NATIONAL SPATIAL DATA INFRASTRUCTURE FRAMEWORK DATA

Framework Data Content Standard – Digital Orthoimagery

Related Topics

NSDI Training Tracks:
An initiative to define areas, topics, and materials for training within the NSDI.

ISO 19100 Series:
Suite of standards developed for geographic data and datasets. The most notable is ISO 19135 which pertains to metadata.

ANSI Standards:
Similar work to ISO, but standards directly apply to data created within the United States.

Course Information

The National Spatial Data Infrastructure (NSDI) Framework is a collaborative initiative to develop a set of commonly used geographic datasets that are compatible based upon spatial location and content. The Framework approach allows data collected for variety of reasons and agencies to work together seamlessly; which can ultimately reduce project costs and increase interagency cooperation. The Framework Data Content Base Standards Suite dictates the requirements for Framework data.

This course covers the fundamentals of the Framework Data Theme: Digital Orthoimagery as developed by the Framework Data Content Standard. It is designed for users who are both interested in an overview of the Framework Data Content Standard Digital Orthoimagery theme as well as designers and developers implementing Framework data, and associated tools specific to Digital Orthoimagery data.

Prerequisites

- **General Understanding of GIS, Geospatial Data and Metadata**
- **Familiarity with the Federal Geographic Data Committee (FGDC)**
- **Familiarity with the National Spatial Data Infrastructure (NSDI)**
- **Basic knowledge of Geographic Data Standards (specifically ISO 19100 series)**
- **Completion of Framework Data Content Base Standard Course**

Learning Objectives

Understand Digital Orthoimagery Data

Comprehend Basics of Digital Orthoimagery Framework Standard

Understand How to Implement the Standard

Course modules

- **Understanding Digital Orthoimagery Data**
- **Digital Orthoimagery (Part 2) of the Framework Data Content Standard**
- **Implementing the Digital Orthoimagery Standard**
- **Course Review**

Estimated Time

Estimated time for the entire course is 100 minutes.

Module 1: Understanding Digital Orthoimagery Data

Topics

- **What is Digital Orthoimagery Data?**
- **Types of Digital Orthoimagery Data**
- **Digital Orthoimagery in Action Module Exercise**
- **Summary**

Time Requirement

Estimated time for this module is 30 minutes

First Topic

What is Digital Orthoimagery Data?

What Are Digital Orthoimagery Data?

Digital Orthoimagery combines the image characteristics of an aerial photograph, digital image, or other remotely-sensed data with the geometric qualities of a map. Unlike a typical aerial photograph, distortions due to relief displacement (hills, stream valleys, buildings), camera lens, and aircraft attitude have been removed so that all ground features are shown in their correct ground positions. This makes a “true image” map possible and permits direct measurement of distances, areas, angles, and the detailed portions of ground features that are typically omitted or generalized on traditional maps. In a digital format, orthoimagery fulfills a fundamental role as a geometrically accurate base map.

More about Digital Orthoimagery Data

Aerial and satellite imagery, in the form of digital orthoimagery, is the foundation for most public and private GIS systems (NSGIC, Digital Imagery for the Nation, 2006).
Aerial Imagery - A photograph of the earth's surface taken from a platform flying above the surface but not in orbit, usually an aircraft. Aerial photography is often used as a cartographic data source for base-mapping, locating geographic features, and interpreting environmental conditions.
Orthophotograph - An aerial photograph from which distortions owing to camera tilt and ground relief have been removed. An orthophotograph has the same scale throughout and can be used as a map.

Next Topic

Types of Digital Orthoimagery Data

NSDI

Types of Digital Orthoimagery

A more technical look at Digital Orthoimagery reveals that Digital Orthoimages are georeferenced images of the Earth's surface, collected by a sensor and then image object displacement has been removed by correcting for sensor distortions, orientation, and for terrain relief. Digital orthoimages encode the optical intensity of sensed radiation in one or more bands of the electromagnetic spectrum as discrete values in an array of georeferenced pixels that model the scene observed. Additionally, these images have the geometric characteristics of a map and are captured from a wide variety of sources and are available in a number of formats, spatial resolutions, and areas of coverage. Many geographic features, including some in other framework data themes, can be interpreted and compiled from an orthoimage.

The details and requirements to ensure the data meets Framework Standards will be addressed later; however the next series of slides will provide a snap shot of some of the different types of orthoimagery in use today.

http://2.bp.blogspot.com/_zJrVQFqitUA/SYtGnJ1E3hI/AAAAAAAAGHg/fhNrVS6cy9U/s320/contentsite1.gif

Data Collection

There are many different types of sensors, and platforms to collect orthoimagery; however the basic principals are similar. The picture above shows an airplane mounted sensor collecting data.

Next Topic

Types of Digital Orthoimagery Data

Types of Digital Orthoimagery- Aerial Photo

Aerial Photos are one of the most commonly used types of Digital Orthoimagery. Characteristics if these varieties include different resolutions and styles. The examples included on this slide document some of the differences.

The photo to the left is an example of a true color aerial photo of Boston, MA.

The photo to the right is an example of a Color Infrared Photo showing a sewage treatment plant.

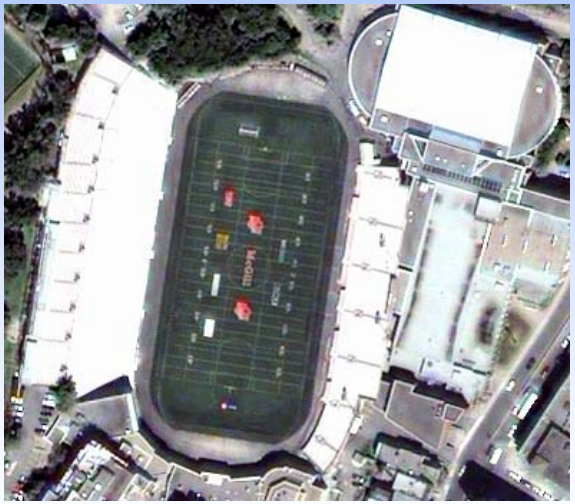
The photo above is an example of a black and white DOQQ, which were common until the early 2000's.

