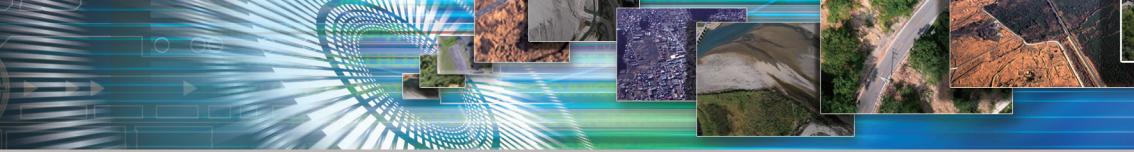


Maps and GIS Digitization Procedures Guideline

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International Collaboration and Promotion of
Taiwan e-Learning and Digital Archives Program



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Publisher's Preface

Since the launch of the “National Digital Archives Program” in 2002, members of numerous institutional projects and request-for-proposals projects joined our team to engage in digital work that covered countless categories and massive amounts of content. The first phase of the five year project was successfully completed in 2006. The following year, the “National Digital Archives Program” and “National Science and Technology Program for e-Learning” were integrated into the “Taiwan e-Learning and Digital Archives Program (TELDAP, <http://teldap.tw/>)”, striving to achieve the ultimate goal of “presenting Taiwan’s cultural and natural diversity” while continuing to expand digital archives and contents of e-learning, and systematically promoting digital achievements into education, research and industries. TELDAP hopes to more actively collaborate with the private sector to drive growth in related industries, for not only preserving important cultural assets, but also accelerating the development of a new culture in the digital age of today.

As a subproject of TELDAP, we renamed from our original “Content Development Division”, to “Taiwan Digital Archives Expansion Project” (<http://content.teldap.tw>) and took more active measures to expand the sources of digital content, extending our reach to the collections of private institutions and even individuals. We have widely requested proposals for digitization projects related to archives, archeology, philology, geography, ethnicity, art, daily life, fauna and flora, and endeavored to better integrate digital content with a wide range of characteristics, to develop them into fun and inspiring digital materials, and to provide them free of charge to the public for education and research. This will also help firms and public or private holding institutions to find cooperation opportunities in value-added applications. The collaboration between the “Taiwan Digital Archives Expansion Project” and other projects under the “Taiwan e-Learning and Digital Archives Program” will help accelerate the development of educational, research and commercial value-added applications of digital content, which will benefit the presentation of Taiwan’s cultural and natural diversity, and allow people everywhere around to understand and appreciate the richness of our history and culture, as well as the beauty of our natural ecology.

While collecting and developing value-added applications of digital content, whether during the “Content Development Division” or “Taiwan Digital Archives Expansion Project” period, members of this project have continuously followed up on digital workflow related technologies used by public and private institutions and open request-for-proposals projects, and compiled a series of “Digitization Procedures Guideline Books” that introduced various international standards related to digitization technologies and workflows. Since 2005, we have written 21 digitization procedures guidelines on different themes (full text of all of the 21 books can be downloaded from the “Taiwan Digital Archives Expansion Project” website under “Virtual Library: Digitization Books”), selecting exquisite digital objects, such as ceramics, paintings, calligraphy, and string-bound books, combining the experiences of different institutional projects, and supporting them with domestic and foreign theories and practice results.

Since last year we have prepared to revise and expand our “Digitization Procedures Guideline” book series, hoping to expand distribution channels so that they may be



available to even more museums, libraries, institutions and individuals as reference. Our preparations are mainly divided into revising existing guidelines for “selected objects” and compiling new guidelines on “common principles”. The former refers to revising the existing 21 guidelines with a focus on introducing new digitization technologies and specifications, more practical software and hardware, and digital content protection mechanisms; we expect to revise seven books per year and complete all 21 books within three years. As for compiling guidelines on “common principles,” our emphasis will be on the introduction of key concepts, such as the “life cycle” of digital information and quality control, studying multiple types of objects instead of a single type of object, and adopting common principles as the guideline framework. The so-called common principles refer to project management, workflow management, audiovisual management, text management, color management, outsourcing management, and international resource analysis. These eight common principles are topics that we will investigate, research and write guidelines for; we expect to publish eight guidelines in three years.

Guidelines for selected objects and on common principles complement each other. Guidelines on common principles emphasize on the analysis of important topics in digitization work, guiding readers to thoroughly consider the advantages and disadvantages of digitization. Guidelines on selected objects describe practices and techniques for digitizing specific objects, helping readers to select the most suitable, most effective digitization workflow. By publishing this “Digitization Procedures Guideline” book series, we believe that we are providing institutions and individuals with the intention to engage in digitization work with a series of practical guidelines that provide an overall view, while guiding them step by step through the digital workflow. Here we must stress that the theoretical foundation of this book series is the precious accumulated experiences of institutional and request-for-proposal project teams. These experiences allow higher quality digital content to be produced, presented and maintained with less cost, further enriching our digital archives and e-learning content. As we continue to publish our “Digitization Procedures Guideline” book series, we must give special thanks to working partners who were interviewed and colleagues who were involved in writing the guidelines, and are grateful to the scholars and specialists that reviewed and provided their advice on the book series. Finally, we hope that readers will not hesitate to help us with corrections and offer suggestions that will help us become even better.

Taiwan e-Learning and Digital Archives Program
Taiwan Digital Archives Expansion Project
Digital Archives Sub-project of Project Integration

Project Director
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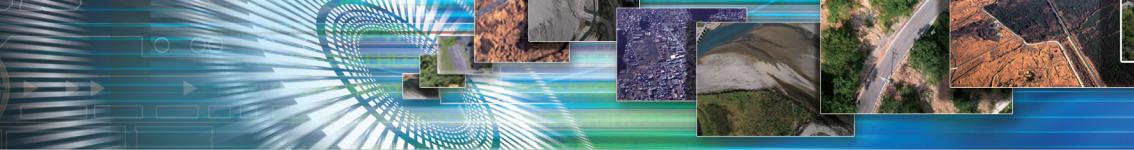
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One. Introduction



▶ WEB ▶

Maps are a form of graphical language that record geographical information, and serve as a medium for storing and communicating geographical information. They follow certain mathematical rules and utilize a symbol system to represent natural and artificial phenomena after map generalization. Maps mainly express the natural distribution of space, as well as social, cultural and economic information.¹ In other words, this ‘tool’ has the ability to describe objects on earth’s surface, and following further applications:²

1. Maps can be used to study the pattern of how various phenomena are distributed, including characteristics and regional differences of a certain element or phenomenon, or the alternation and change of varieties of the same element.
2. The comparability of maps can be used to analyze related maps and discover the internal connection between various elements and phenomena.
3. Maps can be used to study the dynamic change of various phenomena.
4. Maps can be used for comprehensive evaluations, e.g. land quality evaluation, environment quality evaluation, and agricultural natural conditions evaluation.
5. Maps can be used for geographic forecasts, e.g. long-term weather forecasts, weather forecasts, hydrological forecasts, environment pollution forecasts, and forecasts of the environmental effect of large scale natural engineering.
6. Maps can be used for area division and planning.
7. Maps can be used to compile other maps.

In general, not only are maps a way to express results of regional scientific survey studies, they also serve as important data that many departments and disciplines rely on for analytical research, calculation, comprehensive evaluation, forecasts, planning and design, and command and deployment. For this reason maps are widely applied in economic, military and scientific research. Traditional maps consist of mathematical elements, geographic

¹ Li Je-Yu, “Introduction to Geographic Information Systems,” Chuan Hwa Science & Technology Book Co., February 2006, pages 1-6.

² Entry: Map geographic elements, “Encyclopedia of China,” Search: January 2009, <http://etd.sinica.edu.tw/cpedia/Content.asp?ID=74645&Query=9>

elements and layout elements, together known as the “three map elements,” in which geographic elements make up the main portion of maps and serve as a basis for positioning and orientation.³ Maps can roughly be divided into the following three categories:⁴

1. Regular maps: show natural elements and social and economic phenomena within a specific region.
2. Thematic maps: emphasize one or several natural elements or social and economic phenomena.
3. Other maps: contour maps, hypsometric maps, shaded relief map and 3D topographic maps.⁵

Following the development of science and technology, our understanding of natural elements has grown, and this continuous growth has been changing the definition of maps. Thanks to the rapid development of electronic and information technologies, diversified applications of maps have been derived from the integration of digital technology with traditional cartography, thus leading to different opinions on the meaning of maps. For example, we can store and transfer maps in digital form after digitization, and search or overlap different information layers at will, creating broader and richer applications of maps. Digital technology has brought maps into the electronic era. The limitation of paper maps application can mainly be observed in the following areas:⁶

1. Source data gathered from surveys must be simplified and categorized to make maps easier to understand, but useful information is often lost during the process of categorization .
2. To reduce the loss of information, maps must be elaborate and precise. This increases the workload, while over complex and detailed maps makes observation difficult.
3. If a new method is used for categorization after information

³Entry: Map method, “Encyclopedia of China,” Search: January 2009, <http://etd.sinica.edu.tw/cpedia/Content.asp?ID=74642&Query=1>

⁴Entry: Maps, “Encyclopedia of China,” Search: January 2009, <http://etd.sinica.edu.tw/cpedia/Content.asp?ID=31795&Query=1>

⁵Same as Note 1, pages 1-10.

⁶Wu Lun, Chang Ching, “Geographic Information Systems,” Beijing Electronic Industrial Press, July 2002, pages 11-12.

categorization, then personnel must start from scratch.

4. Searching for information on maps is inconvenient and has large error margins: it is extremely difficult to add new information or establish connections between different thematic maps.
5. Updating maps is a complex and long process that often takes several decades or even longer.
6. It is hard to keep track of rapidly developing things, such as urban constructions.

The rise of geographic information systems sprang from the need of tools that can more effectively study, plan and manage the space that people live in, i.e. tools that could provide convenient, rapid and accurate storage, access and analysis so as to make up for the drawbacks of hand drawn thematic maps and regular maps.

Geographic Information Systems (GIS) first appeared in the 1970s, and were an emerging field that gradually developed on the basis of database, remote sensing, and computer aided drawing (CAD) technologies. From a historical perspective, GIS emerged from maps, thus theories and methods of cartography play an important role in the development of GIS. GIS can be considered a new medium for map information, and has the functions of space information storage, analysis, display and transferring. At the same time, maps are still an important source of data for GIS. GIS tools can process paper maps and convert them into electronic maps displayed on a monitor, so as to satisfy new demands on maps.⁷ Therefore, the digitization of maps is an extremely important task, especially for old maps with historic value. Digitization of such maps not only preserve maps in digital form, but also allow maps to become source data for compiling new maps using GIS software.

Thus, the focus of this guideline is on how to digitize maps and implement proper quality management with two featuring characteristics – balanced emphasis on both theory and practice, and providing flexible options.

In regards to the emphasis on theory and practice, this guideline is based on practical experiences of the Taiwan e-Learning and Digital Archives

⁷ Wu Lun et al., “Principles, Methods and Applications of GIS,” Beijing Science Press, 2001, pages 17-18.

Program (TELDAP), and evaluates the appropriateness and applicability of the digitization workflow of each project. Digitization knowledge, digital imaging concepts and equipment selection information are then utilized on this foundation, so that participants or those who are interested could learn the theoretical background of map digitization. As for flexible options, different options are provided based on media, application and budget considerations, so that implementation units can select digitization plans that best suit their needs. The applicable scope of this guideline is briefly described below, including intended users, digitization objects, digitization methods and digitization workflow.

I. Intended Users

This guideline is intended for those who are already engaged in digitization work and wish to further understand principles and standards of each procedure, so that proper adjustments can be made; or those who intend to implement digitization projects and need assistance with making suitable digitization plans; as well as those who are interested in digitization work.

II. Digitization Objects

Map information consists of two major portions: the map itself and the remote sensing image. Remote sensing is a new technology that can gather information on a target without coming in direct contact, and usually refers to the acquisition and processing of information on the earth's surface, especially natural resources and human environment, which are then displayed as photos or digital images. Remote sensing images usually need to be processed before they can be used. Image processing includes image compression, image storage, image enhancement, processing and quantified image. At present, remote sensing is an extremely valuable tool in environmental research, and experts in different fields are continuously discovering potential applications for remote sensing data. The main feature of remote sensing is that it can provide immediate, accurate data of various resources and the environment within a large area in a dynamic way. Thus, remote sensing is an important source of information for GIS.⁸ Remote sensing images mainly consist of aerial

⁸ Same as Note 7, page 19.

images and satellite images. The main source of aerial images is the photos of Mainland China and Taiwan from the 1940s which are under the possession of the military.

Maps are a form of artificial spatial information that accurately record landforms, objects, directions and distance within a specific area. In comparison to remote sensing technology, maps have the following characteristics:

(I) Mathematical rules result in the measurability of maps.

The compilation of maps is based on strict mathematical rules, including projection, scale and direction, which allows position, length, area and volume to be measured on maps.

(II) Using symbols to represent objects to create intuitive maps.

The symbol system on a map is called the map's language, and is designed according to international rules. The symbol system expresses surface objects using symbols and texts, and has the following advantages when compared to images:⁹

1. Maps have the advantage of being intuitive because they use special map language to express objects.
2. Surface objects often have complex outlines. Through abstract generalization and categorization, map symbols greatly simplify the figure, allowing a clear display even in a reduced scale.
3. Photographs cannot indicate quantity and characteristics of objects, e.g. water quality, temperature, humidity, soil properties, road materials, population, and industrial and agricultural output value. But by using dedicated symbols and notes, maps can achieve this. Map language can re-create these objective entities, and are strongly intuitive and easy to read.

Despite the above characteristics, maps are made of paper and therefore are susceptible to being damaged or becoming brittle due to natural disasters, usage, temperature and humidity. Consequently, the digitization of maps is an important and urgent task.

⁹Chu Kuo-Jui, "Map Design and Compilation," Wuhan University Press, 2001, pages 1-3.

III. Digitization Method

At present, maps are mainly digitized by “scanning.” Occasionally, there will be maps in special sizes or poor condition that cannot be handled by a scanner. In this situation, a plateau and digital back are used for digitization. However, this is a special case, and therefore excluded in this guideline.

