A 1m x 1m resolution digital elevation model of the University of Texas campus computed from airborne lidar. Draped over the lidar DEM is a 1m resolution IKONOS satellite image.

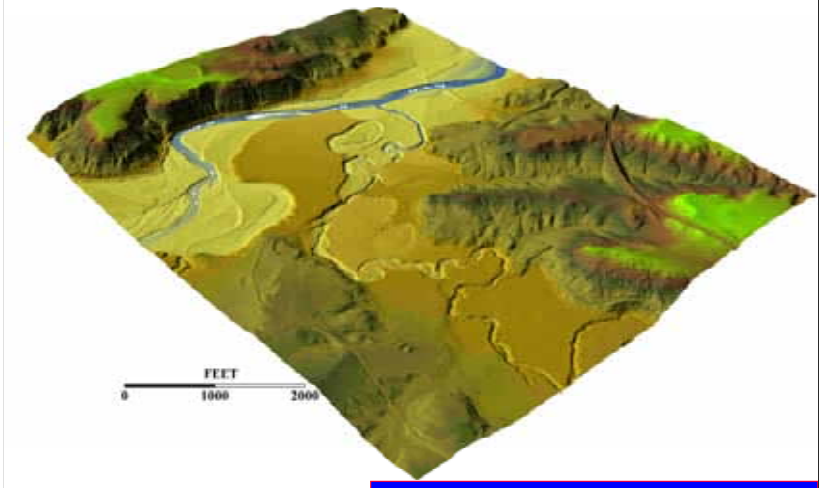
Accurate Topography for Wetlands

- Wetlands develop in areas of low topographic relief.
- A wetlands can contain many habitat units that mingle in patterns of varying complexity.
- Accurate, detailed topographic mapping is very useful for wetlands research and management.
- Hydrology and Hydraulic Modeling
  - Delineate drainages and water levels
  - Understand water flow paths
- Habitat mapping
  - Topography may be important factor in soil type, soil moisture content, water salinity.
  - Therefore elevation may be useful in understanding the location of vegetation/habitat types.
- Synoptic/comprehensive view of the geomorphology and its relationship to habit units, land use, and cultural features.

Airborne Laser Terrain Mapping

- **Airborne Laser Terrain Mapping (ALTM) combines the precision of LIDAR (Light Detection and Ranging) with the absolute accuracy of the Global Positioning System (GPS) to measure the Earth's topography.**
- **ALTM can produce accurate, high-resolution topographic information with 1-2m horizontal resolution and 6-15cm vertical accuracy.**
- **High resolution topographic information can be collected over 100's square kilometers in a few days.**
- **Using a powerful computer and appropriate software, the ALTM information can be used to create digital elevation models (DEM); either regularly spaced, three-dimensional grids or triangulated, irregular networks (TIN).**

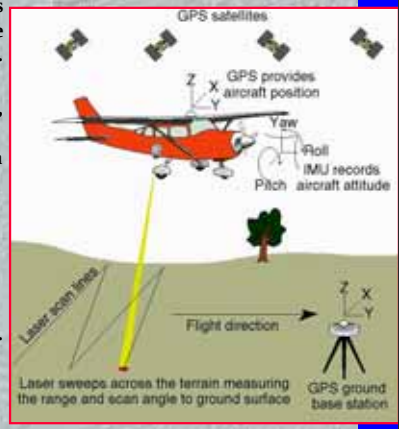
Digital Elevation Model: Powder River Basin, Wyoming



1.5m x 1.5m lidar DEM
Vertical accuracy = approx. 12-15cm

ALTM System

- **During a ALTM survey, a powerful laser pulses thousands of times each second. A rapidly moving mirror deflects the laser's beam, causing it to scan across the Earth beneath the survey aircraft.**
- **The position of the aircraft is estimated using GPS equipment in the aircraft and at ground control stations.**
- **An Inertial Measurement Unit (IMU), a set of accelerometers and gyroscopes, measures the accelerations and rotations of the aircraft. The IMU data are used to remove the effects of aircraft attitude on the horizontal and vertical position of each laser pulse.**
- **All three data streams (laser ranges, IMU information, and GPS positions) are combined and processed to generate a series of topographic points.**



