GUIDE TO MANAGING GEOSPATIAL ELECTRONIC RECORDS

Version 1.00

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Preface

The Guide to Managing Geospatial Electronic Records offers recommendations for improving practices for managing and preserving geospatial data and related electronic records. Version 1.00 is the initial release of the guide. Subsequent versions of the guide will reflect comments and suggestions received on the current version as well as new information and resources that may become available.

Disclaimer

Organizations and individuals may use the Guide to Managing Geospatial Electronic Records to improve their practices and do so at their own risk. CIESIN, Columbia University, and its sponsors are not liable for any application, use, or misuse of the guide. Any opinions expressed in this guide are those of the authors and are not necessarily the opinions of the Advisory Board members, Columbia University, or the National Historical Publications and Records Commission.

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Dr. Robert S. Chen, Deputy Director of CIESIN, and Dr. Robert R. Downs, Senior Digital Archivist and Senior Staff Associate Officer of Research at CIESIN, served as the Director and Co-Director, respectively, of the project. Other project team members from CIESIN included Mark Becker, Branko Djapic, Annie Gerard, John Mickelson, and John Scialdone. Many aspects of the guide reflect insights obtained from community members who participated in "Extending the Boundaries: A Workshop on Managing and Preserving Geospatial Electronic Records," and from the anonymous practitioners who participated in the study of geospatial data management practices (Downs and Chen, submitted). In addition, the guide has also benefited from the expertise of the members of the project Advisory Board, listed below.

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Introduction

This Guide to Managing Geospatial Electronic Records describes ways to improve practices for managing geospatial electronic records (GERs). The prescribed practices are applicable to government agencies and other organizations that create or use geospatial data in the completion of their missions. The guide may also be applicable to organizations that create and use other types of digital data and information. These suggestions and other guidance on managing and preserving data are intended to help improve the long-term stewardship of GERs and to support their continuing access and use.

Efforts to manage GERs include various activities necessary to provide effective lifecycle stewardship of geospatial data and related electronic records that have been acquired or created by the organization. These activities include appropriate planning, documentation, and custodianship to insure the integrity and continuing availability of resources designated as GERs.

Benefits of Managing Geospatial Electronic Records

Geospatial data and related scientific and technical information (STI) have become increasingly important information assets for government agencies, institutions, and other organizations during the last few decades. Many of these information assets represent considerable investments on the part of the organizations that have created or acquired them. Some geospatial data constitute vital records for a wide range of government responsibilities, including permitting, zoning, tax collection, resource management, public safety, public health, and management of public infrastructure. Such GERs can incorporate extensive historical information on past transactions and activities important for legal, programmatic, scientific, and/or historical purposes. Geospatial data may also have significant potential value for future use, either similar to their current uses or for new, unplanned applications. Like other information assets in either printed or digital form, geospatial data need to be properly managed and preserved so that they can continue to be used and reused.

Geospatial data and other information in digital form are at risk of becoming inaccessible if they are not properly managed. Digital assets are susceptible to changes in the technology used to access the information or may become inaccessible as a result of changes in application software, operating systems, or hardware. Storage media, and the technological artifacts that access the media, are also likely to deteriorate. In addition, digital information, media, and technology are exposed to the possibility of human error.

Government regulations and laws generally recognize the need to protect GERs because of their importance as official records. However, in many instances, they do not yet fully recognize the complexity of dealing with GERs, which pose issues of preservation and access that extend beyond traditional printed records such as maps and documents. Complying with legal and ethical concerns for managing GERs can reduce the risks associated with non-compliance. In addition, improving practices for managing GERs may benefit other areas of digital information management.

Infrastructure to Manage Geospatial Electronic Records

Organizations need to create an overall infrastructure for managing geospatial data and related electronic records. This infrastructure should include appropriate policies, plans, and procedures, professional staff to support geospatial data management activities, and the systems, facilities, and instruments needed to manage GERs.

Policies, Plans, and Procedures

The starting point for establishing an overall infrastructure for managing GERS is an appropriate set of policies that communicate the importance of managing these data as organizational assets to attain the mission and goals of the organization. Such policies should provide broad guidance to the organization in its data management and preservation efforts. Specific policies should address data stewardship, collection development, and records retention and disposition. Policies established for data management should address issues of acquisition, including selection and appraisal, intellectual property, and preservation.

