

Minnesota's Lake Superior Coastal Program

The North Shore Data Consortium: Acquiring and Distributing High-Resolution Geospatial Information

**George Host and Gerry Sjerven
Natural Resources Research Institute
University of Minnesota Duluth
Duluth, MN 55811-1442**

August 31, 2012

Project No. 306-09-11

Contract No. B31517/3000003745

This project was funded in part under the Coastal Zone Management Act, by NOAA's Office of Ocean and Coastal Resource Management, in cooperation with Minnesota's Lake Superior Coastal Program.



Introduction

This project came about because of strong local and regional interests in the acquisition and distribution of high-resolution spatial data needed for land use planning, natural resource management, and environmental assessment. Included among these data was LiDAR – light detection and ranging imagery which provides very high resolution (0.5 to 1 m) elevation data, which in turn can be used to generate other spatial data, such as hierarchically structured watersheds, topographic moisture indices, and refined wetland classifications. In spite of the strong interests in these data sources, acquisition was hampered because no single agency had the mandate for developing interagency strategies to coordinate funding and planning for large-scale data acquisition projects.

To address this, we proposed to create the North Shore Data Consortium (NSDC), with the purpose of developing specific funding strategies and timelines for collecting LiDAR and contemporary high-resolution aerial photography for the region. The Consortium created partnerships among local, state, and federal agencies along with interested NGOs to develop data standards, provide for data sharing and leveraging of funds for contracting LiDAR acquisition. The NSDC worked closely with the Digital Elevation Committee of the Governor's Council on Geographic Information, who coordinates statewide data efforts. A secondary goal of the proposal was to facilitate data distribution and training.

Work Completed

Outcome 1 North Shore Data Consortium

We introduced the concept for NSDC at the annual Minnesota GIS/LIS conference Oct 2009 in Duluth. In November 2009 we presented the NSDC concept to Digital Elevation Committee of the Governor's Council on Geographic Information Systems, and in January 2010 we held the first meeting of the NSDC at UMD's Natural Resources Research Institute (NRRI). We had 14 attendees representing various local, state, federal, and private groups, including the Minnesota DNR, the Natural Resources Conservation Service, Fond du Lac Natural Resources Department, representatives from St. Louis and Douglas counties and the cities of Duluth and Superior. The group discussed their various data needs and, in particular, interests, uses and specifications for LiDAR data, a relatively new high-resolution source of elevation data. As a result of that meeting, we agreed to write a letter of support to the Minnesota DNR and MnGEO about the interest of the North Shore Data Consortium in working with the state on projects that would acquire LiDAR data in northern Minnesota. We have had a number of follow up conversations with the MN DNR and MnGEO about the content, wording and signature chain for the letter, resulting in a draft ultimately approved by the NSDC.

In May 2010 we again met with the Digital Elevation Committee to discuss future directions for the statewide LIDAR collection project. Given the interest and organization of the NSDC, and lack of similar groups in other parts of the state, there was a recommendation to request a rescheduling of the LiDAR flights for northeast Minnesota. The NSDC drafted and submitted a letter of recommendation, citing the rapid pace in development in northeastern Minnesota, the upcoming development of TMDLs, the requirements of MS4s to develop sound stormwater

management plans, and increasing sensitivity to implications of altered Lake Superior water levels as key reasons to acquire and distribute this data ahead of schedule. Signatories of the letter include St. Louis County, city of Duluth, Minnesota, and UMD's Natural Resources Research Institute and Department of Geography. In August 2010 the Digital Elevation Committee of MnGEO approved this request, and the flights were moved ahead to spring 2011.

In subsequent meetings, we discussed specifications for the LiDAR collection and worked with state agencies closely involved with LiDAR data collection: Minnesota DNR, MnGEO, and MnDOT. As part of these discussions, we helped coordinate "buy-up" options: increases in the spatial resolution of the data and collection of additional imagery. Ultimately the Minnesota Pollution Control Agency and the city of Duluth contributed additional funding for these additional data sets.

LiDAR data is now available, and distributed through this project as discussed in outcome 2. NSDC members continue to meet periodically to discuss data issues, most recently to consider a new flight to document changes to the landscape caused by the extensive flooding of northeastern Minnesota in summer 2012.

Outcome 2 Data storage processing, and distribution

We developed a six TB RAID storage system to house the LiDAR data.

