DEVELOP National Program

Climate Project Proposals

Spring 2015

Proposals Snapshot

1. Great Lakes Climate II: Monitoring the Impacts of Climate Change and Decreasing Water Levels on Wetlands in the Great Lakes Region of North America (Langley)
Wetlands in the Great Lakes region are at risk of degradation due to changes in land cover and increasing water demands, which are causing lake levels to decrease. Historic Landsat and Aqua/Terra MODIS data will be used to determining areas of change while Jason-2 will show changes in water levels to enhance coastal management in Georgian Bay.

2. Regional US Climate & Energy: Predicting Heating Degree Days and Natural Gas Demand in the Midwest Eastern United States Using Climatic Signals and the NCDC Climate Data Records (NCDC)
This project will use several tropical climate signals, including Madden-Julian Oscillation (MJO), Kelvin Waves (KW), and Equatorial Rossby Waves (ERW) to forecast heating degree days for an area defined in the energy sector as the Midwest and Eastern United States. This region incorporates both the Midwest and Northeastern United States. These forecasted heating degree days can be used to estimate natural gas demand.

3. Navajo Nation Climate: Assessing Climate Change Impacts on Ground Water Availability and Drought Vulnerability in the Navajo Nation Using NASA Earth Observations (Ames)
Climate variability and change has the potential to substantially impact water resource availability in the southwestern United States. The Navajo Nation (NN) may be disproportionately affected by climate change impacts due to limited water rights, endangered cultural practices, and infrastructural limitations. This project aims to assess impacts on water resource availability on the NN with climate change using NASA Earth observing satellites and hydrological modeling techniques.

Partners Snapshot

Regional Partners
- Great Lakes and St. Lawrence Cities Initiative (Partner/Boundary Organization)
- Tennessee Valley Authority (End-User)

NGO Partner
- Earth Risk Technology Inc. (End-User)

International Partner
- Georgian Bay Forever (Partner/End-User)

Federal Partners
- Global Science & Technology National Climatic Data Center (NCDC) (Partner)
- Cooperative Institute for Climate and Satellites-NC (CICS-NC) (Partner)

Tribal Partners
- Navajo Nation Department of Water Resources (NNDWR): Water Management Branch (End-User)
- Navajo Technical University (End-User)
- Navajo Nation Division of Natural Resources: Water Management Branch (Partner)

Letters of Support

- Ames Navajo Nation Climate – Ramsey Seweingyawma, Geospatial Engineering Technology Instructor, Navajo Technical University

Project Proposals

1. Great Lakes Climate II (Langley)

Great Lakes Climate II
Monitoring the Impacts of Climate Change and Decreasing Water Levels on Wetlands in the Great Lakes Region of North America

Objective:
Wetlands in the Great Lakes region are at risk of degradation due to changes in land cover and increasing water demands, which are causing lake levels to decrease. Historic Landsat and Aqua/Terra MODIS data will be used to determining areas of change while Jason-2 will show changes in water levels to enhance coastal management in Georgian Bay.

Community Concern:
Wetlands are vital ecosystems in the Great Lakes because of the diverse species that live there and the social and economic benefits that come with tourism. However, many of the Great Lakes' wetlands have been shrinking due to demand for land. Furthermore, the overall health of the wetlands has been degraded by invasive species and other harmful environmental factors. Increasing demand for water in rising populations as well as climate change are causing the water level of the lakes to decrease to potentially historic lows.

End-Users/Partners/Boundary Organizations:
Great Lakes and St. Lawrence Cities Initiative (Partner/Boundary Organization, POC: Dave Ullrich, Executive Director)
Georgian Bay Forever (Partner/End-User, POC: David Sweetnam, Executive Director)

DEVELOP has had a strong partnership with the Great Lakes and St. Lawrence Cities Initiative (GLSLCI) for the past 6 years, supporting management and monitoring strategies for the entire area. As evidenced by on-going communication with the GLSLCI and Georgian Bay Forever, the need for tracking long-term changes in wetlands and water levels is very important for the economic and ecological communities surrounding the Great Lakes. Using NASA's EOS to augment current monitoring practices will greatly improve the historical record, showing changes in wetland health and extent. Project deliverables will be transitioned to the end-users through the project collaborators listed above.

