NV5

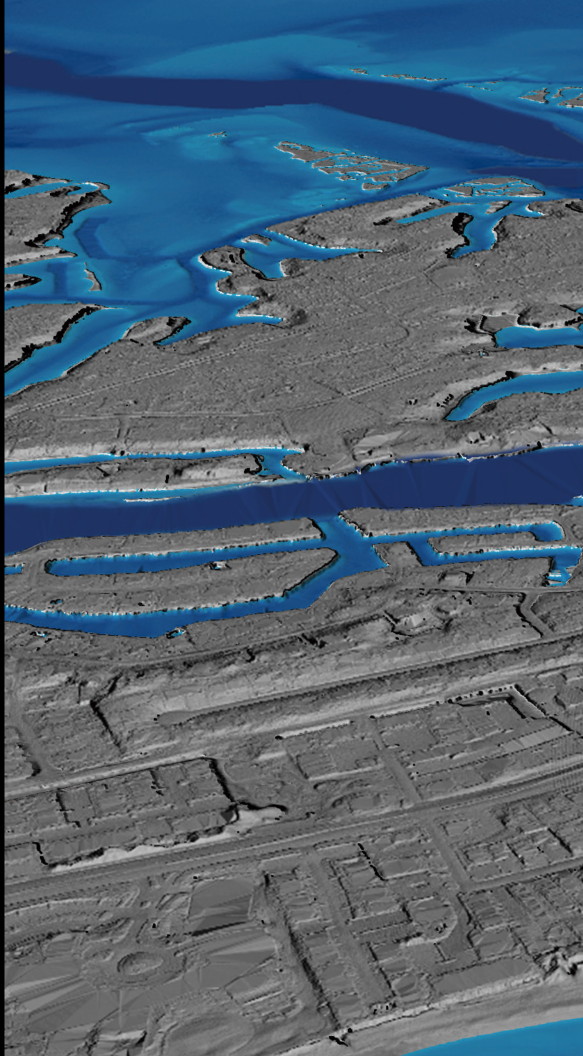
Topobathymetric Lidar

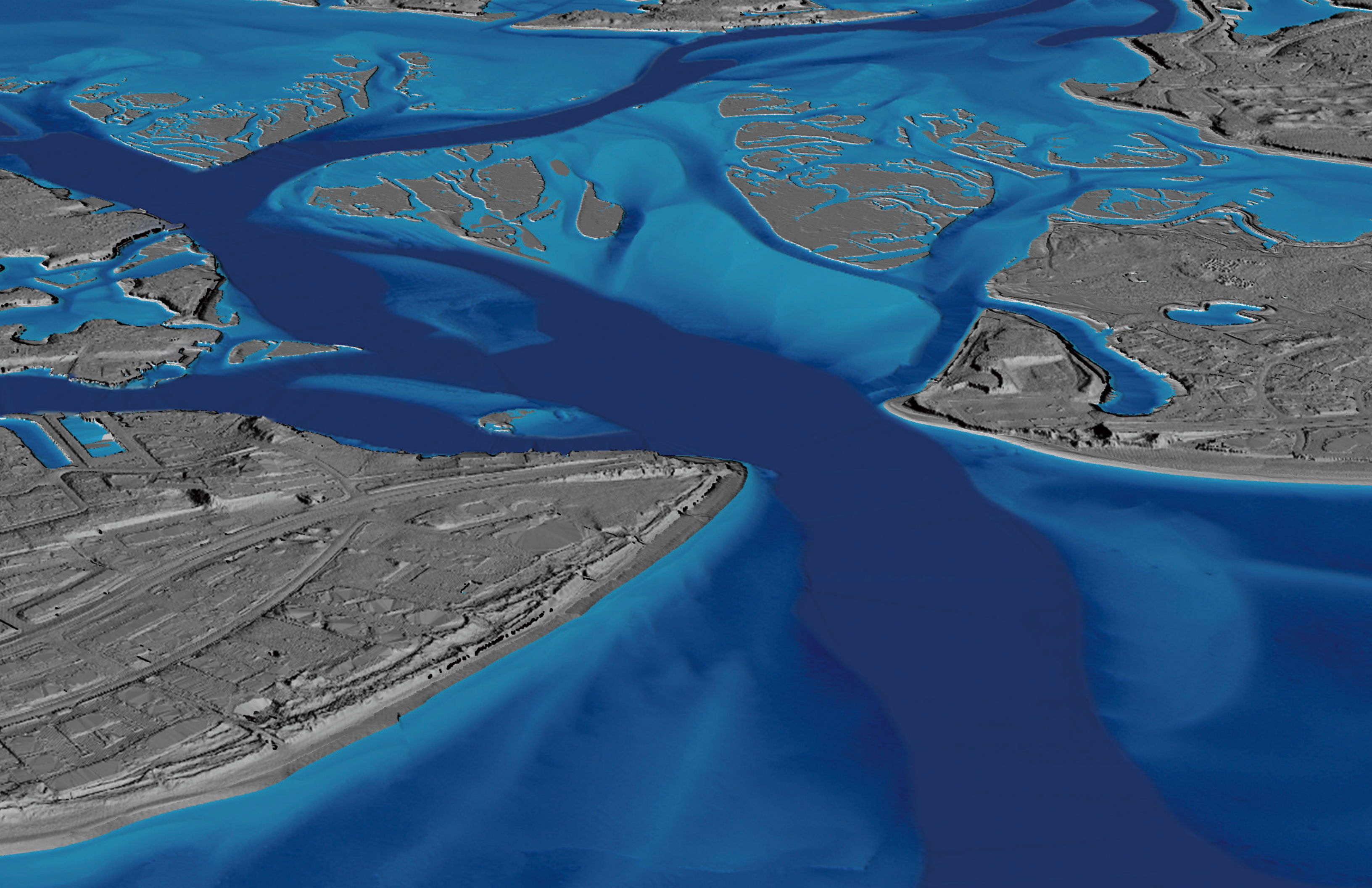
Mapping Nearshore and Riverine Environments

