

GEODATABASE DEVELOPMENT TO SUPPORT HYPERSPECTRAL IMAGERY EXPLOITATION

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Geodatabase development for coastal studies at the Naval Research Laboratory (NRL) are essential to support the exploitation of hyperspectral imagery collected in regions that have been governed by barrier islands, coral reefs, and mangrove swamps. By its very nature, the coast is a dynamic environment, one that numerous researchers have tried to partition into descriptive groups [1], [2], [3]. The remote sensing and mapping science community benefits from coastal classifications that group coastal types based on similar features. The coastal features are a consequence of similar biological and physical forces. The classification system helps in understanding factors that are necessary for imagery post processing, especially since features of importance have a high degree of temporal and spatial variability. Project geodatabases developed by NRL enhance sparse data archives in littoral areas and include a hierarchy of environmental factors that extend from shallow water bottom types and beach composition to inland soil and vegetation characteristics.

Beginning in September 2007, the NRL has conducted three coastal characterization studies in conjunction with other institutions. The first investigation used NRL's Compact Airborne Spectral Imager (CASI) (www.itres.com), a visible and near infra-red (VNIR) HSI sensor, to study the barrier island coast and lagoons found along Cape Charles, Virginia [4], [5], [6], [7]. The second study occurred during January and February 2009 and involved analysis of the coralline coast surrounding Kaneohe and Waimanalo Bays in Hawaii. A third experiment was conducted during May 2009 along the extensive mangrove coast surrounding Shoalwater Bay in

Queensland, Australia. Remote sensing campaigns in Hawaii and Australia both used HyMap™, a VNIR and short-wave infra-red (SWIR) HSI sensor (www.hyvista.com), to acquire imagery over the study area. Once post processing was complete, all hyperspectral imagery was stored in the geodatabase along with other forms of digital products such as nautical charts and historical images.

All three investigations included a comprehensive calibration and validation component where scientists collected in-water optical data, meteorological data, geotechnical information, and canopy and leaf level spectral reflectance. Calibration for bathymetry consisted of both in-water spectral reflectance profiles measured with an Analytical Spectral Devices (ASD) spectrometer as a function of depth for various bottom types with validation data provided by small boat soundings and beach surveys with post-processed kinematic GPS in the foreshore. Other beach properties measured along transects consisted of grain size profiles, substrate moisture, bearing strength, shear, as well as the in situ spectral reflectance and GPS location of each position. Vegetation spectral libraries were also developed including both canopy and leaf level spectral reflectance to retrieve vegetation coverage maps. Data used for atmospheric correction, calibration, and validation of imagery comprise the hierarchical coastal classification system. Detailed analysis of the archive supports the development of look up tables and forms the basis of statistical relationships that are used to produce bathymetric retrievals and bearing strength maps.

NRL coastal remote sensing campaigns are storing project data in ArcGIS [8], to facilitate the analysis of observed data elements and parameters across investigations and coast types. ESRI's ArcCatalog is used to store geographical information, while tabular data are stored as Microsoft® Excel spreadsheets sectioned into similar attribute data folders in Microsoft® Explorer. Study data are viewed using ArcMap. The geodatabase supports tasks such as atmospheric correction since information on atmospheric gases, winds, and waves are accessed to remove spectral atmospheric transmission and scattered path radiance from radiance data collected by hyperspectral imaging [9]. In addition, the geodatabase includes all ground-based or laboratory-based spectral libraries to identify key features in the imagery. In ArcMap and ArcGIS Explorer attribute data are accessed by linking to spreadsheets or document files. Linking to spreadsheets containing the attribute data allows one to view actual instrument measurements as well as graphs pertaining to the data. By utilizing the identify tool in ArcMap, links to attribute data spreadsheets, photographs, web sites, and text files can be accessed by simple clicking the hyperlink icon. ArcGIS Explorer also allows for access to important archives that are web-enabled such as weather station observations. One can link to website attribute data by clicking the shapefile and navigating to the website in the pop-up window. Project attribute data such as spreadsheets of bearing strength of beach sediments and the corresponding photographs are accessed through relative file pathname links in the contents section of the GIS.

Presently the NRL has developed three geodatabases that represent a barrier island, coral, and mangrove coast. NRL coastal geodatabases have a common look and feel and support the objective determination of the

dominant influences contributing to the characteristics of a particular coast. For those researchers not having an ArcGIS Desktop license, NRL provides collaborators with a geodatabase that was built using ArcGIS Explorer 900, a free-ware version of ArcGIS Desktop. The freeware version has allowed non-ArcGIS specialists to be able to easily view quicklook format images of HSI; view and obtain data from GPS ground truth points; and use the attribute data for those points to develop mapping products with the use of HSI and ENVI. The combined data in the geodatabase was essential in the production of shallow water bathymetric charts, vegetation layers, and trafficability maps. This work extends the work of Francis Shepard's classification system to support the remote sensing and mapping science community.

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