IV. Digitization Work

Map digitization is divided into the following three stages: “Preliminary Procedures,” “Object Digitization Procedures” and “Metadata and Database Establishment.” “Preliminary Procedures” describes preparations before implementing actual digitization, and includes 1. understanding the condition of digitization objects; 2. Evaluating equipment and cost effectiveness; 3. Establishing digitization specifications; and 4. Establishing digitization workflow standards. “Object Digitization Procedures” expounds each step in the digitization process and also matters needing special attention, image editing and backup management; contents include: 1. Establishing the color management mode; 2. Scanning procedures; 3. Digital image editing; and 4. Backup management. “Metadata and Database Establishment” describes map metadata standards and cataloging rules, including: 1. Metadata establishment; 2. Metadata cataloging; and 3. Database establishment. In addition, this guideline dedicates an entire chapter introducing software/hardware equipment and cost analysis for map digitization,, describing the purpose, functions and price of various scanning equipment and software, to provide a solid basis for selecting digitization plans.

Finally, the standards and practical experiences of various projects, as well as literature used by this guideline are summarized below:

I. Books

- (I) “Illustrated Introduction to the Digitization Workflows of Fifteen Thematic Teams” book series. Apart from the architecture team, which still had a limited number of projects, all of the fifteen remaining thematic teams participated in the compilation of this book series. The digitization workflow of each team is described in detail through text and figures, and contains various standards and workflow survey

forms. This is currently the most detailed book series on digitization work, and is the best option for learning the practical experiences of each team.

- (II) “Digital Archive Technology Collection 2002, 2004” is a reference for digital archive related technology standards. A total of 187 chapters on technology related standards were included. Digitization specifications, standards, tools and equipment are all described, but most of its content focuses on metadata establishment.
- (III) “Tasks and Techniques for Digitization of Documents” by Hung Shu-Fen, editor at the Special Collections Department, National Taiwan University Library, analyzes each step and technologies in the digitization workflow. His rich practical experiences allow the publication to thoroughly cover an extensive scope, elaborating on even the tiniest steps from preliminary procedures to digitization operations.
- (IV) Other books on digital image editing, color management, digital photography, image output and printing, and collection preservation all provide detailed descriptions of image formats and color management, and help strengthen the theoretical foundation of digitization projects.

II. Standards related periodicals

This guideline mainly uses articles collected by digital archive related conferences or journal papers published by project personnel as its sources of reference. For example, “Digital Archives in Maps and Remote Sensing Images” published by Fan Chen-Lien and Liao Hsiung-Ming of Academia Sinica Computing Center introduces digitization standards for maps and remote sensing images, so that they meet requirements of vectorized applications, and further analyzes and introduces developed technologies; “Exploration of SOP in Digital Archive Establishment” published by Huang Ju-Chu and Mei Shih-Chieh introduces the basic concept of SOP and how to establish SOP, using the National Museum of History as an example to define SOP, and further extends its application and research. Standards such as the national land information system standard description, metadata requirements specification and digital file naming principles are all good references for standards establishment.

Two. Digitization Flowchart



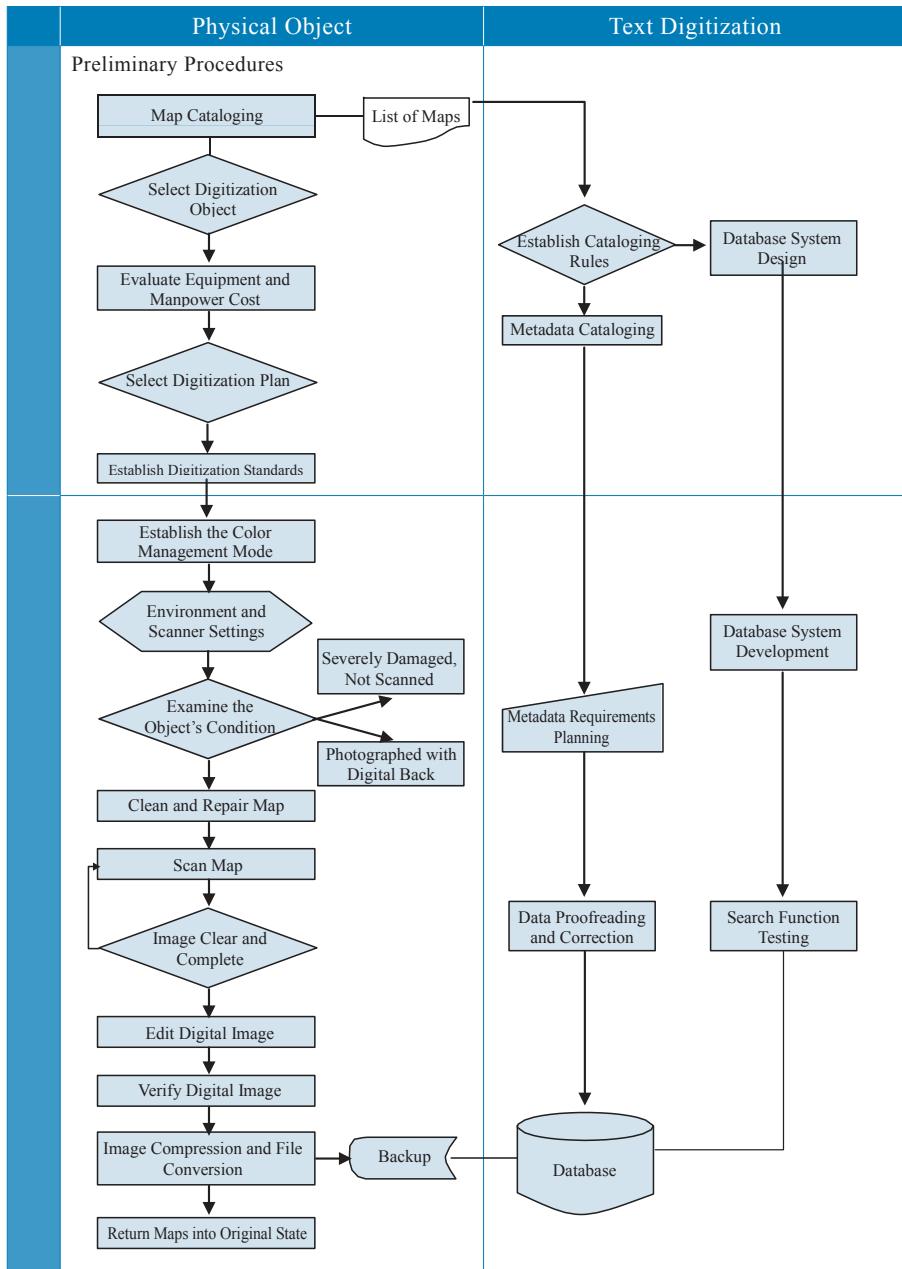


Fig. 2-1 Digitization Flowchart for Maps and GIS

Three. Preliminary Procedures



“Preliminary procedures” are the necessary preparations prior to carrying out digitization operations, which includes organizing and cataloging objects, deciding on future applications of digital objects, selecting equipment, evaluating costs, and designing the database. In simpler terms, preliminary procedures are “digitization work planning”. Planning in advance greatly benefits the actual digitization work. In TELDAP, most project have extremely large amounts of data to digitize, requiring long operating time and large numbers of personnel. Therefore, establishing standards in advance is necessary to maintaining the consistency and quality of digital output because it provides a basis for digitization operations to follow. However, special situations or miscalculations, no matter to what extent, that require adjustments are bound to occur, but can be reduced with thorough planning. Problems can instantly be found with proper planning and the time required for making adjustments can be significantly reduced. Preliminary procedures can be divided into the following four main tasks: understanding the condition of digitization objects; evaluating equipment and cost effectiveness; establishing digitization specifications; establishing digitization workflow standards.

I. Understanding the condition of digitization objects

(I) Compiling a list of digitization objects¹⁰

The best way to understand the condition of digitization objects is to compile a list that clearly records the quantity, dimensions and condition of objects according to their respective volumes, books and objects. Project units can consult with senior managers of museums or libraries for how to make detailed remarks because their rich experiences enables them to offer valuable advice. Problems that might be encountered when organizing objects may include: how certain conditions should be recorded and how files should be arranged. These lists are then entered into a computer for future access.

(II) Catalogue preparation

When preparing the catalogue, consider the characteristics of map data so that it allows convenient access. Maps are similar to regular documents

¹⁰ Hung Shu-Fen, “Tasks and Techniques for Digitization of Documents,” National Digital Archives Program Training and Promotion Division, February 2004, page 25.

in that they both record natural and human activity, and that they both come in paper and non-paper materials. However, maps are special in that they come in a wide variety of forms, e.g. single frame maps, tellurion, 3D model, and maps drawn on cloth and silk. They even have different presentation methods and technologies, e.g. unique method for generalizing geographic phenomena, systematic symbols, and unique research perspective on natural and human activity. Project units can refer to map cataloging principles when considering the characteristics of maps.¹¹

(III) File naming

The naming method for map files is to express as many conditions as possible using specific characters and numbers in different sections. This procedure benefits subsequent digitization operations, enabling personnel to immediately determine whether if the file requires repair and what equipment to use for digitization. Project units should note that filenames should be designed in coordination with database establishment for the convenience of programming; the “National Repository of Cultural Heritage” of the Council for Cultural Affairs (CCA) offers simple file naming principles for reference. Furthermore, project units should keep naming principles of the operating system in mind to avoid errors when data is imported into the database or displayed online. For example, in Windows XP/2000, the filename and file extension must not exceed 255 characters, spaces and numbers are allowed, but */<>\:|? and Aux, Com1, Com2, Com3, Com4, Con, Lpt1, Lpt2, Lpt3, Prn and Nul are not allowed.

(IV) Selecting digitization objects

After gaining a some understanding of digitization objects, objects can be selected according to: 1. rareness of the object, 2. difficulty of preservation, and 3. application value. Normally, rare objects that are hard to preserve and have high application value should be prioritized for digitization. This is a procedure in consideration of cost and effectiveness. If there are only a few simple objects, then of course all of them can be digitized. However, if there are large quantities of complex map files, with limited time and budget, proper planning can ensure that all objects

¹¹ Su Pin-Hung, Liu Hsi-Tai, “MARC Format Manual for Cartographic Data,” Beijing Library Press, November 2004, page 17.

are digitized. Still, object selection is not an easy process, and requires personnel with considerable professional knowledge and market experience to accurately determine the priority of objects. We recommend seeking advice from scholars or museum personnel with abundant experience in the field of cartography, or search for related information for making the most informed decision.

II. Evaluating equipment and cost effectiveness

Cost effectiveness tone of the major concerns to project personnel when planning digitization plans. Who are the ones to decide what type of software/hardware to use, what price the equipments should be, how much should be spent on manpower, and other efficiency issues. Equipment often depends on the condition, and manpower decisions depend on the equipment adopted. Software/hardware equipment specifications are introduced in a further chapter.

(I) Evaluating equipment

Before cost evaluation, project units should first understand the categories of maps to select suitable equipment:

1. Forms of maps include: paper, film and photographs. The most common form of maps is on paper; aerial images are stored the form of film or photographs. From the perspective of scanners, paper and photographs are reflection copies and are suitable for typical scanners. On the other hand, film are transparent copies and require a platform scanner with a mask or film specific scanner.

2. Preservation condition can be divided into: flat and complete, creased or mildly torn (needs repair), and severely damaged. Preservation condition affects the type of scanner selected; i.e., if the paper is brittle or in poor condition, then sheetfed scanners should not be used so as to avoid damaging the original copy; if creases are too apparent, then a plateau should be used to flatten the map and then a digital camera used to photograph it.

3. Frame size: A3; A3~ A0; A0

Maps that are smaller than A3 are suitable for typical platform scanners; maps in the range \leq A3~ \geq A0 are suitable for large size sheetfed scanners; maps larger than A0 should be photographed using a high definition digital camera.

4. Colors: Color copy, black and white copy.

Select scanners as required, e.g. color or black and white scanner.

A simple flow chart can be used to describe digitization method selected for different types of maps:

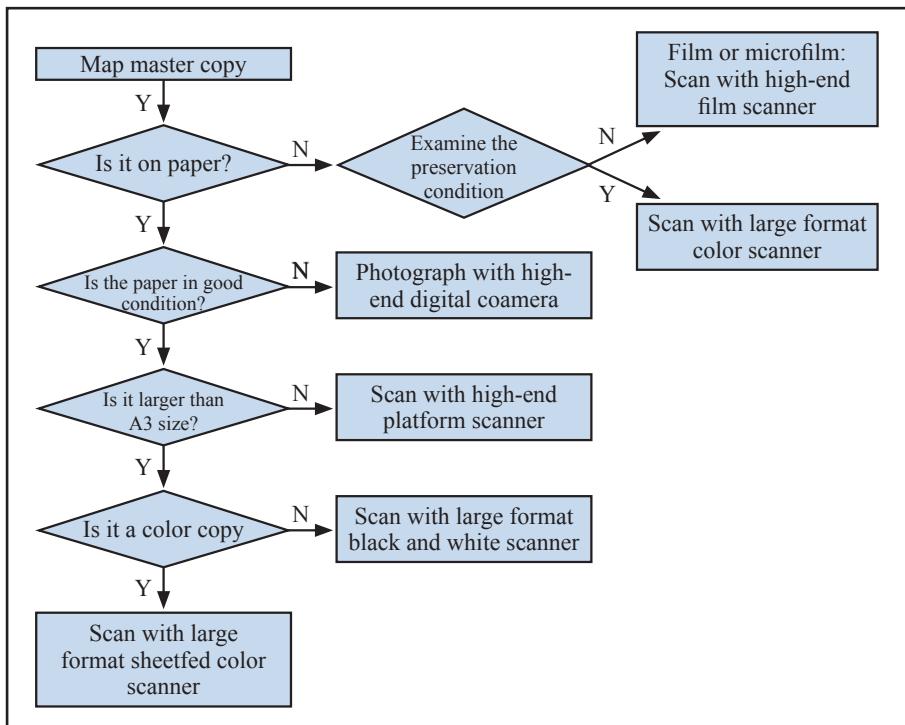


Fig. 3-1 Map digitization method selection flowchart

Source: "Technology Collection 2002," Map digitization equipment and specifications 4-1

(II) Basic manpower planning

1. Preliminary procedures stage

As long as the rules and synopsis are established beforehand, object list compilation and file naming can be completed by several part-time workers depending on the amount of data. However, they should be supervised by professional personnel to ensure that data is correct.