Next Topic

Types of Digital Orthoimagery

Types of Digital Orthoimagery- Satellite Imagery

With the advances in technology, cameras and sensors can be placed on satellites to provide high quality images at varying scales, and can incorporate different sensors to suit a variety of purposes. The examples on this slide highlight some of the types of data available.



The photo to the left is an example of a true color aerial photo of Boston, MA.

The photo to the right is an example of a continent level satellite image showing Europe.

The photo above is an example of a high resolution (60cm) satellite image of a football stadium.

Next Topic

Digital Orthoimagery Exercise

Digital Orthoimagery Module 1 Exercise

Digital Orthoimagery is being applied and used in real world projects by many different agencies. These agencies use digital orthoimagery data for a variety of reasons. Now that you have some basic digital orthoimagery knowledge let's see some digital orthoimagery data sets in action.

Step 1) **Open an Internet Browser and proceed to:**
http://kymartian.ky.gov/doqq/default.htm

Step 2) **Explore the Kentucky Digital Ortho Image Download Center**

Step 3) **Pay specific attention to the Digital Orthoimagery data and how it is displayed, and how the tools provided can be used to view and acquire the data**

Step 5) **Close all Internet windows and proceed with the course**

Questions to Consider:

1. How does this differ from a traditional Internet Mapping Service (IMS)?
2. What types of data are available?
3. Does the site provide adequate information about the data?

Next Topic

Module Summary

Digital Orthoimagery Module 1 Summary

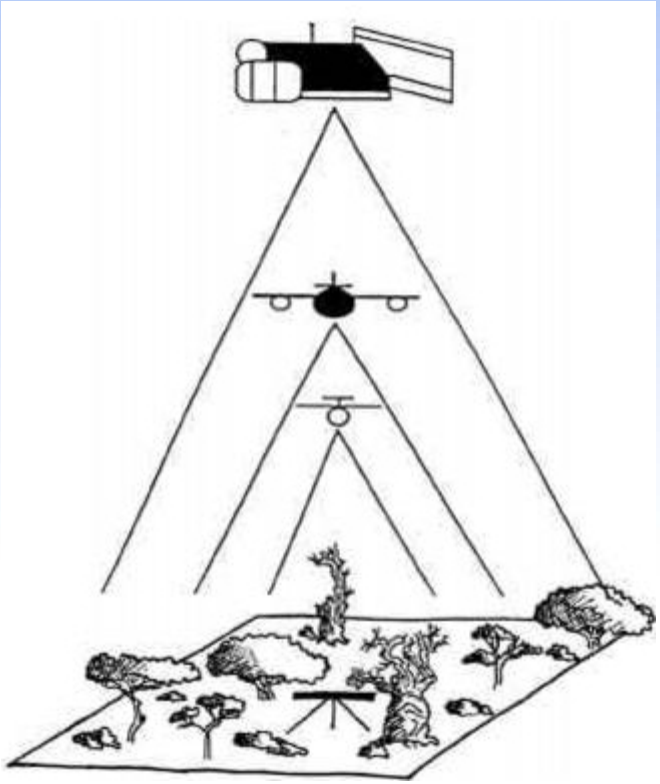
In this module we have explored Digital Orthoimagery Data, the different types and why it is important.

• Digital Orthoimagery combines the image characteristics of an aerial photograph, digital image, or other remotely-sensed data with the geometric qualities of a map.

• Unlike a typical aerial photograph, distortions due to relief displacement (hills, stream valleys, buildings), camera lens, and aircraft attitude have been removed so that all ground features are shown in their correct ground positions.

• In a digital format, orthoimagery fulfills a fundamental role as a geometrically accurate base map.

The diagram at the right shows a variety of sensor techniques for collecting digital orthoimagery.



http://www.idrc.ca/openebooks/812-0/img/regionalint_307_la_19.jpg

Next Topic

Module 2: Digital Orthoimagery (Part 2) of the Framework Data Content Standard

Module 2: The Framework Data Content Standard: Digital Orthoimagery

Topics

- What is the Digital Orthoimagery Standard?
- Purpose for Standard
- Goals of the Standard
- Capacities of the Standard
- Standard Related Contact Information
- Module Exercise and Summary

Time Requirement

Estimated time for this module is 30 minutes

Key Terms

Digital Orthoimagery Framework Standard

Framework

Resolution

Areal Extent

Next Topic

What is the Digital Orthoimagery Standard?

What is the Digital Orthoimagery Standard

The Digital Orthoimagery Framework Data Content Standard is:

- **One of the seven themes defined by the FGDC as Framework data**
- **Establishes a baseline for Digital Orthoimagery data collection and distribution**
- **Builds on the Framework Data Content Base Standard and Framework Digital Orthoimagery Standard.**
  - *Only when a dataset meets the requirements set forth in its thematic standard part and the Framework Base Standard can it be considered Framework data.*

Quick Facts

Each Framework standard part was developed and edited by thematic experts

Digital Orthoimagery is one of the seven themes of Framework data. Each has a separate standard, some including subparts.

All standards use the Framework Data Content Base Standard as the baseline for this data.

Next Topic

Purpose for the Standard

Purpose for the Digital Orthoimagery Standard

Digital orthoimagery is one of the basic digital geospatial data framework themes as envisioned by the Federal Geographic Data Committee. This part of the Geographic Information Framework Data Content Standard specifies data content and logical structure for the description and interchange of framework digital orthoimagery. To a certain extent, it also provides guidelines for the acquisition and processing of imagery (leading toward the generation of digital orthoimagery), and specifies the documentation of those acquisition and processing steps. The primary focus of this part is on images sensed in the visible to near infrared portion of the electromagnetic spectrum. However, images captured from other portions of the electromagnetic spectrum are not precluded.

http://giscoordination.mt.gov/images/roadmap.jpg

Next Topic

Goals of the Standard

Goals for the Digital Orthoimagery Standard

It is the intent of this part of the Framework Data Content Standard to set a common baseline that will ensure the widest utility of digital orthoimagery for the user and producer communities through enhanced data sharing and the reduction of redundant data production. The framework will provide a base on which to collect, register, and integrate digital geospatial information accurately.
This part is intended to facilitate the interchange and use of digital orthoimagery data under the framework concept. Because of rapidly changing technologies in the geospatial sciences, this part covers a range of specification issues, many in general terms. This part stresses complete and accurate reporting of information relating to quality control and standards employed in testing orthoimagery data.

http://www.aoc.co.za/resources/images/products/satellite/RapidEyeImagery.jpg

Next Topic

Capacities of the Standard

Capacities for the Digital Orthoimagery Standard

The development of this part of the Framework Data Content Standard will greatly assist in mitigating the following issues:

- Duplication of data and application development
- Complications exchanging Digital Orthoimagery data and information
- Difficulties in integrating data
- Ensure complete and accurate reporting of quality control information
- Define the definition of what is and isn't a digital orthoimage

More Information

The FGDC is the responsible organization for coordinating work on all parts of the Geographic Information Framework Data Content Standard including the Digital Orthoimagery Theme.

