GIS Data Sharing System for International Research Projects

Shinsaku NAKAMURA, Tomomi TAKEDA and Kazuyo HIROSE

Japan Space Systems, 3-5-8 Shibakoen, Minato-ku, Tokyo 105-0011, Japan

Abstract
GIS Data Sharing System (GDSS as followed) developed by Japan Space Systems is a web-GIS for data sharing over the network system. GDSS was developed considering about an easy structure, an easy user interface and an easy operation. GDSS is run on one desktop PC without any professional operators. GDSS was developed of open source programs, but its user interface is simple for users. GDSS was installed into two international research projects in Peru and Serbia for deforestation monitoring and sustainable resource development systems respectively. The result indicates that GDSS would have potentials to be used in various fields and spread other projects all over the world.

Introduction

Web-GIS is web-based application, which opens Geographical Information System (GIS as followed) data and information all over the network system, such as local area network and/or the Internet. Google Map is one of the most famous web-GIS in the world: users can share any geographical information from everywhere on the Earth. Many people are easy to understand GIS data without special GIS handling techniques (Alesheikh et al., 2002). Also, various international studies have been conducted on web-GIS (Suresh and Mani, 2016). One of web-GIS systems was developed by commercial software for earthquake information (Garagon Dogru et.al., 2004) although some of web-GIS were developed by using open source software, which required expensive servers and professional manipulation (Suresh and Mani, 2016). In this study, web-GIS named GIS Data Sharing System (GDSS as followed) and developed by Japan Space Systems with open source software, was installed into two international research projects: illegal deforestation monitoring in Madre de Dios, Peru (Hirose et. al., 2015) and sustainable resource development in Bor, Serbia. Researchers collect samples and analyze data in each project. They recognize that their projects would be accelerated to share their data by using web-GIS. Therefore, the authors have developed a comprehensive system to solve this problem.

Concept of GDSS

By GDSS, many researchers even who have not much skills about GIS, network, or computer systems would be able to share and see visualized GIS data on their own PC screens, understand and accelerate their own research projects.

GDSS has three "easy" features: 1) an easy structure, 2) an easy user interface, and 3) an easy operation. The easy structure of GDSS realizes low cost of developments and operations. The easy user interface makes people use and share their GIS data over GDSS simply. The easy operation does not require any professional operators. Those three characteristics would lead each international project sustainable even after the project was terminated.

Structure of GDSS: Desktop PC, Virtual Machine and Open Source Software

Nowadays, common web-GIS requires many expensive servers (Suresh and Mani, 2016). It needs high speed Internet for stable network communication, many CPUs for data calculation, and storage servers for data archiving. GDSS, on the other hand, does not need them. It can be developed on one desktop Windows or Mac PC. The minimum specifications of the PC for GDSS are shown in Table 1. Each project needs the PC around 1,000 USD for the development of GDSS.

GDSS was developed on a virtual machine. The virtual machine is an emulation of computer system, which is developed on a physical computer server, and it is a program file and run by software. Once GDSS was developed on the virtual machine, the developers can make some copies as clones and install easily. When GDSS has some troubles, developers can fix the master virtual machine, and they can update clones easily as they overwrite files.

Open source software realizes low cost of development because it is free (Suresh and Mani, 2016). GDSS was constructed with open source software. GDSS was developed with it as shown in Table 2. All open source software for GDSS is independent each other but shows logging data into a same file. Developers would be able to fix programs by reading the logging file if GDSS

Table 1   Minimum Specification of PC for GDSS Development.

OS	Windows 7 or later, or Mac OS X or later
CPU	Intel i3 or higher
Memory	8GB

HDD	500GB

Table 2 Open Source Software for Development of GDSS.

Open Source Software	Object	Note
VMware Workstation 12 Player	Virtual Machine Environment	Running on a Windows desktop PC
CentOS 7	OS	For the virtual machine environment
PostgreSQL	Database	Extended by PostGIS for spatial data management
Perl	Script Language	For development of GDSS Core Engine for geographical calculations
gdal	GIS Data Calculation	Picturing vector data, calculating area, etc.
Ruby on Rails	Search on Map	Showing GIS data and searching function on a map
Wordpress	User Interface	Realizing GDSS easy user interface and user management

Table 3 GDSS Functions and User Interfaces by "Wordpress".