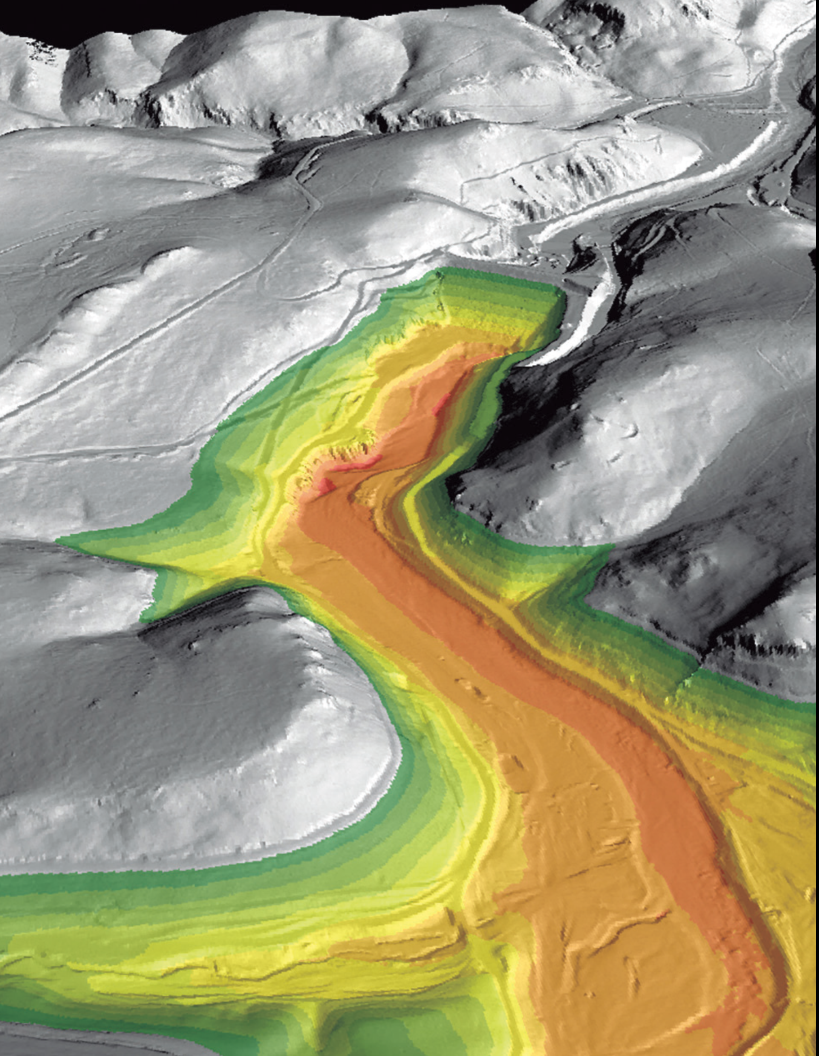
Why NV5?

