CHAPTER 9: STRUCTURES

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Theme Description:

Structures are considered to be all human-made fixed features that are planned, designed, engineered, and constructed to withstand most environmental conditions for the life of the structure. However, this definition would include all manner of transportation structures, utility structures, infrastructure, tunnels, bridges, dams, underground fuel tanks, and a host of other structures that should not be overlooked but would already be inventoried as part of other themes. The primary inventory of structures consists of buildings. In the broadest meaning of the term "buildings", nearly everything that is fixed, human-made, and protects life or property is a building. The CADD/GIS Technology Center' Spatial Data Standard provides perhaps a more concise concept in the following definition:

"Buildings are structures located on the face of the earth that were created, by man, to protect man and his possessions from the environment; or to enhance man's activities."

Maps showing the location and shape of building structures are needed to support many types of government services, including land use planning, construction permit approvals, tax assessment, utility management, homeland security, and other major programs. Building locations and outlines data are used by various agencies to assess the physical characteristics or constraints of specific site locations. Government review of site location conditions can be accomplished quickly and effectively using digital databases of these structures and their physical conditions. Thus, the integration of geographic representation of building structures, i.e. their outlines and locations, with object datasets that describe the physical characteristics of the structures, comprise what is commonly referred to as a spatial database of building footprints.

Status:

A central repository and complete spatial inventory of buildings for the State of Hawai`i does not exist. However, building information can be found at many levels of government, facility management offices, insurance companies, planning firms, survey firms, and architectural/engineering firms. The type of information that exist for

buildings range from as-built plans in hard copy and CADD files, GIS layers, aerial photography, imagery, permit or administrative data. The City & County of Honolulu (CCH), Department of Permitting and Planning (DPP) continually gather building information as part of the permitting process (see Chapter 6 - Cadastral). Currently, CCH is in the process of creating a GIS building footprint dataset for all of Oahu. All information pertaining to building external and internal structures as 3-Dimensional (3-D) objects are part of the Building Dataset. Once buildings are constructed, modifications do occur overtime that alter the physical structure and are, to a degree, tracked.

Based on interviews with Larry Kanda of the State Civil Defense is also compiling building information as well for the State of Hawai`i.

Data Sources:

Existing Sources:
Sanborn Map Company has historically maintained paper maps that contain building outlines (footprints), as well as general information about construction types, height, stories, and date built. Other private firms also have numerous building footprints that have been created for planning or construction projects that could be acquired.

Facility managers maintain and manage property spaces updating boundaries, floor plans, and building modifications.

Air survey companies have current and historical air photography of Hawai`i urban areas that could be used to determine building outlines.

CCH and other local planning and permitting departments acquire building plans and information as part of the permitting process. In the case of CCH, the plans and building information are in the process of being scanned, for historical documents, and in developing digital submission standards for new building permits and construction plans.

Hawai`i Department of Transportation, Airports Division is also in the process of scanning all building engineering plans. Hawai`i State Survey Office is scanning all of their stored maps that have current as well as historical value. Hawai`i Department of Land and Natural Resources (DLNR) are considering the feasibility of developing a public land trust system and would likely have facility maps or plans of property.

Many federal facilities, like 300 Ala Moana Blvd. (Prince Kuhio Federal Building) maintain digital floor plans and building information using CAD software linked to a relational database. These other sources could be available for compiling a building dataset.

Potential Sources:

There are many means of acquiring building location and dimensions using Light Detection and Ranging (LIDAR), radar, remote sensing, aerial photography, ground surveys, ground laser scanning, and ground photography.

Federal Emergency Management Agency (FEMA), DLNR, and Research Corporation of the University of Hawai`i (RCUH) are planning to utilize LIDAR to scan the terrestrial surface of Hawai`i. LIDAR collects both horizontal and vertical positional information on the ground from an aircraft. LIDAR utilizes an Inertial Measurement System (IMS) and Global Positioning System (GPS) to correct for acquisition errors while providing positional data.

Radar is similar to LIDAR and is also a potential data source. Point clouds are then analyzed to extract features such as buildings.

Typical aerial photography requires costly processing of aerial photographic film, image scanning, individual processing of stereo images, and rectification. Technology like Lieca's ADS40 provides remote sensing from aircraft that can provide seamless stereo swaths, in multi-spectral bands, accurately rectifying images using IMS and GPS. While this approach dramatically reduces the number of control points, this does not entirely remove the need for ground control points.

