REINWARDTIA

A JOURNAL ON TAXONOMIC BOTANY,
PLANT SOCIOLOGY AND ECOLOGY

Cover images: *Zingiber engganoensis* Ardiyani. A. Habit B. Leafy shoot and the inflorescence showing rhizomes, roots and root-tuber C. Leaves D. Ligule and swollen petiole E. Dissection of inflorescence showing fruit F. Spike and flowers G. Dissection of flowers and fruits showing bract, bracteole, two lateral staminodes, two petal lobes, labellum, and the four appendages of the anther H. Flower. Source of materials: E190 (BO). Photo credits: B, C, D by Arief Supriatna. A, E, F, G, H by Marlina Ardiyani.

GEOGRAPHIC INFORMATION SYSTEM (GIS) WEB SERVER FOR BIODIVERSITY INFORMATION SYSTEM

IBRAHIM DJAMALUDDIN

Faculty of Engineering, Hasanuddin University, Jl. Poros Malino KM 6, Bontomarannu, Gowa, South Sulawesi, 92171. E-mail:ibedije@gmail.com

POPPY INDRAYANI & YASUHIRO MITANI

Faculty of Engineering, Kyushu University, Motooka 744, Nishi-Ku, Fukuoka 819-0395 Japan. E-mail:poppy@doc.kyushu-u.ac.jp; mitani@doc.kyushu-u.ac.jp

SHUICHIRO TAGANE & TETSUKAZU YAHARA

Faculty of Sciences, Kyushu University. Hakozaki 6-10-1, Fukuoka 812-8581, Japan. E-mail: stagane29@gmail.com; tet.yahara@gmail.com

ABSTRACT

DJAMALUDDIN, I., INDRAYANI, P., MITANI, Y., TAGANE, S. & YAHARA, T. 2015. Geographic Information System (GIS) web server for biodiversity information system. *Reinwardtia* 14 (2): 249 – 258. — Ecological protection strategies, designed by sharing information and integrating data, play an important role in defining interconnections and interdependencies in research as well as in increasing global awareness. The Geographic Information System (GIS) web server is one technology solution to improve the interoperability and sharing between the biodiversity databases of an organization and the databases of other research groups. In this paper, a database system integration framework based on GIS technology and a GIS server system using the latest cloud-based technology have been developed to incorporate biodiversity databases in Asian region. A GIS server is a GIS web platform integrating multiple geodatabases and provides data display and query, allowing users to apply internet browsers to manipulate the functions and query the data, etc. To demonstrate the effectiveness of a GIS web server, plant biodiversity survey dataset of Mt. Gede-Pangrango, West Java in Indonesia, was given as a case study for development and utilization of biodiversity information system in Asian region.

Key words: Biodiversity information, database system, GIS, interoperability, web server.

ABSTRAK

DJAMALUDDIN, I., INDRAYANI, P., MITANI, Y., TAGANE, S. & YAHARA, T. 2015. Server web GIS untuk sistem informasi keanekaragaman hayati. *Reinwardtia* 14 (2): 249 – 258. — Strategi perlindungan ekologi, disusun berdasarkan pembagian informasi dan data yang terintegrasi, memegang peranan penting dalam mendefinisikan inter-koneksi dan interdependensi pada penelitian, demikian juga halnya dalam meningkatkan kesadaran global. Server web Sistem Informasi Geografi (SIG) merupakan salah satu solusi teknologi untuk meningkatkan interoperabilitas dan pembagian antara pangkalan data keanekaragaman hayati dari suatu lembaga dengan lembaga penelitian lainnya. Dalam makalah ini, kerangka integrasi sistem pangkalan data didasarkan pada teknologi SIG dan sistem server SIG yang menggunakan teknologi berbasis *cloud* terbaru yang telah dikembangkan untuk menyatukan pangkalan data keanekaragaman hayati di kawasan Asia. Server SIG merupakan web SIG gabungan dari berbagai macam pangkalan geodata dan menyediakan tampilan data dan isian, memungkinkan pengguna untuk mengajukan mesin pencari di internet untuk memanipulasi fungsi dan isian data dan lain sebagainya. Untuk mendemonstrasikan keefektifan server web SIG, seperangkat data survei keanekaragaman tumbuhan di Gunung Gede-Pangrango, Jawa Barat, Indonesia disajikan sebagai contoh studi kasus bagi pengembangan dan penggunaan sistem informasi keanekaragaman hayati di kawasan Asia.

Kata kunci: Informasi keanekaragaman hayati, interoperabilitas, server web, sistem pangkalan data, SIG.

INTRODUCTION

There are many factors that are linked in complex ways to human population increase as well as transformation of the land for human use and global change in climate (Battrick, 2006; Letcher, 2009). These processes are resulting in the reduction of biodiversity, including the loss of entire ecosystems and the extinction of many species. Currently, biodiversity changes are eminent in Asia where the most serious biodiversity loss in the world is observed (Yahara, 2009). Recently, the program of the Asian conservation ecology is recognized to develop global conservation science and integrated research group for establishing new integrated research trends emphasizing biodiversity-ecosystem links. Furthermore, a network of biodiversity observation is created in Asia as research fields to carry out integrative biodiversity observations which located in Japan, China, Cambodia, Thailand and Indonesia. Hence, ecology conservation strategies designed by sharing information and integrating data, play important role in defining interconnections and interdependencies in research

as well as in increasing global awareness.