NV5 is the geospatial pioneer pushing the boundaries of data and analytics to transform the way our clients use and value geospatial data. As such, we lead the nation as the only end-to-end geospatial solutions provider with capabilities in all specialty service areas. Topobathymetric lidar is one of these specialized services.

Only a handful of firms in North America share topobathymetric capabilities at any level, much less have our mastery of the science. We lead our peers in acquisition capabilities with leading-edge sensors and world-class experts to manage the challenging data processing and develop informed answers that our clients demand.







Applications

Topobathymetric lidar has many important applications. These include:

- Shoreline and coastal intelligence
- Habitat restoration
- Floodplain modeling
- Volumetric analysis
- Infrastructure planning and engineering
- Coastal zone management

This specialized capability allows you to significantly increase your knowledge of the nearshore environment for improved marine resource mapping, benthic habitat mapping, shoreline delineation, nautical charting, and marine debris mapping.

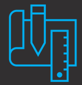
Moreover, Topobathymetric lidar provides the ability to seamlessly map stream channel morphology, floodplain topography, habitat connectivity, and riparian vegetation with unprecedented detail. This technology has advanced our ability to map dynamic floodplains to guide inundation modeling comprehensively, dam and canal infrastructure evaluations, and river and watershed restoration efforts.

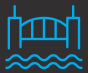
Finally, we can now provide essential baseline data to support engineering and planning for dam removal projects, pipeline and telecom infrastructure, and road and rail crossings.


Coastal


Riverine


Fisheries


Engineering


Infrastructure


Charting

Topobathymetric Lidar

Topobathymetric lidar is the science of simultaneously measuring and recording three distinct surfaces – land, water, and submerged land using airborne laser-based sensors. While this technology shares a lot with the traditional airborne lidar mapping of the terrestrial landscape, significant differences and major challenges are introduced.

Topobathymetric lidar sensors use two independent laser sources to acquire the raw data needed to map the three surfaces accurately. First, a near infrared laser is used to map the land and surface of the water. This light is both absorbed and reflected by the water and provides an accurate representation of the location and shape of the water surface. Second, a visible green laser is required to penetrate the water surface and make measurements of the submerged land below.