Decision Making Process:
Currently, the extent and health of wetlands is monitored using aerial photography and ground surveying. NASA Earth observations are not currently used, and could offer a more cost-effective solution at a higher temporal resolution.

Earth Observations:

Platform	Sensor	Geophysical Parameter
Landsat 8	OLI/TIR	Land Cover
Landsat 7	ETM+	Land Cover
Landsat 5	TM	Land Cover
Aqua	MODIS	NDVI

Terra	MODIS	NDVI
OSTM/Jason-2	Poseidon-3	Lake Levels

NASA Earth Observations to be Highlighted:
The Landsat series will be used to create a time series of the wetlands' health and extent. Aqua and Terra MODIS will be used to create NDVI maps for the study area with the possibility of creating an additional time series for changes in NDVI. Jason-2 (Poseidon-3 sensor) will be used to monitor the change in lake levels and will be validated by water gauges provided by partner organizations.

Ancillary Datasets:
Water gauge data, in situ measurements, aerial imagery, previous wetland assessments

Decision Support & Analyses:

Proposed End Products	Decision Impacting	Current Partner Tool/Method
Time-series of Wetland Extent and Health	Restoration efforts or policy design based on monitoring results	Aerial imagery and field surveys

Time-series maps of Wetland Extent and Health – historical and current wetland extent and health will be assessed by land cover classification methods using Landsat and Aqua/Terra MODIS data.

Project Details:
National Application Area Addressed: Climate
Source of Project Idea: This project idea was proposed by Dave Ullrich from the Great Lakes and St. Lawrence Cities Initiative through continuing communications with the National Program Office.

Advisor: Dr. Kenton Ross, NASA DEVELOP National Program
# of Participants Requested: 4
Project Timeline: 2 terms: 2014 Fall (Start) and 2015 Spring (Completion)
Study Location: Great Lakes region of United States and Canada: list states and provinces
Period being Studied: TBD

Previous Related DEVELOP Work:
Great Lakes Climate
Monitoring the Impacts of Climate Change and Decreasing Water Levels on Wetlands in the Great Lakes Region of North America
2014 Fall (LaRC)

Multi-Term Objectives:
- **Term 1** – Classify land cover to identify wetland extent historically and currently for the Georgian Bay region to highlight the changes in wetland health.
- **Term 2 (Proposed Term)** – Expand the methodologies of term 1 to include Lake Michigan and St. Lawrence River – Lac San Pierre. This term will also improve on the land classification system and include a more complete time series account of the change in wetland extent.

2. Regional US Climate & Energy (NCDC)

Predicting Heating Degree Days and Natural Gas Demand in the Midwest Eastern United States Using Climatic Signals and the NCDC Climate Data Records

Objective:

This project will use several tropical climate signals, including Madden-Julian Oscillation (MJO), Kelvin Waves (KW), and Equatorial Rossby Waves (ERW) to forecast heating degree days for an area defined in the energy sector as the Midwest and Eastern United States. This region incorporates both the Midwest and Northeastern United States. These forecasted heating degree days can be used to estimate natural gas demand.

Community Concern:

Heating degree days are used to forecast demand in natural gas. Demand is the key driver in the price of natural gas. Decision makers typically look at forecasts for one to four weeks out in determining demand for natural gas. However, after week 3 and 4 these forecasts become less reliable. This project aims to investigate the relationship between tropical climatic signals and heating degree days. This research could provide a more effective method for forecasting heating degree days for the natural gas industry.