In addition to the statewide LiDAR collection, NOAA collected LiDAR along the Lake Superior coastline; the intent of this data was to quantify nearshore bathymetry. NOAA data were acquired from their digital coast website and incorporated into the NRRI GIS laboratory database. We created a number of images for locations along the coast and compared LiDAR bathymetry with other datasets. Several artifacts in the data were identified, as well as locations where turbidity may result in less reliable depth estimates.

In January 2012, the project team identified data quality issues with the edge-of-water breaklines. The vendor was notified and a new timeline for delivery was established. The final LiDAR data for the Arrowhead region were delivered to NRRI in spring 2012 and are available through the CoastalGIS website through FTP at <http://gisdata.nrri.umn.edu/lidar/>, as well as through websites at Minnesota DNR and MnGEO. We also have provisions for users to pick up the data on personal hard drives at the NRRI GIS laboratory.

Outcome 3 Facilitate LiDAR training

In April and May 2012, NRRI worked with the Water Resources Center (WRC) of the University of Minnesota to provide targeted training to end users in the Arrowhead. Two "Basics of Using LiDAR Data" workshops were held, one on April 26 in Cloquet and the other in Duluth May 21. An advanced workshop on terrain analysis and hydrologic applications was held at UMD on May 22. All workshops were filled to capacity. A workshop on Forestry and ecological applications of LiDAR was also in conjunction with the hydrology workshop.

The May 2012 workshops were not part of the regularly scheduled WRC series; they were added under the modification to this Coastal Program grant. NRRI's Gerald Sjerven made arrangements for the computer facilities and worked with WRC personnel on content and

materials. Sjerven also served as assistant instructor in the May workshops. Each class had 20 students from the Arrowhead region, representing local, state, and county governments.

As per the grant requirements, the Water Resources Center included the logos and text for both NOAA and the Coastal Program on their training materials and slides. Example course materials and letter of acknowledgement are attached.

Results

- We created the North Shore Data Consortium, which created partnerships among municipal, county, state, tribal, and federal partners. We expect these partnerships will persist beyond this grant.
- We contributed toward rescheduling the Arrowhead collection a year an advance, which is particularly relevant given the landscape changes that occurred due to flooding in summer 2012.
- We facilitated meetings among agencies that allowed significant leveraging of funds to increase the LiDAR resolution and collect supporting aerial imagery.
- We developed systems for increasing access to LiDAR data.
- We provided training to area professionals on the basic use of LiDAR, as well as its applications in forestry and hydrology.

Partnerships

The NSDC itself comprises partnership of professionals interested in promoting the use of high-resolution data to inform management decisions. Key partners in this effort were the Minnesota DNR, Natural Resources Conservation Service, Fond du Lac Natural Resources Department, several departments at UMD, and representatives from St. Louis, Lake, Cook and Douglas counties, as well as the cities of Duluth and Superior.

Leveraged dollars

There was considerable leveraging of state dollars related to the ‘buy-up’ of LiDAR data resolution and additional aerial photography. The Natural Resource Conservation Service and the MN Pollution Control Agency contributed \$171,000 and \$140,000, respectively; Lake County contributed \$25,000. The city of Duluth also added a considerable amount, but the specific dollar amount is not available.

The project also had non-monetary leveraging; the counties coordinated efforts to collect ground-truth data that was used to evaluate and improve the accuracy of the data.

Conclusions

This project was highly successful on many fronts – it created partnerships, it allowed groups to discuss and achieve consensus on data issues, it created leveraging and other collaborative opportunities, and it provided training to end users. LiDAR is now actively being used for environmental assessment and planning at numerous governmental and agency levels. We fully expect these groups will expand into digital terrain analysis, as well as the forestry, hydrology

and urban land use planning arenas as the skills, understanding, and potentials of these new data sets.

Performance measures checklist

			If Yes, Please fill in below	
	YES	NO	Number of Activities	Number of Participants
Government Coordination and Decision Making				
1. Project conducted educational activities (no booths/displays)	<input type="checkbox"/>	<input checked="" type="checkbox"/>		
2. Project conducted training activities	<input checked="" type="checkbox"/>	<input type="checkbox"/>	4	40-50 (76 seats filled across 4 activities)
3. Project conducted coordination activities	<input type="checkbox"/>	<input checked="" type="checkbox"/>		

Future Plans

We will continue to pursue opportunities to maintain and update the data resources on the CoastalGIS website.