Based on such policies, plans can be established to direct specific geospatial data management activities. For example, building on the collection development policy, plans can be established for geospatial data acquisition and development to meet long-term and short-term organizational goals for the use of these data and related electronic records. If data distribution or sharing is included in the policy, it should address confidentiality, security, and privacy issues as well as intellectual property rights. Establishing general policies provides guidance for those who must then create specific data management plans and procedures.

By developing written procedures to conduct geospatial electronic records management activities, staff members assigned to specific tasks can complete these routinely. Following a written procedure may help to ensure that each aspect of a particular process is completed in a manner that has been tested and used successfully. In addition, when improvements are identified and developed for a particular process, the written procedure can be updated to improve the way that the procedure will be conducted in the future.

For examples of data policies, plans, and procedures, see the portal section on Example Geospatial Data Management Policies and Guidelines.

Managers and Professional Staff

Given the mandate described in organizational policies and plans, managers have the authority to utilize organizational resources to attain these objectives. Such authority enables managers to delegate the responsibility to specific individuals who can serve in various data management roles and provide leadership for groups and projects to manage geospatial data.

The managers and professional staff who are assigned responsibility for managing geospatial data also need appropriate training, which might include courses on metadata, geospatial data management, electronic records management, and digital preservation. In the U.S., geospatial metadata training is coordinated by the Federal Geographic Data Committee (FGDC); a registry

of metadata trainers and a training calendar are maintained by the FGDC at: http://www.fgdc.gov/metadata/education.html. Organizations such as the Association of Records Management Administrators (ARMA) also offer relevant training. For additional resources, please see the portal section on Training Opportunities.

Similar to other professionals, those responsible for data stewardship also need to continually develop their skills and assess the availability of technologies to support their work. Data management technologies should be identified and implemented to improve data stewardship and reduce manual processing, whenever possible. Ideally, technologies should be adopted to automate the preparation and processing of the data.

A common problem in many organizations is that much greater attention is given to the acquisition or creation of a dataset or database than to the long-term maintenance or custodianship of the data. Thus, it is important to ensure that some individual or set of individuals are specifically given authorization to serve as data custodians. Typically, this would be a staff member identified and trained as a digital archivist or archives manager, an electronic records specialist or manager, or a geospatial data librarian, data manager, or records manager.

Personnel appointments to positions of responsibility for geospatial records management should be communicated throughout the organization so that individuals who have acquired data independently will know whom to contact about managing such data as electronic records. The professionals authorized to manage geospatial electronic records also need resources, as described below.

Systems, Facilities, and Instruments

Appropriate management of GERs requires systems for recording and accessing the data and related documentation, instruments for preparing and processing data, and appropriate facilities where data can be managed and protected.

Ongoing planning is needed to establish and maintain the computer hardware and software to store expected volumes of data, to convert the data among existing and future formats, and to migrate the data to new platforms and new storage media. Unfortunately, there is no simple formula to apply, as technologies and standards are constantly evolving. There is no guarantee that data stored in older formats or on older media will be accessible in the future. For the present, it is clear that geospatial data managers need to remain cognizant of ongoing trends in storage media and in geospatial data interoperability. An active program of data migration, perhaps tied in with other electronic records, can help prevent older data from becoming inaccessible. It is also important for geospatial data managers to monitor the efforts of the FGDC, the Open Geospatial Consortium (OGC), and the International Organization for Standardization (ISO) to develop and improve standards for geospatial data.

Standards for geospatial metadata are the most mature. Standards exist at both the international and national levels, and are implemented to varying degrees by a wide range of organizations and services (e.g., see CIESIN's Metadata Guide). In addition, other working standards are also widely used, such as the Directory Interchange Format (DIF) used by the NASA Global Change

Master Directory (GCMD). These geospatial metadata standards primarily support data discovery and access, and do not fully support needs for management and preservation of geospatial data.

Capturing information about the status of digital objects and formally managing these objects can improve the efficiency and effectiveness of the geospatial data management effort. The Design Criteria Standard for Electronic Records Management (DOD 5015.2-STD) specifies the requirements for software applications to manage electronic records. An electronic record-keeping system can help manage GERs as collections of digital objects. At present, several digital object management systems are under development (see section of portal on Open Source Digital Preservation Software), but their application to GERs is still at an early stage.