End-Users/Partners/Boundary Organizations:

Earth Risk Technology Inc. (End-User, POC: Dave Margolin, Research Team Lead)
Tennessee Valley Authority (End-User, POC: TBD)
Global Science & Technology National Climatic Data Center (NCDC) (Partner, POC: DeWayne Cecil, Chief Climatologist and Program Manager)
Cooperative Institute for Climate and Satellites-NC (CICS-NC) (Partner, POC: Carl Schreck, Associate Researcher)

Initial contact has been made with Dave Margolin (Earth Risk Technology). He has expressed interest in working with the DEVELOP team on this project. The team would meet with Dave throughout the term to gain his input and feedback as an end user. He would really like an analysis that identifies how tropical climatic signals impact heating degree days for the Midwest and Eastern United States. This information would then be included in the statistical methods and models currently used at Earth Risk Technology. The end products and analysis will be handed off to him via email and teleconference.

Decision Making Process:

Dave Margolin's focus at Earth Risk Technology is to link applied weather research and forecasting with energy markets. The current decision making process involves examining several types of tools and models to understand how weather will drive demand for natural gas and other energy markets. These models include both dynamical weather models and statistical techniques. These various techniques incorporate earth observations into the models.

Earth Observations:

Platform	Sensor	Geophysical Parameter
OLR-CDR	High-resolution Infrared Radiation Sounder (HIRS) Level 1-b, Geostationary Orbiting Environmental Satellites (GOES) Surface and Insolation Product	Outgoing Longwave Radiation

NOAA Earth Observations to be Highlighted:

The Outgoing Longwave Radiation CDR (OLR-CDR) has been used in previous work (Schreck et al, 2013) to create the Multivariate Pacific-North American (PNA) (MVP) index, to identify how extratropical wave patterns change over North America with the influence of the Madden Julian Oscillation. The MVP demonstrated how the OLR-CDR can be used to identify tropical patterns that influence temperatures across North America.

Ancillary Datasets:
In situ calculations of heating degree days (HDDs) using the Global Historical Climatology Network

Decision Support & Analyses:

Proposed End Products	Decision Impacting	Current Partner Tool/Method
Spatial Multivariate Regression Analysis	Predict HDDs throughout the study area	Processed images and animation of predicted values throughout study area
Probability Analysis	Predict the likelihood of the number of extreme HDDs throughout the study area.	Processed images and animation of likelihood of extreme number of HDDs throughout the study area
Contingency Analysis	Compares predicted values of HDDs with those that actually occurred to assess the accuracy and reliability of the regression analysis.	This will either be a set of graphs or images

Spatial Multivariate Regression Analysis - A multivariate regression analysis will be performed which will use Empirical Orthogonal Functions derived from OLR-CDR of MJO, KW, and ERW as predictors to predict heating degree days. This will be a pixel-wise calculation to show the spatial variation in the predicted heating degree days throughout our study area.

Probability Analysis – A pixel-wise probability analysis will show the likelihood of strong or weak heating degree days occurring in a given week throughout the study area.

Contingency Analysis - The accuracy of our predictions will be assessed through a set of contingency statistics, which compare the forecasted heating degree days with observed heating degree days.

Project Details:
National Application Areas Addressed: Energy, Climate, Weather.
Source of Project Idea: The idea for this project came from Dr. Carl Schreck who has worked on pervious work involving tropic climatic signals and mid-latitude temperatures.

Advisors: Dr. Carl Schreck(CICS-NC/NCSU, and NOAA/NCDC), Dr. DeWayne Cecil (Chief Climatologist and Program Manager Global Science & Technology NCDC)
# of Participants Requested: 4
Project Timeline: 1Term: Spring 2015
Study Location: Midwest-Northeast US (MN, IA, WI, MI, IL, IN, MO,AR, TN, KY, OH, PA, VA, NC, SC, MD, DE, NJ, CT, RI, MA, NH, VT, ME)
Period being Studied: December – March, 1983 – 2013

Note: NOAA funds project activity taking place at the DEVELOP NCDC location.

3. Navajo Nation Climate (Ames)

Navajo Nation Climate

Assessing Climate Change Impacts on Ground Water Availability and Drought Vulnerability in the Navajo Nation Using NASA Earth Observations

Objective:

Climate variability and change has the potential to substantially impact water resource availability in the southwestern United States. The Navajo Nation (NN) may be disproportionately affected by climate change impacts due to limited water rights, endangered cultural practices, and infrastructural limitations. This project aims to assess impacts on water resource availability on the NN with climate change using NASA Earth Observing (EOS) satellites and hydrological modeling techniques.

