CDI FY17 Request for Proposals

Changing landscapes: Comparative analysis of land use footprints from oil and gas development across the United States

Submission Title: Changing landscapes: Comparative analysis of land use footprints from oil and gas development across the United States

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Mission Area: Energy and Minerals

Region: Northwest Region

Organization: Northern Rocky Mountain Science Center

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Co-PIs and Collaborators:

Science Support Framework Element 1: Information

Science Support Framework Element 2: Science Data Lifecycle - Analysis

Science Support Framework Element 3: Science Data Lifecycle - Publishing/Sharing

In-Kind Match: $23,500.00

List of anticipated deliverables from the project: National energy development shapefile, webmap, GIS portal, peer reviewed journal article

Lead Cost Center: Northern Rocky Mountain Science Center

Notes, Comments: This project has three USGS Co-PIs.

Project Description: This project will compile numerous spatial datasets pertaining to energy development, perform a comparative analysis in land use footprints, develop a web map for visualizing these data, and create a GIS data portal to house current and developed data sets.

Total Budget: $46,445.00

Title: Changing landscapes: Comparative analysis of land use footprints from oil and gas development across the United States

Lead Principal Investigators:
Todd Preston, Geologist, Northern Rocky Mountain Science Center
Cericia Martinez, Mendenhall Fellow Research Geophysicist, Central Energy Resources Science Center
Stephen Opsahl, Hydrologist, Texas Water Science Center

Project Summary: New advances in lateral drilling and hydraulic fracturing technologies have resulted in rapid oil and gas (energy hereafter) development and associated land cover changes in the United States. Recognizing the importance of land cover change from energy development, several studies have recently been conducted at key energy plays, including the Williston Basin[1], Piceance Basin[2], Green River Basin[3], the Marcellus Shale[4], and the Eagle Ford Shale[5]. While these studies have been instrumental in evaluating land cover changes on a local scale, little research has been done to examine differences in land use footprints from energy development on a nation scale. In order to gauge land cover changes on a national scale, we must first develop an understanding of the baseline land use footprint of energy development on a national scale. Thus, this project will compile numerous spatial datasets pertaining to energy development, perform a comparative analysis in land use footprints, develop a web map for visualizing these data, and create a GIS data portal to house current and developed data sets.

Considerable efforts have been made to digitize energy development infrastructure across the nation and this project seeks to compile this data into a single, publically available dataset and develop a web map and GIS portal to serve this data. Well pads (i.e. well sites) have been digitized for the Williston Basin, Green River Basin, and the Colorado portion of the Piceance Basin. Similar digitization efforts, that also include roads, pipelines and other related features, have been completed in select counties within the Marcellus and Eagle Ford Shale. Additionally, there are likely other datasets that we are unaware of. We will compile and cross-walk available and discovered datasets, develop FGDC compliant metadata, and develop a web map similar to the USGS Wind Turbine or Energy maps for product sustainability.

There are profound spatial and temporal differences in energy development that this project plans to explore to improve our national understanding of land change from energy development. Specifically, the comparative analysis will examine key metrics of land use such as area, fragmentation, and creation of edge environments in conjunction with energy specifications such as energy type and well density. Examples on how differences in energy development affect these land use metrics are illustrated below.

The extraction of specific subsurface resources (gas vs. oil) varies nationally and produces different spatial footprints in land cover change across regions and ecosystems. For example, different energy plays have varying well pad geometries which affect edge length. Well pads are generally small and rounded in the Piceance Basin compared to the generally rectangular pads in the Williston Basin (Fig 1). As a result, a more circular well pad with an area of 5,000 m^2 produces ~250 m of edge compared to the 300 m of edge from a rectangular pad (50 × 100 m) with the same area. Understanding the consistency and edge environments regionally and the differences nationally would further our knowledge of land use changes on a national scale.

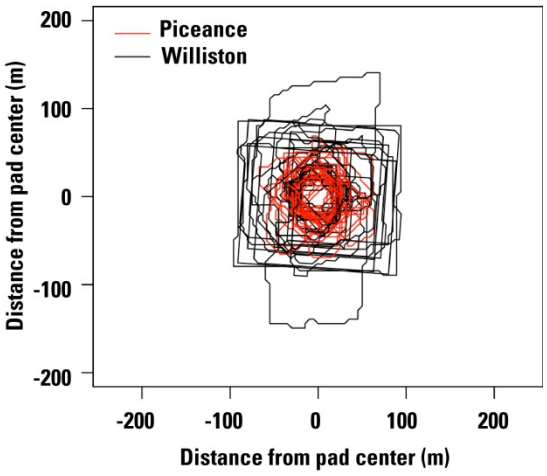

Figure 1. Outlines of 30 randomly selected well pads in the Piceance and Williston Basins. Note differences in pad sizes and geometries.