The Geographic Information System (GIS) web server is one technology solution to improve the interoperability and sharing between the biodiversity database of the organization and the database of other research groups (John & Donald, 1994). To support sustainable data-sharing for Asian conservation ecology, a GIS database is desirable to construct by using storage system using Spatial Database Engine (SDE) based on a GIS web server. SDE can managed spatial data in a integrated database management system (RDBMS) and enables it to be accessed by many clients (Bradley *et al*., 1994). Any SDE database that deals with biodiversity information has to be geographically based and able to predict where new populations of species with a limited recognized range might be expected, indicating potential hot spots. Locating biodiversity features associated with their attributes allows diverse data to be combined, compared and analyzed in a single GIS database server.

GIS technology for ecological assessment tool

GIS is a system that processes digitized geographic information in an integrated manner on digital maps to provide visual expressions and high-level analyses. Massive amounts of biodiversity information acquired through the use of GIS can be used to "visualize" changes in complex phenomena in the world that occur moment by moment (Pollock & McLaughlin, 1991). Furthermore, high-level analyses can enable the accurate sharing of information and help to resolve problems. GIS can be used as an effective tool for monitoring biodiversity changes. Data on species or habitat distribution from different dates allow monitoring of the location of change (where) to be

identified and the extent (how much) measured. The variety of data potentially able to be entered into a GIS is large. In addition, GIS can be applied as geospatial model tools for assessing biodiversity. Generally, assessment of biodiversity is based on availablelity data on the range of species. For instance, a species range is the area occupied by a species, and is used to refer to a distribution area. To determine species range, biologists record the geographic location of their observations and collect specimens. These data can be plotted on maps to represent species range using various way of mapping techniques. For a comprehensive assessment of biodiversity, environmental factors such as climate, vegetation, soils and geology should be considered. Models of the distribution can be constructed in GIS to assess where study efforts may be targeted, to be used as substitutes for full investigations of species in biodiversity analysis at a regional scale and to assess possible impacts of environmental changes.

In respect to our current research, GIS can be utilized as an advanced cloud computing technology to develop a web server application to distribute species distribution maps, share biodiversity databases and delivering biodiversity information services to improve internal workflows, communicate vital issues and engage stakeholders in Asian region. An illustration of a GIS web server managed by using a geodata for utilizing biodiversity information is shown in Fig.1.

A framework for databases and system integration

An advanced research has been performed to create and design geodata integration which makes full use of the capabilities of a GIS web application and a server. Fig. 2 shows designing framework to
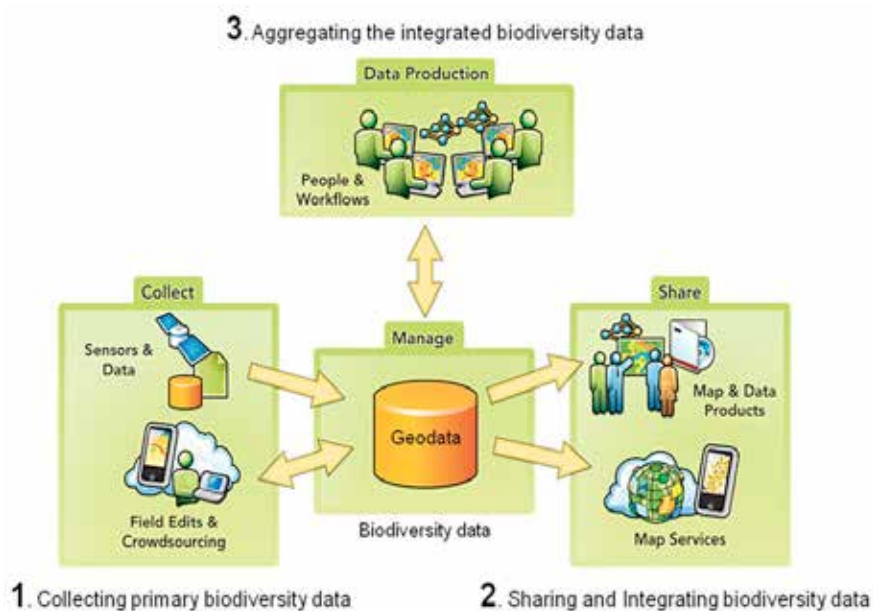
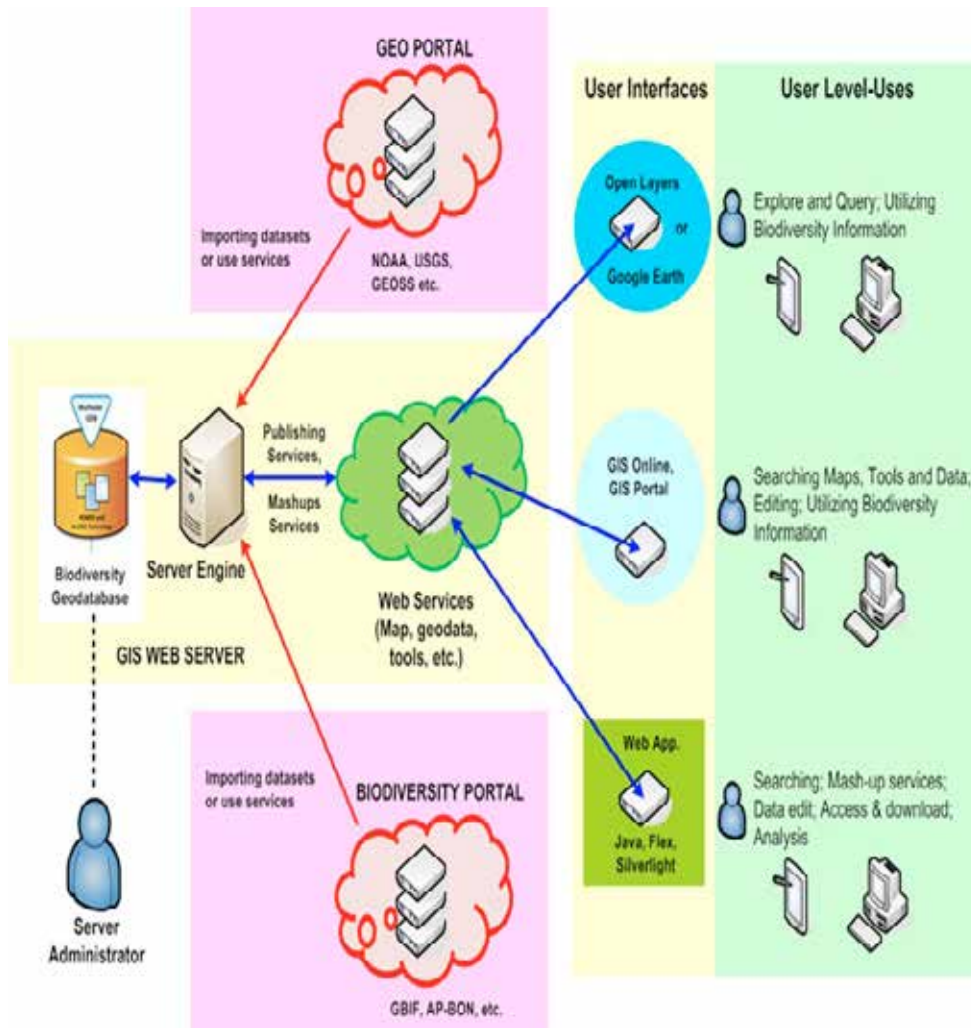