Community Concern:

Water is one of the most important resources for the NN, and has implications to the successful management of many operations. Over 70,000 Navajo (roughly one-third of the Reservation population) do not have access to running water due to water rights and infrastructural issues. Climate change impacts in the Southwestern US are predicted to disproportionately affect the NN, with substantial issues in regard to water resource availability. The projected climate change impacts on water resources include: declines in snowpack, more persistent and long-term droughts, decreases in late spring and summer streamflow due to changes in snowmelt timing, and decreases in water quality. In a recent report addressing the climate change and variability adaptation on the NN, water was deemed a "super sector" that has implications for all sectors of the NN including agriculture, forest management, energy, economic development, and human health.

End-Users/Partners/Boundary Organizations:

Navajo Nation Department of Water Resources (NNDWR): Water Management Branch (End-User, POC: Jason John, Branch Manager)

Navajo Technical University (End-User, POC: Ramsey Seweingyawma, Geospatial Engineering Technology Lead)

Navajo Nation Division of Natural Resources: Water Management Branch (Partner, POC: Raymond Benally, Water Resources Director)

The previous DEVELOP mentor at Ames Research Center, Dr. Cindy Schmidt, has been working with students from the United Tribes Technical College (UTTC) for many years on an internship with tribal students using remote sensing for issues related to native lands. These internships have been successful, and there has been a further need for research, especially within other organizations, such as the NN. We have conducted an in-person meeting with representatives from NNDWR and Navajo Technical University to assess the current water infrastructure and the needs of the NN. Subsequently, we are in close contact with the Geospatial Engineering Technology Lead for the Navajo Technical University, Ramsey Seweingyawma. We also anticipate an in-person handoff session at the conclusion of the project. The anticipated benefits to the end-users will be an increased knowledge of current and future water resources and the ability to make informed decisions about how to improve the existing water supply infrastructure. The handoff materials will be presented in the form of videos, data, maps, tools, and a set of tutorials for continued use of these methods on the Reservation.

Letter of Support: Ramsey Seweingyawma, Geospatial Engineering Technology Lead (Navajo Technical University)

Decision Making Process:

Water supply adaptation strategies include: settling water rights, creating more diverse water supply portfolios to spread risk, identifying and developing alternative water sources, integrating surface water and groundwater management, and rehabilitating or developing additional storage capacity. The Navajo Division of Natural Resources (DNR), the United States Bureau of Reclamation, the United States Bureau of Indian Affairs (BIA), and the Navajo Department of Environmental Management (NDEM) have developed a Drought Contingency Plan (DCP) to provide an effective systematic means of assessing drought conditions and to develop mitigation actions and programs to reduce risk. The DCP outlines the components and decision-making process for the NN, including the use of a six-month Standardized Precipitation Index (SPI) to issue drought alerts, warnings and declarations, and to trigger drought responses. NNDWR Water Management Branch issues a monthly drought status report that includes national and regional precipitation along with temperature estimates, a 12-month drought outlook, a streamflow outlook, and a Palmer Drought Severity Index (PDSI) outlook. While the DCP integrates information provided by governmental organizations, specific management decisions can be improved with more accurate and longer-term climate projections through the use of remotely-sensed and modeled datasets.

Earth Observations:

Platform	Sensor	Geophysical Parameter
GRACE	K-Band Ranging Assembly	Terrestrial water, North American Land Assimilation System (NLDAS) Land-water quantities (evapotranspiration, rainfall, snowfall rate, surface and runoff, etc.)
Aqua & Terra	Moderate Resolution Imaging Spectroradiometer (MODIS)	Snow cover, Land cover type, Vegetation indices, Land surface temperature, Derived soil moisture,
Aqua	Atmospheric Infrared Sounder (AIRS)	Atmospheric temperature and humidity, Precipitation
Landsat 5 & 8	Thematic Mapper(TM) and Operational land Imager (OLI)	Land cover change and NDVI products
Suomi NPP	Visible Infrared Imaging Radiometer Suite (VIIRS)	Land surface temperature, Land surface type
GMP	GPM Microwave Imager (GMI) and the Dual-frequency Precipitation Radar (DPR)	Precipitation intensities and horizontal patterns
TRMM	Precipitation Radar(PR)	Rain rate and rain rate profile, Accumulated rain

