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Tuesday, March 27
8:30 AM – 10:00 AM
SESSION 12: Decision Support / Water and Power

Using GIS to Identify and Evaluate Potential Irrigation Dam Sites in Afghanistan and Reduce the Need for On-the-ground Support - Joshua Melliger, US Army Corps of Engineers, Omaha, NE

Agriculture is the largest production sector in Afghanistan with more than 80% of the population dependent on it for their livelihood. Approximately 85% of crop production comes from irrigated lands. Over the last 30 years, conflict has taken its toll on the nation's limited irrigation infrastructure. In April 2010, the US Army Corps of Engineers (USACE) - Afghanistan Engineer District (AED) tasked Omaha and several other stateside districts with performing watershed assessments to identify and evaluate new potential water resource development projects in fifteen provinces within Afghanistan. These assessments focused on the feasibility of 5-30 meter dam heights with their primary purpose being irrigation. GIS data (e.g. high resolution digital elevation models and remote sensing imagery), tools, and mapping capabilities were essential to meet project objectives as acquiring on-the-ground information such as survey data (including detailed agricultural surveys) and field photographs in Afghanistan is often extremely dangerous. GIS methodologies assisted in screening out poor potential irrigation dams and prioritized sites that would require further investigation. This presentation will focus on the types of raw GIS data used, the types and applications of various GIS tools, overcoming data gaps, and using GIS to generate maps usable by all parties.

Using GIS to Analyze the Potential for Small Hydroelectric Power Installment in the Dominican Republic - Jim Nelson, Brigham Young University, Provo, UT (co-author: Blake Buehler, Fidel Perez)

The Dominican Republic (DR) is in need of reliable, cost-effective power generation. A prolonged electricity crisis and increasing power demand have left over seven percent of citizens without access to electricity, and much of the population suffers from sporadic outages. This paper defines a GIS-based methodology to evaluate small hydropower potential, which can be used to alleviate the DR's energy problem among rural communities. The work is being done for the Instituto Nacional de Recursos Hidrulicos (INDRHI), who oversees the design and construction of multiple small hydropower projects (SHEPs) within the country. This project has two major tasks: the development of water flow prediction equations through a linear regression analysis; and the design of an ArcGIS toolset to estimate the flow duration curves (FDCs) at ungaged locations. An explanation of the inputs to the tool, as well has how it produces a suitable output for SHEP evaluation will be presented. INDRHI provided the temporal and spatial hydrologic data, including drainage areas, precipitation, curve numbers (CNs), and slopes, for 13 different gaged sites within the DR. An ordinary least squares (OLS) analysis and manual numerical search for least square error (MNS) were both calculated while implementing the regression procedure. The flow prediction equations are based on the more accurate MNS method. Equations for flows ranging from 99 percent to 20 percent were developed, with the emphasis being placed on the top 30 percent of flows. The flow prediction tool performs three main functions: the delineation of a watershed using a pour point placed upon a digital elevation model (DEM); the extraction of the temporal and spatial hydrologic data from raster and polygon feature layers; and the calculation of a watershed FDC using the flow prediction equation and calculated regression parameters for the ungaged watershed. Using the statistical flow prediction equations and ArcGIS toolset, INDRHI engineers can now determine which sites will make the best use of the available SHEP financing.

A Multi-Objective ACO Algorithm for Ice Road Planning - Kelly Brumbelow, Texas A&M University, College Station, TX (co-authors: Walter McDonald, Stephen Bourne)

Lakes on the North Slope of Alaska provide water supply for the wintertime construction of ice roads and ice pads. The North Slope Decision Support System (NSDSS) has been developed in support oil and gas exploration on Alaska's North Slope to provide a water resources management solution for ice road and ice pad construction. The NSDSS web portal is a GIS-based application which serves as the front end of NSDSS and contains several modules that interact with the map. The Ice Road Planning module within NSDSS uses a multiple objective ant

colony optimization algorithm to produce ice road routes that consider optimal water use, direct and cumulative environmental impacts, as well as multiple objectives and values among stakeholders. The ant colony algorithm within the Ice Road Planning module is able to find solutions to various planning scenarios, including problems with multiple start and multiple end points. This capability allows NSDSS users to plan ice roads off of a stretch of road where there is no defined starting point or for cases with multiple oil well locations. The Ice Road Planning module also includes several pre-processing and post-processing techniques which improve the performance of the algorithm. Using the Ice Road Planning Module coupled with the Environmental Analysis module users are able to conduct both near and long term water availability and water quality analysis of the lakes used for construction.

Lessons from the Development of New York City's Water Supply Watershed Hydrography Model - Ricardo Lopez-Torrijos, Institute for the Application of Geospatial Technologies, Albany, NY (co-authors: Cheryl Rose, Karen Kwasnowski)

Synchronous lidar and orthophotography collected in 2009 forms the basis for a New York City sponsored update of hydrographic data, aimed to manage and model NYC's 6,500 km2 water supply watershed. The database design included project and data life cycles considerations: it uses open and public hydrography and modeling standards (NHD and NHDPlus), to allow leveraging of community resources for data maintenance and implementation of management and modeling applications. Data development required 'best practice' proposals for extraction of hydrography from lidar, and tight communication with standard guarding entities to develop data compilation protocols suited for database ingestion. We present a summary of lessons for high resolution, high accuracy hydrography data collection and compilation learned in the project. Because of dense forest ground cover, the lidar collection specification was upgraded from those in federal guidelines. To achieve vertical alignment between hydrography and topography, hierarchical precedence and conflict resolution rules, constrained by temporal, horizontal and vertical accuracy characteristics of each, governed the processing of the lidar, orthophotography and other reference datasets during hydrography delineation. These spatio-temporal characteristics also determined the role that flow concentration and accumulation models played in hydrography compilation. Underground urban and transportation related storm water infrastructure, with a density of about 1 underground feature per linear km of stream, were a dominant factor in achieving the required horizontal accuracy. The product is a 3-dimensional hydrography network, vertically aligned with terrain to within the source data accuracy; an important side benefit is the underground water infrastructure collected. The standards-based data puts its maintenance in the hands of users spread around dozens of municipality, county, and state government agencies: a data update gathering network orders of magnitude larger than if done on closed models. This data also allows the City government to implement community-developed hydrographic network and surface flow analysis aligned to its existing GWLF-based modeling capabilities. Linear measures allow the enterprise planning, management and reporting databases to be connected to their spatial representation.