**NASA DEVELOP National Program**

**2018 Summer Project Proposal**

**Alabama – Marshall**

**New Mexico Energy**

*Identifying Optimal Site Location for Wind Energy Farms through an Ecological and Social Impact Analysis*

**Project Overview**

***Project Synopsis*:** The team will collaborate with the National Renewable Energy Laboratory (NREL) to provide the New Mexico Energy Conservation & Management Division (ECMD) and the New Mexico Department of Game & Fish (NMDGF) with four Optimal Wind Farm Site Maps based on three criteria: social impact, ecological impact, and power production efficiency. The team will determine power production efficiency using SRTM elevation data, land cover from Landsat 8 OLI, the High Density Infrared Cloud Drift Winds below 700 mb Operational Product, and ancillary datasets. These products will assist in meeting New Mexico’s Renewables Portfolio Standard goals and demonstrating the viability of this approach for consideration in other states or regions

***Community Concern:*** In 2004, Bill Richardson, the governor of New Mexico, established a Renewables Portfolio Standard that requires investor-owned utilities to generate 20% of total sales from renewable energy. According to NREL, New Mexico is expected to increase from 0.78 GW of wind power capacity in 2013 up to a potential of 2.35 GW in 2020 and 4.85 GW by 2030. However, in order to accomplish these goals and fulfill predicted capacities, a 520% increase of wind power capacity must occur. Wind characteristics such as wind speed and direction are essential for planning wind farm sites with the greatest efficiency, thus reducing costs. Simultaneously, it is imperative to incorporate the social and ecological impact of wind turbine placement. The NMDGF emphasizes the importance of considering turbine impact on eagles, as a primary species that brings in regulatory considerations. The ECMD is currently working on solutions for balancing the renewable energy growth that is needed for a healthy New Mexico economy while supporting the military flyways that comprise a majority of New Mexico’s air space and are needed to maintain a modern and effective defense system. As conflicts between military use of airspace and wind energy development are bound to increase as the wind energy sector grows, more tools are needed to mitigate these conflicts.

***Source of Project Idea:*** This project idea came from discussions among Alabama – Marshall node leadership with the goal of developing an energy-related project that could have an impact on sustainability. The project partners identified that the results of this project would be beneficial for their decision-making processes.

***National Application Area Addressed:*** Energy

***Study Location:*** NM

***Study Period:*** February 2013 – May 2018

***Advisors:*** Dr. Jeffrey Luvall (NASA Marshall Space Flight Center), Dr. Robert Griffin (University of

Alabama in Huntsville), Leigh Sinclair (University of Alabama in Huntsville/Information Technology and

Systems Center), Maggi Klug (University of Alabama in Huntsville)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **New Mexico Energy, Minerals & Natural Resources Department, Energy Conservation & Management Division** | Jeremy Lewis, Bureau Chief | End User | Yes |
| **New Mexico Department of Game & Fish**  | Ronald Kellermueller, Mining & Energy Habitat Specialist | End User | No |
| **Department of Energy, National Renewable Energy Laboratory** | Robi Robichaud, Researcher IV | End User | No |

***End-User Overview***

***End User’s Current Decision-Making Process:***The ECMD runs a wind power program where they foster the development of wind power within the state. Specifically, the ECMD provides information that is instrumental to the creation of wind utilities to wind power developers, the energy holding company PNM Resources, land owners, etc. The ECMD primarily collects and provides *in situ* data, like wind speed, as a resource for wind power development. The NMDGF conserves wildlife in New Mexico according to the State Wildlife Action Plan (SWAP). Approved by the department in 2017, SWAP defines needs and opportunities related to wildlife conservation in NM through 2025.

***End User’s Capacity to Use NASA Earth Observations:***

*New Mexico Energy, Minerals & Natural Resources Department, Energy Conservation & Management Division* – This end user primarily collects *in situ* measurements of wind speed and provides them to wind power developers. In addition, the ECMD has partnered with the NREL and TrueWind Solutions, LLC to display wind speed data at various heights in the atmosphere using GIS.

*New Mexico Department of Game & Fish* - This end user prioritizes the conservation of New Mexico’s wildlife while also managing various recreation activities. This end user primarily uses *in situ* data to make decisions about licensing, recreational opportunities, and conservation efforts.

*Department of Energy, National Renewable Energy Laboratory* – NREL is always looking at new approaches to support local, state and regional organizations to better understand wind energy development potential. Based on the results and effectiveness of the work, NREL may implement the defined process in other parts of the US. A key issue will be understanding how the different datasets will help identify which areas can be developed, to address this, NREL will provide technical insight into wind technology and development.

***Boundary Organization Overview***

***Dissemination by Boundary Organizations*:**

*New Mexico Energy, Minerals & Natural Resources Department, Energy Conservation & Management Division* – The ECMD acts as a boundary organization, connecting wind power developers, PNM Resources, and land owners to critical information to expand wind power facilities, such as wind speed data. This data is primarily *in situ* data, but ECMD does make use of GIS to represent their data. The ECMD also provides educational material related to conservation of resources as well as renewable energy tax credits, loans, and more, for the state of New Mexico.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The Project Lead will be the main POC for communication throughout the term. The team will communicate with the partners via teleconference every one or two weeks. Additionally, the Project Lead will update the project partners regularly through email.

***Transition Plan:*** Handoff will be conducted remotely via a webinar during the last week of the term. During this webinar, the team will explain their methods and answer any questions about the end products. The products will be delivered digitally via google drive at the end of the term for immediate implementation by the end users.