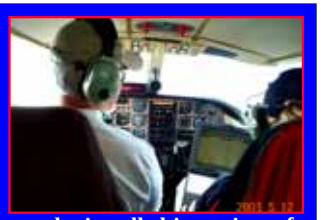
Bureau of Economic Geology's OPTECH 1225 ALTM

- **Laser pulse rate: up to 25000 per sec.**
- **Laser scan rate: variable from 0 to 28 Hz.**
- **Laser scan angle: variable up to ±20°, depending on scan rate.**
- **Operating altitude: 410-2000 m above ground level (AGL).**
- **Records the range of the first and last reflections for each pulse.**
- **Records the intensity of the first and last laser reflection.**

ALTM 1225 installed in P-68

ALTM system
A. Laser and IMU,
B. Computer/equipment rack
C. Ashtech Z-12 GPS receiver.

Lidar Survey Aircraft:



System can be installed in variety of aircraft:

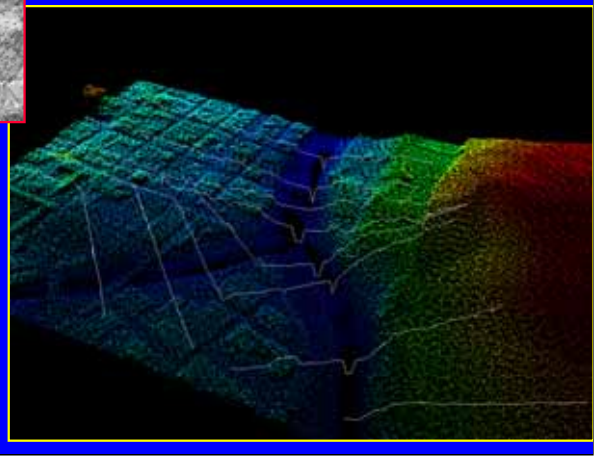
- **A single-engine Cessna .**
- **Partenavia P-68.**
- **A twin-engine Beech King Air A-90.**
- **Helicopter.**

Global Positioning System (GPS)

- **One or more GPS base stations operate on the ground during the lidar survey.**
- **The survey aircraft operates within 50km of a GPS ground station.**
- **The GPS units are dual-frequency, geodetic receivers.**
- **GPS data from the aircraft and base station are combined and processed to provide a solution for the aircraft trajectory.**
- **The trajectory is typically accurate to within 10cm of the true position of the aircraft.**

Tegucigalpa, Honduras: LIDAR Point Cloud

Left: Shaded relief image of a 1.5m X 1.5m DEM of Tegucigalpa, Honduras.

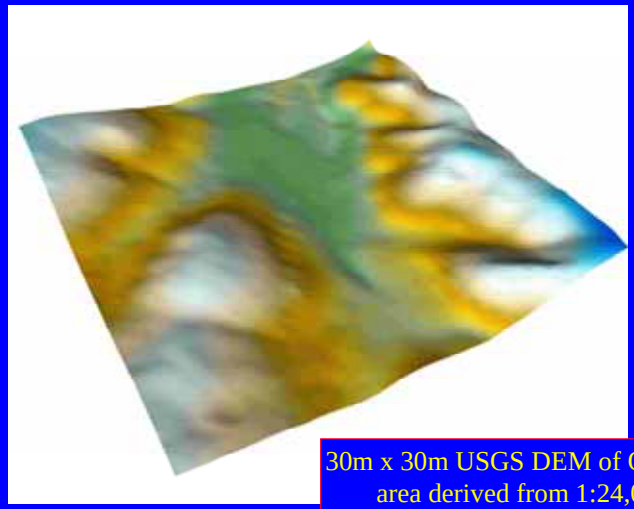


Right: The LIDAR point cloud used to generate the above DEM.

Individual laser points are colored relative to elevation.

