Developing online dynamic-inventory of plants database management SINDATA© of Cibodas Botanical Garden

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Abstract. A botanical garden is an area consisted plants collection which has a high conservation value, maintained and managed as ex-situ principles. Other specific differences are systematically recorded of historical data of each plant and the dynamics, time over time. The study was purposed to build a valid plants database of Cibodas Botanical Garden (CBG) and the dynamics, and to manage the other related information, so these can be used widely for the public, and to efficiently of supervision for operators. The system was built by integrating MySQL®, Mapserver® and PHP© software to manage three basic data: inventory of plants collection and the dynamics, geospatial information, and daily microclimates conditions. This integrated system was established as Sistem Informasi Data Tanaman or SINDATA©. SINDATA© has managed 8,309 of outdoor (from ground cover type up to large trees) and 2,932 of indoor (i.e. orchids, cactus, herbs and Nepenthes spp.) plants specimen database, a set geospatial information and interactive map of CBG and daily microclimates (i.e. temperature, humidity, rainfall, solar radiation, wind velocity, and air pressure) information. This system was expected to be a representative source and scientifically valid data to disseminate the information and knowledge references of CBG for conservation-research-education purposes.

Keywords: Cibodas Botanical Garden, daily microclimates, information technology, interactive map, plants database management

1. Introduction
The difference of botanical gardens lies in embedded plants collections which having scientifically and well-documented data. Conventional plants collection data has been running over a century, while processing and documenting plant data in new digital ways just for last decades [1]. Since the introduction of digital plant data processing systems in the form of ‘Botanic Garden Recorder’ (BGR) applications by Botanic Garden Conservation International (BGCI) in 1996. BGR is an international standard plant data processing application used to process plant data in various botanical gardens, especially in Southeast Asia. BGR applications can only process the data that is textual and incapable to process images or maps, so that there is difficulty when will display them. BGR applications are not network-based or web-based so can only standing alone.
SINDATA© or Sistem Informasi Data Tanaman application is built and developed beside as a data processing media for plants which needed by Cibodas Botanical Garden (CBG), as well as a public needs for personal development and social environment. This importance as well as a part for national resilience, especially the policy of biological resources management [2] [3] [4], and for public which entitled to obtain information of plants collection in the botanical garden as a human right for the purpose of educational development and improvement of sciences. The presence of SINDATA© applications is based on a strategic botanical garden that refers to the world's conservation strategy (Global Strategy for Plant Conservation). Among which sets out ways to improve the documentation of plant data including computerized the systems for the purpose of improving collection management [3], prioritizing the provision of educational facilities to community and provide a service to the public as a source of information, especially information related to the plants. SINDATA© is a digital data processor has provided a great solution to solving problems related to inputting various types of data, such as data in the form of text or image data such as maps and photos, as well as SINDATA© applications provide solutions to the desired output by the user.

SINDATA© is an innovative application, which integrates plant data [4] [5] with microclimates condition data at CBG which updated every five minutes and spatial information data [6] [7] of CBG. SINDATA© is accessible on the internet by simply typing http://sindata.krcibodas.lipi.go.id. The updated microclimates data is important to describe general atmospheric condition surrounding CBG for various purposes of research and education, especially to analyze the influences to plants growth, the climate comfort and others. This information is also important as a reference to the potential tourist to visit CBG and planning their activities.

The SINDATA© application also contains plant information by using up-to-date references or literature to ensure that plant data is not outdated and valid in a scientific way and the information is always updated in accordance with the latest crop knowledge developments, using internationally-recognized references. Plants collection richness of CBG are 11,241 specimens, which consist of 8,309 of outdoor (from ground cover type up to large trees) and 2,932 of indoor (i.e. orchids, cactus, herbs and Nepenthes spp.) plants specimen. The plants collection is dynamical which mean these can be increased because of the planted addition; reduced because of plants dead (by several causes such as old ages, fallen, pests and diseases, dried, withered etc.). The dynamics are also referring to the scientifically update of the plant's name because of the development of plants taxa classification. All these dynamics are recorded in SINDATA© routinely per-month for the number of specimens and periodically per-semester for name updating if there any.

The purposes of study were build a valid plants database of CBG and these dynamics, and to manage the other related information, so these can be used widely for public and to efficiently plants collection supervision for operators. SINDATA© was also developed as an advance system of dynamic-inventory of CBG's plants database management and to construct by online to disseminate for public information and knowledge, and for research or educational purposes. The scope of the study was to develop a web-based system of SINDATA© so that widely accessible to the public. The development was also built a multi-user system that manageable by several competence operators at the same time. The system managing three basic data: inventory of plants collection and the dynamics, geospatial information, and daily microclimates conditions of CBG. The results were expected as an added value for information and knowledge-transfer to the stakeholders.