Next Topic

Contact Information

Who to Contact for Questions about the Digital Orthoimagery Standard Part

Federal Geographic Data Committee Secretariat
c/o U.S. Geological Survey
590 National Center
Reston, Virginia 20192 USA
Telephone: (703) 648-5514
Facsimile: (703) 648-5755
Internet (electronic mail): gdc@fgdc.gov
WWW Home Page: http://www.fgdc.gov

Standard Coordination

The FGDC is the responsible organization for coordinating work on all parts of the Geographic Information Framework Data Content Standard. The development and maintenance authority for Part 2: Digital Orthoimagery is held jointly by the U.S. Geological Survey and U.S. Environmental Protection Agency.
The FGDC shall be the sole organization responsible for direct coordination with the InterNational Committee for Information Technology Standards (INCITS) concerning any maintenance or any other requirements mandated by INCITS or ANSI.

Next Topic

Module 2 Exercise

Digital Orthoimagery Module Exercise

1. **Open an Internet browser**
2. **Explore Lancaster County's HRII Map website:**
   http://dnrmap2.dnr.state.ne.us/website/highres/viewer.htm
3. **Which site offers more current data? What is the resolution of the data?**
4. **Close web browser and continue on with the next part of the module**

Next Topic

Module Summary

Module summary

- **The goal of the Digital Orthoimagery part of the Framework Data Content Standard is to provide common definitions and model to enable collaborative development, use, and exchange of Digital Orthoimagery data.**

- **Establish the content requirements for the collection and interchange of Digital Orthoimagery features**

- **The Digital Orthoimagery part is just one piece of the seven themes of Framework Data that collectively in unison with the Base Standard comprise the Framework Data Content Standards**

- **Changes in technology are constant, thus the standard addresses Digital Orthoimagery in general terms to ensure its currentness.**

Next Topic

Module 3: Digital Orthoimagery Standard Requirements

Module 3: Digital Orthoimagery Requirements

Topics

- Framework Data Content Digital Orthoimagery Standard Requirements
- Encoding and Implementing the Standard
- Module Summary

Time Requirement

Estimated time for this module is 60 minutes

Key Terms

UML
Coding Elements
Feature Relationships

First Topic

Digital Orthoimagery Standard Requirements

Framework Data Standard Digital Orthoimagery Requirements

In this module you will learn about the three main requirements for Framework Digital Orthoimagery data, as specified in the standard. Each requirement is addressed as a separate topic, however more attention may be given to certain requirements as they are the most crucial requirements for creating Framework quality Digital Orthoimagery data. The six main requirements are:

1. **Digital Orthoimagery Structure**
2. **Resolution**
3. **Areal Extent**
4. **Coordinate Systems and Reference Datums**
5. **Accuracy Requirements**
6. **Production Components**

The Digital Orthoimagery Standard is unlike the other Framework Standards because of the types of data it addresses. As such there are additional components that aren't specific requirements but do need to be addressed including:

1. **Image Rectification and Restoration**
2. **Image Mosaicking**
3. **Data Transfer Formats**
4. **Metadata**

Additionally the standard also follows a UML diagram, with a data dictionary that need to be followed to ensure data meets the standard. These materials assume a basic understanding of UML diagrams and flow charts, if you need more information about these topics please visit http://www.uml.org

