

American Water Resources Association
2010 SUMMER SPECIALTY CONFERENCE
GIS & Water Resources VI
March 29 – 31, 2010
Orlando, FL

Tuesday, March 30
8:30 AM – 10:00 AM
SESSION 11: LiDAR III

Hydrologic Terrain Processing Using Parallel Computing - David Tarboton, Utah State University, Logan, UT (co-authors: D.W. Watson, R. Wallace, K.A.T. Schreuders, T.K. Tesfa)

Digital Elevation Models are widely used to derive information for the modeling of hydrologic processes. The increasing availability of high-resolution terrain datasets for large areas poses a challenge for existing algorithms that process terrain data to extract hydrologic information. This paper will describe parallel algorithms that have been developed to enhance hydrologic terrain pre-processing so that larger datasets can be more efficiently computed. Message Passing Interface (MPI) parallel implementations have been developed for pit removal, flow direction, and generalized flow accumulation methods within the Terrain Analysis Using Digital Elevation Models (TauDEM) package. The parallel algorithm works by decomposing the domain into striped or tiled data partitions where each tile is processed by a separate processor. This method also reduces the memory requirements of each processor so that larger size grids can be processed. The parallel pit removal algorithm is adapted from the method of Planchon and Darboux that starts from a high elevation then progressively scans the grid, lowering each grid cell to the maximum of the original elevation or the lowest neighbor. The MPI implementation reconciles elevations along process domain edges after each scan. Generalized flow accumulation extends flow accumulation approaches commonly available in GIS through the integration of multiple inputs and a broad class of algebraic rules into the calculation of flow related quantities. It is based on establishing a flow field through DEM grid cells, that is then used to evaluate any mathematical function that incorporates dependence on values of the quantity being evaluated at upslope (or downslope) grid cells as well as other input quantities. The parallel generalized flow accumulation implementation relies on a dependency grid initialized with the number of upslope grid cells, that is reduced as each upslope cell is evaluated so as to track via a ready queue when each grid cell is ready for computation. The parallel implementations of these terrain analysis methods have enabled the processing of grids larger than were possible using the memory-based single processor implementation, as well as reducing computation times when run on multi-core desktop workstations and parallel computing clusters.

Assembly and Management of an Extensive LiDAR Elevation Database in a Low-Relief Coastal Area - Timothy Liebermann, S. Florida Water Mgmt. Dist., Fort Myers, FL (co-author: Diana Umpierre)

Much of the South Florida Water Management District is composed of low-lying coastal areas. As part of a statewide effort by the Florida Department of Emergency Management to evaluate the potential for coastal flooding, as well as engineering studies on the safety and improvement of the protective dike around Lake Okeechobee, some 8,000 square miles of new LiDAR data have been acquired. The delivered data, in the form of LAS files and geodatabase breaklines, was produced by several contractors and a host of subcontractors to match a single set of specifications for the whole state. Any type of topographic-data collection is difficult in southern Florida, due to extremely dense vegetation canopy, the necessity of depicting very subtle, low-relief topographic features, and the trackless nature of the Everglades, wetland forests, and coastal mangrove areas. Nevertheless, the availability of LiDAR technology represents a great improvement in overall utility, accuracy, and detail. The effort to assemble these LiDAR deliverables at the SFWMD was carried out by an ad hoc group of volunteers. After initial research and experimentation, a standardized processing routine was developed, using a series of Python scripts to run ArcGis geoprocessing commands. Each 5000-by-5000-foot tile was processed separately to produce a raster dataset (DEM) with 5-foot cell size; then individual tiles were merged for larger areas. Draft products were given an independent QA review. For modeling and display, the finished rasters were aggregated into larger cell sizes of 10, 25, 50, and 100 feet. A strategy for reviewing, documenting, storing, distributing, updating, and utilizing these large datasets is under development. The task of integrating this data into District activities - including an active surveying and GIS program, hundreds of engineering projects, and an extensive list of complex hydrologic-modeling efforts - is formidable.

The Red River of the North LiDAR Dissemination Portal and Flood Forecast Display Tool - Brian Fischer,
Houston Engineering, Inc., Maple Grove, MN (co-author: Charles Fritz)

In 2008, the International Water Institute (IWI) secured funding to collect LiDAR for approximately 45,000 sq. miles or parts of 45 counties in the U.S. portion of the Red River of the North watershed. As of spring of 2009, all the LiDAR information has been acquired and is currently being delivered in large blocks of data. This presentation will demonstrate a web GIS application developed to disseminate the LiDAR data to the public and stakeholders. The application was built with ESRI's ArcGIS Server and the FLEX API allowing users to download the LiDAR data, produce printable maps and share the data as web services to other users. This presentation will discuss the challenges of serving such a large quantity of data to users. In 2009 the Red River of the North experienced one of the worst floods on record. This presentation will also review how the LiDAR data were used prior to during the flood event. One of the tools developed in cooperation with the National Weather Service that made use of the LiDAR data was the Fargo-Moorhead flood forecasting tool. This tool provides flood inundation forecasts in a web mapping application. The presentation will discuss the importance of the current LiDAR data and the flood forecast tool in flood planning and response during an actual flood event. This project has been invaluable as organizations and residence discover the usefulness of LiDAR data and web GIS tools to support decision making and has lead to ideas for future decision support tools in the watershed.

LiDAR: A Blessing in Disguise for Watershed Modeling - Al Karlin, SWFWMD, Brooksville, FL (co-authors: Gordon McClung, Jamison Janke)

Watershed Modeling and Floodplain Mapping are among the most visible and evident activities of the Engineering and Mapping & GIS Sections at the Southwest Florida Water Management District (SWFWMD). Mapping and modeling functions are the primary components and form the basis of the Watershed Management Program for each of over 600 watersheds in the 16 county District. Prior to 2002, topographic information in the form of photogrammetrically derived 1-foot contour data was the gold-standard for watershed modeling. The lack of relief in southwestern Florida combined with the abundance of surface water during the seasonal rains precludes the effective use of 2-foot or 5-foot (USGS) contours for modeling purposes. Starting in 2004, the District replaced the use of contour data with LiDAR (Light Detection and Ranging) data to construct terrain models for surface water modeling. While this major change in technology has resulted in greater detail surfaces, it has also cost the District with increased data storage, data handling and processing times, and has presented new challenges to the Mapping & GIS Section. Coincident with the use of LiDAR data for topographic mapping, the District partnered with ESRI, to develop an ArcHydro-based geodatabase called the Geographic Watershed Information System (GWIS.) The GWIS, now in version 1.6, contains 5 Feature Datasets (Basin, HydroNetwork, Model, TopographicInformation, and Watershed) and over 100 business tables and relationship classes. (Interested readers can obtain the schema, data dictionary, white papers, learning materials, and other details for GWIS v1.6 database at <http://ftp.swfwmd.state.fl.us/pub/GWIS>.) The TopographicInformation Feature Dataset in the GWIS was designed to contain the LiDAR data, breaklines, and ESRI Terrains. The District has discovered that using LiDAR data for the Watershed Management Program has been a "blessing in disguise." In general, LiDAR provides a greatly enhanced surface, containing details that were not apparent in the photogrammetrically derived contour data. Once the LiDAR data were acquired, the processing times to derive a surface were drastically reduced as were the processing times to derive model sub-basins. This paper describes some of the advantages and disadvantages of using LiDAR for surface water modeling.