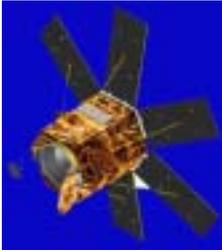


CHAPTER 3: IMAGERY



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Theme Description:

In a broad sense, imagery refers to ortho photography from airborne platforms that include traditional film-based cameras or digital sensors, and satellite imagery from a variety of sensors including multi-spectral, hyperspectral, and synthetic aperture radar (SAR). Imagery datasets have a variety of uses. They can serve as a common spatial standard and as a display tool for other data. They also are an important source for smart growth planning, as well as a spectral source for vegetation type and location, biomass determination to support fire behavior modeling, plant species identification, habitat mapping, alien plant control, and baseline imagery supports the change detection that facilitates post disaster damage assessments. Our State needs statewide coverage of both a consistent, flexible use, and widely available ortho imagery dataset that is high resolution natural color and a perhaps lower resolution 4 band multispectral dataset of similar coverage.

Status:

There are a variety of ortho imagery datasets available and in use in Hawai'i. However, many of these datasets are project-based and may have a limited coverage area or have a very specialized collection profile. Some examples of this type of coverage are a limited area hyper spectral bathymetry study, or an extremely high-resolution air photo survey of one or more military bases for use in facilities management. These datasets are not widely used because they usually cover such small areas. They are often not widely available, either, for a variety of reasons, such as restrictive licensing, lack of ortho control in processing, or no processing at all.

A statewide coverage of a consistent, flexible use, and widely available ortho imagery dataset is needed. There are four current or relatively current datasets that are partial solutions to this need. They are:

- 1. USGS Statewide Digital Ortho Quarter Quads (DOQQ's):** 1 – 1.5 meter panchromatic UTM zone 4 and 5, NAD83 Datum, DOQ format (BIL), 1993 –1995

timeframe. (IDP, or imagery derived product, meaning they are only releasable to Federal agencies that sign non-disclosure agreements)

Issue: IDP DOQ's are only releasable to federal agencies and their contractors, because they are marked "U.S. Government Use Only" by NIMA (where the photography originated) and the USGS. This distribution is too small to allow this dataset to serve as the spatial standard that it should, given that most of the newer USGS spatial products for Hawai'i are either aligned with or derived from this dataset. (DLG's, DRG's, DEM's) For use as one would air photos, it is also getting quite out-of-date especially in areas of significant growth.

2. EMERGE Statewide Digital Ortho Quarter Quads (DOQQ's): 1-meter digital false color Infrared, UTM zone 4 and 5, NAD83 Datum, MrSID format 1999 – 2003 timeframe. USDA/NRCS had contracted with EMERGE to fly the main eight Hawaiian Islands and to process the data to ortho spatial quality. NRCS owns this data, but makes it available to the geospatial community in Hawai'i in MrSID format.

Issue: Slow completion of this dataset over several years, as well as quality control issues, is causing GIS analysts to look elsewhere for similar data. Also, digital pixel mosaic, false color IR is not the optimum format for some applications; it is neither a good multispectral dataset nor is it a natural looking/layman accessible backdrop for the display of vector data or other information.

3. NOAA/NOS Coastal Aerial Photography: 1-meter natural color, scanned and rectified air photos, UTM zone 4, NAD83 Datum, geotiff format, 2000 timeframe. The dataset includes coastal land areas with reef only, often extends about one mile inland, but is widely available from the Pacific Disaster Center.

Issue: Although many of the most populated areas in Hawai'i are concentrated along its coastlines, many areas of interest and population are not. This dataset's area of coverage is far too limited.

4. Hawai'i IKONOS Consortium: 1 meter natural color imagery and 4 meter, 4-band multispectral imagery for of the state (by 25km² tiles for the main 8 islands). The consortium is a cost saving effort designed to achieve a consistent statewide imagery dataset. Federal, State, Nonprofit and even commercial organizations join the consortium at certain levels of investment and then are given access to all of the available purchased data. The Hawai'i Natural Heritage Program is coordinating this effort. They report that as of 5/26/03, some 162 tiles of 771 for the main 8 Hawaiian Islands have either been purchased have been spoken for. Each tile costs \$2,264 including both 1 meter and 4 meter data and all fees and taxes.

Issue: Should the bulk of the State be covered as a result of this effort, it should constitute at least a 70 or 80% solution to the goal of this chapter, having high resolution natural color imagery of populated areas and relatively high resolution multispectral imagery data for at least the vegetated areas of the State. The areas of concern include

whether or not the dataset will indeed be completed and if 1 meter color fully satisfies some organization's needs for almost facilities-management-level resolution data.