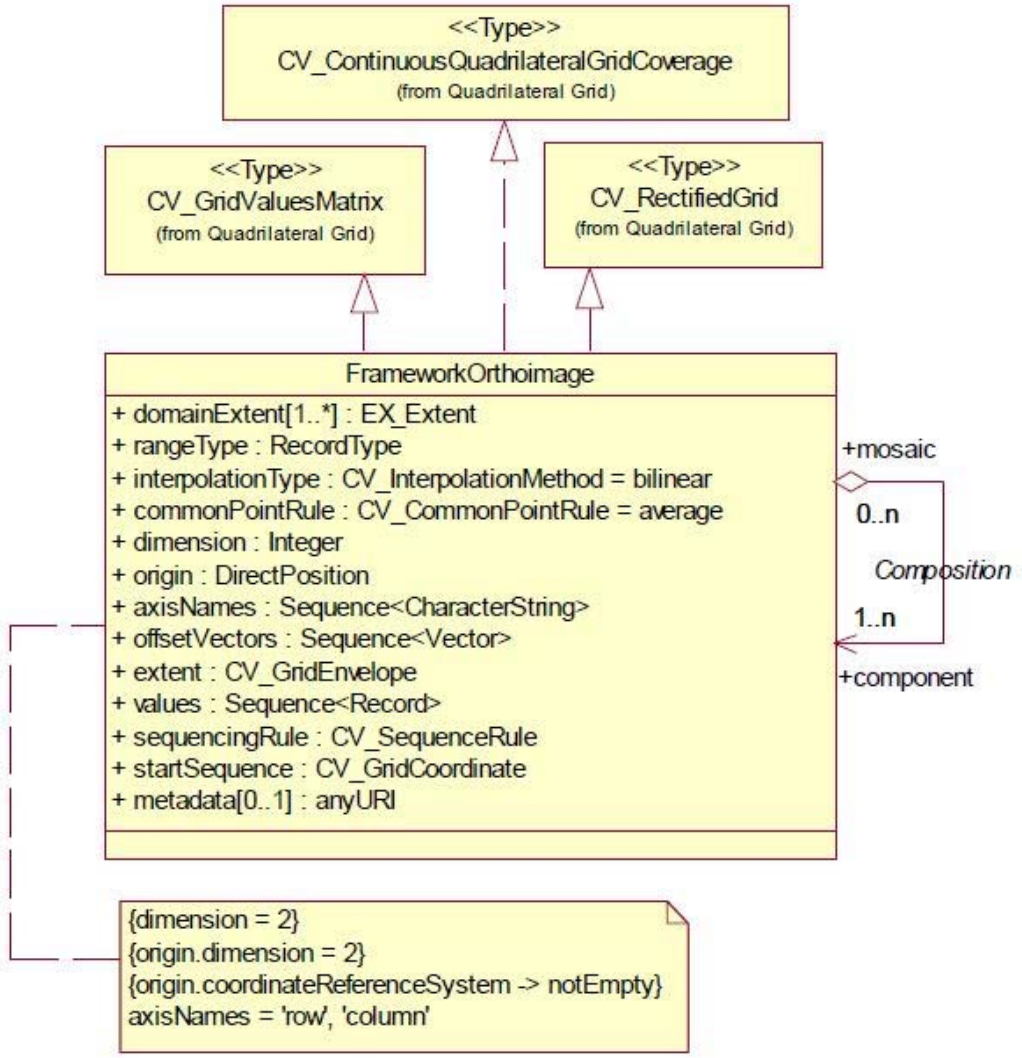
Next Topic

Digital Orthoimagery Requirements Continued

Framework Data Standard Digital Orthoimagery Requirements

The diagram to the right is the UML flow chart for one piece of the Framework Digital Orthoimagery Standard. This diagram shows the components and relationships that comprise a part of the Framework Digital Orthoimagery Standard. UML is designed to show these relationships in a generic manner without specifying a coding language or specific software needed to complete the task. For more information about UML visit:
http://www.uml.org

To see all the parts of the diagram please see Appendix B in the Standard itself.



Next Topic

Digital Orthoimagery Requirements Continued

Framework Data Standard Digital Orthoimagery Requirements: Data Dictionary

A data dictionary is a collection of definitions, rules and advisories of data, designed to be used as a guide or reference with the data warehouse. The standard data dictionary includes definitions, examples, relations, functions and equivalents in other environments. Each Framework Data Content Standard Part has its own data dictionary that describes the necessary elements needed to define that theme as Framework. Below is a portion of the Digital Orthoimagery Data Dictionary, for the full table please consult the standard itself.

Line	Name/Role Name	Definition	Obligation/ Condition	Maximum Occurrence	Data Type	Domain
1	FrameworkOrthoimage					Lines 2-16
2	domainExtent	Spatial extent of the image	M	*	<<DataType>> EX_Extent	Defined in ISO 19115
3	rangeType	Description of the types of values in the range of the coverage	M	1	RecordType	Unrestricted
4	interpolationType	Recommended method for interpolating values at points within grid cells	M	1	<<CodeList>> CV_InterpolationType	Defined in ISO 19123
5	commonPointRule	Rule to follow in interpolating a value at a point that falls on the boundary between two pixels	M	1	<<CodeList>> CV_CommonPointRule	Defined in ISO 19123
6	dimension	Dimension of the image grid	M	1	Integer	2
7	origin	Coordinates, in an external coordinate system, that map to grid coordinates 0, 0	M	1	<<DataType>> DirectPosition	Defined in ISO 19107
8	axisNames	Names of the axes of the image grid	M	1	Sequence<CharacterString>	"row", "column"
9	offsetVectors	Vectors that specify the orientation of the grid axes and the dimensions of the pixels in directions parallel to the axes	M	1	Sequence<Vector>	Unrestricted
10	extent	Limits of the set of pixels included in the image	M	1	<<DataType>> CV_GridEnvelope	Defined in ISO 19123

Next Topic

Digital Orthoimagery Requirements Continued

Framework Data Standard Digital Orthoimagery Requirements: Structure

•Framework digital orthoimagery is defined as images, each of which consists of a two-dimensional, rectangular array of pixels.

•The ground area covered by each pixel, called ground resolution cells, determines the resolution of each pixel.

•The pixels must be arranged in horizontal rows (lines) and vertical columns (samples). The order of the rows shall be from top to bottom; the order of columns shall be from left to right. The uppermost left-hand pixel shall be designated pixel (0,0).

•Images describing more than 1 band of electromagnetic radiation (natural color, color infrared, multi-band) shall be structured in one of three orders: band interleaved by line (BIL), band interleaved by pixel (BIP), or band sequential (BSQ).

•The image shall have equal line (row) and column lengths, resulting in a rectangular image. This may be accomplished by padding with over-edge image or non-image pixels, that have a digital number (DN) equal to zero (black or no reflectance), to an edge defined by the extremes of the image.

•The bounding coordinates of the image shall be documented in accordance with the FGDC Content Standard for Digital Geospatial Metadata. For images that contain over-edge coverage or are padded with non-image pixels, descriptions of both the specific area of interest and any over-edge coverage shall be documented by the metadata.

More about the Metadata:

Some digital orthoimagery quadrangles include over-edge imagery beyond the boundaries of the area of interest. This part recognizes that annotations may be included in an over-edge image. These images are generally created using color lookup tables that provide for a transparent pixel value to accommodate the portrayal of the over-edge information; otherwise this part limits the orthoimage to the significant pixel values of the image.

Next Topic

Digital Orthoimagery Requirements Continued

Framework Data Standard Digital Orthoimagery Requirements: Resolution

When referring to Digital Orthoimagery, resolution is most simply described as the ability of a sensor to render a sharply defined image, and the properties that it takes to achieve that resolution. There are 3 separate types of resolution that all play a vital role in determining the overall resolution of an image:

Spatial Resolution: Spatial resolution is the smallest unit which is detected by a sensor , it is often expressed as pixel resolution . Simply put, it defines the actual area of the ground that is represented in each pixel. For the purpose of this part, framework digital orthoimages shall have a spatial resolution of 2 meters or finer. Images may be resampled to create coarser resolution images than the original raster data. Images of higher resolution can be used to create orthoimages of less resolution but the reverse is not acceptable.

Spectral Resolution: Spectral resolution describes a sensor's sensitivity to a particular wavelength band or bands. For the purpose of this part, the focus for framework orthoimage will be on images sensed in the visible to near infrared portion of the electromagnetic spectrum, 0.4 to1.0 micrometers. However, this does not preclude images captured from other bands.