The Data Model for Managing and Preserving Geospatial Electronic Records identifies tables and fields that may be adopted for the design of an electronic record-keeping system (CIESIN, 2005). The Data Model contains an extensive schema, organized into a relational model, which has been informed by several metadata standards and other benchmarks that are relevant for managing and preserving geospatial electronic records. This data model may be implemented in a database management system for an electronic record-keeping system or for a digital asset management system. The data model is available from the GER website as a single document and contains a narrative description, an entity-relationship diagram, a database dictionary, and crosswalks that can be used to match fields of the data model to elements in other standards and benchmarks.

When investigating options for an electronic record-keeping system, records managers and archivists might also consider implementing a digital repository system, an institutional repository system, or a digital asset management system for managing GERs. While such systems can be considered an integral aspect of an enterprise information system, and priced accordingly, open source software presents alternative options that might be considered. In addition to cost, a consideration for choosing between purchasing a software product offered by a vendor and acquiring open source software includes the level of support available within the organization. A Guide to Institutional Repository Software describes several open source alternatives for institutional repository software and presents a comparison of the features offered by each (The Open Society Institute, 2004).

It is also important to establish secure, environmentally controlled archival facilities to meet the specifications of the storage media in use. Changes in humidity and temperature can contribute to the deterioration of storage media, which could result in the loss of data. The primary archival facility should be established onsite or near current office locations to facilitate access. Establishing redundant facilities for storing archival media enables storage of a duplicate copy that can be used in the event of a disaster occurring at the primary archival facility. The section on Disaster Planning describes the establishment of an offsite archival facility.

Geospatial Data Accession

Care should be taken during the accession of geospatial data and related electronic records to identify, appraise, and select the data to be acquired in light of the objectives, plans, resources, and purposes that have been established for using and managing the data. During acquisition, the data should be thoroughly inspected and verified for integrity. Similarly, intellectual property rights and restrictions need to be observed as well as any restrictions for security, confidentiality, privacy, or ethical issues. The retention period also should be established.

Appraisal and Selection

An organization is unlikely to have enough resources to manage all datasets or documents that it creates or acquires. Many datasets and documents that are created and acquired do not have future value to the organization. Managing works with little or no future value could utilize resources that might otherwise be used to manage more valuable works. Appraisal and selection enable organizations to limit their geospatial data management activities to only those data that are designated as essential electronic records of the organization. Establishing criteria and procedures for appraising geospatial data provides the organization with a consistent way to identify data that will be treated as electronic records.

The criteria used to appraise geospatial data and information as electronic records should reflect the potential future value of these records for meeting organization objectives. Factors in appraising future value should include managerial, operational, and technical concerns as well as the scientific, scholarly, and historical dimensions. Once decided, the criteria should be specified in the written procedures for appraising geospatial data as electronic records.

In many instances, it may be helpful to establish an advisory board or an internal committee that represents the diversity of organizational interests to be considered for a particular collection or series. An external advisory board can provide outside perspectives and expertise with regard to the uniqueness and value of particular records. An internal committee may be more responsive to organizational priorities and needs in the short term.

Data Inspection

Appropriate procedures should be established to inspect all data received to ensure that these data do not have problems such as computer viruses, incompleteness, or corruption. When receiving any digital objects, and especially those to be managed as electronic records, each file should be scanned by at least two different virus protection software packages to ensure that no infected file enters the system to contaminate other files. Of course, it is essential that the virus definitions and licenses are kept current for each software package used for virus protection.

During the acquisition of geospatial electronic records, software and hardware requirements for accessing the data should be identified and tests should be conducted to ensure that the data can be accessed and used as intended. Such tests could require the use of special software applications that may need to be licensed or purchased.