Fig. 1. Geodata can manage biodiversity information

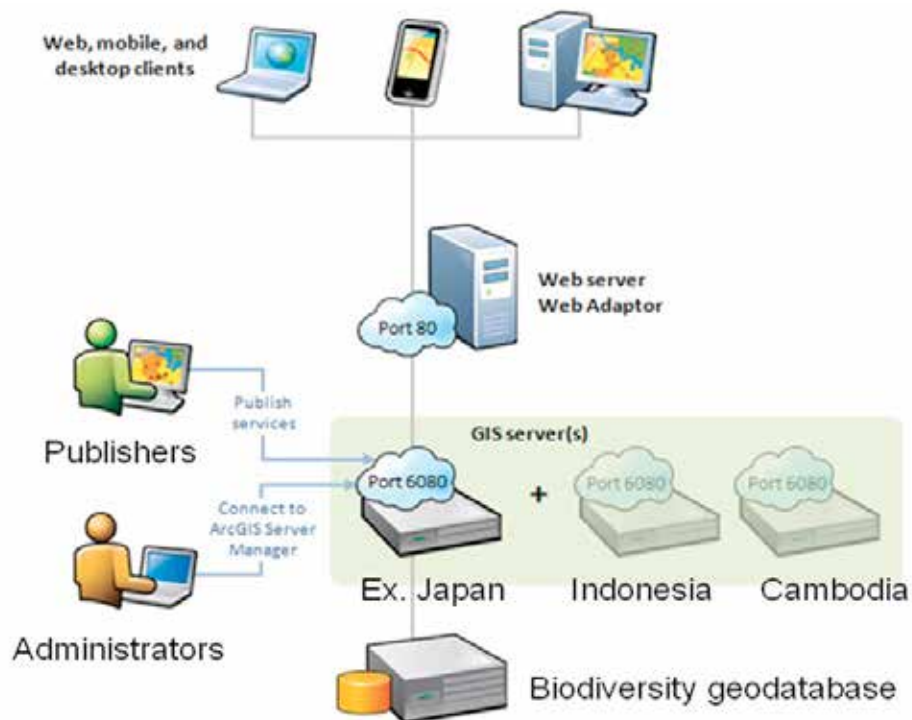Fig. 2. Framework of designing biodiversity integration databases and services system

Fig. 3. Architecture of a GIS server system for biodiversity information

integrate biodiversity databases and biodiversity related geospatial databases for enabling the comprehensive searching, acquisition, development and utilization of biodiversity information services. In this framework, the geodata for biodiversity information are not just another spatial data format that can be used; it is an integral part of the GIS web server system. Biodiversity datasets from research groups and public organizations will be collected to develop datasets, data modeling and geodata by utilizing GIS workflow process and interoperability functions. By storing biodiversity datasets from many database resources, geospatial relationships will be modeled between observation researches data (feature datasets), enabling more advanced analysis to contribute a useful component for ecological forecasting.

Development of GIS Web Application of Client Side

Nowadays, it is ordinary to observe maps or other geographic information integrated seamlessly into Web sites (Peterson, 2005). A GIS-based server can be used to share the GIS resources across an enterprise and across the GIS web resources are the maps, globes, address locators, geodata and tools. The main advantages of sharing GIS resources on a GIS server are the same as sharing any data through any kind of server technology (Goodchild, 1993).

Components of the GIS Server System

Demands are rising for easy-to-use biodiversity information that is geared toward the diverse and intensive needs of users. Fig. 2 shows the framework of designing biodiversity integration databases and services system. The following components comprise a GIS base server system site that exposes the scalability and functionality (ESRI, 2007) (Fig. 3).