2. Methods
SINDATA© system was built by integrating MySQL©, Mapserver© and PHP© software to manage three basic data, which are inventory of plants collection and these dynamics, geospatial information, and daily microclimates conditions. The main plants database consists plants richness of CBG, such as number of plants specimen and the dynamics.

A plants data consists of the number of plants collection (refers to the location in the garden), the sources (self-exploration, donation, or self-propagation), the collector, the access number, scientific name (since division to species or sub-species, if any), local name (if any), the origin, type of the habitat
(refers to the latitude), type of the material and type of the habitus. The access number is a series unique number which established for a plant acceptance. The code consists eleven digits, first digit is “C” code for Cibodas, four digits afterwards are code for the year, next two digit is the month in the year which plant accepted, and last four digit is the order of plant registered in that month. For example, access number C2016020016, this means the plants accepted to Cibodas in February 2016, with registered as a sixteenth order. All these information are inventoried in Microsoft Office© Excel© and further to be inputted to the system.

The plants dynamic consists previous month the basic number of plants specimen, addition, reduction, scientific name changes (if any) and plants photos. The inputting process was conducted daily by the operators. Up to October 2017, SINDATA© has managed 8,309 of outdoor and 2,932 of indoor plants specimen database. The outdoor plants included from ground cover type up to large trees and indoor plants consisted orchids, cactus, herbs and Nepenthes spp.

Furthermore, daily microclimates conditions (i.e. temperature, humidity, rainfall, solar radiation, wind velocity, and air pressure) were obtained by self microclimates tool which installed in CBG. Weather equipment which used was Precision Weather Station Davis Instruments Vantage Pro2 Plus©. The equipment was automatic constantly sent current data to server regarding microclimates condition of CBG. The collected data were accurately to describe weather condition surrounding equipment minimum in radius of one kilometer square. These data were uploaded by using MySQL© and PHP© software to web-based data in SINDATA© system.

Next, geospatial information which displayed previously conducted field inventory and data processing. The activities has been initiated in 2013 and finished in 2016. Geospatial information map of CBG was consisted borderlines area of CBG, elevation and contours, water body, roads, other infrastructures, and the important one is planted points of each plant specimen. These data were processed by Mapserver© software and serve to web-based data used MySQL© and PHP© software.

All data was serve to web-based and may widely accessed http://sindata.krcibodas.lipi.go.id . The data changes and dynamics were up-to-date and controlled by operators daily since 08.00 am to 16.00 pm, Monday to Friday. These information and data content of SINDATA© were expected as public knowledge and a valid scientific data for research and educational interest

3. Results and Discussion

Plants which have been rescued from their habitat, be collected and their data capable of being processed, documented and re-displayed by the botanical garden are a very urgent material for the benefit of public knowledge, research, and policies in the context of the flora conservation. SINDATA© application was managed its system and data by Registration Unit of CBG in cooperation with other units. SINDATA© users both internal and external may easily access the application of SINDATA© by typing the site, i.e. http://sindata.krcibodas.lipi.go.id or go first through the website of CBG athttp://krcibodas.lipi.go.id.

3.1. Data content

SINDATA© or Sistem Informasi Data Tanaman to be presented on the website (figure 1a) encompassing about 8,309 of outdoor and 2,932 of indoor plants specimen database, a set geospatial information and interactive map of Cibodas Botanical Garden, and daily microclimates (i.e. temperature, humidity, rainfall, solar radiation, wind velocity, and air pressure).The main menu of were Status IUCN, SIG, Cuaca and apk(figure 1b). Status IUCNOr IUCN status was a list of CBG plants collection that included to the IUCN Red-list. IUCN Red-list consists a plants list in the world that threatened (by over-exploited) in their natural wildlife. The SIG (sistem informasi geografis) or geographic information system was a series spatial information of CBG. Cuaca or weather was the atmospheric information condition surrounding CBG. The apk was application of SINDATA© that can be downloaded to the android©-based self phone.

The plants information were first entered into Microsoft Office© Excel© spreadsheets by Registration Unit of CBG. Each plant entry has all the information including species name, author citation, sub-
species if any, variety if any, family, subfamily and general others description. A plants data consisted
the number of plants collection (refers to the location in the garden), the sources (self exploration,
donation, or self propagation), the collector, the access number, scientific name (since division to species
or sub-species, if any), local name (if any), the origin, type of the habitat (refers to the latitude), type of
the material and type of the habitus. The general summary of the CBG plants collection (based on family
or genera or species and others classification such as genus dubious and intermediate) can be explored
in the homepage system (figure 1c). The data further comprise in which the species are described.