Authenticity and Integrity

It is important to establish the authenticity of geospatial data and related works that have been selected as electronic records and to regularly verify their authenticity when managing them. When acquiring data from both internal or external sources, procedures should be in place to ensure that the copy of the data, the documentation, and any other descriptive or packaging information are the original records and the correct version provided by the source. Any discrepancies should be resolved immediately. It should be determined whether the received geospatial electronic records are designated for acquisition, management, and preservation. Similarly, once received and confirmed as authentic, each object should be digitally validated so that it can be subsequently and systematically verified on a regular basis. An electronic file can be identified from other files by parsing the file with a software program that employs an algorithm to generate a unique signature for the file.

Various types of message digests or signatures are used to establish and to verify the integrity of electronic files being managed. Regardless of the type of validation that is used to establish the authenticity of files acquired from other organizations, each organization should establish internal procedures for validating and subsequently verifying the records that it manages. Such procedures should include the techniques for validating and routinely verifying the specific digital signatures or message digests used to uniquely identify each file that is managed. The National Institute of Standards and Technology (NIST) has designated Secure Hash Algorithms (SHA) for the Secure Hash Standard (SHS) to generate secure message digests and validate the integrity of files (2002).

Intellectual Property Rights and Restrictions

Each organization should establish a policy on intellectual property rights and restrictions that can be used to guide practices for using and sharing GERs. Increasingly, these rights and restrictions are determined by an organization's general information policy and/or by applicable regulations or laws. However, a clear statement of the rights and restrictions associated with each type of GER is helpful both to internal staff and potential external users. Longhorn, Henson-Apollonio, and White have developed a primer on legal issues associated with the use of geospatial data and related tools (2002).

Forms are very helpful in obtaining permissions from data providers and authors. Using such forms can increase the efficiency of negotiations on intellectual property rights issues. Permission forms can be created to address various uses. Data sources may be asked to authorize public dissemination without restrictions or to specify specific limitations. The availability of permission form templates enables both parties to discuss the language contained in the form and to identify any issues that need to be resolved. Review of standard form templates by top management and by the organization's legal counsel should facilitate the approval process over time.

Similarly, forms can facilitate the provision of permissions for other parties to use geospatial records that an organization owns. The organization can identify a small set of options for external data dissemination and use, adjusting allowable uses and restrictions as needed.

CENDI (2004) has compiled an extensive description of Frequently Asked Questions (FAQ) about Copyright that can be a valuable reference for managers of GERs.

Security, Confidentiality, Privacy, and Ethical Issues

Some data contain information that may be restricted for security, confidentiality, privacy or ethical reasons. Data containing information that has been designated as restricted information by an organization or by regulation or law must be carefully protected. Likewise, data containing information about the identities or locations of individuals, such as human research subjects or medical patients, must be identified and protected to ensure the confidentiality of these individuals and to protect their privacy.

In the case of geospatial data, information on location in combination with other data could be used to identify specific individuals, households, or organizations whose identity might otherwise be impossible to determine. An extensive analysis of this issue is available at: http://www.ciesin.columbia.edu/pdf/SEDAC_ConfidentialityReport.pdf.

Data creators, managers, providers, and users must restrict access to data that contain any restricted information. Any data containing restricted information or data that can be used in combination with other data to obtain restricted information should be identified to protect it from being used by unauthorized users. The revised Circular A-16 describes responsibilities and reporting requirements for federal agencies that use geospatial data (US OMB, 2002).

Restricted data can be protected in various ways. Those responsible for managing restricted data could require confidentiality agreements to be signed by anyone who is given access to protected data. In some cases, sensitive data can be masked or censored from public versions of databases, although this may have significant impacts on the value of the database to external users. Various technical measures to restrict access to datasets include use of passwords, encryption, and physical access limitations. Of course, many of these measures rely on the ability of an organization's information technology specialists to prevent unauthorized entry and access to the computer systems that host the restricted data.

Retention Scheduling

In accordance with National Archives and Records Administration (NARA) requirements, a retention schedule must be established for each record, or series of records, to specify how long each record will be managed before disposition. Requirements for retention schedules, also known as disposition schedules, apply to GERs as well as to printed records. Assigning each record to a specific series that has an assigned duration period, in accordance with established retention policies and plans, aids the organization in efficiently managing retention schedules for all records. During acquisition, each record should be assigned to the appropriate collection and series. NARA offers guidance and training on records management and distributes regulations on establishing retention schedules for electronic records (2001), on records disposition (2002), and on the transfer of geospatial data records (2004).