1. *GIS server*, the GIS server does the work of fulfilling requests to web services. It draws biodiversity maps, runs tools, queries species data and performs any other action with a biodiversity information service. The GIS server can consist of one machine or many machines working together.
2. *Web adaptor*, is to integrate GIS servers with existing enterprise web server. The Web adaptor receives web service requests through a common URL and sends them to the various GIS server-machines in a site.
3. *Web server*, a web server can host biodiversity web applications and provide optional security and load balancing benefits to GIS server site.
4. *Data server*, biodiversity databases as a geodata can be stored directly on each GIS server, or access it from a central biodiversity database repository.

METHODS

Development of a GIS web application for utilizing biodiversity information services

At present, our research is developing a GIS web application using Silverlight technology to investigate the capability and functionality of a GIS web application for utilizing biodiversity information services for client-side. Once biodiversity data resource has been created, it can be published rapidly as a biodiversity information service and it can be shared by a GIS web application. The interface of the web application created by Silverlight technology that mainly uses to increase the quality and convenience by, for example, providing easy access to a high level of useful biodiversity information services, ecological analysis tools and other biodiversity related geospatial information services. Fig. 4 shows the tool interface functions of the developed GIS web application in which user can access the services for searching and utilization of biodiversity information. Fig. 5 shows the interface of the developed GIS web application using Silverlight technology and interface of tools to provide easy access of biodiversity information. Detail explanation of the tool functions are described as follows.

1. *Layer tools (scalability)*
   Layer tools are established to provide the user-side for integrating other biodiversity information services or base map which is provided by the developed GIS server or other available server. The operation tool is set according to the content of the operation such as Add Layer is used to add data to the biodiversity distribution map by browsing to an GIS server endpoint, and Add web map services (WMS) layer is used to add OGC (open geospatial consortium) web map services. The Base map and Search services are provided as a common tool to add a base map and online map services.

2. *Map tools (functionality)*
   Map tools are basic function for the map and the data that makes the users uses it in the exploration of biodiversity information. The map function tools of the content, the printing, the measure and the zoom & pan is provided as a user function to the comprehensive searching, acquisition. A content function is included in the map tools to give biodiversity information about the data services, and layers.

3. *Access data tools (accessibility & inter-operability)*
   Access data tools are commonly function to access the biodiversity databases on a GIS server that provides the authorized users to download biodiversity and other geospatial dataset in different format, and the biodiversity database is able to be edited via a web browser. The access data functions
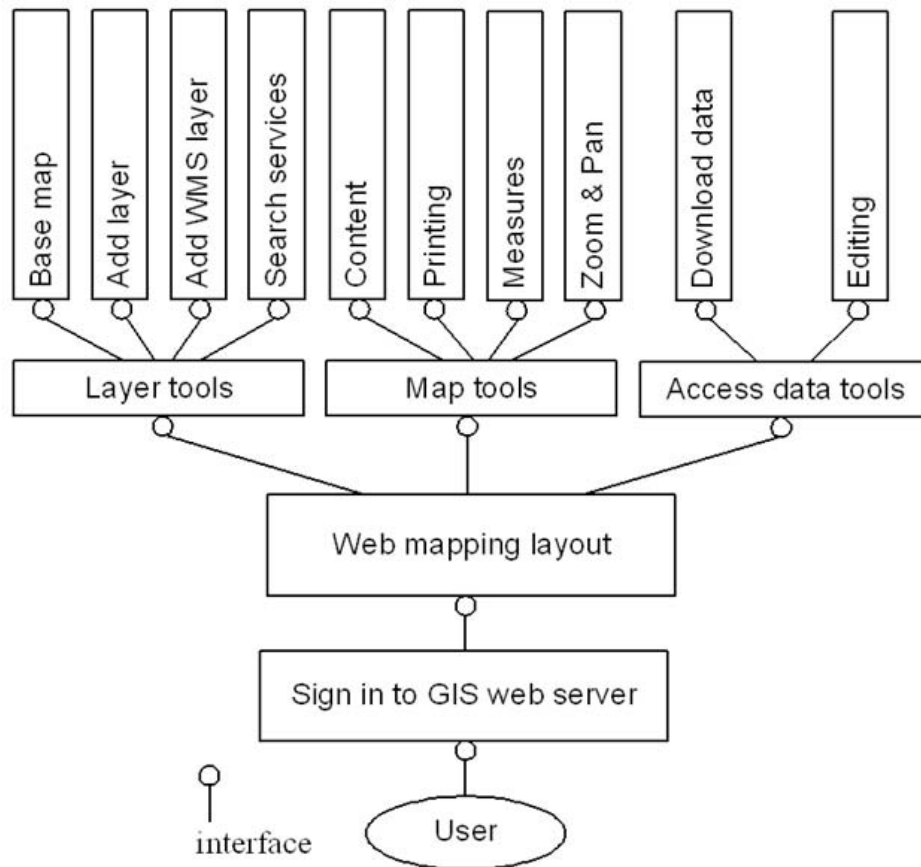
Fig. 4. Tool interface functions of the developed GIS web application for utilizing biodiversity information services.
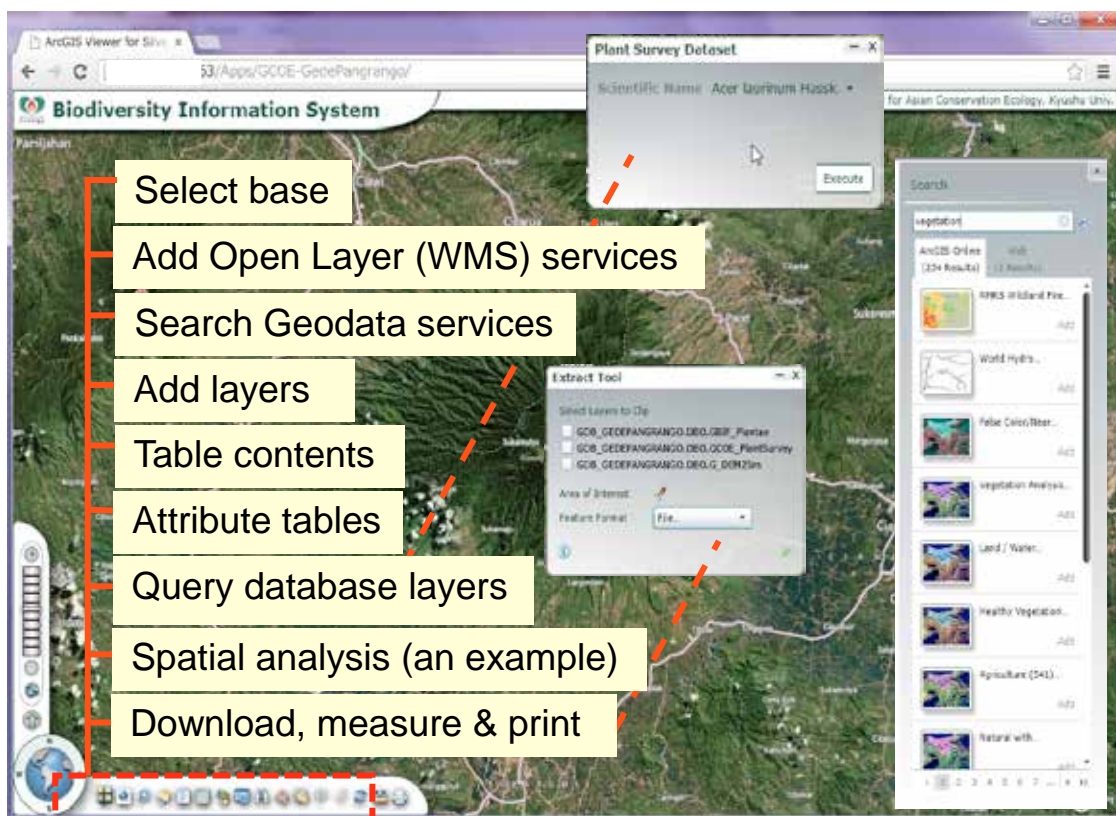