2. Object digitization stage

One or two scanning personnel is required. Since the work is relatively simple and repetitive, it can be carried out by part-time workers if there is limited budget. Subsequent image calibration should be handled by professional image processing personnel.

3. Metadata and database establishment stage

Information personnel with expertise or experience in database or webpage design should be recruited; personnel with related backgrounds are required for metadata cataloging; or establishing cataloging rules and hire part-time workers to catalog metadata.

(III) Cost of other consumables

Digitization work also requires a certain amount of consumables, such as paper, figure sets, cotton gloves, brushes, cleaner, masks, CDs and tape.

III. Establish digitization specifications

(I) Digital Image File Format

Image files can be divided into three levels based on their purpose: permanent preservation, commercial purpose, and browsing.

1. Permanent preservation

The quality and resolution of mage files for permanent preservation should be the highest, so as to meet possible requirements in the future.

2. Commercial purpose

These are for commercial purposes are provided for printing, duplication and commercial applications. Image quality must meet printing requirements. Printing quality is determined by the density of lines, generally 1.5~5 times the image resolution. Please refer to the table below for screen ruling requirements of various publications:

3. Browsing

These are provided for online display and browsing. Image quality must meet computer monitor browsing and internet transfer requirements, most image files have a resolution of 72dpi.

(II) Digital file format

Image files generated by scanners may be vary in formats due to default settings, processing software or different applications. Of these formats,

Table 3-1 Ruling and resolution required for different publications

Publication	Screen Ruling	Resolution
High quality printed matter, such as catalogues and replicas	200~400 lpi	300~800 dpi
General printed matter: color magazines, books	175 lpi	300~350 dpi
Text pages	133~150 lpi	200~300 dpi
Newspaper, advertisements	100~110 lpi	150~220 dpi

TIFF files are the most suitable for long-term preservation because they use LZW lossless compression and support CMYK output. TIFF files have broader applications, but also take larger space (an A4 size full color image file is roughly 25MB). JPEG and GIF files are relatively small (an A4 size full color image file is roughly 3~5MB) and are suitable for online browsing; JPEG files are also suitable for backup and file management. At present, image compression formats commonly used by GIS include MrSID (Multi-resolution Seamless Image Database), ECW (Enhanced Compressed Wavelet) and JPEG2000. These formats are further described below:

1. MrSID

MrSID is a new image compression, decompression, storage and access technology developed by LizardTech. It compresses, binds and embeds images using discrete wavelet transform, and achieves consistent resolution and image quality via local transform. Characteristics of MrSID are as follows:¹²

(1) Relatively high compression ratios

Its compression rate is determined by image content and color depth. Compression rate of gray scale images is 15-20 : 1, and can reach 30-50 : 1 for full color images. There is almost no perceivable image quality loss after compression. Its compression ratio can be adjusted from lossless compression to lossy compression. MrSID can compress multiple images into a single file and establish a large image database.

¹² Liang-Chun, "Influence of MrSID on GIS Applications," GIS Forum, Search: December 2005, <http://www.gisforum.net/show.aspx?id=867&cid=32>. Ou Kui-Wen, "Application of MrSID Technology in GIS," GIS Forum, Search: December 2005, <http://www.gisforum.net/show.aspx?id=868&cid=32>.

(2) Supports multiple resolutions

MrSID can compress different resolutions of the same image into a single file and display clear images under each resolution.

(3) Selective decompression technology

MrSID is able to rapidly decompress the specific portion that needs to be viewed, allowing large images to be opened and browsed in a short amount of time. This has a significant meaning to GIS because it allows rapid and convenient browsing and zooming using relatively less system resources. Low demand on data quantity makes MrSID files extremely suitable for online transfer.

(4) Seamless compression

MrSID achieves real-time, seamless browsing of large quantities of images, automatically combining hundreds of images with geographical coordinates into a single frame, allowing users to roam through the image and zoom any part without needing to switch between numerous smaller maps.

MrSID is widely applied in GIS due to the above characteristics. However, MrSID is patented technology and requires special software for compression and decompression. This software is somewhat expensive, so other formats can be considered if there are budget constraints.

2. ECW

ECW is a compression format designed by ERMapper that uses wavelets as its core algorithm and supports a number of formats, including: ERMapper series, JPG, GeoTif/Tif, USGSOrtho Quad, etc. The compression interface is a simple window interface. This compression format has the following characteristics:¹³

(1) Capable of compressing large images

ECW is capable of compressing images over 2GB on the Microsoft Windows NT platform, and can inlay files in the compression process.

¹³ Wu Hung-Chien, "Using JPEG2000 in Aerial Photo Compression," National Chiao Tung University Department of Civil Engineering master's thesis, June, 2003, page 26.

(2) Free plug-ins

Free plug-ins are provided for numerous applications to support images compressed using ECW; related tools can be downloaded on the website of ERMapper. Users can choose compression ratios of 1-100; the actual compression ratio and compression time is displayed after compression.

3. JPEG2000

JPEG2000 is an international standard formally named “ISO 15444,” and was established by JPEG. At present, JPEG2000 is gradually being applied on the internet, printing, scanning, digital images, remote sensing, digital libraries, e-commerce, wireless networks and handheld electronic products. JPEG2000 has the following characteristics:¹⁴

(1) Lossy and lossless compression

Under single compression, discrete cosine transform cannot achieve lossless compression, whereas discrete wavelet transform can achieve both lossy and lossless compression. Wavelet transform allows both lossy and lossless compression, and eliminates the need to use Huffman encoding for lossless compression as done by JPEG.

(2) Robustness to bit-errors

Robustness to bit-errors is required for data to be transferred via wireless network; inconsistent marks in an independent and relative block allow errors in each block to be detected, and organized dataflow provides the ability to correct errors.

(3) Progressive decoding and SNR (Signal-to-Noise Ratio) scalability

This technology eliminates the need to store a complete image in memory and directly reads the image on a web browser. For the SNR method, the outline of an image is first transmitted, and the image turns from blurry to clear as its file size increases. Progressive transmission by image resolution first transmits a smaller low resolution image, and then provides a larger clearer image as more data is transmitted.

¹⁴ Same as Note 13, page 23.

(4) Regions of Interest (ROI)

JPEG2000 adopts a multiple resolution encoding method mainly based on DWT. Therefore, using varying degrees of granularity, it provides better resolution (lower compression ratio) for ROI and lower resolution (higher compression ratio) for the background.

(5) Open architecture

In an open architecture encoding only involves coding of data and core tools, making the system more efficient and consistent with requirements.

(6) Protective image security

Through the application of watermarks, labeling and encryptions maintains the integrity of image data and prevents it from being altered. Labeling is already regulated in SPIFF and can easily be used in JPEG2000 files.

(7) Content-based description

Image search and index are important applications in the field of image processing. Content-based descriptions are the equivalent of metadata for images, providing more efficient and accurate results when searches are conducted.

JPEG2000 is an international standard that is supported by most image processing software, such as the latest versions of ACDSEE and Photoshop, and is therefore a viable option.

(III) Color model and color depth

The color model decides which colors will comprise the digital image, and the color depth decides the gradations of color and file size. A few commonly used color models are introduced below:

1. RGB

RGB is an additive color system that consists of three primary colors – R (Red), G (Green) and B (Blue). The final color when each of the primary colors is added is white. RGB has good color performance and is suitable for computer monitors and TV screens.

2. CMYK

CMYK is a subtractive color system that consists of three primary

colors – C (Cyan), M (Magenta) and Y (Yellow). When light enters a certain object, the object absorbs certain wavelengths of light and reflects the remaining wavelengths of light, which are then interpreted into colors by our eyes. CMYK is applied in printed matter. For example: colors that appear on paper are the result of ink absorbing specific wavelengths of light.

3. LAB

A color model that uses the visual perception of human beings as axes, creating a 3D color space with lightness (L) and color opponent dimensions (a) and (b).

4. Duotone

Mixes two colors to create image layers.

5. Grayscale

Table 3-2 Color model and color depth

Color Model	Color Depth	
RGBTrue Color	24bit (3 bytes)	Common computer color model
CMYK	32bit (4 bytes)	Used in printing
Indexed Color	8 bits (1 byte)	Internet color compression model
Duotone	8 bits (1 byte)	Black and white dye performance
Grayscale	8 bits (1 byte)	Typical black and white performance
Bilevel	1 bits	Pure black or white
LAB	24bit (3 bytes)	Visual space of mathematical coordinates

Source: Hsu Ming-Ching 2001, “Digital Photography Technology”

(IV) Image resolution

Before going into image resolution specifications, we must first explain the meaning of common resolutions:¹⁵ “Resolution” refers to the number of pixels represented or captured in a unit length, and is divided into three stages:

1. Input: Scanner resolution, digital camera resolution.
2. Display: Monitor resolution.

¹⁵“Image Resolution,” DC View, Search: December 2005, <http://www.dcvview.com.tw/photoclass/res/02-res-image.htm>.

3. Output: Image resolution, printer resolution.

Resolution is explained in the three stages of imaging:

1. “Image resolution” uses ppi (Pixel per Inch), which represents the total number of pixels in each inch. Image resolution affects printing quality and the size of the image, but does not affect image quality displayed on a computer monitor. Image resolution can be changed by image processing software, such as PhotoImpact and Photoshop. Image resolution ppi is used interchangeably with output resolution dpi.
2. “Scanner resolution” refers to the ability of scanners to identify details of images, and is further divided into “optical resolution” and “software resolution.” “Optical resolution” is the true resolution of scanners; “software resolution” uses extrapolation method to enlarge scanned images, which has extremely limited ability to improve image quality.
3. Similar to scanners, digital cameras also have “software resolution.” Therefore, the true resolution of digital cameras must be calculated based on the effective pixels of the CCD.
4. “Printing resolution” uses dpi (Dot per Inch), meaning “the number of dots printed in each inch.”
5. “Monitor resolution” is the size of the Windows screen. In the case of a 17 inch monitor, when we adjust the monitor resolution from 640x480 to 1024x768, the 17 inch monitor must contain more pixels, so the original image looks more detailed, but is reduced to 40% of the screen size.

From the perspective of capture equipment (e.g. scanners and digital cameras), equipment with higher resolution can capture images with higher resolution. From the perspective of printing equipment, more detailed images can be printed from images with higher resolution. Therefore, the quality of digital images is decided when it is captured, so if the original copy is in fine quality and the scanner has good resolution, then good digital images can normally be obtained.

Table 3-3 Digital file format recommended by the National Digital Archives Program

	Permanent Preservation	Commercial	Browsing
File Format	TIFF TIFF	JPEG	JPEG
Color Model	RGB (24bit/pixel)	RGB (24bit/pixel)	RGB (24bit/pixel)
Resolution and Size	Original size, 300dpi or above	Original size 300dpi	72 dpi

Depending on the size of the map, the resolution may be increased to 400dpi~600dpi or above to ensure that the image can be used for vectorized analysis applications in the future.

IV. Establish digitization workflow standards

After selecting a digitization plan, begin establishing digitization workflow standards. Establish a series of work rules and standards for personnel to follow. The next chapter introduces key points of object digitization procedures, providing a basis for establishing related standards.

Four. Object Digitization Procedures



I. Establish the Color Management Mode

Color management aims to make color performance consistent with the scanner, digital camera, computer monitor and printer, so that the colors input are the exact as the colors output. The ICC Profile of the input and output devices are acquired and used as standard colors, and maintain consistent color performance on each equipment; colors on one device are corresponded to colors on another device when images are transferred.¹⁶ The ICC Profile of a device can usually be downloaded from the manufacturer's website, or project units can purchase color management software, such as Profile Maker, to create ICC Profiles, but such software are extremely expensive (roughly NTD150 thousand).

II. Scanning Procedures

(I) Scanning environment settings

The following description is for scanning A0 size paper maps using a large format sheetfed scanner:

1. Place the scanner horizontally and keep it stable.
2. Clean the scanner and prevent dust from getting into the scanner. Personnel should wear white cotton gloves and use scanner specific cleaner to thoroughly remove any stains in the scanner. Make sure that the cloth used for wiping will not scratch the scanner. This task should be carried out once a week.
3. Warm up the scanner 10 minutes each time before use to stabilize the color temperature.
4. Verify the scanner's linkage to the computer.
5. Run the scanner's calibration software, use the calibration paper of the scanner (use white copy paper as a replacement) and place it according to scanner procedures, and follow the software's instructions for calibration.

(II) Scanner settings

1. Before formally scanning maps, personnel should first conduct a trial

¹⁶ ICC Profile is a color description file established by the International Color Consortium (ICC). ICC Profiles record characteristics of color performance on each device and related information. Its purpose is to provide a unified format to resolve the issue of color performance on different devices and operating systems.

- scan and adjust scanner settings to maintain scanning quality.
2. Set the gamma curve.¹⁷ The relationship between gamma value (z) and output (Y) input (X) is represented by $Y=XZ$. Setting the gamma value at 1 indicates that the color tones output are the same as the original. At the same time, set the curvature so that layers of the original copy can be expressed, and adjusted the lightest and darkest parts. This setting can be configured and saved in Adobe Photoshop.
 3. Adjust the brightness and contrast so that image details are displayed and the image is not too dark.
 4. Adjust the color tone and saturation.
 5. If color shift occurs in the image, adjust the color tone back to its original appearance by increasing or decreasing certain colors, and then strengthen all colors to achieve saturated colors.
 6. Verify the image's color balance settings.

(III) Scanning preparations

1. Scanning should use volume as a unit. Specialized personnel with acid free cotton gloves should open each volume and check if the number of maps is consistent with the list.
2. Examine condition of maps. First scan maps in good condition and make a note on the list.
3. Use acid-free tape for simple repair if the map is slightly damaged. If the map is damaged but can still be scanned, first mount and repair the map before scanning.

(IV) Scanning procedures

1. Flatten the map and place it in an acid-free transparent packet that does not cause light polarization. Besides reducing the pressure on maps when entering the scanner, this also helps keep the map flat and even.
2. Open the image editing software.
3. Place the map in the feeding position of the scanner and press the scanning button.
4. After scanning the map, carefully examine the image on the computer to see if there are any specks and if the entire map is in the image.