Data Sources

Table A

Sources of Existing Data				
Agency/Vendor	Sensor	Contact	Address	Phone
USGS DOQ	NTM satellite	Henry Wolter hwolter@usgs.gov	U.S. Geological Survey 677 Ala Moana Blvd Suite 415 Honolulu, Hawaii 96813	Tel: 808-587-2409 Cell: 808-295-4713 Fax: 808-587-2401
EMERGE	Digital airborne imagery	Pat Shade Pat.shade@hi.usda.gov	NRCS Hawaii 300 Ala Moana, Room 4-118 Honolulu, HI 96850	Tel: 808-541-2600 ext. 120 Fax: 808-541-1335
NOAA/NOS	Aerial photography	Rhett Rebold rrebold@pdc.org	Pacific Disaster Center 590 Lipoa Pkwy Suite 259, Kihei, Maui, HI 96753	Tel: 808-891-7932 Fax: 808-891-0526
IKONOS Consortium	Digital satellite imagery	Shannon McElvane mcelvane@hawaii.edu	Hawai'i Natural Heritage Program Center for Conservation Research and Training 677 Ala Moana Blvd., Suite 705, Honolulu, HI 96813	Tel: 808-587-8600 Cell: 808-222-8531 Fax: 808-587-8599
Potential Sources of Imagery Data				
Agency/Vendor	Sensor	Contact	Address	Phone
Air Survey Hawaii (ASH)	Aerial Photography	Brenda C. Timas (Office Manager) Jay Whiteford (Owner)	22 Lagoon Drive, Honolulu, HI 96819	Tel: 808-833-4881 Fax: 808-839-7046
Radarsat, Inc. www.rsi.com	QuickBird	Farida Raghina FRaghina@rsi.ca North American Sales and Service	13800 Commerce Parkway MacDonald Dettwiler Building Richmond, BC Canada V6V 2J3	Tel: 604-231-4985 Fax: 604-244-0404
Space Imaging www.spaceimaging.com	IKONOS	Dan Bellisemo Dbellisemon@spaceimaging.com	12076 Grant Street Thornton, CO 80241	Tel: 800-425-2997 (Customer Service)

Science and Technology International www.sti-services.com	Airborne Multispectral	Jonathan C. Gradie, Ph.D. jgradie@sti-hawaii.com	733 Bishop Street, Suite 3100 Honolulu, HI 96813	Tel: 808-540-4710 Fax: 808-540-4850
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Standards:

Due to the wide variety of data sources and types, standards for data include:
 FGDC standards for metadata (http://www.fgdc.gov/metadata/meta_stand.html)
 USGS and NOAA/NOS aerial photography standards
 (<http://oceanservice.noaa.gov/mapfinder/products/photos/welcome.html>)
 American Society for Photogrammetry & Remote Sensing (ASPRS)'s standards
 (<http://www.asprs.org/asprs/resources/standards.html>)

Certainly any new imagery dataset should be as spatially accurate as the USGS DOQQ's (<http://rmmcweb.cr.usgs.gov/public/nmpstds/doqstds.html>) or better. Generally, for many applications, 1 meter or smaller pixel size is adequate resolution for imagery to be used as display backdrops or for manual feature extraction. Additional spectral bands such as three visible bands and at least one reflected IR band could allow spectral feature classification at lower spatial resolutions. Cloud cover should generally be less than 10% for the dataset, although it can be decided whether a higher amount can be tolerated in the highest elevations in order to speed collection.

Priority:

Priority 1 – Obtain 1 meter natural color IKONOS of the main Eight Islands

This is obtainable through the IKONOS Consortium and is recommended as the most likely to satisfy many data users. Although it doesn't satisfy some data users need for additional resolution, it seems the most likely to actually come to fruition.

Priority 2 – Obtain .3 meter of the more densely populated areas of the State

This is obtainable through Air Survey Hawai'i or other qualified aerial photography companies that have experience flying in our State's challenging island conditions. This dataset could be collected for less than half the total price of the IKONOS purchase but processing costs make it potentially costly depending on methodology and total area of what is considered densely populated.

Priority 3 – Obtain 4 meter 4 band multispectral imagery of the main Eight Islands

This is obtainable through the IKONOS Consortium and is recommended as the most likely to satisfy many data users who need multispectral for vegetation issues. Although it may not satisfy some data users who may need to break out very small occurrences of specific plant species it will achieve a 90% solution by allowing medium sized plant groups to be identified. It is by far the most likely dataset to actually come to fruition due to its consistency, price, and good organization of the collection effort. (As opposed to airborne multispectral or 2 meter Quickbird multispectral.)