NASA Earth Observations to be Highlighted:

The main objective of this project is to analyze historical water availability through the use of EOS, in-situ data, and predict future changes along with climate change projections. Drought indicators will also be outlined using Gravity Recovery and Climate Experiment (GRACE), Global Precipitation Measurement (GMP), and Tropical Rainfall Measuring Mission (TRMM). Vegetation health will also be assessed as a drought indicator using Landsat 5 and 8, Aqua AIRS and MODIS, Terra MODIS, and Suomi National Polar-orbiting Partnership (NPP) Visible Infrared Imaging Radiometer Suite (VIIRS) products.

Ancillary Datasets:

- Digital Elevation Model (DEM), National Elevation Dataset
- Hydrological Sub-Regions, National Hydrology Dataset (NHD), USGS
- Land Cover (1990, 2001, 2006), National Land Cover Data (NLCD) products
- Snow water equivalent (2004-2014), Snow Data Assimilation System (SNODAS)
- Duration and intensity of the long-term drought-inducing circulation patterns, Palmer Drought Severity Index (PDSI)
- Forecasted Precipitation, Forecasted Maximum Temperature, Forecasted Minimum Temperature (2010-2100), Coupled Model Intercomparison Project Phase 5 (CMIP5), NASA Earth Exchange (NEX) Downscaled Climate Projections (NEX_DCP30)
- Soil Moisture and Soil Temperature, NASA's North American Land Assimilation System (NLDAS-2) data

Models:

- Automated Geospatial Watershed Assessment Tool (AGWA) (Amber Kuss, ARSET) will be used for watershed analysis and incorporating climate change projections into water availability analysis
- DEVELOP Drought Severity Index (Tiffani Orne, DEVELOP National Program) will be used to measure areas of drought risk. It is based on the Scaled Drought Condition Index (SDCI) model C12 and is optimized for arid regions.

Decision Support Tools & Analyses:

Proposed End Products	Decision Impacting	Current Partner Tool/Method
Navajo Nation Water Resources Analysis	Quantitative assessment of water resource availability to assist water managers to better understand historical and future availability	Palmer Drought Severity Index, Drought Contingency Plan
Modeled Stream flow in the San Juan River Basin	Allow decision-makers to identify potential problem areas where additional monitoring can be undertaken or mitigation activities can be focused	None
Navajo Nation Water Resources Database and Comprehensive Tutorial Package	Enable end-users the ability to begin using NASA EOS products and update end products for future monitoring and research purposes	None

Navajo Nation Water Resources Analysis (Spring/Summer 2015) - This product will utilize NASA observed (e.g. GRACE, MODIS, TRMM, etc.) and modeled (e.g. NLDAS-2, CMIP5) products along with ancillary data (e.g, PDSI, SNODAS, NLCD) to create a set of static and time series visuals representing historical and current changes on water resources for the NN. The geophysical parameters outlined above (Earth Observations) are critical components in drought monitoring because they are indicators of water and energy balance, as well as hydrologic drought conditions. Trends will be produced from these data and correlated to past drought periods. Additionally, this will also be compared to the currently used Palmer Drought Severity Index to serve as a more focused and accurate drought monitoring method for the NN. This analysis will represent changes in the region that can be used for future planning activities. This product will also be useful for future agricultural management decisions regarding crop inventory and domestic supply and demand estimates.

Navajo Nation Water Resources Database (Spring/Summer 2015) - This product will be a large data package with all processed data created from the *Navajo Nation Water Resources Analysis.* Data in this package will include all processed and clipped EOS, modeled, and ancillary data. The database will also include graphs and raw statistical data for each water resource variable. Additionally, tutorials will be included for downloading and processing each EOS product. The purpose of this database is to enable our end-users the ability to begin using NASA EOS and update these end products for future monitoring and research purposes.