¹⁷ Hayakawa Hiroyuki, "Printing and Output Practices," Art Book Publishing House, 1996, pages 50~51.

Rescan the map if it is blurry or not in the right position.

5. After examining the image, use image processing software to cut the image, leaving 0.5~1cm white margins at each side to verify the image's completeness.
6. Name the image file according to file naming principles and save the file. Specify the map's condition and date of information, and see if it is consistent with the list.
7. Carefully return the map to its original state, folded or rolled, after scanning, and place it separately from maps that have not been scanned yet. Return all maps to their original order after the entire volume is scanned.

Basically, operating procedures for each scanner can be found on the user's manual, but also pay attention to the following principles of scanning:

1. Scanning personnel should wear acid-free cotton gloves to avoid leaving sweat or other stains on maps, which might cause damage and affect scanning quality.
2. Verify that each volume and map numbers are consistent with the list.
3. Carefully take apart or return volumes to maintain maps in their original condition.
4. Maintain stable lighting and humidity in the scanning environment to keep the map from deteriorating.
5. Settings of equipment used in the scanning process should be verified by specialized personnel to maintain consistent quality.
6. Flatten the map for scanning to prevent overlapped or slanted images.
7. Carefully examine the image to see if it is clear, complete and has accurate colors.
8. Files should be named according to file naming principles, and make sure that they are saved in the right folder.
9. Image files should be stored on a hard disk separate from the one containing the operating system. Maps are large and therefore produce large image files, occupying too much space on the hard disk, which will cause insufficient resource of the or even crash the system.
10. The acid-free transparent packets should be replaced if their transparency becomes poor after the packet is worn down.

III. Digital Image Editing

Map digitization might cause certain errors, which is not entirely the result of digitization operations, but may include error margins of map data, such as error margins of field survey data, source data, map compilation and printing, and paper deformation. Error margins of map data must be corrected using reference data and GIS software after digitization, but this process is not within the scope of this guideline thus will not be elaborated. Paper deformation is the result of paper size being affected by humidity and temperature changes. If temperature remains constant and humidity increases from 0% to 25%, then paper size might change by 1.6%. The expansion and contraction rate of paper is not the same, so even if humidity returns to its original value, the paper will not return to its original size. The error margin of a 6 inch sheet of paper caused by humidity change might reach 0.576 inches.¹⁸ Error margins caused in the digitization process are mainly the result of insufficient resolution or slanted images. For this reason it is necessary to verify and adjust images after scanning. This ensures the completeness and correctness of images, and prepares them for input into GIS software.

(I) Verification and Adjustment

Verification and adjustment of images should be carried out by specialized personnel, who should verify that image details, resolution, file format and color model are correct, and use image processing software to adjust the brightness, contrast and color tone of the image. If large maps were scanned in separate regions, pay attention to the order that images are stitched together, verify that the brightness and colors of each region are the same and that the images are properly aligned. If the paper is slightly deformed or slanted in the scanning process and results in a deformed image, then the map image needs to be adjusted.

(II) Demand on Digitization Precision¹⁹

At present, the resolving power of digitizers can reach 0.025mm, but digitization precision requirements are usually between 0.5mm and 1mm due to limitations of the naked eye and digitization instruments. Maps that

¹⁸ Wu Lun, Liu Yu, Chang Ching, Ma Hsiu-Che, Wei Chung-Ya, Tien Yuen et al., "Principles, Methods and Applications of GIS," Higher Education Press, January 2007, pages 11-12.

¹⁹ Wang Hsin-Min et al., Hsieh Ching-Chun Editor-in-chief, "Digital Archive Technology Collection 2002," page 2.2.4.1.

are compiled based on measurements of field surveys will demand 0.5mm precision; maps compiled based on artificial projections usually demand 1mm precision. Some maps have irregularly expanded or contracted as a result of aging, humidity or being folded for long periods of time. This will affect the digitization precision of maps. If the images are to serve research purposes only, then digitization precision of 1mm~3mm will suffice.

IV. Backup Management

Images should not only be stored in different file formats for the convenience of future utilization, but also on different storage media and in different locations to avoid being destroyed by artificial or natural disasters.

(I) Compression and file conversion

Use image processing software to convert batches of image files into JPEG and GIF format, and then use corresponding compression programs to compress the images and save them into suitable folders.

(II) Hard disk backup

This is a task that should be carried out each day: image files and compressed files should be stored in a different hard disk of the computer. Transfer the data to other locations after accumulating a certain quantity, or replace the hard disk to add storage space.

(III) DVD recorder

Once images reach a certain quantity, backup the images on DVD and specify the contents, date and format of images. It is recommended to put DVDs in individual cases and place them in a dry place.

(IV) Centralized magnetic tape cabinet

If large quantities of maps are digitized, storage space becomes a major issue. DVDs and hard disks are all in danger of being damaged. If there is sufficient funding, project units can purchase a centralized magnetic tape cabinet. At present, a single magnetic tape can have up to 1TB of storage space.

Five. Metadata and Database Establishment



Metadata for maps mainly include type of map, legend, description of map contents, scale and precision, issuer, date or latest update, and sales information. Such metadata emphasize exchanges between the producer and user of maps; users can determine whether a specific map can satisfy their application requirements or not. Following developments in computer technology and GIS technology, especially networked communications technology, spatial information sharing is growing in popularity. Metadata, including the contents, quality and condition of spatial information, has thus gained growing importance and become a means for effectively managing and applying information and resources.

Regarding the analysis of metadata, the Metadata Architecture and Application Team (MAAT) under the “Taiwan e-Learning and Digital Archives Program (TELDAP)”, recommends establishing metadata elements from the perspective of “who,” “what,” “when,” “why” and “where,” and since metadata has three characteristics – “content,” “background” and “structure,” project units should consider the nature of their collection and external connections. Project units should further consider the purpose of metadata from four aspects – “management,” “access,” “preservation” and “application,” so that it may meet the needs of each aspect.

I. Metadata Establishment

The “life cycle operation model” proposed by the MAAT for the Research and Development of Digital Archives and e-Learning Technologies Project of TELDAP can serve as basis for planning metadata elements. The model consists of four stages with a total of ten procedures:

(I) Requirements evaluation and content analysis

1. Requirements interview
2. Project related standards and case study
3. In-depth analysis of metadata requirements
4. Verify the metadata strategy and interoperability between standards

(II) Compile metadata functional requirements

1. Establish metadata functional requirements
2. Metadata system evaluation

(III) Establish the metadata system

1. Establish best practices

2. Develop the metadata system

(IV) Service and evaluation

1. Metadata services
2. Metadata operations evaluation

Maps are carriers of geospatial information and the purpose of related specifications and standards is to establish consistent acquisition, processing, quality control, analysis, access, presentation, exchange, transfer and sharing methods.²⁰

International metadata standards for spatial information have long been in existence. NGIS adopts the ISO19115 metadata standard as a common framework for establishing TWSMP: Taiwan Spatial Metadata Profile. Related national and international standards are as follows:

(I) ISO TC211 Geographic information and geomatics related standards.

(II) Related International Standards

1. CEN TC287: Geographic Information - Data description - Metadata. Draft V2 - for 2nd informal vote by WG 2, January 1996.
2. CERCO/MEGRIN: GDDD - Geographical Data Description Directory.
3. HO: S57, version 3.
4. ISO / TC 211: ISO 19115:2003 Geographic information- Metadata, 2003-05-08, 140 pages.
5. NATO DGIWG/DIGEST: N469 Geographic Information - Data description - Metadata.

(III) Related National Standards

1. Australia & New Zealand: Core metadata elements for land and geographic directories in Australia and New Zealand / The Australia New Zealand Land Information Council (ANZLIC).
2. Canada:
3. Directory information describing digital geo-referenced data sets (DIDD) / Canadian General Standards Board.
4. Canadian Geomatics Interchange Standard - Spatial Archive and Interchange Format (CGIS-SAIF)
5. Finland: Paikkatietohakemisto (Metadata service specification)

²⁰ "Spatial Information Related Standards and Development Status," Map and Remote Sensing Imagery Digital Archive Project, Search: January 2009, <http://www.ascc.sinica.edu.tw/gis/soda/main4-2.htm>.

6. Russia: Metadata of digital terrain models and electronic maps (MDTMEM).
7. British: NGDF
8. Taiwan: NGIS related standards
9. China:
 - (1) China's sustainable development information sharing standard
 - (2) NREDIS draft
10. TWSMP: Taiwan Spatial Metadata Profile

II. Metadata Cataloging

Cataloging rules must first be established before cataloging metadata. Cataloging rules should include details of elements, text, and format and give suitable examples. Specialized personnel should proofread metadata after it is cataloged.

Using the Map and Remote Sensing Imagery Digital Archive Project of TELDAP as an example, metadata cataloging rules are based on the standard established by NGIS. The table below lists a portion of metadata elements of the Research and Development of Digital Archives and e-Learning Technologies Project. Please see the project website for the complete table.

Table 5-1 Common Core of GIS

Element		Definition	
Identification Information	Citation Information	Originator	Name of organization or individual that created the data
		Publication Date	Date that the data was published
		Publication Time	Time that the data was published
		Title	Known title of the data
		Edition	Edition of the data
		Geospatial Data Presentation Form	Form in which geospatial data is presented
		Series Information	Title of the series that data belongs to
		Publication Information	Detailed publication information
		Other Citation Details	Other information on citations
	Citation Information	Larger Work Citation	Identification data of the database
Identification Information	Time Period of Content	Online Linkage	Website link
		Description	Abstract
			Brief description of the data
		Purpose	Purpose of the data
		Supplemental Information	Supplemental descriptions of data
		Calendar Date	Single date, including year, month and day
		Time of Date	Single date including minutes and seconds
		Single Date	Code of single date
		Single Time	Code of single time
		Beginning Date	Beginning date of event, including year, month and day
		Beginning Time	Beginning time of event, including minutes and seconds
		Ending Date	Ending date of event, including year, month and day
		Ending Time	Ending time of event, including minutes and seconds
		Currentness Reference	The meaning of the above times

Source: MAAT Website²¹²¹ http://metadata.teldap.tw/standard/gis/common_core_fgdc.htm.

Example

Ministry of the Interior

19940706

8230001

1/5,000 Orthophoto Base Map of Taiwan numerical data file (97234096)

First edition

Maps

1/5,000 Orthophoto Base Map of Taiwan numerical data file

Ministry of the Interior

<http://meta.ngis.moi.gov.tw/Map/5000/97234096.exe>

1/5000 Orthophoto Base Map of Taiwan numerical data file

To promote the national land information system, establish a basic topographic database, and provide the database for national land planning.

The Ministry of the Interior is actively establishing a basic and topographic map database to implement the national land information system. Created numerical files of water systems, roads and administrative borders contained in 3,224 1/5,000 orthophoto base maps and 564 1/10,000 orthophoto base maps; created numerical files of water systems and roads contained in 261 1/25,000 topographic maps, and will continue to create numerical files of other data.

19930226

Completion date of digitization was

III. Database Establishment

Not only are databases convenient for administrators, but they also expand the applications of data, so that cultural value may be gained and business opportunities may be created. Databases should have flexible search functions, so that users may use key words, themes or images to search the data they require. Technical staffs are responsible for programming, testing and modifying the database to ensure it achieves convenient access.

Six.

Introduction for Maps and Archives Cooperation

In 2002, the Computing Center, Academia Sinica, began cooperating with external units in map digitization using the title Tsai Yuan-pei Research Center for Humanities and Social Sciences and Academia Sinica, and applied GIS to its research. “Archiving Historical Map and Remote Sensing Imagery of Modern China”, for instance, is an institutional project that extensively gathers maps and aerial photos of Taiwan and China, and preserves them in digital form. Academic cooperation agreements are signed with external units, such as the Forestry Bureau, Water Resources Agency and Ministry of National Defense on a basis of a mutual vision of academic cooperation and exchanges. The project is also engaged in international cooperation with the Library of Congress. Maps collected by most units were left by the Taiwan Governor-General Office during the Japanese Colonial Period. Although we hope to digitize all collections, maps that have high utilization value but are in poor condition are prioritized due to space, funding and time constraints. Cooperation projects with external units from 2002 to 2006 are as follows:²²

1. Maps collected by the Ministry of the Interior
2. Maps collected by the Fei Yuan Project
3. Maps collected by the Water Resources Agency
4. Maps of Mainland China reproduced by Japan Science College
5. Archives and Maps of Taiwan Governor-General Office (Taiwan Historica)
6. Forest Resource Maps of the Forestry Bureau
7. Government-owned Wild Forest Maps of the Land Survey Bureau
8. Chinese maps and literature collected in the Library of Congress

I. Contents of Academic Cooperation Agreements

Academic cooperation agreements are formal contracts signed by two parties. Personnel changes will not cause such agreements to terminate. Since the agreements are based on academic cooperation and exchanges, they mainly list key points to declare the intention of two parties to work together, and therefore do not list detailed regulations, retaining flexibility for revision. Academic cooperation agreements mainly include the following items:

²² Maps and literature of China query system of the Library of Congress, Search: February 2009, http://metadata.teldap.tw/standard/gis/common_core_fgdc.htm.

1. Purpose: briefly describes the purpose and expectations of both parties.
2. Parties: the parties entering the agreement.
3. Contents: mainly describes project output and results, e.g. the establishment of a digital file management system and optical disks containing digital files.
4. Cooperation method: rules and coordinating and supervising units of project implementation, e.g. data retrieval, digitization related matters (fees, workplace), and applicable scope of output data.
5. Revision of the cooperation agreement: specifies how to revise or change provisions if unlisted matters in the agreement should arise.
6. Expiration date: the period of time in which the two parties will work together.

II. Cooperation Methods and Experiences

Collections of most repositories are stored in archives and have not been digitized; such repositories do not have digitization workflows or rules. Therefore, most units that cooperate with the Computing Center, in accordance to their respective cooperation agreement, follow the Computer Center's digitization workflow for scanning or photographing maps. However, if there are special requirements, digitization will proceed only if matters are negotiated in advance. At present, the most common method is for units to retrieve collections from their storage and the Computing Center provides equipment, working space, technologies and personnel for digitization. After digitization is complete, Academia Sinica and the unit each keeps a copy of the source file, both parties own joint copyright, and the files can be provided for academic research within Academia Sinica. The workflow of most cooperation projects is as follows: compile a list of maps, retrieve the maps, group the maps according to their condition, scan the maps, save digital files, backup files, and return the maps. For details of the digitization workflow, please refer to related chapters of this guideline.