Function/User Interface	Object	Note
User Management	Manages User Registration, Login, Logout, and Password Management	GIS Data Upload/Download functions are required user account.
Top	Shows Contents and Functions: Login, Logout, Blog, User's Manual	The first interface which all users access.
Blog	Shows information about the project	Users make blog, leave comments and discuss with each other.
Operator's User Interface	Manages all settings about User Interfaces and User Managements	Only an operator can access the interface and manage GDSS user interface.
GIS Data Upload Interface	Users upload GIS Data and make some information	It shows only user interface, the actual function was processed by Perl program named GDSS Engine.
GIS Data Search by Text Interface	Users search, see and download dataset	This interface was developed for reducing data volume on the network system. It shows only user interface, the actual function was processed by Perl program named GDSS Engine.
User Interfaces for Tablet and Smartphone	All user interfaces of GDSS adjust for all tablet and smartphone devices	It was designed by listening to user requests. They want to use GDSS outside of their offices such as fields shown Fig. 2.

has a trouble. GDSS with open source software is constructed simply as show in Fig. 1.

Easy User Interface of GDSS

GDSS has two user interfaces, "Wordpress" based and "Ruby-on-Rails" based. "Wordpress" is open source content management system (CMS as followed) platform while "Ruby-on-Rails" is a web application platform. It is developed of Hypertext Preprocessor (PHP as followed), a programming language for web-design and MySQL Database for data management. Web developers will be able to create website, blog, and application with this platform easily. Some parts of GDSS user interfaces were used with "Wordpress" are shown in Table 3. Because of "Wordpress", GDSS would be more secure

data management system for not only GIS data but also user

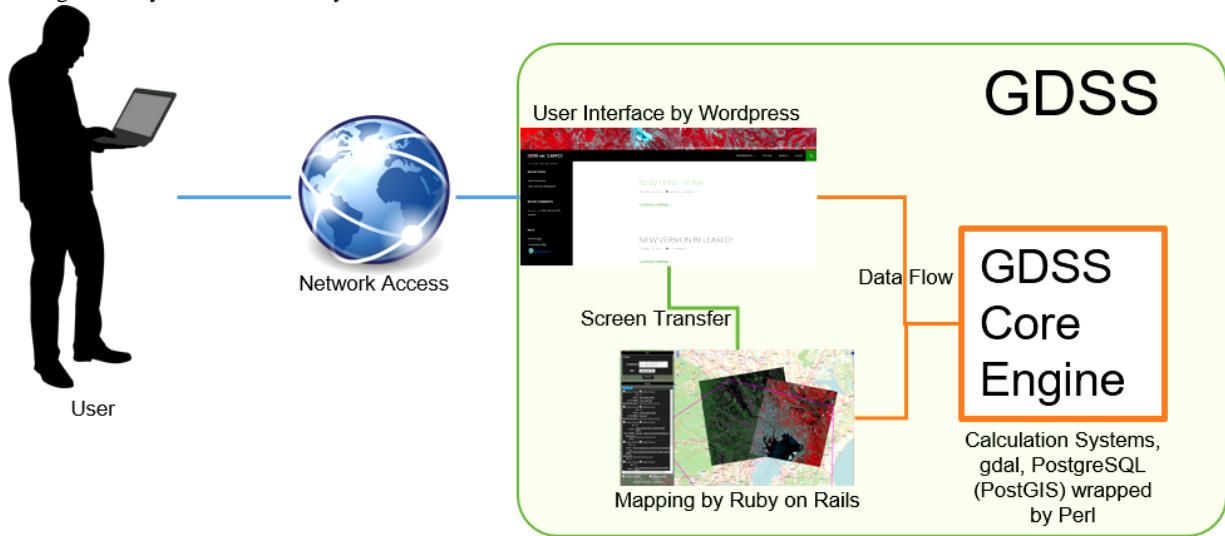information. It can announce some information with its blog
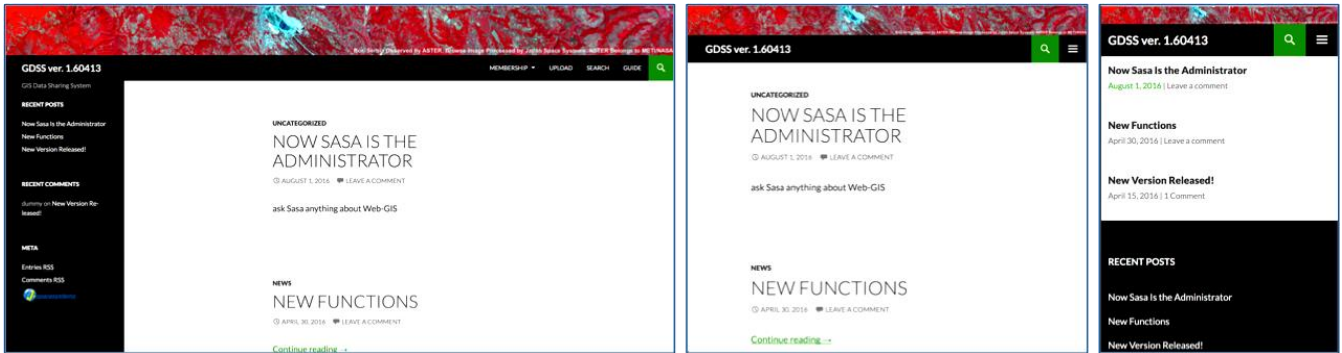