Water Resources Center
College of Food, Agricultural and
Natural Resource Sciences
University of Minnesota
Extension

Room 173 McNeal Hall
1985 Buford Avenue
St. Paul, MN 55108
612-624-9282
Fax: 612-625-1263
<http://wrc.umn.edu/>

Amber Westerbur
Acting Program Manager
Minnesota's Lake Superior Coastal Program
Minnesota Department of Natural Resources – Division of Ecological and Water Resources
1568 Highway 2
Two Harbors, MN 55616

Dear Amber,

I am writing in appreciation of Gerry Sjerven's time and for funding from the Lake Superior Coastal Program and NOAA in support of the Conservation Applications of LiDAR training program. Your program helped us extend our training offerings by paying the \$300/day computer lab fee for the sessions in Duluth May 21st and 22nd, 2012.

In addition to the direct financial support, the instructors were grateful for the on-site assistance Gerry provided at the sessions in Duluth and at the April 26th and April 27th sessions in Cloquet. Teaching computer skills takes a lot of hands-on assistance, so it was a tremendous benefit to the students to have someone with Gerry's expertise to help them through the process and to answer questions specific to resources in northeast Minnesota.

The statewide LiDAR data is a tremendous resource for conservation efforts in Minnesota. Our training program aims to ensure that it is well-utilized. Thank you for your support of our work.

Sincerely,

Conservation Applications of LiDAR Program
Les Everett (Project Manager)

Ann Lewandowski (Project Coordinator)

Basics of Using LiDAR Data

This workshop is part of the "Conservation Applications of LiDAR" project – a series of hands-on workshops designed to help Minnesota GIS specialists effectively use LiDAR-derived data to address natural resource issues. The project is funded by a grant from the Environment and Natural Resources Trust Fund, and is presented by the University of Minnesota Water Resources Center with expertise provided from the University of Minnesota, MN Department of Natural Resources, MN Board of Water and Soil Resources, and USDA Natural Resources Conservation Service. More information is at <http://tsp.umn.edu/lidar>.

Objectives

By the end of the session, participants will be able to download, manipulate, and use LiDAR data in its several provided forms. They will learn what is LiDAR data, limitations and error management, data formats, and data acquisition and management for various applications. Many tips and tricks of working with LiDAR and raster data in general will be shared.

Instructor

Joel Nelson, University of Minnesota - Department of Soil Water and Climate, GIS Specialist, M.S. - GIS. Manager, Soil and Landscape Analysis Laboratory (SLAL).

Agenda

(Times are approximate)

- 8:30-9:00 Registration
- 9:00-9:45 Raster Data – what it is, how to work with it, comparing types of digital elevation models.
- 9:45-10:45 Exercise 1: Raster Processing
- 10:45-11:00 BREAK
- 11:00-11:30 What is LiDAR? – how it is collected and processed, features of LiDAR data in Minnesota, understanding and managing error and accuracy.
- 11:30-12:30 Exercise 2: MN LiDAR Data
- 12:30-1:00 LUNCH
- 1:00-2:30 LiDAR Applications and Products – introduction to uses of LiDAR data, software for using LiDAR data, methods for representing LiDAR data, forms of data available in Minnesota, methods for visualizing data
- 2:30-4:00 Exercise 3: Visualization and Management

Minnesota locations

St. Paul, Mar 12, 2012
Brainerd, Mar 14, 2012
Winona, Mar 28, 2012
E. Grand Forks, Apr 11, 2012
Cloquet, Apr 26, 2012
Duluth, May 21, 2012
Mankato, Jul 11, 2012
Morris, Jul 25, 2012



Certification of Completion

_____ attended this one-day "Basics of Using LiDAR Data" workshop.
Print name

_____ *Signature of participant*

_____ *Signature of instructor*

_____ *Date*



Conservation Applications of LiDAR

Basics of Using LiDAR Data

Workshop Exercises

2012

These exercises are part of the "Conservation Applications of LiDAR" project – a series of hands-on workshops designed to help Minnesota GIS specialists effectively use LiDAR-derived data to address natural resource issues. The project is funded by a grant from the Environment and Natural Resources Trust Fund, and is presented by the University of Minnesota Water Resources Center with expertise provided from the University of Minnesota, MN Department of Natural Resources, MN Board of Water and Soil Resources, and USDA Natural Resources Conservation Service. More information is at <http://tsp.umn.edu/lidar>.