Before digitization operations are carried out, the work team will first establish the map file catalog system, and then import digital files into the system as digitization proceeds. This allows the team to control the progress of digitization work and metadata cataloging. The system will also be able to provide resources to the public in the future, allowing users to view map

images from their browser. The searching system will provide statistics of digital files, e.g. the total number of map images, number of maps acquired, number of maps scanned, number of maps waiting to be processed, and number of maps processed on the day.

Map digitization is, however, still limited by the condition of maps. Although maps in poor condition are not digitized, their value for utilization has not been lost. After maps are digitized, their preservation condition, including processing, preservation and latest update of information, must be recorded. Units must note whether if the map is in good condition and can be scanned in the preservation condition field. Metadata of maps in poor condition can still be found in the search system, and units are recommended to repair the maps, but this should be determined by whether or not units have the funding to do so. Such maps should be digitized when they are repaired or new technology is introduced in the future. The method ensures the utilization value of data on maps that cannot be digitized. The search system continues to operate even after project conclusion, in which the GIS team of the Computing Center is responsible for operating and maintenance.

In terms of international cooperation, the Research Center for Humanities and Social Sciences, Academia Sinica is currently working with the Library of Congress, and sends personnel on an annual basis to carry out digitization work. The Library of Congress holds more than five million maps, and continues to increase its collection each year, encompassing maps of all regions around the world. Maps of China collected by the Library of Congress include ancient Chinese maps and maps of modern China, all of which are extremely valuable and in considerable quantities. According to regulations of the Geography and Map Division, Library of Congress, no maps may leave the library and digitization may only use cameras with extremely short flashes, so as to minimize the damage to maps.

This is an ongoing project that hopes to gradually expand to other maps of China or Taiwan in the Library of Congress. Due to the limited time and long journey, personnel do not compare versions or concern themselves with whether or not a certain map has already been photographed; all image files are compared and cataloged after they return to Taiwan. Due to regulations of the Library of Congress, all maps are digitized via digital camera, so the images are not as clear as ones digitized by scanning. Although there are limitations

to the resolution of map images, it still allows us to learn how many of these maps are stored in their collection. Nevertheless, compiling a complete list of maps for searches and comparison is still an important breakthrough. In addition to maps, this project also plans to establish a WebGIS catalog in the future.

Seven. Digital Rights Management and Applications



WEB

“Digital content” is a product or service that integrates and applies images, text, video and audio that were digitized using information technology. The Digital Content Industry Promotion and Development Office of the Industrial Development Bureau, Ministry of Economic Affairs indicated that the eight fields promoted by digital content policy include digital games, computer animations, e-learning, audiovisual applications, mobile content, network services, content software, and digital publications.²³ The Computing Center of Academia Sinica continues to collaborate with units with map collections for digitization work. Tens of thousands of digital map files have been accumulated over the years, thanks to the efforts of project personnel. Following rapid technological developments, traditional communication media, such as text, images and sound, can now be easily converted into digital files. The advantage of digital content is that it is easy to process, duplicate, disseminate and preserve, but these advantages are the reason why digital content is also prone to illegal downloading and duplication. Plagiarism, unauthorized reproduction and piracy severely infringe the creativity and copyright of content creators, and further affect their motivation to create. Therefore, digital content protection and declaration and management of rights are an essential link in the digital era. Below we will discuss common digital content protection technologies, and introduce their applications in maps and remote sensing images.

I. Digital Content Protection Technologies

(I) Digital Rights Managements (DRM)

DRM is a technology that combines hardware and software to control access rights of electronic files. After digital content is created, copyright related constraints are added to the electronic file, e.g. number of times the file can be played, if the file can be copied or printed, and also has an expiration date, protecting digital content through programming techniques. In terms of hardware mechanisms, iTunes and Adobe Systems requires users to have their own player to legally download digital content. When the device opens a file, it decides whether or not a file can be played based

²³Digital Content Industry Promotion and Development Office Website, Search: February, <http://proj3.moeaidb.gov.tw/nmipo/>.

on the copyright constraints recorded on the file.

DRM is suitable for protecting images (JPEG, TIFF...etc.), audio (MP3, WAV, WMV...etc.) and video (MPEG-1, MPEG-2, MPEG-4...etc.).²⁴ In simpler terms, the technology that protects digital content in each stage of its lifecycle is called DRM. Access rights not only include permission to unlock protected content, but also allow who, when and how digital content is used to be designated.²⁵ Creators or copyright owners can use DRM to negotiate access rights, including whether if digital content can be output, modified, copied or downloaded, with publishers and the larger the scope of licensing and the more valuable the digital content, then the higher the licensing fee. Users can only access digital content if they are authorized to do so achieving aim of “restricting duplication at will” to maintain economic operation.²⁶

DRM encompasses an extensive range from digital content creation, licensing, user management and access rights control. If a problem occurs in any individual link, then digital content will be at risk of infringement. However, numerous management mechanisms and different formats for digital content have been created as a result of independently operating units. Incompatibility between systems cause inconvenience and impose numerous restrictions on users. This is an issue that has yet to be resolved.

(II) Watermark

Digital watermarking is a technology that protects the intellectual property rights of digital content by embedding copyright information, such as the creator, owner, publisher and contact information, into digital media. Digital watermarks can be text, static images, dynamic video or audio signals, and are able to prove the legitimate owner when digital content is illegally used. Digital watermarks generally have the following characteristics:²⁷

²⁴ Industrial Technology Research Institute Website, Search: December 2008, <http://newwww.iti.org.tw/>.

²⁵ Gary Calder, “Increasing the Interoperability between Content Protection Systems,” Global Sources, Search: January 2009, http://www.eettaiwan.com/ART_8800446976_480802_TA_97c4f038.HTM.

²⁶ Hsueh Liang-Kai, “How to Sign Digital Copyright Contracts with Creators,” The ROC Government Publications Newsletter, Search: Janauary 2009, http://openpaper.nat.gov.tw/epaper/org/59/epaper02_chapter03.htm.

²⁷ “Digital Content Protection Technology,” TWCERT-CC, Search: September 2006, <http://www.cert.org.tw/document/column/show.php?key=97>.

1. In a broader sense watermarks are “digital/analog signatures” used to differentiate itself from source data.
2. Mainly used for copyright control (users, buyer/seller, patent/copyright) and identity verification.
3. Copyright owner embed watermarks and are able to detect and decode them as a means of copyright control. Watermarks serve as evidence of copyright ownership.
4. Only the copyright owner is able to decode the watermark.

Generally speaking, watermarks are divided into “visible” and “invisible” watermarks based on their appearance. The former is visible on the digital file, but damages the original image. This has the advantage of deterring users from illegally using digital content. Digital files with “invisible” watermarks do not seem to be any different before and after the watermark is embedded, only a reliable third party processor (TPP) can extract the watermark using special decoding algorithms for authentication.²⁸ Technically, watermarks can be expressed as a form of noise added to source data; images with watermarks can only be restored using extraction software.

In the case of the National Palace Museum’s digital content protection mechanism, double layered encryption provides better protection than single layered encryption, but is applied based on the purpose of files.²⁹ If double layered encryption is adopted, then the image is protected by both visible and invisible watermarks, this way attackers need to destroy both watermarks to remove an image’s protection. Most images on the internet have a resolution of 72dpi, damaging such images to remove the watermark will greatly reduce the image’s value and applicability.

Watermarks that provide higher protection result in poorer image quality; watermarks that provide lower protection result in better image quality, but puts copyright information at risk. Therefore, based on experiences of the National Palace Museum, watermarks are not added to high resolution files for permanent preservation, but are required for image files licensed for publication.

²⁸ Same as Note 27.

²⁹ Compiled by the National Palace Museum, “Watermark Mechanisms, Website of the National Digital Archives Program,” Search: January 2009, http://www.ndap.org.tw/2_technicalreport/files/228.pdf.

For the protection of maps and remote sensing images, the Computing Center of Academia Sinica adopts invisible watermark technology to avoid future image reading or applications; however, Academia Sinica's logo is placed at the center of the image for online browsing. The map image search system does not allow downloading and only provides images for browsing, so although users can see map images at 1:1 resolution of the original, they cannot download the entire image file.

(III) Public Key Infrastructure

The internet is an open world; technological developments have turned a virtual space into an important exchange platform for the human society. However, the internet is replete with viruses, spam and hackers, so when important digital content is being transferred on the internet, it must be protected from being tampered with or damaged, which might result in unpredictable loss. Public Key Infrastructure (PKI) is based on public key cryptography, and utilizes public keys and electronic certificates to ensure the safety of internet transactions and verify the identity of the other party. PKI is based on the trust mechanism of network certification, in which both parties of a transaction trust the certification authority. Each party can verify the other's identity based on the electronic certificate issued by the certification authority using public key generation and electronic signature functions, achieving the following purposes in the process of transmitting and exchanging electronic messages:³⁰

1. Authentication

Allows the identity of the person transferring data to be authenticated, or prevents false data to be transferred by an impostor.

2. Integrity

Allows the source of data to be identified. Authentication of electronic signatures allows both parties to ensure the integrity of transaction data and prevent it from being altered.

3. Non Repudiation

Users cannot deny that they transferred data. Transaction data with electronic signature of the sender has legal effect; after the receiver

³⁰ Chih Nieng-Wen, "PKI," Windows Server 2003 electronic magazine, Search: January, 2009, <http://www.msservermag.com.tw/technicwords/021031.aspx>.

verifies the data, the transaction cannot be denied. This protects both parties of a transaction and prevents dispute from arising.

4. Private, Confidentiality

Transaction data can be encrypted using a key to achieve confidentiality.

Cryptography is the turning plain text into codes via algorithms and its process is called encryption. The process of turning codes back into plain text is called decryption. At present, the most common cryptographic systems include: symmetric key and asymmetric key cryptographic systems. The main difference between the two is that the former uses the same key for encryption and decryption, and the later uses two different keys. The asymmetric key (also called public key) cryptographic system is currently the most secure one, and uses different pairs of public and private keys for data encryption and decryption.³¹ Only the parties of the transaction have the private key, while the public key is made public. According to this method, when Party A wants to send a message to Party B, Party A uses the public key of Party B to encrypt a file, and then Party B uses its private key to decrypt the file. Party B can also use its private key to encrypt a message, and send the message to a person who has its public key (or send an e-mail to tell the person its public key), this way the receiver will know that the message did indeed come from Party B.

(IV) Creative Commons

Creative Commons is an open copyright licensing method. Unlike typical copyright licensing contracts, Creative Commons allows creators to license their work to non-specific users. Anyone can directly use a work licensed through Creative Commons as long as they abide by the licensing terms declared by the creator. This way, users do not need to worry about infringing the rights of creators when using the work without acquiring authorization from the creator.³²

Licenses announced by Creative Commons in 2002 were designed on the basis of related laws in the U.S. However, this created the issue of

³¹ Tsao I-Fan, "Two Keys that Open the Ultimate Door of Information Security (1)," Search: October 12th, 2006, <http://office.digitimes.com.tw>ShowNews.aspx?zCatId=525>.

³² "What is Creative Commons," Ministry of Education Creative Commons website, Search: December, http://cncnet.moe.edu.tw/faq_cclist01_q1.htm.

different legal systems of different countries. For this reason, in 2033, Creative Commons introduced iCommons, where Creative Commons licenses are translated into different languages and gives consideration to the applicability of the licenses under different jurisdictions (including countries and regions).³³

Taiwan currently uses Creative Commons version 2.5. Version 3.0 is still being discussed and revised. Using version 2.5 as an example, there are four terms used to protect works. If the creator labels  “Attribution-NonCommercial-ShareAlike,” it means that the work is protected by a Creative Commons license. When users use the work, they must specify the name of the copyright owner, may use the work freely for non-commercial purposes, and any derivatives users create based on the work must be shared with the public in the same method. Furthermore, if  appears on a work, it means that users may not create any derivatives of the work, or will be liable for infringement.

Creative Commons licenses is widely applicable encompassing music, stories, illustrations, novels, pictures, website content, movies, sound effects, books and articles. There are two main ways to license work:³⁴

1. Based on the form of work.

Forms of work include: (1) Music and audio recordings; (2) Photographs and illustrations; (3) Text and books; (4) Video and animations; (5) Handouts, teaching materials and academic papers; (6) Computer programs. If you are familiar with the licenses provided by Creative Commons, or if your work does not belong to any of the above categories, then you can directly choose a license based on the content of licenses.

2. Based on licensing method

- (1) Core licenses: Six standard Creative Commons licenses available.
- (2) Sampling license: Two sampling licenses available.
- (3) Other Creative Commons licenses: in addition to core licenses and sampling licenses, other licensing methods include joint licenses.

³³ “Creative Commons Taiwan,” Creative Commons Taiwan website, Search: January 2009, <http://creativecommons.org.tw/static/about/ctw>.

³⁴ “Choose a License,” Creative Commons Taiwan website, Search: January 2009, <http://creativecommons.org.tw/static/choose/work>.

Creative Commons Taiwan provides links to the licensing methods listed above. After clicking on a link, users will be directed to the U.S. Creative Commons website to choose licensing terms. At present, most contents on the Creative Commons website of the U.S. have Chinese translations, so users can use Creative Commons licenses without a language barrier.

Digital content protection mechanisms are still being developed. Mechanisms such as DRM watermarks and PKI all have their limitations in technology, and cannot provide full protection of digital content from infringement. Project units should consider requirements on digital content protection technology from different aspects, and integrate various technologies to provide better protection.

II. Applications and Services

(I) Geographic Information Systems

Geographic Information Systems (GIS) is a comprehensive field, rather than an independent one. It is the common basis of information processing and spatial information analysis in other research fields.³⁵ Paper maps of the past record the geographic relationship within a certain time period and area. However paper maps today face several issues:

1. Repetition of data gathering but inability to share.
2. Storage and access issues
3. Analysis and display issues
4. Transmission and update issues

Computer information and emerging technologies help GIS to breakthrough limitations of paper maps. Since GIS is not an independent research field, and is the basis of information processing and spatial information analysis in other research fields, there are different definitions based on the scope of application. Here are the main definition of GIS:³⁶

1. GIS is designed to effectively extract, store, update, process, analyze and display various forms of geographic information. GIS integrates spatial information and helps handle issues that occur in the real world.