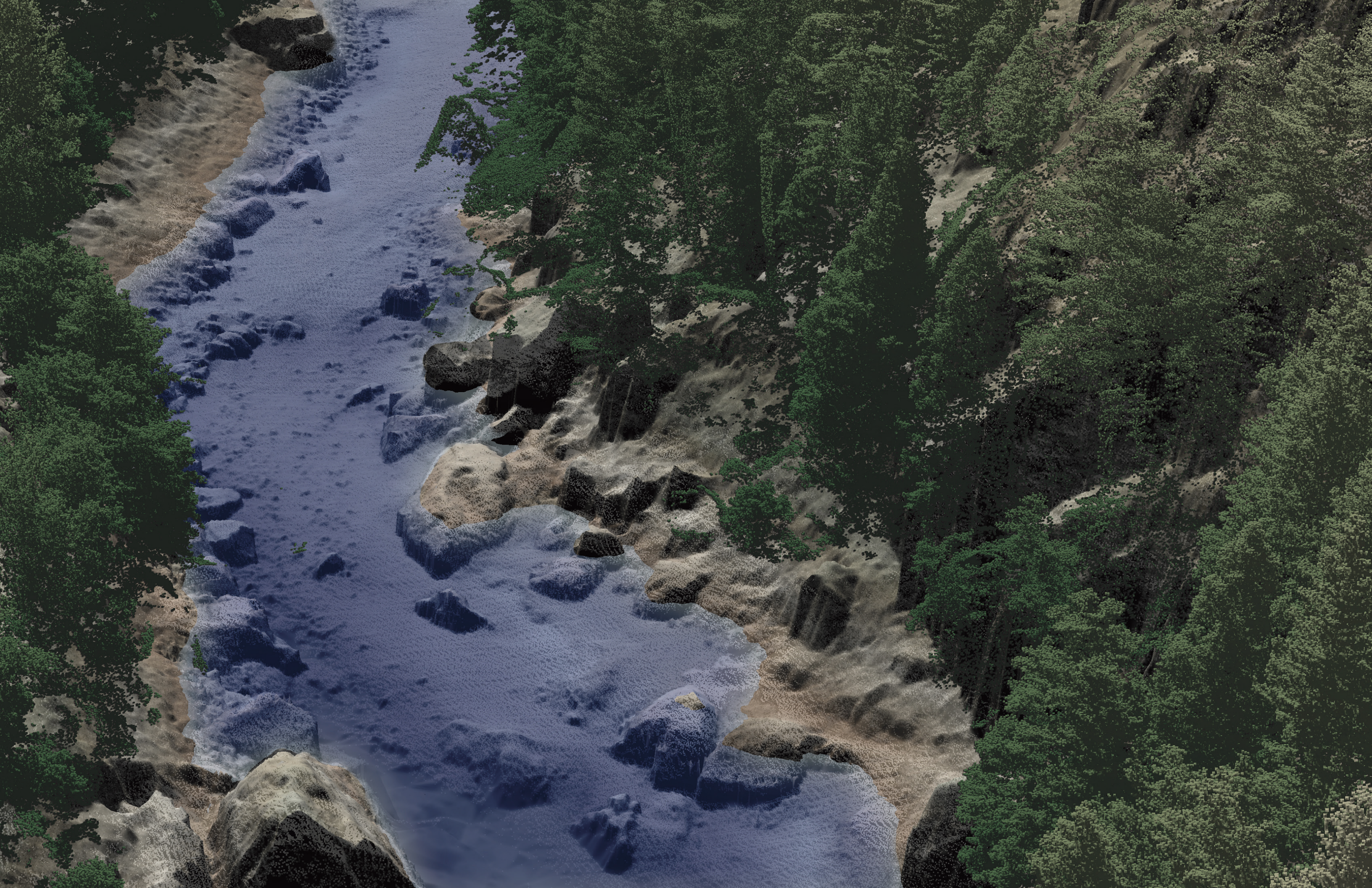
Maximum Depths

One crucial question for any topobathymetric lidar project is the maximum achievable depth of mapping. The answer is highly dependent on project conditions, most notably water clarity and bottom reflectance.

We use available resources to understand water clarity dynamics in the project area, including local knowledge, real-time monitoring stations, and available satellite and aerial imagery. This information is used to plan data collection under optimal conditions and predict depth performance of the sensor.

We measure local water clarity at the time of flight and quantify that numerically using a standard black and white disk (known as a Secchi disk). The recorded Secchi depth is the depth at which our eyes can no longer see the disk as it is lowered into the water. The green laser sensor is more sensitive than the unaided eye and typically maps to 1.5 or more times this depth.

Overall, we frequently capture depths in riverine systems from two to five meters or more. However, in the highly variable nearshore coastal environments, the mapped depths can range from three to five meters along the Atlantic seaboard to twenty or more meters in the Florida Keys or Caribbean, where the water clarity is near ideal.



Bottom Reflectance, Depth Penetration, Accuracy, and Remotely Sensed Data

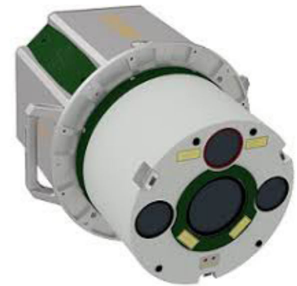
A water body with bright sand or rocky bottom frequently provides an increased ability to see greater depths than water with a dark, murky bottom. This is obvious to the human eye and holds true when the sensor's green (visible) laser looks into the same water. In addition, brighter, more reflective bottom substrates provide much better lidar results.

Beyond the intrinsic elevations computed from the lidar returns, NV5 has the ability to extract additional information from the raw data. For example, each lidar return contains an amplitude that is indicative of the reflective properties for the bathymetric bottom. Our custom routines allow us to create a seabed reflectance image by correcting for many variables and normalizing between flight lines. This normalized image provides a valuable data layer for accurately differentiating critical benthic habitats such as seagrass and coral reefs.