Fig. 5. Interface of the developed GIS web application layout and tools for biodiversity information system
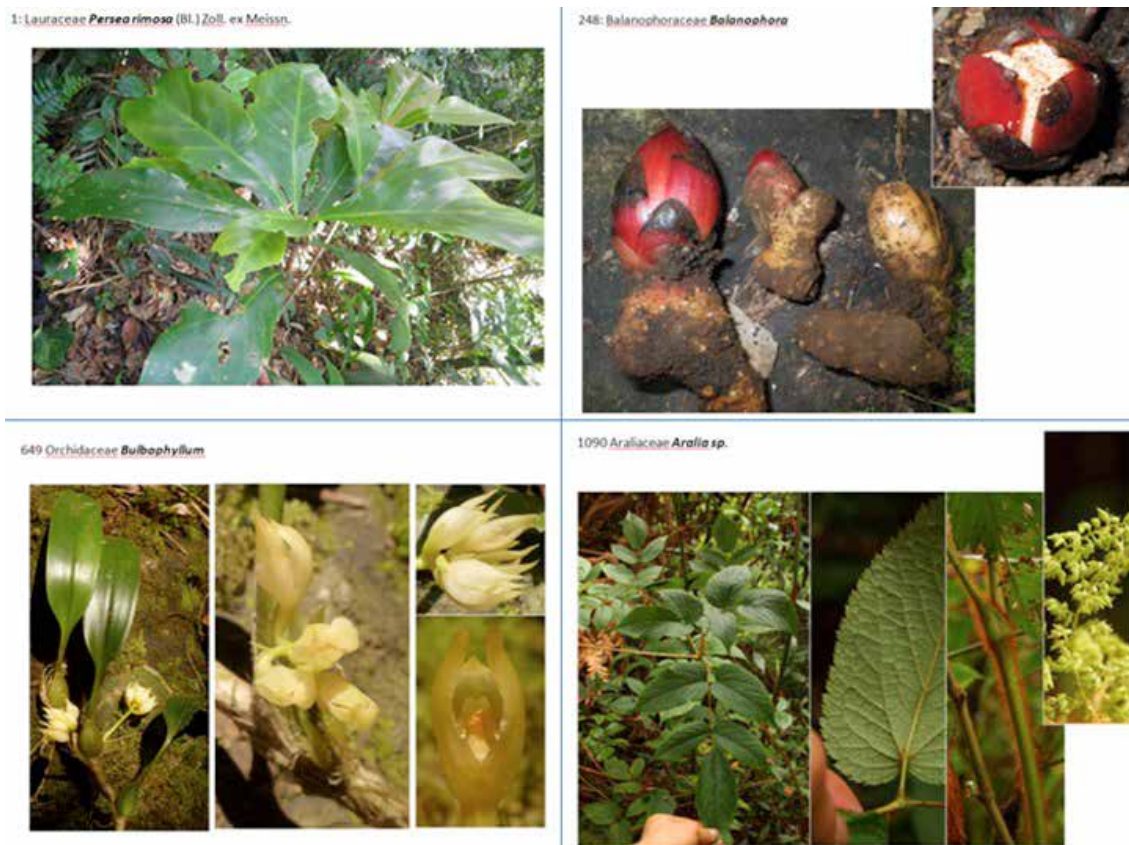
Fig. 6. The location and shape of transect 3 and landmarks near the transect.