Figure 1. (a) Homepage of the SINDATA ©; (b) Main menu of the system; (c) The summary of the richness of CBG
plants collection; (d) Plant taxonomic description and images.
3.2. Additional information includes the nomenclature update according to ‘The Plant List’ (http://www.theplantlist.org/), a detailed description in plants database pages, phenology, distribution, threat status and comments on any special features of the taxon. The digitized plant specimens at a minimum resolution of 300 dpi and images of live specimens provided in the database form an information synergy on the species (figure 1d). Once entered, the data were subjected to scrutiny for accuracy and formatting consistency, and subsequently imported into MySQL© database tables.

3.3. ‘The Weather’ menu is obtained from real time weather data at CBG and updated every five minutes. The data were included temperature, humidity, air pressure, wind speed, wind direction, solar radiation, ultraviolet rays, rainfall, and evaporation. All microclimates data were subsequently imported into MySQL© database tables (figure 2a) and presented by PHP© scripting language. Furthermore, geospatial information map of CBG was consisted borderlines area of CBG, elevation and contours, water body, roads, other infrastructures, and the important one is planted points of each plant specimen. Full map of CBG in which there are points as a representation of plants collection. These data were processed by Mapserver© and serve to web-based data used MySQL© and PHP© database.

![Figure 2. (a) Web-display of weather condition; (b) Geospatial image of CBG in SINDATA©](image)

3.4. Website design
The website was developed using standard open-source software on the Linux operating system, including Apache, a web server (http://www.apache.org/); MySQL©, a database system
(http://www.mysql.com/), and PHP®, a scripting language (http://www.php.net/). Plant taxonomic data are stored in the database, which allows rapid indexed searches to be carried out and the content to be generated dynamically. Binary (non-text) content such as high quality digital image files and documents requiring considerable storage are stored on the file system instead of inside the database, for greater efficiency.

3.5. Website user interface
An image gallery is provided that allows species to be identified by browsing images. Each image is hyperlinked to the corresponding species webpage. Alphabetically sorted species and family lists allow users to browse by species name and family respectively. The website provides basic and advanced search capabilities. Text entered in basic search is searched in all fields of the plants database, while advanced search allows text to be searched in one or more fields (e.g. genus). Furthermore, in interactive map by clicking each point on the map will appear plant data, for example in Figure 3.

Koleksi Kebun (XI.C.27. ~ Long: 721507.977 m ~ Lat: 9254514.686 m)
No. akses : C1996000492  Nama : Castanopsis argentea (Blume) A.DC.
Kolektor : DE.622  Suku : Fagaceae
Habitus :  Asal :
Tanggal Tana : 01/01/1976  Material :

Figure 3. Interactive map showing point to plant collection description and its location in the garden.

3.6. Accessibility and monitoring
SINDATA® is a data processing plant application based on multi user system [5]. For internal environment of CBG, the presence of SINDATA® provided an ease in operation because each plant personal data processing can be data entry by sharing between personal and data can be validated. Data and information entries can be monitored by all data processors. Data and information users of other units within CBG such as researchers, collection units, nursery units, service and information units and other units can directly access data, and these can be used directly by their respective users.

SINDATA® can be accessed data and information anywhere and anytime. This has been proven to get a good response from users as seen from the number of external users recorded in 2017 alone reached
more than 14,176 users. SINDATA© provides convenience to people who need information on plants and microclimate information of CBG. The data and information can be used as references by students, government agencies, private or public for various purposes, such as for research, scientific papers, be used in the business world and can be used as a reference to take policy at the level of government and private policy [2]. For interests of other institutions, data and information in SINDATA© can be shared with government or private institutions [5], such as Research Centre of Biology-LIPI with its InaBIF application, or with Botanic Garden Conservation International (BGCI), with the application of distance education (Digital Class System) of CBG. The presence of SINDATA© provides an ease in transferring data or data sharing with various related institutions.

The data and information completeness were continually needed includes new records, the number of dynamics data, the number of images uploaded, and the number of general information collection plants and how far the system developed. These update will be needed by internal user both CBG and external public.

4. Conclusion
Based on the display and the data that described in the system, SINDATA© has succeeded to present a user-friendly information to the public. The construction of the system was simple with a complete content to described most of all of the richness of CBG plants collection. The content of the system did not only describe the plants collection but also give the information of related data and information that important to improve the development of research and education. SINDATA© is an information system that provides access to data on plant diversity of Indonesian tropical mountain plants, especially CBG plants collection. The information content of the database is essentially built general knowledge for public and so research and educational interest. The presentation of this information implies that information specimens shown are available for examination and for further research. An integrated plants database, thus, maximizes the usefulness of the collection by providing authentic and lasting information.

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