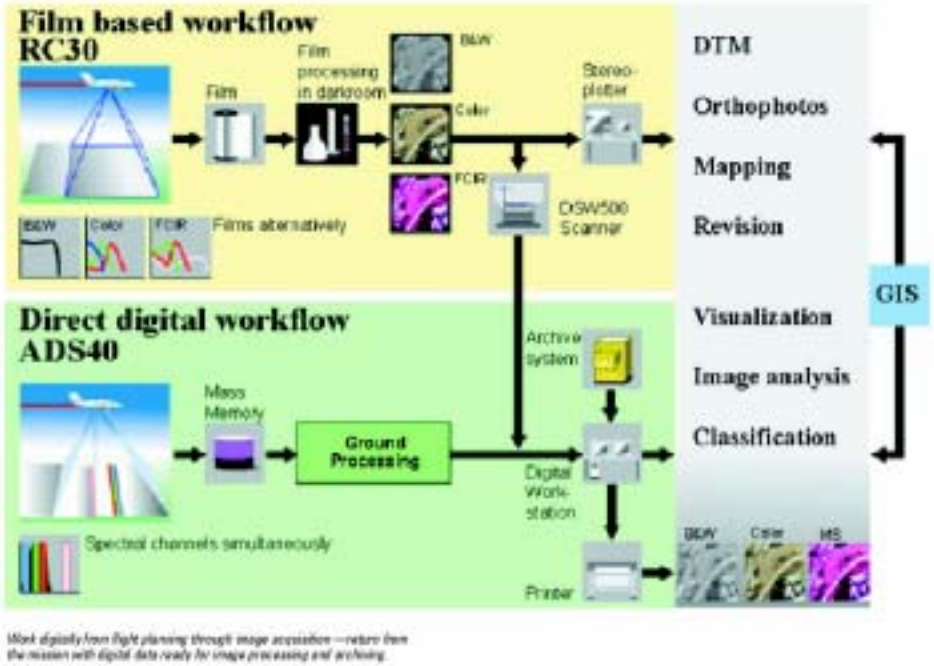

Figure 1

Ground photography of buildings can enhance the existing body of aerial imagery. Ground photography of infrastructure can be integrated into a 3D view and would be highly detailed compared to aerial views that have been stretch across a 3D model of a building.

GPS surveys of sites and ground controls provide highly accurate positional information. In conjunction with GPS Surveys, LIDAR technology provides site acquisition of building structures. Ground laser scanner and software is capable of providing as-built structural information and could be integrated with a LIDAR acquisition as simple x, y, and z coordinates.

Standards:

No standards are established

Priority:

The priority for information about residential, commercial and government building structures is very high. Because of the current awareness and apparent risks to buildings from many types of hazards, there is a desire to be prepared for any event, however unlikely.

Estimated Total Investment in this theme:

Currently, less than $50k has been spent for a building dataset compilation. This does not take into account any ongoing acquisition of building information that is part of current government business processes, planning or construction projects.

Estimated current state and local contributions:

$100k may be contributed to acquire current information. The existing GIS infrastructure and staff would also be contributed to maintaining the building dataset, and roughly estimated at $100k annually.

What is Needed?

Accurate ground control points, both vertical and horizontal, are needed to correct existing building layers. Because of the relationship of buildings to parcel boundaries the relative accuracy between these datasets needs to be very accurate. Having stated this, the parcel base needs to be rectified using accurate control points.

Existing building datasets need to be converted and updated using remote sensing or aerial photography.

Processed LIDAR and digital aerial imagery of urban areas, with 6 inch or better resolution would provide detailed information that would meet the current needs for accurate building locations.

Data would need to be complied from different agencies, planning and permitting departments and property tax assessment departments.

Business processes would need to be adjusted to maintain the building datasets.

What is the likely source?

With the current funding constraints, priority areas, using existing information could be acquired from local government and aerial survey companies. Homeland security could be a source of funding and would likely be requesting this type of data. Additionally, agencies like FEMA, RCUH, Civil Defense, and DLNR are interested in LIDAR acquisitions for updating of FIRM maps and maybe able to acquire the needed funding. The USGS would seem to be the best coordinator for LIDAR or high-resolution push broom scanning to ensure that a broader user base would benefit.

Estimated total investment needed to complete this theme:

Using the current method and piece meal approach, it may cost as much as $2 million to complete over the next 4 to 6 years.

Estimated current allocation of funding:

Roughly $100k has been allocated for acquisition of building information.

Estimated budget shortfall:

$1,900,000

Possible ways to overcome this gap:

Not considered.

Most appropriate data steward:

Local government should produce, maintain, and distribute the information.

Maintenance Process:

Estimated Maintenance cost:

$100k annually