Priority 4 – Obtain 2 meter 4 band multispectral imagery of the main Eight Islands

This is obtainable through Quickbird or airborne multispectral collection companies such as STI. It would allow for great discernment of small groups of plants but would be more expensive and would demand close management of consistency.

Estimated total investment in this theme:

\$1.75 million would cover the complete IKONOS Consortium purchase including both the 1 meter color and the 4 meter multispectral for the main 8 islands. Approximately \$367,000 of this total is already purchased, ordered, or has been expressed as intent to purchase. It would take an additional \$1.38 million to complete the coverage.

Estimated current state and local contributions:

Hawai'i state and local agencies hold some specialized imagery data and have also in some cases, contributed to the IKONOS Consortium effort. Exact dollar amounts of current contributions are unknown.

What is needed:

Since the spatial data community in Hawai'i makes such broad use of imagery data, it is doubtful that any single imagery dataset will satisfy all possible applications. Some example applications could include: use as a common spatial control standard, a display backdrop for other data, a source for smart community growth planning, a spectral source of vegetation type and location, a source for biomass determination to support fire behavior modeling, or for alien plant control. Generally, for many applications, visible color imagery, 1 meter or smaller pixel size is adequate resolution for imagery to be used as display backdrops or for manual feature extraction. Multispectral imagery that has three visible bands and at least one reflected IR band could allow spectral feature classification at lower spatial resolutions, such as 2-4 meter pixel sizes. At least the two following datasets are necessary for many applications:

1. Natural Color photography or satellite imagery that has .25 – 1 meter pixels for at least all populated areas of the State, if not the entire main eight Hawaiian Islands. It should be ortho rectified into the same geographic space as the USGS data: UTM zones 4 and 5 with a NAD1983 datum.

Sources: Air Survey Hawaii , (ASH), EarthWatch, Inc, and Space Imaging, (see Table A for contact information)

2. Multispectral imagery either airborne or satellite that has 2 – 4 meter pixels and covers the entire main eight Hawaiian Islands. The imagery should have three visible bands and at least one reflected IR band. It should be ortho rectified into the same geographic space as the USGS data: UTM zones 4 and 5 with a NAD1983 datum.

Sources: EarthWatch, Inc, Space Imaging, Science and Technology International (see Table A for contact information)

What is the likely source:

In lieu of a large benefactor agency (such as USGS, NRCS, NOAA) paying for such a dataset as part of their mission; some kind of local group would have to be formed. A Hawai'i -wide consortium of spatial data users, perhaps a subset of those organizations represented at HIGICC. The currently existing IKONOS Consortium is perhaps the most viable forum and source.

Estimated total investment needed to complete this theme:

High-resolution natural color dataset approx: \$400,000 to \$875,000 (high end is 1 meter color map precision IKONOS for all of the main 8 islands, low end is .3 meter color aerial photography of just the more densely populated areas of the State)
Multispectral dataset approx: \$875,000 to \$1.4 million for (low end is 4 meter IKONOS and high end is 2 meter airborne multispectral) Quickbird 2.2 meter multispectral is on the low side of the middle.

Estimated current allocation of funding:

\$367,000 total has been already purchased, ordered, or has been expressed as intent to purchase in the IKONOS Consortium.

Estimated budget shortfall:

\$1.38 million to complete the IKONOS Consortium coverage, undetermined if other sources are selected with possible more limited coverage areas, etc.

Possible ways to overcome this gap:

The current IKONOS Consortium could be considered at least a 70 to 80% solution to the gap, should enough agencies and departments buy into this process. That effort allows for 1 meter color imagery of the state (by tiles for the main 8 islands) and 4 meter 4-band multispectral imagery for the same area, same configuration. Perhaps the optimal solution would be 1. Some kind of statewide .3-meter resolution color air photo or of .62-meter color Quickbird could be bid for the high-resolution dataset; and 2. An airborne 2-meter multispectral or 2 meter Quickbird multispectral dataset to satisfy the need for spectral information.

Most appropriate data steward:

Perhaps the Hawai'i Natural Heritage Program, should the IKONOS Consortium, which they manage prove successful. HIGICC, MHPCC, PDC, USGS, NOAA, or DBEDT are other possibilities, based on willingness/ability to serve.

Maintenance Process:

Update imagery of the same type and resolution every 2-4 years especially in high growth areas. Update the spectral dataset as needed based on application or damage/change to vegetation.

Estimated Maintenance cost:

Approximately \$50 per square kilometer; updated as needed. Obviously, some set up savings in waiting to do large areas simultaneously.