a region of particular interest. The buttons of Pan allows moving throughout a map. The detailed information of spatial features is tabulated by using the Identify tool after clicking on features in web mapping page.

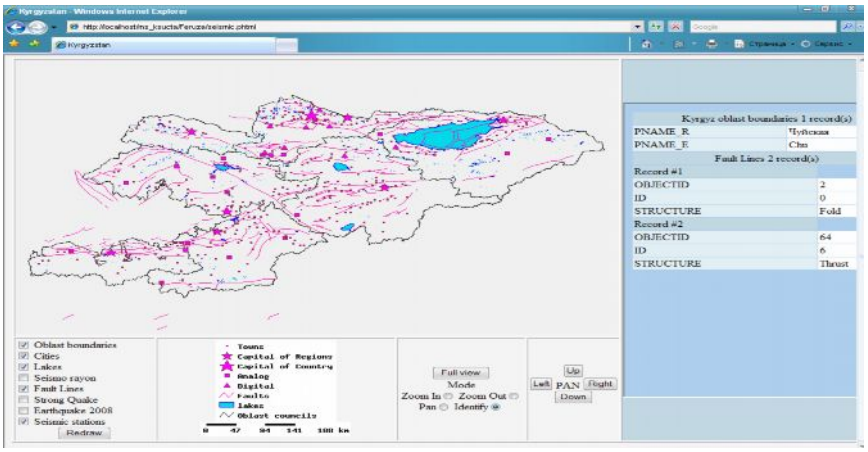

Figure 3. Web GIS application for the seismic data investigation

The development of Web GIS application would is very useful in order to transfer seismicity information. Users using this web mapping service are able to switch on/off geodata layers for visual analysis of their locations and features. Usually users can see the name of street, river, lakes, towns, settlement areas, seismic hazard map, epicenters of earthquakes etc. It would be very helpful for citizen to interact and investigate their houses and buildings for further improvement with antiseismic measures.

5. Conclusion

This study is oriented on implementation of open source desktop GIS and Web GIS software in education process. Open source desktop GIS software like Quantum GIS and KOSMO has been implemented to analyze the spatial seis*m*ic data visualization and the distribution of seismic events. The developed Web GIS application is based on the open source software UMN MapServer. It combined with a geographical information system that has been developed to integrate and manage geographical,

seismological and occurred earthquake information. It is used as a user interface that is designed to allow viewing, zooming and moving of spatial features and identifying the relevant information over the web.

The teaching for use these software's to engineering specialty students will increase their knowledge in the field of GIS and seismic activities of Kyrgyzstan. The seismic data investigation is concentrated to estimate earthquake potential where the earthquake losses can be reduced and developing of mitigation strategies.

The results of research are presented to show the capabilities of open source desktop and Web GIS software's. These software's can easily download and used by interested parties, such as local governments, engineers, administrators, landuse planners, hazard managers and decision makers with better tools to monitor and assess the seismicity of the country, to prioritize risk mitigation measures and to transfer research results to stakeholders.

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