No	Plot	Specimen	Family	Name	Habit	height (m)
1	0-10m	1	Lauraceae	Persea	tr	35
2	0-10m	2	Urticaceae	Procris	cl	0.3
3	0-10m	3	Liliaceae	Smilax	cl	0.3
4	0-10m	4	Acanthaceae	Strobilanthes	woody h	2
5	0-10m	5	Liliaceae	Smilax	cl	0.3
6	0-10m	6	Piperaceae	Piper	epi, cl	1.5
7	0-10m	7	Moraceae	Ficus	epi, liana	2.5
8	0-10m	8	Zingiberaceae	-	h	1
9	0-10m	9	Palmae	Plectocomia?	liana?	2.5
10	0-10m	10	-	-	cl	3
11	0-10m	11	Myrsinaceae	Ardisia	sh	2
12	0-10m	12	Piperaceae	Piper	cl	4
13	0-10m	13	Rosaceae	Prunus	tr	6
14	0-10m	14	Euphorbiaceae	Ostodes	tr	4
15	0-10m	15	fern	-	terrestrial	0.4
16	0-10m	16	Araliaceae	Macropanax	tr	10
17	0-10m	17	Celastraceae?	Celastrus?	sh	0.2
18	0-10m	18	Araceae	-	cl?	0.2
19	0-10m	19	Vitaceae	Tetrastigma	cl	0.3
20	0-10m	20	Palmae	Calamus/Daem	liana	0.7
21	0-10m	21	Moraceae	Ficus	sh	1
22	0-10m	22	Commelinacea	-	cl	0.5
23	0-10m	23	Celastraceae?	Celastrus?	sh	0.3
24	0-10m	24	Zingiberaceae	Boesenbergia	h	0.2

213	Musaceae	Musa	h	1
214	Rubiaceae	Lasianthus	sh	5
215	Palmae	-	tr	4
216	fern	Diplazium	terrestrial h	0.8
217	fern	Nematopteris	terrestrial h	0.8
218	Anacardiaceae?			
219	fern	Diplazium	terrestrial h	0.6
220	fern	Pteris	terrestrial h	
221	Urticaceae	Villebrunea	tr	10
222	Rubiaceae	-	liana	1
223	Verbenaceae	Clerodendrum	sh	2
224	fern	Angiopteris	terrestrial h	0.7
225	Lauraceae	Beilschmiedia	tr	2
226	Lauraceae	Litsea	tr	1
227	Myrtaceae	Syzygium	tr	1
228	Urticaceae	Elatostema	h	1
229	Rubiaceae	Lasianthus	sh	5
230	fern	Goniophlebium	epi, cl	
231	Zingiberaceae	Etlingera punice	h	3
232	fern	Nephrolepis dic	epi, cl	
233	Gesneriaceae	Aeschynanthus	epi, cl	
234	Orchidaceae	-	epi	
235	fern	Asplenium	epi	
236	fern	Vittaria	epi	
237	Euphorbiaceae	-	tr	3

234	90-100n
235	90-100n
236	90-100n
237	90-100n
238	90-100n

Fig. 7. Data of species occurrence, plant habit and height recorded in the field.

Fig. 8. Four examples of power point slides in a draft Pictured Guide.

Fig. 9a. Developed web application model for biodiversity information system.

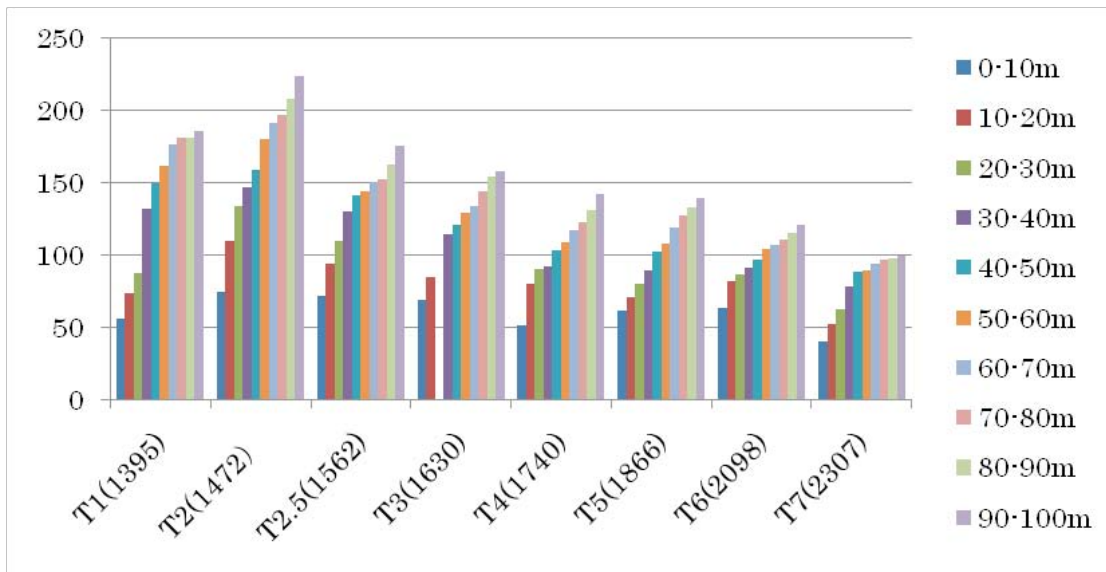Fig. 9b. Basemap provides geographical context and background for the content in a map.