³⁵ “Introduction to GIS” electronic version by Li Hsi-Ti, Cheng Chin-Tung, Liao Chi-Wen, Lin Shu-I, Search: January 2009, <http://gisclass.geo.ncu.edu.tw/91gisintro/class.pdf>.

³⁶ Same as Note 35.

2. GIS uses map overlapping and spatial analysis functions to convert source geographic data into information that can support spatial decision-making.
3. GIS are mainly large scale computer systems that require large capital investments, and are usually built by central, provincial and local governments. The main purpose of GIS is to help administrative authorities effectively manage natural and artificial resources.
4. GIS consists of computer hardware/software, geographic databases, and operating and maintenance personnel.

The GIS team of the Computing Center, Academia Sinica established a spatial and temporal information infrastructure in accordance to the requirements of research or projects of Academia Sinica. The team is responsible for planning, establishing, evaluating, promoting and maintaining GIS software, hardware and applications. The team began evaluating and establishing Academia Sinica's GIS in 1995, and engaged itself in the gathering of basic spatial data, and R&D of application service systems, especially WebGIS technology.³⁷ In recent years, GIS was included as a link of integrated technologies in TELDAP. The team cooperates with digital archive projects or research projects of Academia Sinica in the establishment of GIS, and also employs academic agreements for cooperation with external units. The scope of cooperation includes map scanning and WebGIS establishment.

The spatial and temporal distribution of various themes is displayed by adding spatial and temporal coordinates to project contents in coordination with map layers, fully incorporating cultural and natural sciences, and establishing search systems and databases for different themes. Individual results are presented according to project progress and goals, and mainly include digital file catalogs, thematic information query systems and databases. Catalogs are compiled in the digitization process and contain metadata and images of maps that have already been digitized. Such catalogs can be found in map digitization projects of the Ministry of the Interior and Water Resources Agency. Thematic information query systems integrate project results with

³⁷ Spatial Information Processing and Application (Academia Sinica Computing Center GIS Team), Search: November 13th, 2006, <http://gis.ascc.net/NDASupport/index-2.html>.

GIS and show the spatial and temporal distribution of data. In addition to the establishment of GIS query systems, various resources and studies are integrated into rich thematic databases.

Using maps of indigenous culture as an example,³⁸ in the past, if users wanted to learn about the spatial relationship of “population and villages”, “field surveys”, “distribution of tribes” and “origin of myths”, they needed to have background knowledge of the abovementioned themes and administrative areas to understand the spatial and temporal distribution. Today, WebGIS overlaps different map layers and easily presents the relationship between different themes and administrative areas during the Japanese Colonial Period.

Map digitization and the establishment of GIS are, therefore, two sides of a single coin and complement one another. Geographic information researchers need to extensively collect maps or aerial photos to increase the precision of GIS. Source information contained in maps is presented from a spatial perspective after being processed and analyzed by GIS, providing a more user-friendly search method and consequently Meaning and value are thus gained for research and education applications.

(II) Concept of “Digital Earth”

The concept of digital earth originated in the speech “The Digital Earth: Understanding our planet in the 21st Century” by Vice President Al Gore in the California Science Center in 1998.³⁹ An immense and distributed database is constructed by gathering data from different sources and levels and presented in a virtual 3D globe simulation for people to browse the globe and their hometown via the Internet. The development of related software, such as Google Earth and Virtual Earth, in recent years has realized this vision. Results of various projects can be presented in an interesting, simple and fresh new way using such software as the basic operation interface and then adding map contents collected by digital archive projects. The display system of digital earth consists of three layers. The framework of the concept of digital earth is described below.⁴⁰

³⁸ Aboriginal cultural map website, Search: January 2009, <http://gis2.sinica.edu.tw/website/aborigine/>.

³⁹ “Origin of Digital Earth,” Digital Earth Research Center, Search: November 2006, <http://140.137.13.100/dpage01.htm>.

⁴⁰ Peng I-Fan, Liao Hsuan-Ming, Fan I-Chun, “Map Data Infrastructure and Applications based on the Concept of Digital Earth,” “Proceedings of the 4th International Digital Earth Symposium,” August 2006, page 3.

1. Back-end database:

Immense quantities of map information are accumulated after implementing digital archive projects. The GIS team of Academia Sinica Computing Center uses two storage methods. One method is to display digitization results via WebGIS, the other supports internet map service functions of the Open Geospatial Consortium (OGC). Storage media tools, e.g. GeoExpress Server and ArcIMS, that conform to OGC standards can be used to store files with geographic coordinates. After the files are released and conformed to WMS (Web Map Service) standards, they can be read by the front-end browser.

2. Front-end browser:

Common software that can be acquired on the internet include Google Earth, Virtual Earth, and ArcGIS Explorer. Users can choose operation interfaces that they are familiar with, and browse satellite images, street maps and aerial images on the internet. In addition, Google Earth provides functions for users to view a 3D image of the earth. There is also free software for constructing 3D models.

3. Communication layer in between:

OGC standards for internet maps link together back-end databases and front-end browsers. The images acquired have geographic parameters, so the desired map can be produced by overlapping different images. When users browse through maps, they do not need to load all map data, but use a medium called Reflector to only load the area being browsed instead.

After describing the framework of digital earth, we are going to introduce how this framework is applied in digital archive projects. After careful consideration, the Computing Center, Academia Sinica adopted Google Earth as the browsing interface, mainly because its interface is user-friendly and provides high resolution satellite images of Taiwan, which best meet the needs of digital archive projects.⁴¹ (Related information can be downloaded from the GIS team of Academia Sinica Computing Center at <http://gis.ascc.net/googlemap>.) Import the data downloaded into Google Earth and use the

⁴¹ Same as Note 40, page 5.

interface of Google Earth to browse its contents. If project units wish to display project contents using this method, they need to configure the WMS Connector of the back-end storage media. This method allows users to freely enlarge, reduce and rotate images, giving them a whole new browsing experience.

(III) Digital content services and value-added applications

A frequently discussed topic of map digitization is whether or not map information can be organized into systematic knowledge, or provided to the general public for digital content services and value-added applications. In addition to WebGIS, other services and value-added applications of map information include:

1. Map data download services and copy services

Article 30 of the Copyright Act states “Except as otherwise provided in this Act, economic rights endure for the life of the author and fifty years after the author’s death.” Article 33 states “Economic rights in works authored by a juristic person endure for fifty years after the public release of the work.” At present, map data of digital archives are mainly from the Japanese Colonial Period or earlier. The majority of maps or aerial photos were produced by the government; very few were compiled or taken by private organizations. The second paragraph of Article 33 states “if the work is not publicly released within fifty years from the completion of the creation, the economic rights shall subsist for fifty years after completion of the creation.” Therefore, most maps are no longer restricted by economic rights and are now public property.

In the future, the Research Center for Humanities and Social Sciences, Academia Sinica hopes to cooperate with specific libraries to provide a map information service window, and allow the public to download map files free of charge within the libraries. Since maps are generally larger than other documents, it is necessary to cooperate with libraries that have large format output and scanning equipment. Individuals may copy maps for non-commercial purposes at printing cost, providing digital maps for public access. This project plans to set up the map information service window in the Map Room of the library of the Research Center for Humanities and Social Sciences before the end of 2006.

2. Industry-academia collaborated value-added digital content

The digital content industry is a key industry in the ‘Two Trillion and Twin Star Industrial Development Program’, and focuses on knowledge-based and digital economic developments. The digital content industry aims to increase the knowledge content of traditional industries, and transform them into high value-added industries. According to the Ministry of Economic Affairs’ definition, “digital content industry” refers to “the industry of products or services that integrates and applies images, text, video and audio that were digitized via information technology.”⁴² Numerous institutions have been engaged in digitization work since the implementation of the National Digital Archives Program, hoping that the digital form of their collections will be widely applied. From the perspective of research units, collections that have not been utilized do not lose their value; i.e., digitization is merely a preservation method, rather than the purpose. However, based on the concept of sustainable operation, whether or not digitization can drive the development of the digital content industry remains a topic of concern.

The “Taiwan Historical Spatial and Temporal Knowledgebase” website/optical disk, jointly developed by Academia Sinica Computing Center and Wordpedia, combines the invaluable “Taiwan Baotu” with modern maps, presenting over 19,000 maps from past to present for comparison, allowing users to understand changes of Taiwan through maps.⁴³ This is the application of map files combined with multimedia into digital content products.

(IV) Geography and Map Division of the Library of Congress

The Geography and Map Division of the Library of Congress has over five million maps, 72 thousand atlases, and six thousand reference books. The diversity and value of its rich collection makes it one of the world’s most important map databases. When the Library of Congress was founded in 1800, the Geography and Map Division was the first division

⁴² Digital Content Industry Promotion and Development Website of the Industrial Development Bureau, Ministry of Economic Affairs, Search: January 2009, http://www.digitalcontent.org.tw/dc_p2.php#Scene_1.

⁴³ Taiwan Hundred Year Spatial and Temporal Knowledgebase, Search: January 2009, http://www.ylib.com/hotsale/tw_hundred/index.htm.

to be established. The collection grows by an average of 100 thousand to 120 thousand maps and two thousand atlases each year, where roughly 60% of maps and 20% of atlases are from either government agencies or provided by generous citizens. Historical hand drawn or printed maps of the American Colonial Period, War of Independence and Civil War are mainly provided by American and European collectors. The Library also have many 17th century ancient maps of China, Japan and Korea.⁴⁴ In terms of maps of China, they have the largest collection outside of Asia. These ancient maps play an important role in research on geography, ancient cartography and history.⁴⁵

In summary, the Geography and Map Division's collection can be described as all inclusive, ranging from government maps, mineral and soil resources, nautical charts and geography books belonging to political entities in areas around the world. Only a small portion of this massive collection has been digitized and made available online, and are mostly images that are not constrained by copyright.

In addition, when you visit the website of the Library of Congress, you can use its search function to find certain maps, and view the entire map or just a part of it on your browser. The website also allows the maps to be downloaded in JPEG2000 and MrSID format. If you wish to purchase a replica of a map, you can contact the library, but this, of course, will be at your own expense. The maps that are available online have been carefully selected so they are not involved in any copyright disputes, under the condition that they are merely for the use of academic and/or educational purposes. Therefore, users who intend to publish the maps are still constrained by the copyright owner and Copyright Act.

The Library of Congress's mission is to provide its collections and resources for access by citizens of the U.S. and Congress, and to preserve the essence of human knowledge, so as to inspire more creations and generate more knowledge for the next generation. Digitization allows the Library's collections to be more frequently and conveniently accessed,

⁴⁴ Geography & Map Reading Room website, Search: January 2009, <http://www.loc.gov/rr/geogmap/>.

⁴⁵ China's State Bureau of Surveying and Mapping, "Ancient Chinese maps collected in the Library of Congress," resource website, Search: January 2009, http://big5.lrn.cn/science/surveyknowledge/200801/t20080108_186762.htm.

forming a foundation for education and lifelong learning. “Collection, preservation and accessibility” are the principles of the Library of Congress. According to Mr. Liao Hsuan-Ming, for the Library of Congress, digitization is only a medium, rather than a purpose. Hence, maps are available to the public to download for non-commercial purposes once they are digitized. Digitization work of the Library of Congress aims to establish a “standard,” instead of a “system.” This is the search of a compromising method that various units can all follow. It might not be the fastest or best method, but it will be a sustainable “standard” that can be followed.



Fig. 7-1 Map browsing page of the Library of Congress

(V) American Memories – Maps

“American Memories” is an important theme of digital content on the website of the Library of Congress. The internet provides free and open channels for the accumulation of static or dynamic resources, including text, audio and video, related to the American experience, of which map is one way of presentation: the history timeline of the U.S. is presented in the form of a map. Most of the contents of the website are from the Library of Congress and other institutions, which together molds American memories of the people through various thematic exhibits. This is truly a historic and

creative project.⁴⁶ The map theme is divided into the following:

1. Cities and Towns
2. Conservation and Environment
3. Discovery and Exploration
4. General Maps
5. Cultural Landscapes
6. Military Battles and Campaigns
7. Transportation and Communication

Related contents are selected and grouped according to the seven themes above, and then text descriptions are added to the maps. Users can use key words, geographic location, theme and category, or author and title to search for map information. Other than collections of maps, there are also interesting topics to help users that are unfamiliar with map information understand the meaning of maps. Spatial and temporal changes are also presented on these maps. For example, in the theme Cultural Maps - a topic introducing Macau studies - selects maps from the 17th century to 20th century to show cultural and geological changes in Macau. These include maps compiled by England, Holland, France, China, Germany and Portugal. Combined with text descriptions, these maps show courses of European countries along the coast of China since the 17th century, and the active religious and commercial activities after the opening of trading ports during the late Qing Dynasty. Special exhibitions show cultural and landscape changes of Macau; the monasteries, chapels and castles add an exotic touch to Macau. The appearance of travel maps in the 20th century indicate that Macau has become a popular tourist attraction after numerous cultures have left their trace. Image files with text descriptions help users understand messages that maps are trying to communicate. If teachers or the public are interested in a specific topic, they can go to The Learning Page to access cross-topic resources, where you can enjoy the text, images, audio and animations provided for online learning.