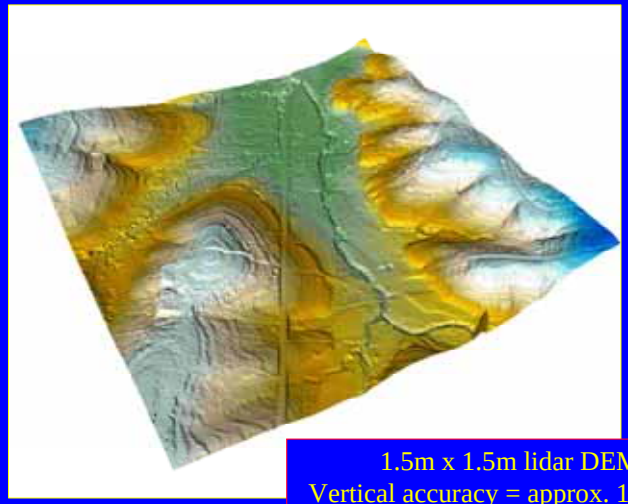
Channel cross-sections extracted from the DEM for flood modeling are superimposed on the point cloud.

Comparison of USGS Topographic Map and Lidar DEM



30m x 30m USGS DEM of Oak Hill area derived from 1:24,000 topographic map.

Comparison of USGS Topographic Map and Lidar DEM



1.5m x 1.5m lidar DEM
Vertical accuracy = approx. 12-15cm

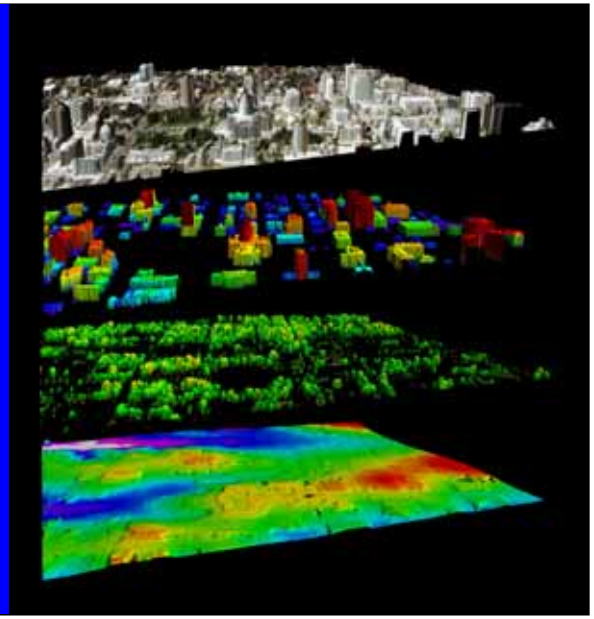
Downtown Austin

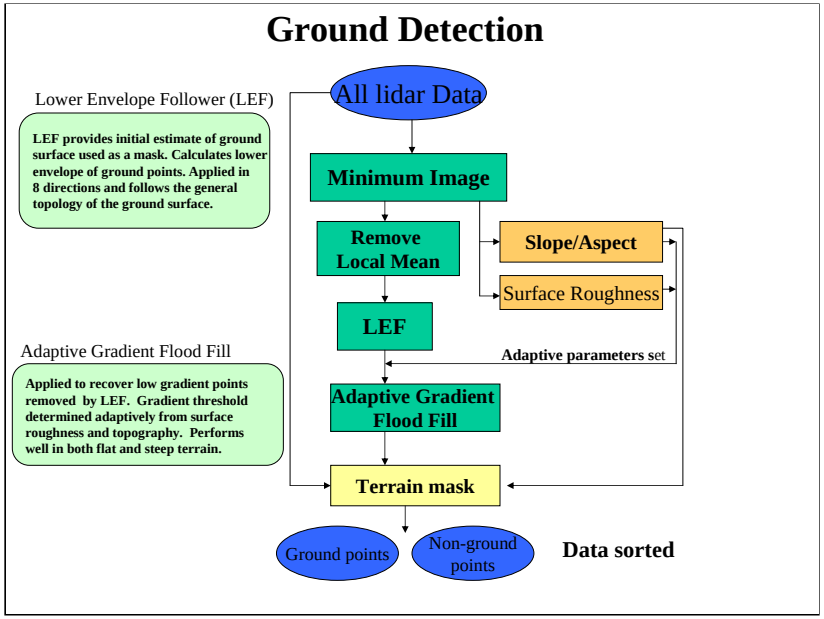
1-m LIDAR draped with Quickbird

Extracted Buildings

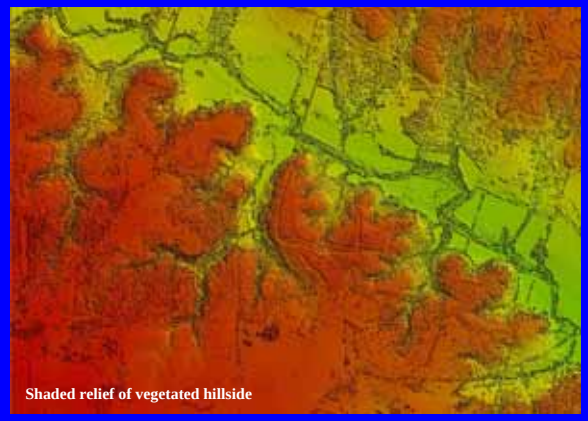
Extracted Vegetation

Terrain – (Bare Earth)



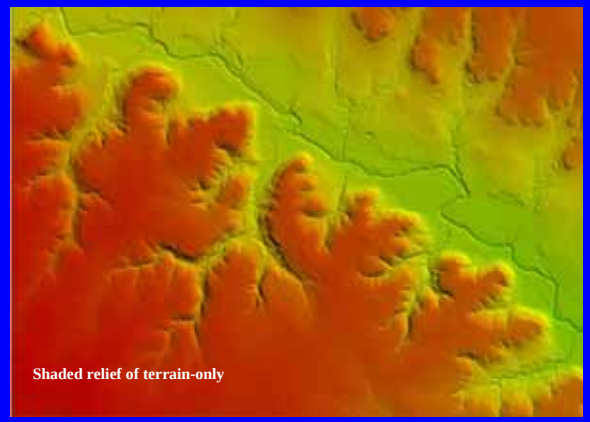

Ground Detection
Lower Envelope Follower (LEF)
LEF provides initial estimate of ground surface used as a mask. Calculates lower envelope of ground points. Applied in 8 directions and follows the general topology of the ground surface.
Adaptive Gradient Flood Fill
Applied to recover low gradient points removed by LEF. Gradient threshold determined adaptively from surface roughness and topography. Performs well in both flat and steep terrain.