Geospatial Data Custodianship

Data management and preservation practices contribute to geospatial data custodianship by protecting the data from destruction, loss, and inaccessibility. Geospatial data custodianship also helps to ensure capabilities for future access and use of the data being managed. Data management practices that contribute to geospatial data custodianship include creating duplicate copies of Preservation Masters, effectively packaging and documenting data when they are created or acquired, managing supplemental documentation that can be used to ensure continuing access, describing the data in accordance with required metadata standards, preparing for disaster recovery, protecting vital records, and maintaining offsite archival facilities. These activities are described in the following sections.

Preservation Masters and Copies

Creating duplicate copies of archival media is a basic step in data preservation. One copy of the geospatial data that is stored on archival media is normally designated as the "Preservation Master." The Preservation Master should be stored at the primary archival facility. Another copy known as the "Security Master" is stored at a separate, offsite facility, located far enough away from the facility housing the Preservation Master so that the Security Master is very unlikely to be affected by any hazards or destructive events that might compromise the primary archival facility. On the other hand, the offsite facility should not be so far away that regular updates become too difficult or too costly to maintain. In this regard, reciprocal agreements with organizations with similar offsite archiving needs may be worth exploring.

A third duplicate, the "Access Service" copy, facilitates access and use of the data without disturbing the Preservation Master or the Security Master. The Access Service copy can be stored online or on media that is accessible to those who may need to use the data on an ongoing basis.

This approach reflects a relatively stable set of data with a relatively manageable volume. For very large databases, or databases that are rapidly updated on an ongoing basis, alternative strategies may be needed to ensure the level of survivability and recoverability of the data that the organization desires and can afford. Many banks, for example, have now implemented "hot" backup systems that not only store duplicates of transactions in real time but are also ready to take over from primary systems at a moment's notice.

Packaging and Documentation for Preservation

Ideally, documentation should begin when geospatial data are being created. Generally, authors of GERs know more about the records than those who will receive them later.

The Consultative Committee for Space Data Systems (CCSDS) has produced a Reference Model for Open Archival Information Systems (OAIS), which has been adopted by the ISO as the standard for Space Data and Information Transfer Systems (ISO 14721:2004). The OAIS framework is applicable to the management of GERs and provides guidance for creating an

Archival Information Package (AIP) to manage and preserve the content of each digital object along with additional information that can facilitate for future use.

The OAIS framework specifies the information to be included in an AIP. In addition to the content information or data, an AIP includes descriptive information to foster discovery and use, packaging information to describe the AIP and its contents, and preservation descriptive information to foster preservation for future reuse.

The CCSDS (2003) also has produced draft recommendations for interactions between producers or creators of data or information products and the archives, which receive such products (CCSDS 651.0-R-1). These recommendations describe the preparation of submission information packages (SIPs) for submitting data and other information products to an archive for ingest.

Metadata and Data Documentation

Metadata and data documentation are necessary for discovering, for using, and for managing geospatial data. Metadata provide a way to describe geospatial data and other electronic records. Like fields in a database management system, metadata elements are employed to describe geospatial data and other digital objects or records being managed. A metadata schema consisting of several metadata elements is used to capture information that describes various aspects of digital objects and collections. Metadata may be maintained in a database management system or stored with the digital object being described. The Library of Congress distributes specifications for the Metadata Encoding and Transmission Standard (METS), the Metadata Object Description Schema (MODS), and, with the Society of American Archivists (SAA), distributes the Encoded Archival Description (EAD).

Several metadata schemas and standards have been developed to describe geospatial data and other electronic records. The Dublin Core Metadata Initiative has identified a standard set of metadata elements that should be included in any metadata scheme that is developed or adopted (2003). There also are many guides and other sources of information that describe metadata. CIESIN's Guide to FGDC Compliant Metadata provides guidance for writing metadata in compliance with the Content Standard for Digital Geospatial Metadata (CSDGM) developed by the FGDC (1998).

Administrative and preservation metadata facilitates the management of data for long-term preservation to support future access and use. Examples include the Data Dictionary for Preservation Metadata (PREMIS, 2005), and the Metadata Standards Framework, Preservation Metadata (National Library of New Zealand, 2003). Crosswalks to these schemas and other standards and requirements for managing electronic records and preservation metadata are included in the Data Model for Managing and Preserving Geospatial Electronic Records (CIESIN, 2005).