Radiometric Resolution: Radiometric resolution is the sensitivity of a detector to measure radiant flux that is reflected or emitted from a ground object. Relative radiance from the ground resolution cells shall be described by numerical representations (digital numbers (DNs) or brightness values). The cell value for a single band shall be recorded as a series of binary digits or bits, with the number of bits per cell determining the radiometric resolution of the image. For more information about how to calculate radiometric resolution refer to the standard itself or additional research by Falkner and Morgan (2002).

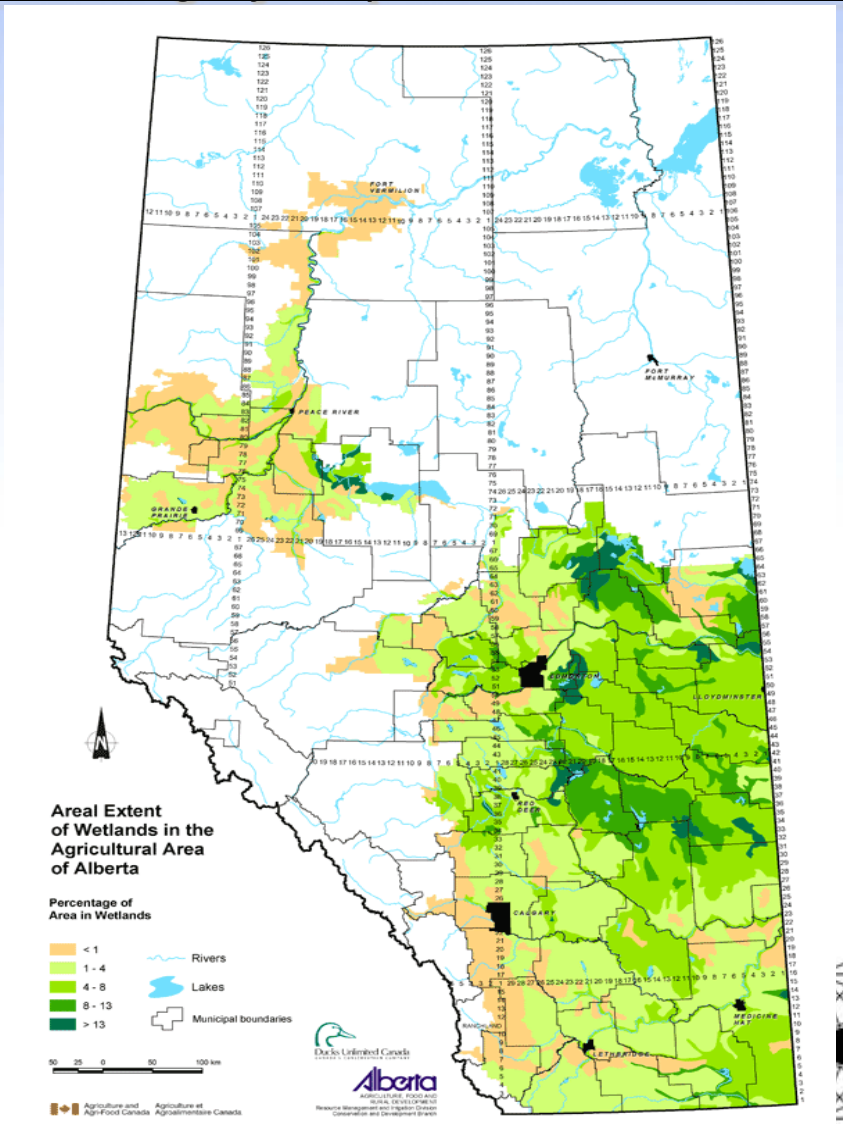
Next Topic

Digital Orthoimagery Requirements Continued

Framework Data Standard Digital Orthoimagery Requirements: Areal Extent

Areal Extent is simply the geographic or spatial area covered or included within the Digital Orthoimage. This framework standard part places no constraints on the geographic extent of an orthoimage. Areal extent of quadrilateral orthoimagery (quad map) can be adjusted to suit the needs of specific types of sensor and sensor platform, height, requirements of the user, etc.

The map to the right doesn't depict a Digital Orthoimage, but rather illustrates the principal of areal extent. The areas in green are the extent of Wetlands in Alberta, Canada.



Next Topic

Digital Orthoimagery Requirements Continued

http://www2.agric.gov.ab.ca/icons/acis/maps/agricultural_land_resource_atlas_of_alberta/soil/soil_conservation/areal_extent_wetlands_2003_big_map.png

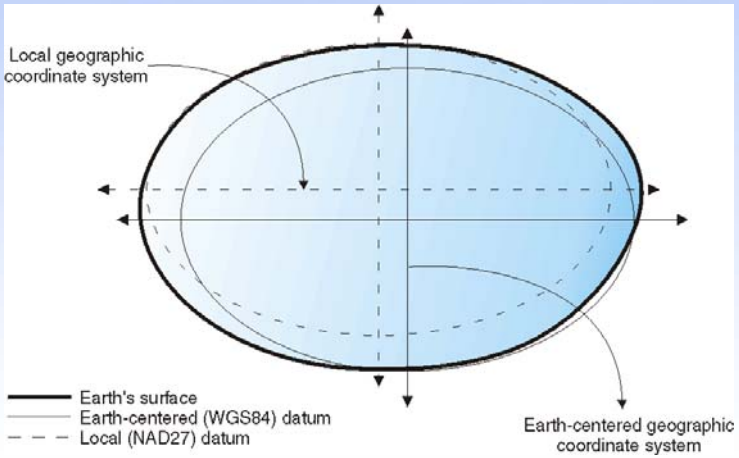
Framework Data Standard Digital Orthoimagery Requirements: Coordinate Systems and Reference Datums

A geographic coordinate system is a coordinate system that enables every location on Earth to be specified in three coordinates (X,Y, Z), using mainly a spherical coordinate system. A geodetic datum defines the size and shape of the earth, and the origin and orientation of the coordinate system used to map the earth. Hundreds of different datums have been used to frame position descriptions since the first estimates of the earth's size were made by Aristotle. Datums have evolved from those describing a spherical earth to ellipsoidal models derived from years of satellite measurements. For the purposes of this standard the following rules apply:

Coordinate Systems: A common method for referencing coordinate positions on the Earth is essential for integrating geospatial data. While it is desirable that framework data be described by longitude and latitude coordinates, orthoimagery is more often represented in a grid coordinate system, such as Universal Transverse Mercator (UTM) or State Plane Coordinate Systems (SPCS).

