SECTION 1. PROJECT ADMINISTRATIVE INFORMATION

CDI Science Support Category to which the proposal is responding:
CDI SSF Category 3: Data and Information Assets (SSF3)
Project title: Hydrologic network generalization using scaled drainage density patterns
Name of lead USGS cost center requesting funding: USGS Northwest Region
Name of USGS principal investigator, mailing address, telephone, fax, and email

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Short description

This project will generate elevation-derived drainage density patterns that reflect 1:24,000-scale (24K) natural drainage density variations related to hydrologic conditions. The density patterns will be used to generalize the high-resolution National Hydrography Dataset (NHD) network (which has been compiled from multiple scales) to 24K through a stratified pruning process for subbasins in the Pacific Northwest (PNW). In addition, the project will design and test a parallel processing workflow that will reduce processing times for this type of effort in the future.

SECTION 2. PROJECT SUMMARY

Currently in the PNW, there is an increasing need in regional natural resource research, monitoring, and evaluation programs to have access to higher resolution data layers to more accurately represent their hydrography networks (Andrews et al, 2002). Many researchers now using the 1:100,000-scale NHD data layer (Larsen et al, 2008; PNAMP, 2009) in their probabilistic sampling designs to support integration of information across time, space, and programs would like to use a higher resolution, 24K layer. The existing high-resolution NHD data layer is a multi-scale layer compiled from 24K or larger scales. Consequently, it must be generalized to a common scale for proper use in map displays, network analyses, and scientific investigations. The USGS mapping program currently does not have near-term plans to generalize the high-resolution NHD layer to a consistent 24K representation in the PNW. However, researchers are currently using the layer for sampling purposes and may not be aware of the inconsistencies. To that end, we propose to begin generalizing the 234 subbasins in the PNW to support research efforts based on a consistent layer and coordination of future biological and natural resource research and monitoring efforts in the region. Aside from supporting these efforts, results may be used to enhance the NHD layer of *The National Map*. In addition, results can be used to support another longer term USGS effort, funded through the National Geospatial Technical Operations Center, to generalize the high-resolution NHD layer to smaller scales (National Geospatial Technical Operations, 2013).

We intend to eliminate variation in the NHD network caused by inconsistent compilation standards and conditions, while maintaining natural variation, in order to improve the high-resolution NHD data layer in the PNW. Using techniques developed by and with support from the Center of Excellence for Geospatial Information Science (CEGIS) and the National Geospatial Program (NGP), we will apply a semi-automated approach to create elevation-derived (ED) drainage densities from the U.S. National Elevation Dataset (NED), using a weighted flow accumulation (WFA) technique to construct naturally varying flow networks. Raster-based measurements of surface runoff, slope, soil permeability, and rock depth (or soil thickness) will be logically integrated to form spatially variable weights for WFA computations, with ground water contributions added subsequently. The goal is to build a 24K drainage density map for these subbasins from weighted ED flow networks that properly depicts natural density variations. The derived 24K drainage density map will then be used to define target densities to hydrologically generalize the high-resolution NHD network to 24K with a stratified pruning process.

Concurrently, we propose to develop and test a parallel processing workflow that should greatly reduce processing times for this type of effort in the future. Hydrologic generalization research and development completed by CEGIS and NGP in 2012 and 2013 furnished tools and procedures to automate the generation of the elevation derived density patterns and to generalize the NHD. However, extensive processing times (about 10 hours per subbasin) are needed to generate the density patterns. Batch processing may be applied to run each process on multiple subbasins, which can greatly improve daily throughput by a single processor. However, a parallel processing work flow can allow multiple processors, or a cluster of processors-such as the Beowulf cluster available in CEGIS—to simultaneously complete the multiple steps in the work flow on multiple subbasins. We plan to design, develop and test a parallel processing workflow for the CEGIS Beowulf cluster. This research will advance the USGS high-performance computing capabilities, and greatly reduce processing times for future work and testing of refined or alternative flow accumulation models.

