# GEOSPATIAL PRODUCTS AND ECOLOGICAL APPLICATIONS

# **Near-shore Bathymetry**

Bathymetric data has traditionally been important for producing nautical charts in support of safe navigation. Hazardous environmental conditions and technological restraints have, however, limited the ability to acquire near-shore data. The National Oceanic and Atmospheric Administration (NOAA) has made great strides in bringing together hydrography, geodesy, tides and remote-sensing data to provide essential information for the coastal manager.

New technology such as Light Detection and Ranging (Lidar), VDatum (a vertical datum transformation tool) and GPS has given us the capacity to acquire and integrate near-shore bathymetric, shoreline and topographic data. This has in turn allowed us to increase our knowledge of the complex coastal environment by expanding the application of data such as habitat restoration, sea-level-rise assessment, shoreline stabilisation efforts, risk assessment and storm-surge warning. The volume of information collected can be used to generate classical nautical products while also providing support for the many applications of coastal zone management.

## **Geospatial Products**

With the introduction of new sensors, new data collection technology and the explosion of digital datasets has come the ability to develop accurate geospatial products. Digital Elevation Models (DEMs) and bathymetric navigation surfaces are generated from combining high-resolution and spatially dense, raw digital data with proper vertical reference datum surfaces and are capable of supporting a variety of applications pertinent to the coastal manager. Using VDatum, bathymetric and topographic data can be transformed into common vertical datum such as shoreline, or Mean High Water; a seamless DEM can then be created. Data integration allows bathymetric-topographic (or bathy-topo) DEMs to be produced upon which various scenarios can be overlaid, such as sea-level rise, storm surge, tsunami and other inundation scenarios (Figure 1). Such products and information are essential for understanding and predicting the ecological and human impact of long-term sea-level rise and variation on specific, local coastal regions. In fact, NOAA is currently performing such a study for the Outer Banks of the North Carolina coast. This is important because studies have shown that one of the most severe impacts on coastal ecosystems is likely to be due to the combined effects of sea-level rise and storm surge on coastal development and wetlands. Integrated geospatial products are also crucial for other applications in the coastal zone, such as successful restoration of habitats.

# Wetlands and Habitat

Coastal areas have intrinsic economic, cultural and aesthetic value. Wetlands act as nurseries for fish and crustaceans and feeding grounds for birds; they store pollutants and nutrients and they serve as buffer zones in flood and wave events. These fragile ecosystems have, however, been degraded and destroyed over the centuries. The United States has lost over half of its wetlands since the late 18th century. Coastal wetland loss is caused by a combination of the consequences of climate and sea-level change, as well as by pressures of increase in human population and development of coastal regions. Habitat destruction and failure of the natural systems supported by estuaries has led to coastal habitat restoration becoming a priority in the United States. It is essential that US habitat restoration projects are properly designed and engineered and subsequently monitored to ensure that the habitat is restored successfully.

#### Salt Pond Restoration

The entire South San Francisco Bay salt-pond complex covers an extensive area of approximately 26,000 acres. Commercial salt production in the San Francisco Bay goes back to 1854. Nearly 90% of the historic tidal marshes in the San Francisco Bay-Delta Estuary have been filled or significantly altered over the past two centuries due to urban development, agriculture and salt production. This wetland loss has led to dramatic fish and wildlife reduction in the tidal marsh habitat, decreased water quality and increased turbidity in the Bay. There is currently a collaborative effort among federal, state and private organisations to restore 15,000 acres of salt ponds in the South San Francisco Bay, constituting the largest tidal wetland restoration project on the west coast of the United States. Restoration of the tidal marshes will provide several benefits, including important habitat for the endangered California clapper rail and the salt-marsh harvest mouse; habitat for fish and other aquatic life and haul-out areas for harbour seals, and resting habitat for migratory shorebirds and waterfowl travelling on the Pacific Flyway.

Since 1849 both natural process and human activities have contributed to alterations in sediment deposition, erosion and the bathymetry of South San Francisco Bay. Historic hydrographic surveys are being used to assess how this complex system has evolved over the past one and a half centuries. The United States Geological Survey (USGS) has created bathymetric models using historic hydrographic sheets made by NOAA and its predecessors, such as United States Coast and Geodetic Survey, and entering the information into a Geographic Information System (GIS). From this study it has been determined that South San Francisco Bay lost approximately 90 x 106 m3 of sediment from 1858 to 1983, but has experienced periods of both deposition and erosion within this timeframe (Figure 2). For successful restoration of these salt ponds it is essential to understand the morphology and sediment sources of the system.

### **Blackwater Restoration**

Blackwater National Wildlife Refuge in Chesapeake Bay, a 26,000-acre waterfowl sanctuary located along the Atlantic Flyway, was established as a refuge in 1933. Habitats include forests, open fields, freshwater impoundment and estuarine tidal wetlands. Over 250 bird

species, including the American bald eagle, the peregrine falcon and the endangered Delmarva fox squirrel may be found at Blackwater for at least a portion of the year. Erosion, sea-level rise, salt-water intrusion and herbage by invasive species (such as nutria) have led to Blackwater National Wildlife Refuge rapidly losing marsh habitat, with an estimated 8,000 acres out of 17,000 being severely impacted; it is losing 150 – 400 acres per year (Figure 3).

Moreover, the next two years will bring the building of more than 6,000 new housing units and a golf course on adjacent lands, with possible impact on Refuge water quality and habitat. Blackwater National Wildlife Refuge is the hotspot for wetland loss on the East Coast of the United States and its situation is often compared with what coastal Louisiana is experiencing. Whilst Louisiana's wetland loss is primarily due to subsidence, the collaborative effort described here is still required to research the reasons in Blackwater, for this is a complex system. Clean sediment from Baltimore harbour is planned to be used as a beneficial use of dredge material at the site for restoration efforts. The establishment of a common reference system based on water-level measurement, GPS survey and Surface Elevation Tables (SETs) is planned, from which a DEM can be produced after incorporation of Lidar datasets. This DEM will then be used as a baseline for further engineering studies and scenario overlays.

https://www.hydro-international.com/content/article/near-shore-bathymetry