**Earth Observations Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **SRTM** | Elevation | Elevation and slope will be used to identify optimal wind farm sites. |
| **Landsat 8 OLI** | Surface reflectance | Landsat 8 OLI will be used to classify land cover in New Mexico, and will be an input for identifying optimal wind farm locations as well as suitable habitat for the species of interest. |

***Ancillary Datasets:***

NASA Surface Meteorology and Solar Energy (SSE) dataset – Provide wind speed and direction for identification of optimal wind farm sites

NOAA U.S. Hourly Climate Normals dataset – Provide *in situ* measurements of wind from National Weather Service stations

NOAA High Density Infrared Cloud Drift Winds below 700 mb Operational Product – Provide wind speed and direction, a factor in determining optimal wind farm sites

USDA National Resources Conservation Service (NRCS) U.S. General Soil Map (STATSGO2) – Provide soil type based on Landsat imagery as well as *in situ* data to determine optimal turbine foundation sites

USGS National Land Cover Dataset (NLCD) – Compare with land classifications

Center for International Earth Science Information Network (CIESIN) Socioeconomic Data and Applications Center (SEDAC) U.S. Census Grids Summary File 1 v.1 – Provide socioeconomic and demographic information at ~1 sq. km resolution as collected by the census to assist with identification of potentially impacted populations

eBird Basic Dataset Cornell Lab of Ornithology – eagle distribution and abundance

New Mexico Natural Heritage Database – eagle distribution and abundance

***Modeling:***

Fuzzy Logic Modeling (POC: Helen Baldwin, NASA DEVELOP)

Land Use Conflict Identification Strategy (LUCIS) (POC: Dr. Rosanna Rivero, University of Georgia)

***Software & Scripting:***

Esri ArcGIS – Land Classification of Landsat imagery, creation of suitable habitat and optimal site location maps

Google Earth Engine API – Large scale Landsat image analysis

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Optimal Efficiency Wind Farm Development Map** | This map will provide end users with an additional tool for identifying potential wind farm sites considering optimal wind power production throughout New Mexico. | The team will overlay SRTM elevation data, land cover from Landsat 8 OLI, High Density Infrared Cloud Drift Winds below 700 mb Operational Product, and additional wind and soil datasets to determine power production efficiency. | N/A |
| **Low Social Impact Wind Farm Development Map** | This map will provide end users with an additional tool for identifying potential wind farm locations that have a low impact on human populations, focusing on impacts on Air Force Bases.  | The team will overlay the optimal efficiency wind farm sites with demographic and socioeconomic data from SEDAC, and incorporate additional data to determine wind farm sites with lower social impacts, especially on Air Force Bases.  | N/A |
| **Low Ecological Impact Wind Farm Development Map** | This map will provide end users with an additional tool for identifying potential wind farm sites considering potential impact on eagles. | The team will overlay the optimal efficiency wind farm sites with habitat suitable for eagles, eagle observation data, and other factors related to eagle well-being to determine wind farm sites with lower ecological impacts on eagles.  | N/A |
| **Optimal Wind Farm Suitability Map** | This map will provide the end user with an additional tool for developing wind farm sites through a GIS representation of locations with the least impact on human populations and species of interest, while allowing optimal power production. | Using LUCIS, the team will overlay data from the previous three maps and determine the most optimal sites for wind farm expansion. | N/A |

***End-User Benefit*:** The end products will provide the end users an illustration of optimal locations for wind power expansion in New Mexico, based on different focusing criteria (i.e. ecological impact on eagles, social impact on military bases, power production efficiency). The team will define these criteria considering available datasets and incorporating partner feedback to make the results relevant to project partners. The compilation of these maps will allow the end users to easily share this information with interested parties without the need of GIS software. As New Mexico works toward the renewable energy goals described by their Renewables Portfolio Standard, the identification of optimal areas for wind power expansion is critical.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2018 Summer

***Related DEVELOP Work:***

2013 Summer (LaRC) – Rwanda Energy: Utilizing NASA Earth Observations to Determine Site Suitability for Green Energy Resources in Rwanda

2013 Fall (WC) – Rwanda Energy: Utilizing NASA’s Earth Observations to Investigate Site Suitability for Renewable Energy Resources in Rwanda

2017 Summer (UGA) - Georgia Energy: Reducing Conflicts in Siting Solar Power Generating Facilities by Identifying Sensitive Habitats and Wildlife Populations in Areas with High Solar Power Potential

2017 Fall (MSFC) - North Alabama Ecological Forecasting: Spatial Modeling of the Fragmentation of Local Species Habitat from Increasing Urbanization in North Alabama

**Notes & References:**

***References:***

Martinez, S. & Martin, D. (2015). New Mexico Energy Policy & Implementation Plan. New Mexico Energy Potential: Creating a More Diverse Economy in New Mexico. Retrieved from www.emnrd.state.nm.us/ECMD/documents/NMEnergyPolicy2015\_000.pdf

Mentis, D., Hermann, S., Howells, M., Welsh, M., & Siyal, S.H. (2014). Assessing the technical wind energy potential in Africa: A GIS based approach. *Renewable Energy, 83*, 110-125. DOI: 10.1016/j.renene.2015.03.072

New Mexico Energy, Minerals & Natural Resources Department.(2016). 2016 Annual Report. Retrieved from <http://www.emnrd.state.nm.us/AD>

MIN/documents/Final\_2016\_EMNRD\_AnnualReport.pdf