Furthermore, the advent of new drilling technologies produces temporal differences in the footprint of energy development as much of the recent development is occurring in areas with a history of production. Historically, oil and gas wells were drilled vertically, which required the construction of a separate well pad for

each well. Numerous, closely spaced wells were required to fully extract oil and gas from a given field. In contrast, recent development has been driven by directionally drilled, hydraulically fractured wells enabling multiple wells to be drilled from a single site. As a result, although well pads may be larger, well pad densities can be lower. Hence, geological and technical constraints can influence the number and density of well pads which influences the resulting disturbed area and habitat fragmentation.

Numerous tools currently exist in order to evaluate area, habitat fragmentation, and creation of edge environments from disturbance and we will use these established methods for our comparative analyses. As part of the FY16 CDI process, Preston and Bolus developed a set of ArcGIS tools to integrate the USGS GAP land cover data with spatially explicit disturbance data to determine the amount of habitat conversion. This method will be used to determine the area of disturbance and also to determine previous land cover classifications. Habitat fragmentation will be classified using the Landscape Fragmentation Tool[6]. Creation of edge effects (both total and per well) will be calculated using ArcGIS. Results from our analyses will be presented in a peer reviewed journal article and available through a web map.

Lastly, while we propose compiling available datasets, a key product of this project is the development of a GIS portal to house current and future datasets related to energy development. Such a portal would allow researchers across the USGS (or other entities) generating similar datasets the ability to upload their data and integrate it with existing data through the web map. Hence, the GIS portal would allow interdisciplinary researchers to broaden their independent studies, bridging the gap between local, regional, and national scale investigations on land use/land change studies.

Budget:

Budget Category	Federal Funding "Requested"	Matching Funds "Proposed"
1. PERSONNEL (SALARIES including benefits):		
Federal Personnel Total:	$35,000	$20,000
Contract/Collaborator Personnel Total	-	
Total Salaries:	$35,000	$20,000
2. TRAVEL EXPENSES:		
Travel Total (Per Diem, Airfare, Mileage) 1 Trip:	$2,000	-
Other expenses (e.g. registration fees):	$500	-
Total Travel Expenses:	$2,500	$0
3. OTHER DIRECT COSTS: (itemize)		
Equipment (inc. software, hardware, purchases/rentals):	$1,500	$3500
Publication Costs:	$1,500	-
Office supplies, Training, Other Expenses (specify):	-	-
Total Other Direct Costs:	$3,000	$3,500
Total Direct Costs:	$30,500	$23,500
Indirect Cost (NOROCK 14.68%):	$5,945	-
GRAND TOTAL:	$46,445	$23,500

References:

[1]Preston, T.M. and Kim, K. 2016. Land cover changes associated with recent energy development in Williston Basin; Northern Great Plains, USA. *Science of the Total Environment.* Vol. 566-567, pp. 1511-1518.

[2]Martinez, C, Preston, T.M. *In review.* Land cover changes in the Piceance Basin. *Science of the Total Environment.*

[3]Garman, S.L., and McBeth, J.L., 2014. Digital representation of oil and natural gas wells well pad scars in southwest Wyoming, U.S. Geological Survey Data Series 800, 7 p.

[4]Slonecker, E.T., Milheim, L.E., Roig-Silva, C.M., Malizia, A.R., Marr, D.A., and Fisher, G.B., 2012, Landscape consequences of natural gas extraction in Bradford and Washington Counties, Pennsylvania, 2004–2010: U.S. Geological Survey Open-File Report 2012–1154, 36 p.,

[5]Pierre, J.P., Abolt, C.J. & Young, M.H., 2015. Impacts from above-ground activities in the Eagle Ford Shale play on sandscapes and hydrologic flows, La Salle County, Texas. *Environmental Management.* Vol. 55, pp. 1262-1275.

[6]Parent, J. and Hurd, J.D. 2007. Landscape Fragmentation Tool v 2.0. University of Connecticut, Center for Land Use Education and Research.