⁴⁶ Map Collections, Library of Congress website, Search: January 2009, <http://memory.loc.gov/ammem/gmdhtml/gmdhome.html>.

getting started
lesson plans
features & activities
collection connections
community center
professional development

- 💡 Don't miss...
- ▶ The Source
- ▶ E-Mail Updates
- ▶ Chat

title	description	audience
 The Big Picture	Complete the jigsaw puzzles, then hunt for information in American Memory to find the theme for each puzzle set.	Students of all ages (readability is upper elementary)
 The Branding of America	What are "brand name" products? Why do they endure over the years? Discover some favorite brand name products from across the USA.	Students of all ages
 Creating the United States: Word Search	A quick way to get acquainted with some of the words related to the founding documents of the United States.	Teachers Students (Gr. 3-6)
 The Declaration of Independence: Rewriting the Rough Draft	Students take a close-up look at Thomas Jefferson's "original Rough draft" of the Declaration of Independence, and then try their hand at crafting an alternate version of the nation's founding document.	Teachers Students (Gr. 4-12)

Fig. 7-2 Online learning page of American memories

III. Future Prospects of Maps and GIS

In the past, maps were often viewed as classified documents, and were mainly compiled, photographed and preserved by the government. Maps have great value to commercial interests, military strategy, geospatial analysis and political decision-making. However, it had not been easy for the general public or researchers to acquire map information. Today, thanks to technological developments and the popularity of knowledge sharing in recent years, geographic information is no longer kept confidential. Maps have grown in quantity following the continuous changes in geographic information. For this reason the accumulation of physical collections and digital collections is still ongoing. According to Mr. Liao Hsuan-Ming, "We will do what we can with the resources we have, map digitization is an ongoing task, and we hope to dedicate our efforts towards collection, preservation and accessibility; in the future. We will also continue to cooperate with related units in the digitization of maps of Taiwan and China."

Eight. Equipment and Cost Analysis



I. Equipment

(I) Scanner

When selecting a scanner, other than budget considerations, the scanner's optical resolution, color deconstruction ability, and scanning speed must also be evaluated.

Master copies can be divided into reflection copies and transparent copies, thus scanners are also divided into reflective and transparent ones. Photographs and paper (e.g. aerial photos and maps) are reflection copies and when scanning these, the light source is under the glass platform, reflecting off the object being scanned and enters the light sensing device (CCD/CMOS), which produces an analog signal that is converted into a digital signal by the A/D Converter and enters the computer. When scanning transparent copies, a mask or panel is added above the scanner; the light source is above the scanner and light directly penetrates the master copy, into the sensor. All new scanners have this special device, so they can process both reflection copies and transparent copies.

Generally speaking, platform scanners can be divided into four categories: platform, sheetfed, film and special scanners. Please refer to the appendix for specifications of map scanning equipment adopted by the Computing Center, Academia Sinica.

1. Platform scanner

Platform scanners are the most common type of scanner in the market. They can scan almost every form of document, and even solid objects. The cost of platform scanners can range from several thousand NTD to some ten thousand NTD. Documents that can be scanned using such scanners are mostly smaller than A3 size with optical resolution usually either 600dpi or 1200dpi. This type of scanner is more suitable for scanning small images, but image quality often cannot meet the requirement for permanent preservation. For this reason Denmark's Contex launched a series of large format scanners (capable of scanning master copies up to A0 size), which allowed it to gain leadership in large format scanners. A Contex scanner costs roughly NTD500 thousand. Japan's Creo also developed a super platform scanner (scanning resolution can reach 5000dpi), which has a resolution almost matching that of drum scanners.

2. Large format sheetfed scanner

Large format color scanners were designed for large format documents, such as large color posters, blueprints, maps, engineering drawings and art designs. Such scanners can accommodate documents with widths in the range 25~54 inches (mainly comes in three models – 36 inch, 42 inch and 54 inch). Large format color scanners are sheetfed, so they cannot be used for documents that are brittle or too thick.

3. Film scanner

Film scanners are professional scanners specially designed for positive and negative film, and relatively expensive: between NTD20,000~50,000. Configuration of film scanners is complicated and highly changeable. Since film often needs to be enlarged and has larger color density and contrast, it needs to be scanned under extremely high resolution (4000dpi) to gain ideal results. In order to enhance work efficiency, most film scanners have a rapid film clip to scan an entire roll of film without needing to change objects. The downside is that film scanners can only scan 35mm film, so there are relatively few manufacturers and consequently limiting options available.

4. Special scanners

Scanners for special requirements do not fall into any of the three categories above. A high resolution aerial photo scanner for scanning large format aerial photos and film (9*9 inches), being one example of this, can cost up to NTD2~3 million because of the high requirements of precision and resolution. This scanner has an automatic feeder and is easy to operate, but usually takes two scans due to the large size of film. After scanning, images are then stitched together.

(II) Computer

Main considerations when purchasing a computer include: motherboard and monitor specifications, CPU speed, memory and hard disk capacity, and graphics card capability, . A DVD recorder can also be considered.

Among the components listed above, the motherboard and CPU are top priority because they determine the computer's speed. Larger RAM allows programs to be executed more smoothly. In the case of Windows

XD, which is currently the most popular operating system, at least 1GB of RAM is recommended. For requirements of other software, please refer to the description on the software package. Due to the large size of maps, relatively large image files are produced, so larger memory is absolutely necessary to more smoothly open or adjust image files. Furthermore, if project units have image processing requirements, then the performance of the graphics card must also be considered when purchasing a computer.

Large capacity hard disks and the DVD recorder are for backing up files. Considering that an alternative should be ready if the hardware should malfunction, a computer should have at least two hard disks to backup any ongoing operations, or use a disk array to offer the best protection for work progress. Combine the considerations above, a computer (excluding the monitor) costs around NTD25,000~35,000.

(III) Other equipment

Project units should decide whether or not a film viewer, aerial photo viewer or color meter should be purchased based on their requirements.

II. Software Requirements

The main difference between maps and documents is that maps present diverse information. In addition to the text properties of regular documents, maps are also carriers of spatial information. Therefore art design processing software, GIS and remote sensing image processing systems should be included when purchasing software. Image compression software is also necessary for convenient browsing management. Several commonly used programs are briefly introduced below:

(I) Word processor

1. Microsoft Office

Microsoft Office is currently the most common word processing software, which includes functions such as text editing, presentation design, numeric data processing, database establishment and webpage design. Microsoft Office is a basic tool for creating text data and operations management. The latest version is Office 2007, and the professional version is priced at NTD17,490.⁴⁷

⁴⁷ Microsoft Office Online homepage, Search January: 2009, <http://office.microsoft.com/zh-tw/default>.

2. Open Office

Open Office is a word processing tool similar to Microsoft Office and operates on common operation systems. It is a cross-platform application that is compatible with Microsoft Office. Functions include Writer (word processing), Calc (calculation), Impress (presentation), Math (formulas), Draw (graphics) and Base (database). Open Office is an open source software developed by programmers from around the world, whose joint efforts bring it towards perfection. The current version of Open Office is 3.0.0. Open Office can be downloaded for free.⁴⁸

(II) Image processing software

1. Adobe Photoshop

Adobe Photoshop is currently the mainstream digital image processing software, and offers powerful color management, image editing, art design and file conversion functions. Adobe Photoshop is the most commonly used professional software. The latest version is Creative Suite 4 and it is divided into different prices based on function; a standard Adobe® Photoshop® CS4 Extended is roughly NTD39,290.⁴⁹

2. ACD Systems

These mainly act as image viewers during its early period, capable of managing various formats of image, and offers a simple batch file conversion function. Recently, ACD Systems developed advanced image processing functions for users to manage, create, edit, share and release images. There are currently two versions for different user requirements, namely ACDSee Pro 2 and ACDSee 10. The former is a complete workflow management tool, while the later allows users to immediate view, manage and edit image files. ACDSee 10 Traditional Chinese version is roughly US\$49.⁵⁰

aspx/.

⁴⁸ zh OpenOffice.org Chinese website, Search: January 2009, http://zh.openoffice.org/new/zh_tw/index.html.

⁴⁹ 3D graphic design software, 3D graphics software Adobe Photoshop CS4 Extended, Search: January 2009, <http://www.adobe.com/products/photoshop/photoshopextended/>.

⁵⁰ ACDSee Taiwan, Search: January 2009, <http://tw.acdsee.com/zh-tw/>.

(III) Image compression software

Due to the immense quantity of map data, image compression is a necessary measure in consideration of storage space and subsequent applications. After applying complex algorithms, the compressed file size can decrease 5% or even lower of the original file size, but visually maintain an image almost equivalent to the original. Depending on the compression format, different compression software should be used.

If the format selected is MrSID, then GeoExpress with MrSID is used for compression. The multi-resolution encoding method is mainly based on wavelet transform, which achieves high compression ratios and lossless compression, can compress large spatial images (e.g. aerial photos, high resolution satellite images, resource satellite images, etc.) into MrSID files but with only 5% of the size of the original file, while maintaining its high resolution and image quality. The current version is 5.0; please contact a retailer for its actual price.⁵¹

If the format selected is ECW, then files can be compressed using the built-in compression program of ER Mapper. Users who have not purchased ER Mapper can download Image Compression SDK at the website of ER Mapper. This program is currently public, so there is no charge for downloading. In addition to ECW, Image Compression SDK also supports JPEG 2000. The latest version of the program is 3.3, and supports 1TB JPEG 2000 image files and 10TB or above ECW image files.⁵²

(IV) Remote sensing image processing software

1. Erdas Imagine

Erdas Imagine is a remote sensing image processing system jointly developed by ERDAS and Leica Geosystems in 2002, and has a considerable market share. Erdas Imagine is used in over 100 countries around the world for the production, visualization and processing of remote sensing images. Erdas Imagine 8.6 is priced at roughly US\$2,200.⁵³

2. ENVI

⁵¹ LizardTech – Products – GeoExpress – Homepage, Search: January 2009, <http://www.lizardtech.com/products/geo/>.

⁵² ER Mapper – Geospatial Imagery Solutions GIS, Search: January 2009, <http://ermapper.com/default.aspx>.

⁵³ ERDAS, Inc. – The Earth to Business Company, Search: January 2009, <http://www.erdas.com/>.

ENVI (The Environment for Visualizing Images) is a product of the American company ITT. Its functions include: image display, processing and analysis. Other than basic remote sensing image processing procedures (e.g. calibration, scaling point, band math, contrast enhancement, filter, transform, edge detection and image output functions), ENVI also has high spectral and multiple spectral analysis tools for users to identify the purest pixels in an image, and verify the components of unknown wave spectrums through comparison with a spectral library.⁵⁴ In general, ENVI provides the various tools required for remote sensing image processing, information access, and GIS integration.⁵⁵ The latest version is 4.5; please inquire with the software developer ITT for its price.⁵⁶

3. PCI Geomatics Software

PCI Geomatics Software is a series of remote sensing image processing software developed by the Canadian company PCI, including EASI/PACE, Radar Softwre OrthoEngine Suite, the series of orthoimage processing software ACE graphics software, and Fly! 3D dynamic simulation system, which are used for photogrammetric analysis, remote sensing image processing, geometric mapping, GIS analysis, radar data analysis, resource management and environment monitoring. The latest version is 10.1.3 and very expensive.⁵⁷ We recommend using services of professional GIS institutions to save software and personnel training cost.

(V) GIS

1. ArcGIS

ArcGIS is the general name for GIS development software of ESRI and includes ArcGIS Desktop Software, Database Gateway and GIS Web Server Software. ArcGIS Desktop Software is a series of GIS applications, including ArcView, ArcEditor, ArcInfo, ArcGIS

⁵⁴ “Supersoft ENVI Remote Sensing Image Processing System,” Soft6.com, Search: January 2009, <http://soft6.com/trade/8/81268.html>.

⁵⁵ “ENVI Remote Sensing Image Processing System,” website of Nanjing Hydraulic Research Institute, Search: January 2009, <http://www.nhri.cn/ztxx/sbgxpt/zysbzs/200806041133348a6da.aspx>.

⁵⁶ ENVI Software – Image Processing & Analysis Solutions, Search: January 2009, <http://www.itvvis.com/ProductServices/ENVI.aspx>.

⁵⁷ PCI Geomatics Home Page – Committed to Image-Centric Excellence, Search: January 2009, <http://www pci.on.ca/index.html>.

Extension, MapObjects, ArcPAD, NetEngine, ArcExplorer and ArcFM; Database Gateway refers to ArcSDE.⁵⁸ ArcGIS can produce, manage, compile statistics, analyze and release geographic data, offering a total solution for GIS. The latest version is 9.3 and priced at roughly US\$4,000.

2. MapInfo Professional

MapInfo Professional is a GIS product developed by the American company MapInfo that provides map drawing, editing, geographic analysis, and grid image functions, integrating image processing, database query, and computing and spatial analysis.⁵⁹ Furthermore, users can import image files created by other software into MapInfo for application; formats support include MapInfo MIF interchange file and AutoCAD DXF. Versions 4.5 or above can use its Universal Translator and ArcLink to convert Microstation DGN, ArcView shapefile and Arc/Info E00.⁶⁰ The current version is 9.0 and a home edition costs roughly US\$1,500.

The list above is provided for your reference only. There are still many free resources on the internet. Websites that have provided more open source software options with simple introductions are also available. A few of them are listed below:

1. FreeGIS.org
<http://www.freegis.org/>
2. GIS – open source label
<http://gis.fupn.tw/?postag=open+source>
3. Free geographic information software
<http://www.education.ntu.edu.tw/school/geog/news/gisroom/freegis.htm>

⁵⁸ “Introduction to ESRI ArcGIS,” Remote Sensing and Spatial Knowledge Lab, Search: January 2009, <http://rskl.geog.ntu.edu.tw/team/gis/doc/ArcGIS/GIS%20News293.html>.

⁵⁹ “Product Introduction – MapInfo,” official website of Geoinfor Scientek, Search: January 2009, <http://www.geoinfor.com.tw/pages/product-mapinfo.htm>.

⁶⁰ “Data Exchange of GIS,” RITI Technology Inc., Search: January 2009, http://www.riti.com.tw/gis_04.htm.

Nine. Benefits and Recommendations

This guideline is based on practical experiences of the maps and remote sensing image team supported with theories of related fields. This guideline depicts the digitization workflow from beginning to end, and can be used as a manual for training new personnel. Due to the limited length of this guideline and the contrastingly vast fields involved in map digitization, we were not able to further elaborate on various theories or operating procedures. Should there be any misunderstandings resulting from insufficient explanations or descriptions provided here, we accept the opinions of experts in various field in hopes of improving this guideline into a more feasible operation manual along with experiences of map digitization of the Research Center for Humanities and Social Sciences with other organizations through academic cooperation. Chapters on digital content protection technologies and application services include related technologies and application results of digital map files in Taiwan and overseas. A matter to keep in mind is that the applicability of this guideline is limited as new equipment and technologies are continuously being developed. Thus, it is necessary to periodically update this guideline in order for it to be consistent with the latest trends. We also hope to gradually include processing methods for other forms of maps, so as to make contents of this guideline more comprehensive. The digital archives program is now in its second stage and hopes to gather more private collections to present Taiwan's diversity. Although project units of the first stage all had rich collections, they mainly used equipment of special specifications and had a fixed staff for digitization, which is not the case for most private collectors or organizations. We recommend dividing manpower and equipment cost based on scale in the future, so better digitization plans can be provided for each scale.