Reference Datums: The North American Datum of 1983 (NAD83) or World Geodetic System 1984 (WGS84) datum shall be used as the horizontal datum for framework digital orthoimagery.

Furthermore, all orthoimages shall be georeferenced to reflect their correct locations, both horizontally and vertically. Georegistration will be described by a 4-tuple (ordered list) in the metadata which will establish the geographical position of the first pixel in the first row of the image [pixel (0,0)].



http://webdocs.caspur.it/ibm/db2/8.1/doc/htmlcd/en_US/opt/0sbp5002.gif

Importance of Coordinate Systems and Datums:

The diagram above shows how important it is to use an appropriate coordinate system and datum, and document which ones you implement so the true location of your data or image can be verified.

Next Topic

Digital Orthoimagery Requirements Continued

Framework Data Standard Digital Orthoimagery Requirements: Accuracy

To develop Framework Digital Orthoimagery, map accuracy can be determined by comparing the mapped location of selected well defined points to their "true" location, as determined by a more accurate, independent field survey. Accuracy of new or revised spatial data shall be reported according to the National Standard for Spatial Data Accuracy (NSSDA). Accuracy of existing or legacy spatial data and maps may be reported, as specified, according to the NSSDA or the accuracy standard by which they were evaluated.
Framework digital orthoimagery accuracy shall employ the NSSDA, which implements a statistical and testing methodology for estimating the positional accuracy of points in digital geospatial data, with respect to georeferenced ground positions of higher accuracy. Accuracy should be reported in ground distances at the 95% confidence level, meaning at the 95% confidence level, 95% of the positions in the dataset will have an error with respect to true ground position that is equal to or smaller than the reported accuracy value. The reported accuracy value reflects all uncertainties, including those introduced by geodetic control coordinates, compilation, and final computation of ground coordinate values in the product. Data producers need to ensure that all critical components have known accuracies suitable for the construction of orthoimagery, and that those accuracies are reported in the metadata.

For further information about how to report specific accuracies for digital orthoimagery please see the NSDDA (http://www.fgdc.gov/standards/projects/FGDC-standards-projects/accuracy/part3/chapter3) or the Framework Data Digital Orthoimagery standard itself

Next Topic

Digital Orthoimagery Requirements Continued

Framework Data Standard Digital Orthoimagery Requirements: Production Components

The Digital Orthoimagery standard part has requirements for the primary production components of digital orthoimages, which include: image sources, elevation data, control, and camera or sensor calibration data. It follows then that all orthoimagery discussed will be created through a true displacement rectification process. **Georeferenced or "rubber-sheeted" images, therefore, are not acceptable as true orthoimages.** Below are the requirements for each of the production requirements.

Image sources - Source for digital orthoimages may be from any remote sensing device capable of producing images with resolutions 2-meters or finer. Remote sensing devices may be photographic or electronic, airborne or satellite. These sources can include: Aerial Cameras, Scanned Photo Image, and Digital Images.

The image in the lower right-hand corner is an example of a an aerial camera suitable for collecting framework quality Digital Orthoimagery.

Next Topic

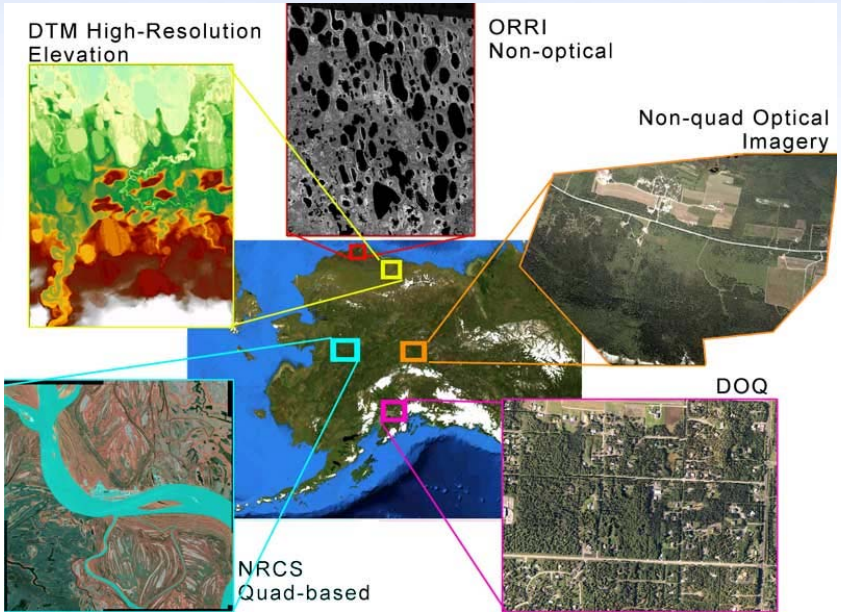
Digital Orthoimagery Requirements Continued

Framework Data Standard Digital Orthoimagery Requirements: Other Important Considerations.

As these materials, the Digital Orthoimagery Standard is more complex, detailed, and involves more components than many of the other Framework Standards. While we have now addressed all of the defined requirements for the Framework Digital Orthoimagery standard, there are several other considerations that need to be addressed. The next few slides will document these considerations and their importance. Below is the list of topics to be addressed:

- **Image Rectification and Restoration**
- **Image Mosaicking**
- **Data Transfer Formats**
- **Metadata**

The collage to the right is an example of the types of orthoimagery that can be created and thus may be subject to all these considerations.



http://alaska.usgs.gov/science/geography/orthoimagery/images/Alaska_from_World_Wind_collage.jpg

Next Topic

Digital Orthoimagery Requirements Continued

Framework Data Standard Digital Orthoimagery Requirements: Image Rectification

Image rectification and restoration are processes for correcting distortions and degradations that result from image acquisition or production. Digital orthoimagery is processed in a number of ways, and different orthoimagery production systems have unique characteristics. However, except for unprocessed imagery , all types contain some degree of error in geometry (geometric distortion) and in the measured brightness values of the pixels (radiometric distortion). The digital orthoimagery standard part specifies rectification or restoration procedures only in context of geometric and radiometric corrections.