Fig. 10. Species richness in eight transects. Bars show cumulative numbers of species in ten sections of the transects.

(access feature and data update, etc.) are prepared, and web browser can be used properly according to user roles and the authority. Accessible biodiversity datasets and the function are limited by the user account at login.

RESULTS AND DISCUSSION

Biodiversity data sharing using a GIS web application (a case study)

A botanical survey at Mt. Gede-Pangrango, West Java, Indonesia was conducted from September 27 to October 5, 2011, in order to describe patterns of plant distribution along the altitudinal gradient on the northern slope of mountain. We recorded presence of vascular plant species in ten transects of 100 m × 4 m placed along the altitudinal gradient. Transect 1 is placed in a reserve of Cibodas Botanical Garden (outside of the National Park) and other nine transects are located in the National Park area. Geo-reference records of these transects are as follows. We placed each transect along a mountain trail, and thus the shape of transect is not rectangular. We divided each

transect to ten sections of 10 m × 4 m (see Fig. 6 as an example) and recorded all the vascular plant species in the first section. From the second to tenth section, we recorded vascular plant species that we found for the first time in that transect and did not record species occurrence at the section for species that were already recorded in previous sections. We made 1705 records of species occurrence and made 1099 voucher specimens to identify species. For most specimens, we took pictures in the field to edit a pictured guide for the flora of Mt. Gede-Pangrango. For epiphytes, we collected species occurring below 8 m height using a pole with a cutter on the top. Thus, some species growing on tree trunks or branches higher than 8 m may be unrecorded. Fig. 7 shows a part of data recorded in transect 1 as an example of raw data structure. In addition to these species occurrence records, we recorded the approximate height of trees higher than 3 m in each section to the nearest 1 m for trees lower than 10 m and to the nearest 5 m for trees higher than 10 m. We used a pole of 8 m as a reference. This data provides the number of trees belonged to a height class in each section.

Identification

We tried to identify as many species as possible in the field using taxonomic literature at hand including the Flora Taman National of Mt. Gede-Pangrango (Sunarno & Rugayah, 1992) in which 844 taxa are listed with a short description. After the field survey, we identified species of Urticaceae, *Ficus*, *Lasianthus* and some other plant groups. However, most specimens remain to be identified or their identifications remain to be verified. Thus, the results described below are based on tentative identifications that should be revised by further studies with specimens.

Pictured guide

We prepared a pictured guide of the plants we collected by editing pictures that we took for 1099 specimens in the field using the software Power Point (Fig. 8). This power point files will be used to give the detail information about the species.

Biodiversity information services

For preliminary assessment of the effectiveness of the developed GIS web server application, plant survey datasets of the Mt. Gede-Pangrango (Microsoft Excel spreadsheet, raster image, power point files, Geo-reference data, etc.) was used to create, integrate and utilize biodiversity information as Geodata. Using a Geodata, a GIS web server can be used to collect primary biodiversity data, share and integrate biodiversity data and aggregate the integrated biodiversity data from many sources of data. Fig. 9a shows the interface of the GIS web application that contains the biodiversity information services of the Mt. Gede-Pangrango. Moreover, the interface of the GIS web application shows the biodiversity database on spreadsheet, picture of specimens and photos. With this application, users can add, edit and manage biodiversity data and ready to use basemaps (topography, geology, vegetation cover, etc.) through internet access. A basemap provides geographical context and background for the content that want to display in a map (Fig. 9b). The GIS web server application for Silverlight provides with several basemaps from which to choose suitable backgrounds for geospatial data of the Mt. Gede-Pangrango in which other technology platforms (*e.g.* MapServer, or GeoServer) do not provided.

Charting species richness using biodiversity information services

By using the distribution of topography data from biodiversity information services, species richness was the highest in T2 at 1270 m and the lowest in T7 at 2300 m. Species richness continuously decreased with altitude in 8 transects placed along the trail to theMt. Gede-Pangrango (Fig. 10). Species richness of T1 at the lowest elevation (in the reserve of Cibodas Botanical Garden) was the second highest. Cumulative numbers of species showed saturating trends in T1 and T7, but increased nearly proportionally in other transects.

CONCLUSIONS

In this paper, a GIS web server for biodiversity information system that is a synthesis of individual systems and services has been developed. Moreover, a GIS web application using Silverlight technology has been established for client-side that enabling the comprehensive searching and utilization of biodiversity information. To demonstrate the effectiveness of the GIS web server application, plant biodiversity survey at the Mt. Gede-Pangrango, West Java in Indonesia, as one of important ecological protection areas has been studied for utilizing biodiversity information services. With the developed GIS web server, users can query the survey data of each species, view the location and photo of the species, and find the data of each species, etc.

The advantages of the developed GIS web server system is, like the intelligent spatial query functions and analysis, species distribution map services, and integrating other biodiversity related services from such as topography map service, climate data service and remote sensing data services. Consequently, the developed GIS web server can provide a framework for delivering

internet-based biodiversity information services that support cooperation among public research organizations, university researchers, community residents, NPOs and others. Using a GIS web application makes sharing biodiversity database about important biodiversity information services and ecological conservation decisions more efficient and effective.

ACKNOWLEDGEMENTS

REFERENCES

BATTRICK, B. 2006. *The Changing Earth*, ESA Publication Division, The Netherlands.

BRADLEY, C. R., THOMAS, R. L., LOUIS, T. S., JESSLYN, F. B., JAMES, W. M. & DONALD, O. O. 1994. *Designing Global Land Cover Databases to Maximum Utility: The US Prototype.* Environmental Information Management and Analysis: Ecosystem to Global Scales. Taylor & Francis, London. Pp. 299 – 314.