Fig. 1　Structure of GDSS.

Fig. 2　User Interfaces for Desktop (Left), Tablet (Center) and Smartphone (Right).

function, and researchers share their project progress situations.

Only Search on Map function was developed by "Ruby-on-Rails". It is written by "Ruby", a programing language, and web-developers can create websites with few processes by its libraries and application.

Search on Map function provides searching and downloading interface for users. They draw a polygon on the map where they are interested and click a "Search" button to show up GIS data images on the map. Once users click GIS data image on the map, its detailed information shows up. This function would make researchers accelerate their researches because they recognize and share their own GIS data visually (Fig. 3).

Easy Operation of GDSS

GDSS does not require any professional operators. Someone, who has experiences to use PC can be an operator. The server of GDSS as a virtual machine, the operator would open it by double click to run GDSS as like to open a Microsoft Office Word document file. They do not have to consider about

operational procedures. "Wordpress" for the user interface of GDSS has a user management and blog management functions, the operator use operator's interface for user registration and blog update without any special database or website management skills. GDSS was designed for non-professional operators. Researchers who concern with GDSS operation can share their GIS data without system management stresses. GDSS operation features, moreover, would help researchers to keep sharing and progressing their activities for a long time.

Installation of GDSS into International Research Projects

GDSS was installed into two international research projects in Peru and Serbia in 2015 and 2016 respectively. Every installation was fast, and it was produced with a capacity building program for remote sensing data analysis and development of a monitoring system. Global issues by illegal deforestation and environmental degradation because of mining activities are serious in those two regions, and the projects aim for developing solution systems and making them sustainable

after the projects.