Ten. Conclusions



The “Taiwan e-Learning and Digital Archives Program” has cultivated countless professional talents and developed numerous advanced technologies. Precious experiences have been accumulated through the efforts of project units in digitization work, and created a foundation for establishing related standards. It is a matter of utmost importance to pass down these technologies and experiences. The establishment of guidelines on digitization procedures achieves knowledge management for digitization work, and further hopes to attract more individuals to join in the ranks of digitization and preservation of national cultural heritage. We hope that in the future digital content will not only be “preserved,” but also applied in academic research and education, and create a foundation for developing the digital content industry.

References



TODD SUTT

Books

李若愚，《地理資訊系統概論》，全華科技圖書股份有限公司，2006年2月初版。

鄖倫、張晶等編著，《地理信息系統》，北京電子工業出版社，2002年7月。

鄖倫等編著，《地理資訊系統原理、方法和應用》，北京科學出版社，2001年。

祝國瑞，《地圖設計與編繪》，武漢大學出版社，2001年。

洪淑芬，《文獻典藏數位化的實務與技術》，數位典藏國家型科技計畫訓練推廣分項計畫，2004年2月。

蘇品紅、陸希泰，《測繪製圖資料機讀目錄格式使用手冊》，北京圖書館出版社，2004年11月。

早川廣行，《印刷、輸出實務大全》，美工圖書社，1996年。

鄖倫、劉瑜、張晶、馬修車、韋中亞、田原等編著，《地理資訊系統原理、方法和應用》，高教分社，2007年1月。

王新民等著、謝清俊總編輯，《數位典藏技術彙編2002年版》，數位典藏國家型科技計畫，2002年，頁2.2.4.1。

內容發展分項計畫，《數位化工作流程》叢書，數位典藏國家型科技計畫，2005年1月，三版。

劉藍玉譯，Konstanze Bachmann編著，《藏品維護手冊》，五觀藝術管理，2001年，初版。

李之聰譯，《美國紐約攝影學院攝影教材》，中國攝影，2003年7月，初版四刷。

徐法坤，《數位影像色彩管理》，龍辰出版事業有限公司，1999年7月，初版。

邱吉雄、邱熙中，《數位基礎攝影》，世潮出版有限公司，2003年。

邱芳信譯，Harald Johnson著，《數位列印／輸出聖經》，旗標出版股份有限公司，2005年。

徐明景，《數位攝影的技術》，田園城市文化事業有限公司，2001年。

施威銘，《數位相片編修聖經》，旗標出版社，2005年2月初版。

博碩文化編譯，MD研究會、DTPWORLD編輯部編著，《圖解色彩管理的實踐》，博碩文化股份有限公司，2005年。

陳寬祐譯，Rick Sutherl and Barb Karg著，《印刷設計色彩管理》，視傳文化股份有限公司，2005年3月初版。

邱芳信譯，Harald Johnson著，《數位列印/輸出聖經》，旗標出版社，

2005年2月，初版。

Journal Papers

- 吳鴻謙，〈應用JPEG-2000於航空影像壓縮〉，國立交通大學土木工程系碩士論文，2003年6月。
- 彭逸帆、廖汝銘、范毅軍，〈以數位地球為概念建構之圖資整合架構與應用〉，《第四屆數位地球國際研討會》，2006年8月，頁3。
- 黃如足、梅世杰，〈標準作業程序（SOP）於數位典藏建置之初探〉，《第二屆數位典藏技術研討會》，2003年。

Electronic Sources

- 詞條：地圖地理要素，《中國大百科》，檢索2009年1月，<http://etd.sinica.edu.tw/cpedia/Content.asp?ID=74645&Query=9>。
- 詞條：地圖方法，《中國大百科》，檢索2009年1月，<http://etd.sinica.edu.tw/cpedia/Content.asp?ID=74642&Query=1>。
- 詞條：地圖，《中國大百科》，檢索2009年1月，<http://etd.sinica.edu.tw/cpedia/Content.asp?ID=31795&Query=1>。
- 梁軍，〈MrSID對GIS應用的影響〉，地理信息系統論壇，檢索：2005年12月，<http://www.gisforum.net/show.aspx?id=867&cid=32>。
- 歐貴文，〈MrSID技術在GIS中的應用〉，地理信息系統論壇，檢索：2005年12月，<http://www.gisforum.net/show.aspx?id=868&cid=32>。
- 〈影像解析度〉，DC view數位視野，檢索：2005年12月，<http://www.devview.com.tw/photoclass/res/02-res-image.htm>。
- 范紀文、何建明、李德財，〈從典藏資料角度探討後設資料之設計與標準化問題〉，數位典藏技術發展組，檢索：2009年1月，<http://daal.iis.sinica.edu.tw/pdf/3-2.pdf>。
- 〈空間資訊相關標準規範與發展概況〉，地圖與遙測影像資訊典藏計畫，檢索：2009年1月，<http://www.ascc.sinica.edu.tw/gis/soda/main4-2.htm>。
- 〈地理資訊空間基本元素〉，中研院後設資料工作組，檢索：2009年1月，http://metadata.teldap.tw/standard/gis/common_core_fgdc.htm。
- 美國國會圖書館典藏之中國相關地圖文獻查詢系統，檢索：2009年2月，http://webgis.sinica.edu.tw/map_loc/default.asp。
- 經濟部數位內容產業推動辦公室網站，檢索：2009年2月，<http://proj3.moeaidb.gov.tw/nmipo/>。

- 工業技術研究院網站，檢索：2008年12月，<http://newwww.itri.org.tw/>。
- 薛良凱，〈如何跟作者簽訂數位著作權合約？〉，中華民國政府出版品簡訊，檢索：2009年1月，http://openepaper.nat.gov.tw/epaper/org/59/epaper02_chapter03.htm。
- 〈數位內容保護技術〉，TWCERT-CC台灣電腦網路危機處理暨協調中心，檢索：2006年9月，<http://www.cert.org.tw/document/column/show.php?key=97>。
- 故宮博物院編撰，〈浮水印機制〉，數位典藏國家行科技計畫網站，檢索：2009年1月，http://www.ndap.org.tw/2_techreport/files/228.pdf。
- 職念文，<PKI>，Windows Server 2003電子雜誌，檢索：2009年1月，<http://www.msservermag.com.tw/technicwords/021031.aspx>。
- 曹乙帆，〈開啟資安終極大門的兩把金鑰(上)〉，檢索：2006年10月12日。<http://office.digitimes.com.tw>ShowNews.aspx?zCatId=525>。
- 〈何謂創用CC〉，教育部創用CC資訊網，檢索：2008年12月，http://ccnet.moe.edu.tw/faq_cclist01_q1.htm。
- 〈台灣「創用CC」計畫〉，創用CC — Creative Commons Taiwan網站，檢索：2009年1月，<http://creativecommons.org.tw/static/about/cctw>。
- 〈選擇授權條款〉，創用CC — Creative Commons Taiwan網站，檢索：2009年1月，<http://creativecommons.org.tw/static/choose/work>。
- 李錫堤、鄭錦桐、廖啟雯、林書毅編著，《地理資訊系統導論》電子版，檢索：2009年1月，<http://gisclass.geo.ncu.edu.tw/91gisintro/class.pdf>。
- 空間資訊處理與運用（中央研究院計算中心GIS小組），查詢時間，2006年11月13日，<http://gis.ascc.net/NDASupport/index-2.html>。
- 原住民文化地圖網站，檢索：2009年1月，<http://gis2.sinica.edu.tw/website/aborigine/>。
- 〈數位地球緣起〉，數位地球研究中心，檢索：2006年11月，<http://140.137.13.100/dpage01.htm>。
- 經濟部工業局數位內容產業推動服務網，檢索：2009年1月，http://www.digitalcontent.org.tw/dc_p2.php#Scene_1。
- 台灣百年時空歷史知識庫，檢索：2009年1月，http://www.ylib.com/hotsale/tw_hundred/index.htm。
- 中國國家測繪局國土司，〈美國國會圖書館收藏的中文古地圖〉，資源網網站，檢索：2009年1月，http://big5.lrn.cn/science/surveyknowledge/200801/t20080108_186762.htm。
- Microsoft Office Online首頁，檢索：2009年1月，<http://office.microsoft.com>

com/zh-tw/default.aspx。

zh OpenOffice.org中文網站，檢索：2009年1月，http://zh.openoffice.org/new/zh_tw/index.html。

ACDSee台灣，檢索：2009年1月，<http://tw.acdsee.com/zh-tw/>。

〈適普ENVI遙感圖像處理系統〉，中國軟件網，檢索：2009年1月，<http://soft6.com/trade/8/81268.html>。

〈ENVI遙感圖像處理系統〉，南京水利科學研究院網站，檢索：2009年1月，<http://www.nhri.cn/ztxx/sbgxpt/zysbzs/200806041133348a6da.aspx>。

〈ESRI ArcGIS簡介〉，遙測及空間知識實驗室，檢索：2009年1月，<http://rskl.geog.ntu.edu.tw/team/gis/doc/ArcGIS/GIS%20News293.htm>。

〈產品簡介-MapInfo〉，九福科技官方網站，檢索：2009年1月，<http://www.geoinfor.com.tw/pages/product-mapinfo.htm>。

〈各GIS軟體之資料交換〉，RITI Technology Inc.，檢索：2009年1月，http://www.riti.com.tw/gis_04.htm。

Gary Calder，〈提高內容保護系統間的互通作業性〉，電子工程專輯網站，檢索：2009年1月，http://www.eettaiwan.com/ART_8800446976_480802_TA_97c4f038.HTM。

Geography & Map Reading Room網站，檢索：2009年1月，<http://www.loc.gov/rr/geogmap/>。

Map Collections，Library of Congress網站，檢索：2009年1月，<http://memory.loc.gov/ammem/gmdhtml/gmdhome.html>。

3D graphic design software，3D graphics software Adobe Photoshop CS4 Extended，檢索：2009年1月，<http://www.adobe.com/products/photoshop/photoshopextended/>。

LizardTech - Products - GeoExpress – Homepage，檢索：2009年1月，<http://www.lizardtech.com/products/geo/>。

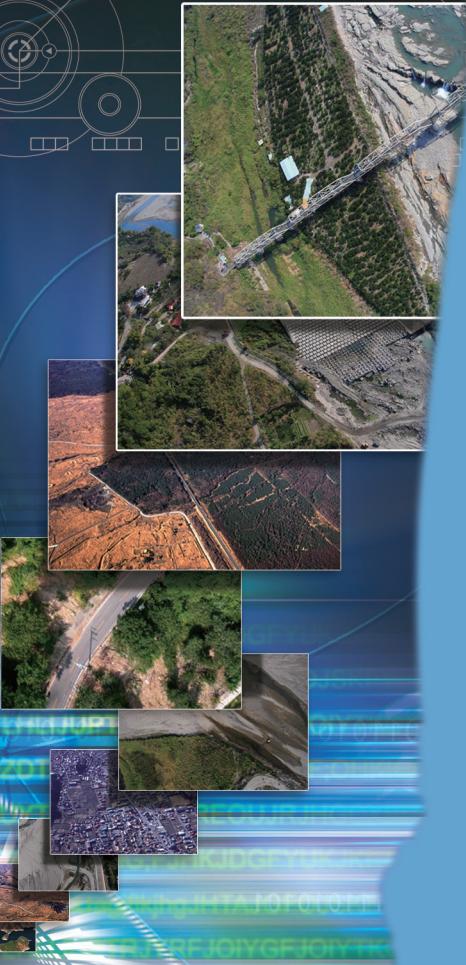
ER Mapper - Geospatial Imagery Solutions GIS，檢索：2009年1月，<http://ermapper.com/default.aspx>。

ERDAS, Inc. -- The Earth to Business Company，檢索：2009年1月，<http://www.erdas.com/>。

ENVI Software - Image Processing & Analysis Solutions，檢索：2009年1月，<http://www.ittvis.com/ProductServices/ENVI.aspx>。

PCI Geomatics Home Page - Committed to Image-Centric Excellence，檢索：2009年1月，<http://www pci.on.ca/index.html>。

Appendix



Appendix 1. Academia Sinica Computing Center Map Scanning Equipment

Equipment	High Resolution Film Scanner	Platform Scanner + Mask	Color Image Large Format Scanner	Film Scanner + Automatic Feeder	High Precision Aerial Photo Scanner
Reference Model/Brand			Contex CHROMA wide format color Scanner	Nikon COOLSCAN 4000 Film scanner + SF-200 automatic feeder	Ultra Scan5000
Specifications	1. Platform X,Y axis technology 2. Max scanning size: 305*432mm 3. Optical resolution: 2000*6000dpi 4. D-max: 3.7 (Max 4.0) 5. Color data structure: 42 bits / 14 bits per color 6. Zoom ratio: 20% ~ 2000% (300dpi)	1. Max resolution: 800dpi 2. Max scanning size: A3 3. Max color level: 36bit (color), 12bit (gray tone)	1. Max Resolution: 600DPI; Scan Mode includes the follow three modes: 24 bit RGB Color, 8 bit Gray-tone, 1 bit black-and-white. 2. Max scanning width: 40 inches 3. Max scanning thickness: 0.6 inches	1. Max resolution: 4000dpi (5959*3946 pixels) 2. Scanning size: 25.1 mm * 38 mm 3. File format: TIFF, JPEG, etc. 4. RGB LED Matrix low temperature light source, RGB continuous linear light source	1. Geometric filter precision: 2μm (inclusive) 2. Effective scanning size: Can reach 28*44 when scanning pixels are 5μm 3. Min optical pixel size: 5μm (Refers to the real pixel size, excluding interpolated) 4. Actual scanning pixel size: From 5μm to 500μm stepless adjustment of color density from 0 to 3.4D 5. Output data format: TIFF, RAW, EPS, DCS, etc. 6. Connects to the computer via a SCSI - 2 standard interface
Applicable objects	Transparencies, microfilm	Books, pictures, small maps	Large format color and black and white maps	Transparencies	Aerial photos, film

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