Datasets

Used

- U. S. National Elevation Dataset
- High-resolution National Hydrography Dataset
- 5-km resolution runoff model (McCabe and Markstrom 2007, McCabe and Wolock 2008)
- Soil permeability and rock depth from State Soil Geographic Database (U.S. Department of Agriculture 1994)
- 1-km resolution base-flow index (BFI) estimated for USGS streamgages (Wolock 2003a, Wolock 2003b)

Impacted/Exposed

- Weighted flow accumulation grid
- Hydrologically consistent 24K drainage density patterns (estimated from modeled values)
- High-resolution NHD network thinned to 24K
- Potential areas of enhancement for high-resolution NHD

Deliverables

For PNW, geodatabases of elevation derived channels along with raster-based drainage density map by subbasin
For PNW, NHD geodatabases pruned to 24K by subbasin
For PNW, density difference maps (archive 24K vs. elevation derived channels vs. hi-res NHD pruned)
Update to existing documentation and workflow for implementing process
Design and test results of parallel processing workflow
Publication(s) and presentation(s) documenting results of work

References

Andrews, P., Ilieve, P.I., Gilland, K.R., Cooter, W.S., Kramer, B., and Dewald, T., 2002, Moving from1:100K NHD to 1:24K Resoultion: Case Studies. U.S. Environmental Protection Agency at URL http://www.epa.gov/waters/doc/p0340.pdf

Larsen, D.P., Olsen, A.R., and Stevens, Jr., D.L., 2008, Using a Master Sample to Integrate Stream Monitoring Programs. Journal of Agricultural, Biological, and Environmental Statistics, 13(3): 243-254.

McCabe, G.J. and Markstrom, S.L., 2007, A monthly water-balance model driven by a graphical user interface. U.S. Geological Survey, *Open-File Report 2007-1088*, 6pp.

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Pacific Northwest Aquatic Monitoring Partnership (PNAMP), 2009, Integrating Aquatic Ecosystem Fish Status and Trend Monitoring in the Lower Columbia River: Using the Master Sample Concept, PNAMP Series 2009-007, 29pp.

U. S. Department of Agriculture, 1994, STATSGO State Soil Survey Geographic Data Set.

Wolock, D.M., 2003a, Flow characteristics at U.S. Geological Survey streamgages in the conterminous United States: U.S. Geological Survey Open-File Report 03-146, digital dataset, available on the World Wide Web, accessed June 30, 2003, at URL http://water.usgs.gov/lookup/getspatial?qsitesdd

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SECTION 3. ESTIMATED BUDGET

Budget Category	**Federal Funds "Requested"**	**Matching Funds "Proposed"**
1. SALARIES (including Benefits):		
Personnel Total:	$ 20,000	$ 20,000
Contract Personnel Total:	$ 27,000	$ 12,000
Total Salaries:	$ 47,000	$ 32,000
2. TRAVEL EXPENSES:		
Travel Total (Per Diem, Airfare, Mileage/Shuttle) **x** # of Trips:	$ 0	$ 1,500
Other travel expense (Registration fees):	$ 0	$ 0
Total Travel Expenses:	$ 0	$ 1,500
3. OTHER DIRECT COSTS: (itemize)		
Equipment (inc. software, hardware):	$ 300	$ 0
Publication Costs:	$ 1,000	$ 0
Office supplies, Training, Other expenses:	$ 0	$ 0
Total Other Direct Costs:	$ 1,300	$ 0
Total Direct Costs:	$ 48,300	$ 33,500
Indirect Costs (21.158% for reimbursable funds on federal personnel):	$ 0	$ 0
GRAND TOTAL:	$ 48,300	$ 33,500

We have checked with and received confirmation from the Contracting Officer's Representative (COR) that the contracting staff can participate if we intend to send funds outside USGS.