My work during this grant period has taken two paths, both focused on water and energy in Asia. The first, titled "Affordable Brackish Water Desalination", was the subject of my research in Fall 2015; and the second, titled "Pumped Hydroelectric Power Storage in China", is a topic that I'm currently exploring for my future PhD research.

Project 1: Affordable Brackish Water Desalination

More than 800 million people in rural India live without adequate supply of water, and an even higher number lack access to *safe* drinking water. Treatment of India's vast reserves of brackish groundwater (1000 – 3500 mg_{salt}/L) is a promising solution to the drinking water crisis. Unfortunately, existing desalination methods like reverse osmosis are energy inefficient and expensive. Capacitive deionization (CDI), a desalination technique in which an applied potential creates oppositely charged electrodes to attract ions, could be an effective alternative. However, CDI must be improved before it becomes appropriate for developing communities. A major challenge to CDI is its low removal efficiency due to the low ion holding capacity of common CDI electrodes. This can be remedied by embedding ion exchange resin (IER) beads into the electrodes, which will increase the capture of charged contaminants. The incorporation of IER beads could significantly improve the energy and charge efficiency of CDI. Working with a postdoctoral researcher in Ashok Gadgil's group, I aided in developing a physically robust, hydrophilic, conductive, high surface area, and high ion-capacity electrode material that incorporates IER. My contribution was the development of an electrode formula (incorporating binders, IER, carbon, and solvent) that is conductive and physically robust in air, distilled water, and salt solution. This innovative electrode material might one day be used for CDI units, providing affordable and high-quality drinking water to rural households across poor communities in developing countries.

Project 2: Pumped Hydroelectric Power Storage (PHPS) in China

China's water-energy nexus comes with many environmental and political tradeoffs. In an effort to move towards cleaner renewable energy, the Chinese government has begun an aggressive hydropower campaign: the country is currently the world's largest producer of hydroelectricity, boasting 220 large and medium-scale (>50MW) and over 40,000 small (<50 MW) plants. While considered a clean technology, traditional hydropower is not without serious environmental and political consequences. The most common forms of hydropower developed in China are storage schemes, in which a dam is used to impound water in a reservoir. These schemes often require resettlement of thousands, and cause water supply and quality problems for downstream users, eutrophication, and increased potential for geologic disasters. There is a need for small, non-dam hydropower like run-of-river hydropower and low head hydropower, which are small-scale alternatives with minimized environmental and political impacts. However, these alternatives come with a complication: given the temporal variability in water supply, an additional smoothing power supply (in China's case, usually coal) or energy storage technique is necessary for times when demand exceeds supply. In answer to this issue, pumped hydroelectric power storage (PHPS) is considered the only commercially proven technology for grid-scale energy storage. Its many advantages include the improvement of grid reliability, flexibility, and affordability (compared to other electricity storage methods). Indeed, 98% of the world's energy storage is currently in the form of PHPS, but surprisingly little is used in central China. I am interested in exploring the potential for run-of-river hydropower and low head hydropower in central China, as well as identifying areas appropriate for pumped storage. I will explore the following scientific questions: (1) what is the accuracy of precipitation and streamflow datasets? Are bias corrections to satellite data necessary, and if so, how should they be performed? (2) How should rainfall-runoff relationships be modeled under the many climate and topographical conditions of China? (3) How can human withdrawals of water be represented to allow accurate prediction of low-head hydropower potential? Answering these questions will make it possible to investigate the potential for low head and run-of-river schemes, as well as determine optimal locations of PHPS.