All lidar Data
Minimum Image
Remove Local Mean
Slope/Aspect
Surface Roughness
LEF
Adaptive parameters set
Adaptive Gradient Flood Fill
Terrain mask
Ground points
Non-ground points
Data sorted

Ground Detection/Vegetation Removal in Leon River watershed, Crawford, Texas



Shaded relief of vegetated hillside

Ground Detection/Vegetation Removal in Leon River watershed, Crawford, Texas



Shaded relief of terrain-only

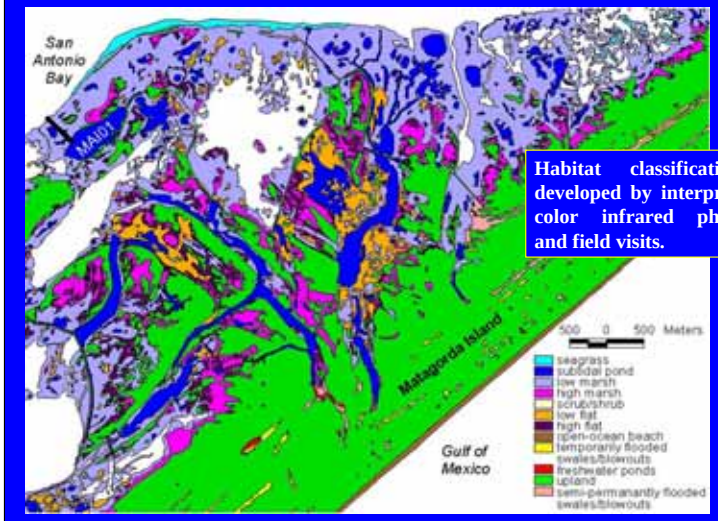
Topographic Variation of Barrier Island Sub-environments

- **Detailed topography is needed to understand the dynamics of habitat distribution on barrier islands.**
- **ALTM helps quantify the relationship between habitat type and elevation relative to sea level.**
- **Lidar DEM of Matagorda Island, a sandy barrier island on the Texas coast, is compared to a map of habitats developed from color infrared aerial photography and field visits.**

Location map of study area.