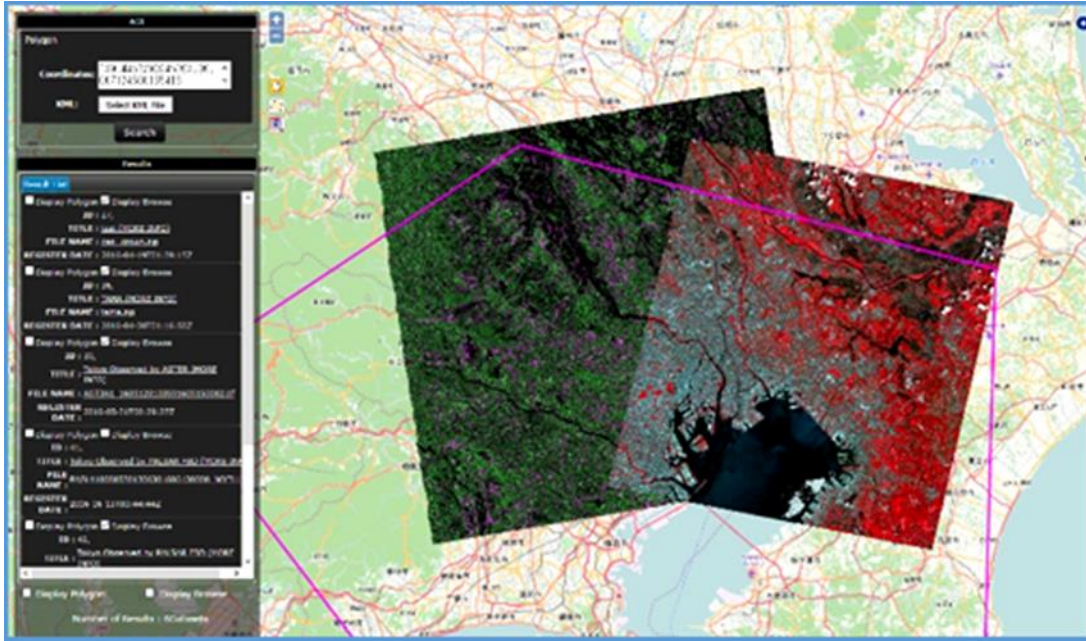Illegal deforestation by the artisanal/ small-scale gold mining

Fig. 3 Search on Map.

Fig. 4 International Research Projects in Peru (Left) and Serbia (Right).

(ASGM as followed) in Peruvian Amazon around Madre de Dios has been a serious issue. About 20% of gold production is provided by ASGM, and 16 to 18 tons of gold has been extracted annually Madre de Dios, where preserves rich biodiversity within national parks named Tambopata, Manu and Bahuaja-Sonene (Hirose et. al., 2015). The authors discussed with Ministry of Environment of Peru about illegal deforestation around Madre de Dios, and they developed a trial forest-monitoring system with local officers. The authors visited there in 2014 and 2015, had field survey and had capacity building programs for local government officers and NGOs at Tambopata. Contamination arising from mining has been also serious issues in Bor, Serbia. Mining and Metallurgy Institute

Bor (MMI Bor as followed), Akita University, Japan Space Systems and Serbian and Japanese sectors have a joint research project entitled "Research on the Integration System of Spatial Environment Analyses and Advanced Metal Recovery to Ensure Sustainable Resource Development." Serbian and Japanese researchers would accelerate the project to the goal by sharing GIS data over GDSS (Fig. 4).

Conclusion

GDSS was developed with considering sustainability for solutions of global issues: not all projects have enough budgets to develop or maintain web-GIS, but they need data sharing system for monitoring and solving the problems. GDSS makes

waves how web-GIS would become a key system for small research projects. GDSS can be started on one desktop PC and developed of open source programs. This concept leads development and management cost low, and researchers manage the system easily. By the trials in the two international research projects in Peru and Serbia, GDSS is expected to be spread to others all over the world. The Japanese researchers will be able to start up faster by sharing GIS data with GDSS at the first part of their research projects because of its concepts: small budgets for the development, easy operation and user interface. GDSS, therefore, will become a key system for developing and operating the international research projects.

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日本語要旨：

国際共同研究のための GIS データ共有システム
中村晋作・武田知己・広瀬和世

一般財団法人宇宙システム開発利用推進機構 〒105-0011 東京都港区芝公園 3-5-8

　一般財団法人宇宙システム開発利用推進機構が開発した GIS データ共有システム(以下「GDSS」という)は，ネットワークを介してデータを共有するための web-GIS である．GDSS は，容易な構成、容易な操作性及び容易な運用性を考慮して開発された．GDSS は，専門の運用者を必要とせず，1 台のデスクトップ PC 上で稼働する．GDSS は，オープンソースで開発されているが，その操作性は簡便なものとなっている．GDSS は，ペルー国における森林監視及びセルビア国における持続可能な資源開発システムという 2 つの研究での導入が試みられている．GDSS は，世界中のあらゆる分野で利用できる可能性を示している．