ESRI (Environmental Systems Research Institute), *Geospatial Service-Oriented Architecture (SOA)*, an ESRI White Paper. Retrieved June 2007 from: http://www.esri.com/library/whitepapers/pdfs/geospatial-soa.pdf.

GOODCHILD, M. F. 1993. Sharing Imperfect Data, Sharing Geographic Information. New Brunswick, New Jersey. Pp. 363 – 374.

JOHN, J. K. & DONALD, L. P. 1994. *Global Environmental Characterization: Lessons from the NOAA-EPA Global Ecosystems Database Project.* Environmental Information Management and Analysis: Ecosystem to Global Scales. Tailor & Francis, London. Pp. 315 – 327.

LETCHER, T. 2009. *Climate Change*, *Observed Impacts on Planet Earth*. Elsevier, The Netherlands.

PETERSON, M. P. 2005. *Maps and the Internet*. Elsevier, The Netherlands.

POLLOCK, R. J. & MCLAUGHLIN, J. D. 1991. Database management system technology and geographic information systems. *J. of Surveying Engineering* 117 (1): 9 – 26.

SUNARNO, B. & RUGAYAH. 1992. *Flora Taman Nasional Gede Pangrango*. Herbarium Bogoriense, Puslitbang Biologi – LIPI, Bogor.

YAHARA, T. 2009. *Climate change, biodiversity loss and challenges of the Asian conservation ecology program*. The 1st International Symposium on Aquatic Environment and Biodiversity Conservation. The Lake Taihu Basin. Shanghai-China.

INSTRUCTION TO AUTHORS

Scope. *Reinwardtia* is a scientific irregular journal on plant taxonomy, plant ecology and ethnobotany published in December. Manuscript intended for a publication should be written in English.

Titles. Titles should be brief, informative and followed by author's name and mailing address in one-paragraphed.

Abstract. English abstract followed by Indonesian abstract of not more than 250 words. Keywords should be given below each abstract.

Manuscript. Manuscript is original paper and represent an article which has not been published in any other journal or proceedings. The manuscript of no more than 36 pages by using Times New Roman 11, MS Word for Windows of A4 with double spacing, submitted to the editor through <reinwardtia@mail.lipi.go.id>. New paragraph should be indented in by 5 characters. For the style of presentation, authors should follow the latest issue of Reinwardtia very closely. Author(s) should send the preferred running title of the article submitted. Every manuscript will be sent to two blind reviewers.

Identification key. Taxonomic identification key should be prepared using the aligned couplet type.

Nomenclature. Strict adherence to the International Code of Botanical Nomenclature is observed, so that taxonomic and nomenclatural novelties should be clearly shown. English description for new taxon proposed should be provided and the herbaria where the type specimens area deposited should be presented. Name of taxon in taxonomic treatment should be presented in the long form that is name of taxon, author's name, year of publication, abbreviated journal or book title, volume, number and page.

Map/line drawing illustration/photograph. Map, line drawing illustration, or photograph preferably should be prepared in landscape presentation to occupy two columns. Illustration must be submitted as original art accompanying, but separated from the manuscript. The illustration should be saved in JPG or GIF format at least 350 pixels. Legends or illustration must be submitted separately at the end of the manuscript.

References. Bibliography, list of literature cited or references follow the Harvard system as the following examples.

Journal : KRAENZLIN, F. 1913. *Cyrtandraceae* novae Philippinenses I. *Philipp. J. Sci.* 8: 163–179.
MAYER, V., MOLLER, M., PERRET, M. & WEBER, A. 2003. Phylogenetic position and generic differentiation of *Epithemateae* (*Gesneriaceae*) inferred from plastid DNA sequence data. *American J. Bot.* 90: 321–329.

Proceedings :TEMU, S. T. 1995. Peranan tumbuhan dan ternak dalam upacara adat "Djoka Dju" pada suku Lio, Ende, Flores, Nusa Tenggara Timur. In: NASUTION, E. (Ed.). Prosiding Seminar dan Lokakarya Nasional Etnobotani II. LIPI & Perpustakaan Nasional: 263–268. (In Indonesian).
SIMBOLON, H. & MIRMANTO, E. 2000. Checklist of plant species in the peat swamp forests of Central Kalimantan, Indonesia. In: IWAKUMA, T. *et al*. (Eds.) Proceedings of the International Symposium on: Tropical Peatlands. Pp.179-190.

Book : RIDLEY, H. N. 1923. *Flora of the Malay Peninsula 2*. L. Reeve & Co. Ltd, London.

Part of Book : BENTHAM, G. 1876. *Gesneriaceae*. In: BENTHAM, G. & HOOKER, J. D. *Genera plantarum 2*. Lovell Reeve & Co., London. Pp. 990–1025.

Thesis : BAIRD, L. 2002. *A Grammar of Kéo: An Austronesian language of East Nusantara*. Australian National University, Canberra. [PhD. Thesis].

Website : http://www.nationaalherbarium.nl/fmcollectors/k/KostermansAJGH.htm). Accessed 15 February 2012.

REINWARDTIA Author Agreement Form

Title of article   :

Name of Author(s) :

I/We hereby declare that:

- My/Our manuscript was based on my/our original work.
- It was not published or submitted to other journal for publication.
- I/we agree to publish my/our manuscript and the copyright of this article is owned by Reinwardtia.
- We have obtained written permission from copyright owners for any excerpts from copyrighted works that are included and have credited the sources in our article.

Author signature (s)   Date

_____

Name

CONTENTS
Page