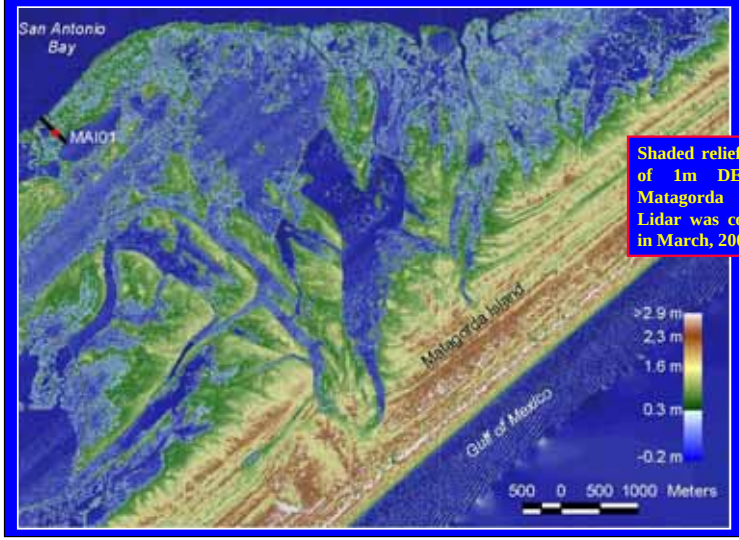
Right: Aerial photograph of the Matagorda Island looking northwesterly toward San Antonio Bay. The Gulf of Mexico is at the bottom.

Topographic Variation of Barrier Island Sub-environments



Habitat classification map developed by interpretation of color infrared photography and field visits.

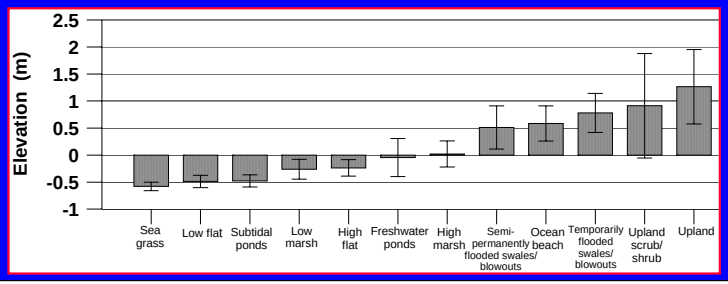
Topographic Variation of Barrier Island Sub-environments



Shaded relief image of 1m DEM of Matagorda Island. Lidar was collected in March, 2002

Topographic Variation of Barrier Island Sub-environments

- **Barrier island habitat units were superimposed on the DEM.**
- **The mean elevation of each habitat unit was then calculated.**
- **Below: Plot of the mean elevations and standard deviations of the island habitats. The units are arranged along the *x*-axis in the expected order of increasing elevation.**
- **Lidar DEM illustrates the relationship between elevation and habitat. The range in mean elevation is less than 2m, and habitat elevation differences are subtle and overlap.**



Conclusions

- **Along the Texas Gulf coast, wetland habitat units are sensitive to small (e.g. 10cm) changes in elevation above sea level.**
- **It is possible that wetlands in Cuatro Ceinegas are equally sensitive to elevation above water level.**
- **ALTM can provide critical information about the relationship of wetlands habitat to elevation and water levels.**
- **Lidar DEM's can help predict the change in habitats if water levels or ground elevation changes .**
- **Lidar digital elevation model can serve as an independent data layer for mapping habitats in conjunction with color-infrared, multispectral, hyperspectral or radar imagery.**