The Duluth sessions were funded in part under the Coastal Zone Management Act, by NOAA's Office of Ocean and Coastal Resource Management, in cooperation with Minnesota's Lake Superior Coastal Program.



Program: Conservation Applications of LiDAR Data

<http://tsp.umn.edu/lidar>



Funding: Environment and Natural Resources Trust Fund

* This "Duluth" session was funded in part under the Coastal Zone Management Act, by NOAA's Office of Ocean and Coastal Resource Management, in cooperation with Minnesota's Lake Superior Coastal Program.



Module: Hydrologic Applications

Instructor: Sean Vaughn, DNR GIS Hydrologist
(Funded by the Clean Water Fund)



Exercise: DEM Display

Objectives

- Learn the basics of setting *Environment Settings* to control raster analysis and processing outputs.
- Demonstrate methods to display a DEM and associated raster products for the purpose of hydrography identification and delineation.

Exercise & Data Location:

Root Folder for this exercise = %root folder% \ = Flash_Drive_sevaughn_LiDAR\DEM_DISPLAY

Note:

If there is a problem with using the flash drive we will switch to using the C:\ drive:

Root Folder for this exercise then = %root folder% \ = C:\Temp_sevaughn_LiDAR\DEM_DISPLAY

Terrain Analysis

This workshop is part of the "Conservation Applications of LiDAR" project – a series of hands-on workshops designed to help Minnesota GIS specialists effectively use LiDAR-derived data to address natural resource issues. The project is funded by a grant from the Environment and Natural Resources Trust Fund, and is presented by the University of Minnesota Water Resources Center with expertise provided from the University of Minnesota, MN Department of Natural Resources, MN Board of Water and Soil Resources, and USDA Natural Resources Conservation Service. More information is at <http://tsp.umn.edu/lidar>.

Objectives

This workshop teaches tools related to LiDAR-derived elevation products. Participants will use terrain attributes to identify and better understand what portions of the rural landscape are prone to erosion or deposition. Several examples of terrain attribute calculations and their interpretation for different landscapes will be offered. Workshop skills can be used to help target conservation measures to the most critical parts of the landscape.

Instructor

Joel Nelson, University of Minnesota - Department of Soil Water and Climate, GIS Specialist, M.S. - GIS. Manager, Soil and Landscape Analysis Laboratory (SLAL).

Agenda

(Times are approximate)

- 8:30-9:00 Registration
- 9:00-9:45 Terrain Analysis – What is it, why is it effective, and how to calculate key terrain attributes that make up the analysis.
- 9:45-10:45 Exercise 1: LiDAR DEM Data and Terrain Attributes
- 10:45-11:00 BREAK
- 11:00-11:30 Visualization and Interpretation – How to perform the analysis and interpret the results. Validation and planning strategies for getting the most out of the DEM, collected data, and ancillary GIS data.
- 11:30-12:30 Exercise 2: Visualization and Interpretation
- 12:30-1:00 LUNCH

Minnesota locations

St. Paul, Mar 13, 2012
Brainerd, Mar 15, 2012
Winona, Mar 29, 2012
E. Grand Forks, Apr 12, 2012
Duluth, May 22, 2012
Mankato, Jul 12, 2012
Morris, Jul 26, 2012



UNIVERSITY
OF MINNESOTA

Certification of Completion

_____ attended this half-day "Terrain Analysis" workshop.
Print name

_____ *Signature of participant*

_____ *Signature of instructor*

_____ *Date*



Conservation Applications of LiDAR

Terrain Analysis

Workshop Exercises

2012

These exercises are part of the "Conservation Applications of LiDAR" project – a series of hands-on workshops designed to help Minnesota GIS specialists effectively use LiDAR-derived data to address natural resource issues. The project is funded by a grant from the Environment and Natural Resources Trust Fund, and is presented by the University of Minnesota Water Resources Center with expertise provided from the University of Minnesota, MN Department of Natural Resources, MN Board of Water and Soil Resources, and USDA Natural Resources Conservation Service. More information is at <http://tsp.umn.edu/lidar>.



The Duluth sessions were funded in part under the Coastal Zone Management Act, by NOAA's Office of Ocean and Coastal Resource Management, in cooperation with Minnesota's Lake Superior Coastal Program.