Geometric Correction: All systematic and random errors shall be removed to the extent required to meet orthoimagery accuracy requirements as defined by the intended user. Nearest neighbor, bilinear interpolation, and cubic convolution resampling algorithms are common methods used to transform image values to fit map geometry.

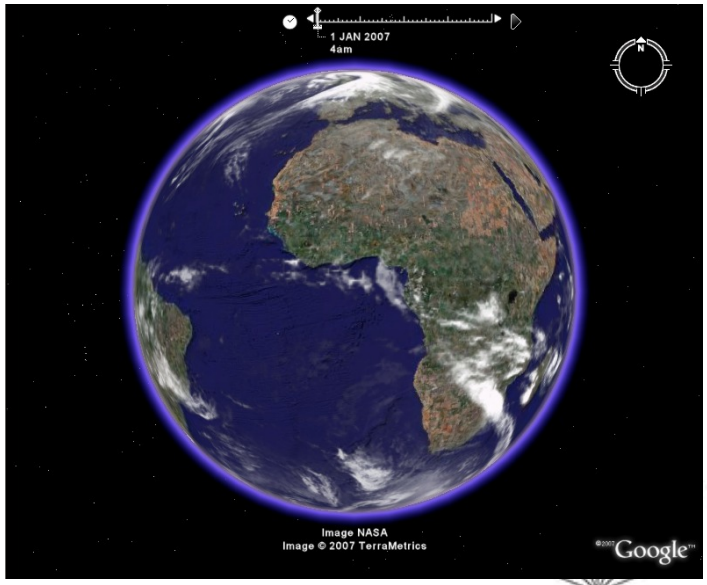
Radiometric Correction: Image brightness values may deviate from the brightness values of the original imagery, due to image value interpolation during the scanning, rectification, and post-processing procedures and it is common practice to perform some radiometric enhancements and corrections (for example, contrast stretching, analog dodging, noise filtering, destriping, edge matching) to images prior to release of the data. However, data producers are cautioned to minimize the amount of radiometric correction applied to an image. Data producers shall use processing techniques that minimize data loss from the time the information was captured until its release to the users.

Next Topic

Digital Orthoimagery Requirements Continued

Cloud Cover:

Cloud cover is an important consideration in digital orthoimagery. As shown in the diagram below it can obscure image features and render it unusable. However, cloud data maybe acceptable for some uses, as such it is a fine line between usable and unusable imagery.

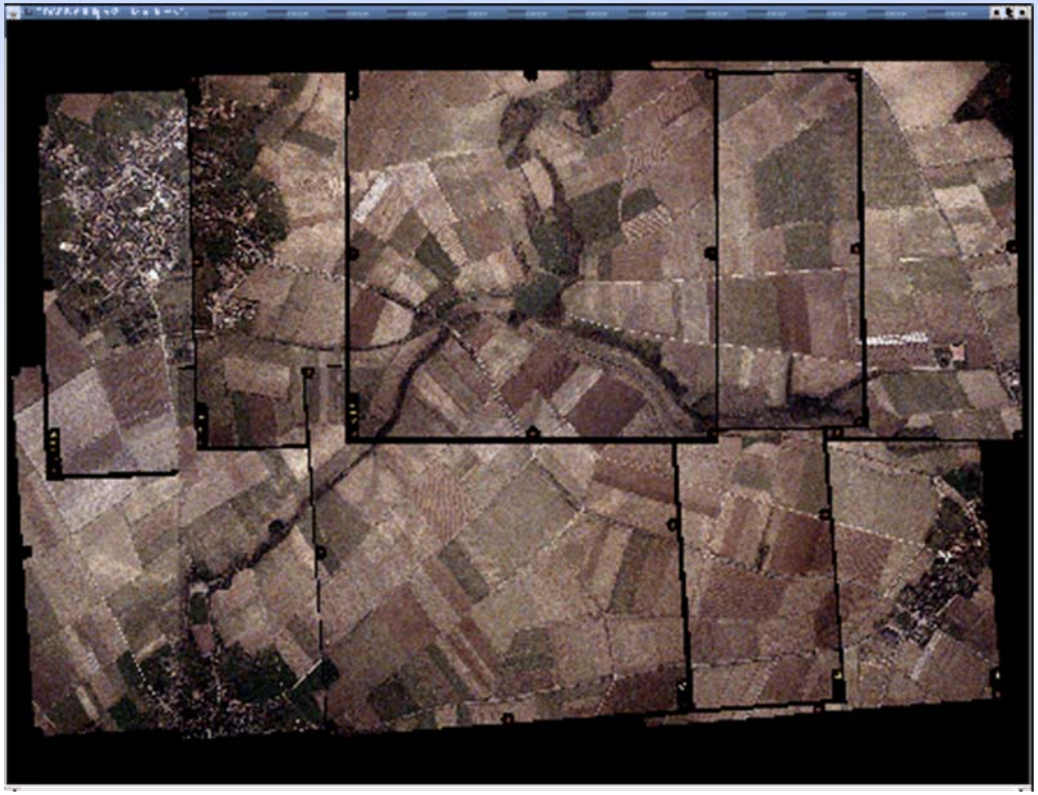


http://www.barnabu.co.uk/wp-content/uploads/monthly-clouds-in-google-earth.jpg

Framework Data Standard Digital Orthoimagery Requirements: Image Mosaicking

Single orthoimages are commonly created through the mosaicking or combining of multiple images to produce a “seamless” appearance. This standard does not document mosaic procedures nor does it prescribe the degree of quality for the appearance of mosaicked orthoimages. However, all the images that comprise the source of a mosaicked image must be fully documented in the metadata field.

The image to the right illustrates the individual orthoimages that will be combined. When completed the final product appears to be a single continuous image with no internal image boundaries or distortions.



http://www.freegis.org/freegis_tutorial/online/img42.png

Next Topic

Digital Orthoimagery Requirements Continued

Framework Data Standard Digital Orthoimagery Requirements: Data Transfer Formats and Metadata

Data Transfer Formats: Digital orthoimagery data transfer formats are not directly specified in this part. Data producers are encouraged to employ ISO and ANSI standards for information exchange. In all cases, producers shall provide detailed descriptions of the format.