Data documentation contains descriptions of the variables, measures, and instruments used to create the data. Without documentation, data may not be usable. Data documentation is critical for using the data and should be managed with the data so that this valuable information is

available to potential users. The Data Documentation Initiative (DDI) is developing standards to improve practices for the documentation of data (2003).

Media Migration and Data Conversion

The vulnerability of storage media to deterioration increases the risk of losing valuable geospatial data and other electronic records. Storage media should be tested routinely for deterioration. Although maintaining multiple copies of storage media in different locations does reduce the vulnerability of data loss, periodic sampling of data stored on media is also necessary to examine the media and assess the accessibility of data stored on each type of media.

It is of course important to maintain stable environmental conditions for storing media in compliance with manufacturers' specifications at both onsite and offsite archival facilities. In addition, regularly scheduled migration of AIPs to new media reduces the risk of data loss. Establishing the duration for which data will be stored on each type of media permits scheduling of the refreshment of media. Preparation for media migration includes maintaining computer systems capable of migrating data from current storage media to new media.

A digital risk management plan can assist in assessing and mitigating risks associated with the media used to store geospatial data and other electronic records. The media risk management plan should include a risk assessment for each media type and describe media characteristics and necessary environmental conditions and controls, archival processes, and risk mitigation efforts. The media risk management plan should be updated periodically to reflect any new media adopted as well as new information obtained about storage media being used.

Data formats also must be considered as technology evolves. Data formats are often dependent on currently operating software applications, operating systems, and computer hardware. Recording information about the data formats of GERs enables identification of formats that may not be supported by future technology. It is therefore necessary to monitor technological changes and the effects on current data formats. When current formats may no longer be supported, older data must be migrated to formats that can be rendered with future technology. Pronom is a file format registry that can be consulted to obtain information about software for rendering specific file formats (The National Archives of England, Wales, and the United Kingdom, 2004

Disaster Planning and Recovery

Planning for disasters can reduce the effects of potential disasters on data management operations. Establishing both a disaster plan and a data recovery plan provides guidance to prepare staff for maintaining data management activities and continuing protection of the data if a disaster occurred. These plans should be tested periodically to ensure that each plan effectively addresses the needs for protecting and recovering geospatial electronic records as well as any vital records of the organization.

Disaster and recovery plans should include keeping copies of vital records, electronic records, and system backup copies at an offsite archival facility. Disaster plans and data recovery plans should be designated as vital records to ensure that they are adequately protected for a disaster.

Vital Records

Records that are critical to operations or to property interests must be designated as vital records. Examples of vital records include operations manuals, recovery plans, security procedures, contracts, and any legal documents that establish ownership of physical or intellectual property. Vital records must be properly protected to ensure that the information contained within the records can be accessed and used.

Offsite Archive

Archival, security, and disaster plans should include establishing an offsite archival location at a separate site that is far enough from the primary archive to minimize the risk of loss of both archives, yet close enough to enable regular visits for media deposits, inspections, maintenance, and recovery tests. Scheduling regular visits to deposit the Security copies in the offsite archive ensures that these copies are deposited in a timely manner and reduces risks of keeping all copies of these records at the same site. Establishing online facilities at the offsite location can enable immediate transmission of records offsite and foster rapid recovery of online operations and access to geospatial data if a hazard or an event affects the online operations located at the onsite archive. A number of commercial services now offer support for these functions.

Procedures for visiting the offsite archive should include inspection of the security and environmental conditions, such as temperature and humidity, to ensure that these conditions conform to expected specification. Similar to the onsite archive, sampled testing of the geospatial data records should be scheduled regularly and all media should be maintained by replacing it in accordance with media refreshment schedules.

Scheduling disaster tests on a regular basis enables verification of capabilities to recover GERs if a disaster were to occur. Disaster tests should simulate a disaster, so that recovery procedures can be practiced and capabilities for recovering the records and operations can be examined for potential improvement. Conducting these tests without prior warning enables the tests to approximate the conditions of an actual event. Observations of the recovery process during the test can identify improvements that are necessary for the plan and for training personnel.

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