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# REGIONAL MAPPING OF THE COASTAL ZONE WITH AIRBORNE LIDAR

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## 1.0 INTRODUCTION

Recent advancements in lidar sensors now allow for near-synoptic, regional-scale mapping of the coastal zone. One such sensor is the US Army Corps of Engineers SHOALS (Scanning Hydrographic Operational Airborne Lidar Survey) system. SHOALS is unique in that it is the only lidar sensor, worldwide, that simultaneously collects bathymetry and adjacent topography. Because of SHOALS' high collection rate, data density, and system accuracy, it is now cost effective<sup>3</sup> to quantify regional coastal geomorphology and to better engineer management solutions on a regional scale (Wozencraft and Irish, 2000). This article presents the SHOALS survey collected in Hawaii and discusses the value of lidar mapping to the coastal zone management community.

## 2.0 THE SHOALS SYSTEM

SHOALS uses a scanning, pulsing laser to deliver light at two frequencies: blue-green and infrared. While the infrared pulse provides a direct ranging of the water surface, the blue-green pulse penetrates the water column to provide direct ranging of the sea bottom (Figure 1). Two- or three-dimensional positioning of the SHOALS aircraft is from differential GPS or kinematic GPS, respectively. In addition to depth measurements, the SHOALS system simultaneously measures adjacent shoreline topography by directly ranging the terrain with its blue-green laser. The ability to map the entire coastal zone from the dry beach through the nearshore reveals linkages between nearshore and upland processes, such as the influence of changes in nearshore bathymetry on the shape of the shoreline.

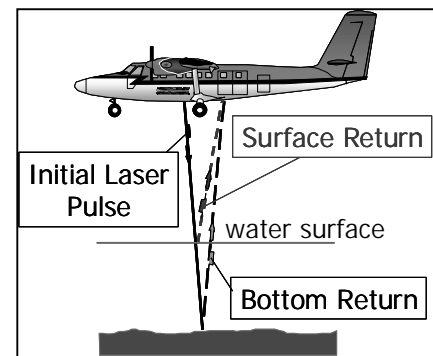


Figure 1: Operating principle.

For regional coastal zone management surveys, SHOALS collects individual soundings every eight meters and surveys at a rate of 400 soundings per second, or 25 km<sup>2</sup> per hour. The accuracy of the soundings conforms to IHO Standards, or  $\pm 3$  m in the horizontal and  $\pm 15$  cm in the vertical (Irish *et al.*, 2000).

## 3.0 REGIONAL SHOALS SURVEYS: MAUI, HAWAII

In 1999, the SHOALS system fully mapped the nearshore regions, from the shoreline to the 30-m depth contour, surrounding the islands of Kauai and Maui in Hawaii (Figure 2; Wozencraft, *et al.*, 2000). This survey comprised a variety of coastal features including sandy beaches, rocky beaches, harbors and bays, and coral reefs. The primary survey mission was to produce an accurate base map for numerical simulations used in hurricane evacuation planning. A secondary objective was to supply high-resolution bathymetry to the US Geological Survey to aid their coral reef mapping and studies initiative. Such extensive and detailed survey coverage provides insight to both large- and small-scale bathymetric and shoreline irregularities critical to the success of numerical simulations and to monitoring and managing natural resources.

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<sup>3</sup> Generally, regional airborne lidar surveys cost  $1/2$  to  $2/3$  that of conventional multibeam fathometer surveys of the same area.

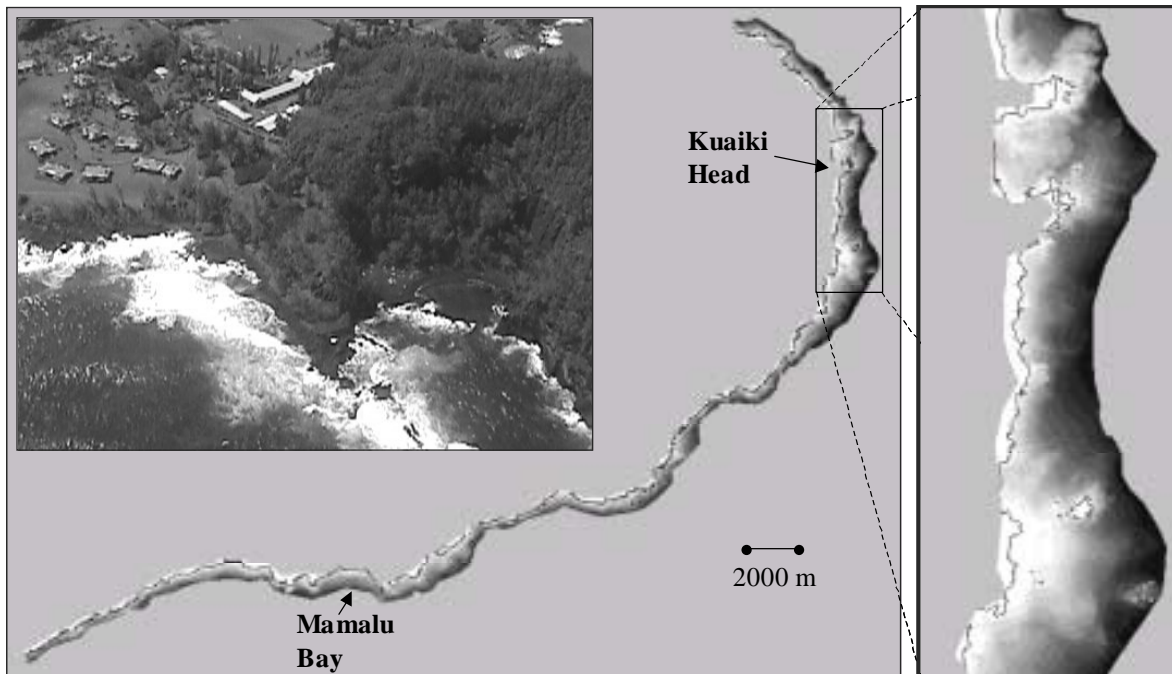


Figure 2: SHOALS data at Maui, Hawaii (1999). Depth contours are every 3 m. North is to top.

#### 4.0 SUMMARY

Bathymetric and topographic lidar sensors such as SHOALS are ideal for regional coastal mapping because large areas can be quickly and cost-effectively surveyed in detail. Since lidar mapping is non-intrusive, conditions that are environmentally sensitive or hazardous for survey vessels, like the shallow rocky shorelines and coral reefs of Hawaii, are easily surveyed with a lidar sensor. Additionally, consecutive regional surveys may be compared to monitor regional as well as site-specific terrain changes over time to quantify natural phenomenon such as coral reef damage, navigation channel and harbor shoaling, and beach and cliff erosion.

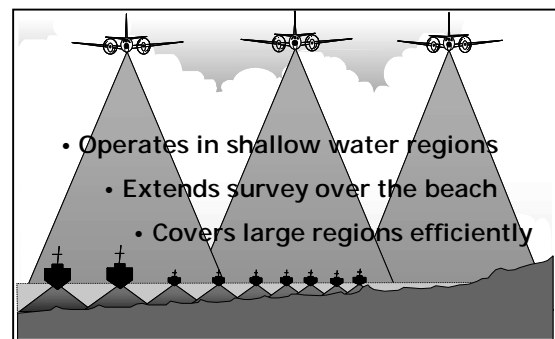


Figure 3: Advantage of SHOALS over conventional multibeam surveys.

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