Metadata*:* The FGDC emphasizes the importance of good metadata to support the exchange and use of geospatial data: providing quality information will allow users to match data to their needs. Well-crafted metadata facilitates the search and collection process while alleviating some of the burden on the user to assess quality and applicability of data. The more metadata there is for a product, the more it can support the user's determination of its reliability, quality, and accuracy. Metadata is intended to be of value to the producer as well as to the user. Metadata should be created in compliance with ISO standard 19115 to be suitable for use with this standard.

Next Topic

Encoding and Implementation

Encoding and Implementation

The process of encoding is simply formatting or structuring data in a regulated manner. The Framework standards are encoded by applying the application schemas through the use of several different modeling and markup languages:

- **Unified Modeling Language (UML)**
- **Extensible Markup Language (XML)**
- **Geographic Markup Language (GML)**

Specific knowledge of each language is important for data and tool designers; for more information see the Framework Base Standard Training Materials.

The Bigger Picture

The Framework Standards do not have a specific application schema that can be implemented. Implementation of the Framework Standards in relation to data and tool creation occurs at the thematic level. Each thematic part complies with the Framework Base Standard. As such a layer (for example) created in accordance with the Framework Digital Orthoimagery part meets all Framework requirements.

Next Topic

Module Review

Module 3: Digital Orthoimagery Requirements Summary

- **Digital Orthoimagery Data is available in many different formats however the standard dictates the specific requirements to ensure it is Framework**
- **Can be used collected using several different sensor types**
- **This module covers the specifications for Digital Orthoimagery framework data implementation**
- **Provides rigid requirements to ensure proper structure and documentation for Digital Orthoimagery data**
- **This module also documents the considerations that need to be addressed in addition to the specific requirements outlined by the standard.**

Next Topic

Module 4: Summary and Review

Module 4: Examples, Exercise, and Certificate

Topics

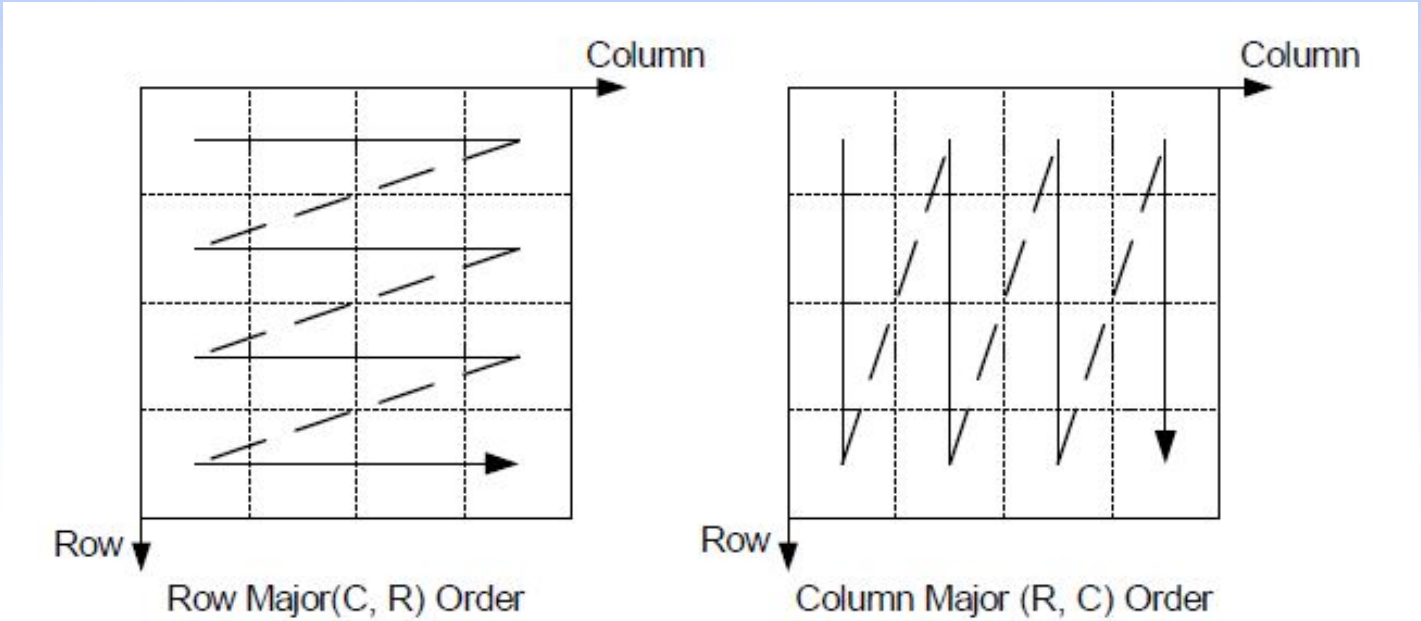
- **Digital Orthoimagery Implementation Example**
- **Digital Orthoimagery Review Exercise**
- **Certificate of Completion**

http://www.usgsquads.com/images/doqq_cir_unionsprg_small.jpg

First Topic

Review Exercise

Implementation Example



This example is from the standard itself and illustrates how to implement one component of the standard: scanDirection. As the diagram illustrates, the grid axes are named Row (R) and Column (C). The grid origin is at the upper left corner, and the axes are positive downward and to the right.

Next Topic

Digital Orthoimagery Final Exercise

Digital Orthoimagery Final Exercise

1. **Click on the following hyperlink:**

   http://www.searchmesh.net/default.aspx?page=1726

2. **Review the website and read about the MESH project.**

3. **What are the benefits of this project?**

4. **Is this project complying with the Framework Digital Orthoimagery standard?**

5. **Are there techniques being used that surprised you in relation to digital orthoimagery collection??**

6. **Close the web browser and continue with the completion of the course.**

Next Topic

Course completion

Course Certificate

Congratulations, you have successfully completed the Framework Digital Orthoimagery Standard Training! In order to print the certificate below you will need a copy of Adobe Acrobat Reader, http://www.adobe.com/products/acrobat/readstep2.html.

After you open the certificate file, type your name and today's date on the name/date line and print.

Click here to receive course certificate