Specialized Sensor Technology

Leica Geosystems and Riegl provide the only high-performance technology in today's shallow water bathymetric market. Both the Riegl VQ-880G2 and Leica Chiroptera 4X are refinements over their earlier sensor technologies, resulting in significant improvements in accuracy and efficiency.

NV5 owns and operates two Riegl 880-Gii's and one Leica Chiroptera 4x. Both sensors provide exceptional performance for a wide range of riverine and nearshore applications. However, both sensors also have design differences that offer certain advantages depending on project requirements. The Riegl has a higher pulse repetition rate, resulting in increased return densities at the land/water interface and shallow-water environments. The Leica can extend the survey to deeper water environments and address a greater range of hydrographic and charting applications. We carefully evaluate their respective advantages for specific projects before choosing which sensor is best for a given application.



Meeting Acquisition Challenges

The challenges in data acquisition are many. They start with the base conditions we see with terrestrial lidar – no clouds below our flying height, light winds, no flooding, and no overly saturated ground. We then add in considerably more limitations that include water clarity; tide stage in nearshore environments; absence of seasonal vegetation; and low rainfall and minimal sediment in the water column.

Water-borne vegetation restrictions are typically seasonal and often eliminate months from the acquisition season. Water clarity varies significantly from day-to-day and may result in unfavorable days or weeks on the ground while mobilized to the project site. A topobathymetric lidar sensor is often not used as much as a topographic-only system, given the added acquisition challenges.

Flight Planning

We typically fly topobathymetric lidar in a fixed wing platform at relatively low altitudes. The optimal height for most surveys is 400 meters (~1,300 ft) above ground level (AGL), which provides the optimal combination of depth performance and pulse density. Maximum flying heights vary with many factors, and NV5 has successfully collected data at altitudes up to 1,200 meters. The selection of a higher flight altitude depends on project objectives.

NV5 transfers the topobathymetric lidar sensor to a rotary winged platform when the project requires data collection at low altitudes in rugged terrain. The rotary winged solution is often used for riverine projects in the mountains west. NV5 designs the flight parameters for the specific project to include platform, altitude, and resolution.

Water Surface and Refraction

Two things happen when light hits the surface of water. First, it bends because water is significantly denser than air. Technically this is known as refraction. Drop a pencil into a glass of water and notice the significant bending that occurs at the surface of the water. Light from the green laser in our sensors will bend similarly at the water surface.

Secondly, the light slows down in the water column because of the denser medium. We must correct for both the bending and the change in speed to accurately model the submerged land underwater. This is known as our “refraction correction.” We can only accurately model the submerged land surface underwater if we know precisely where the water is for all laser measurements.

Our proprietary refraction correction software allows us to work with extensive project areas and provides efficiencies of 10x beyond what is available in COTS industry software.

Comparisons to Sonar

Airborne topobathymetric lidar is a natural complement to boat-based sonar. While sonar methods have to account for hazards and become significantly less efficient in the shallow water environment, airborne technology excels at capturing the shallow water zone and seamlessly extending the survey to the terrestrial environment. Airborne technology can collect data in critical nearshore environments where it is unsafe or practical for waterborne methods allowing survey vessels to focus on deeper water areas.

Well-designed mapping efforts often include both sonar and airborne topobathymetric lidar. In a riverine setting, the lidar can capture the full extent of the floodplain and shallow water environment and inform the sonar collection to the thalweg and deeper water zones. Modern geodetic and processing techniques allow for easy integration of the data sets to create a combined elevation model.

Bathymetric Accuracy Assessment

Most terrestrial lidar projects call for blind quality assurance (QA) points to complete a formal accuracy assessment throughout the project. The same is true for bathymetry projects, but the collection of blind QA points underwater can be a bit more challenging to acquire.

Accurate points can be collected in rivers or nearshore environments with kinematic global navigation satellite system (GNSS) surveys by wading into the water with the survey equipment. Obviously, the depth of capture is limited to a few feet. Deeper points are often collected from boats with sensors that can accurately measure depth.

Office Locations

Contact Us

We would like to hear from you. Reach out to us with any questions about technology, challenges in optimizing the value, or deriving the most critical answers from the data.

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