Modeling Stream flow in the San Juan River Basin (Summer 2015) - This product will use the AGWA Model to assess the variability and trends in volumes and peaks of runoff, sediment yield, and pollution (nitrogen and phosphorus) in the San Juan River Basin. These model outputs greatly influence ground water and surface reservoir recharge, therefore, analyzing these conditions will enhance water resource management. Drought indicators such as changes in plant species, high evapotranspiration, decline in rainfall, are delineated from EOS products. These indicators will be used to support this analysis. USGS gage measurements will be used to validate the model outputs. These results allow NN decision-makers to identify potential problem areas where additional monitoring can be undertaken or mitigation activities can be focused.

Project Details:

National Application Areas Addressed: Water Resources, Climate
Source of Project Idea: Previous DEVELOP mentor, Cindy Schmidt (NASA Ames), has been working with tribal groups for many years to use NASA EOS to assist in a wide range of environmental issues on reservations. She has also been involved with the United Tribes Technical College in North Dakota to provide internship opportunities to native students interested in Environmental Science, Geography, and Remote Sensing.

Advisors: Dr. Juan Torres Perez, (NASA Ames Research Center/Bay Area Environmental Research Institute) and Ramsey Seweingyawma (Navajo Technical University)
# of Participants Requested: 5
Project Timeline: 2 Terms: 2015 Spring (Start) to 2015 Summer (Completion)
Study Location: The Navajo Nation, AZ, UT, NM
Period being Studied: 1990-2099 (climate projections)

Multi-Term Objectives:

- **Term 1 (Spring 2015)** – This term will focus on the historical and future assessment and analysis of water resources on the NN lands, using various EOS and modeled data. The team will obtain and process all aforementioned water related datasets and begin to generate historical and forecasted time series and trends to identify drought periods. These data will be clipped to hydrological basins overlapping the NN. During this time, the team will begin construction of a comprehensive tutorial and data package to provide ease of access to the data and allow updating and future monitoring within the NN. This term will also focus heavily on partner engagement and logistics for the summer term. The team will be contacting partners, setting up regular meetings, and planning to work with a remote team of Navajo Technical University students.

- **Term 2 (Summer 2015)** – During this term, the project will focus using the AGWA Model to assess runoff, sediment yield, and pollution within the San Juan River Basin. These results will allow decision makers to identify areas that may hinder the Reservations ability to provide access to drinking water in this region of the NN. This term will also complete all geospatial processing from Spring 2015 and finalize the Navajo Nation Water Resources Database and Comprehensive Tutorial Package. The final stage of this project will also focus on a

partner handoff and continued engagement with this community for anticipated future needs.

Additionally, there will be a team of Navajo student DEVELOPers who will work remotely with Ames DEVELOPers for the first half of the term. The Navajo team will then work in-person with the Ames team during the second half of the term at Ames Research Center.

Notes:

This is a multi-term project that will address issues of climate change impacts on water resource availability in the agricultural, ecological, and social systems of the NN. This research will create a vital set of maps and tools for water supply managers, specifically the Navajo Nation Division of Natural Resources (NNDNR), to support current and future water supply demands on the Reservation. These tools and products will also better serve the Navajo Technical University when conducting future water resources related projects.

The first term (spring 2015) of the project focused on assessing current and historical water resources within the study region using local DEVELOP participants. After this term, we will have maintained collaboration with the Navajo Technical University to prepare for the second phase (summer 2015) of this project. During this second phase, two students from the university are expected to remotely participant in the DEVELOP program with two to three others located at Ames Research Center. The Navajo students will be in remote collaboration for the first five weeks of the term. They will then travel to Ames Research Center to continue working, in-person, with the rest of the team for the duration of the term. Ramsey Seweingyawma has been instrumental in mentoring and supporting the Navajo Tech students to allow a more subtle transition to and from the reservation. Funding for travel and housing have been established for the Navajo Tech DEVELOPers though outside funding sources by Ramsey Seweingyawma.

References and Helpful Websites:

Garfin, G. (2013), *Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment*, Island Press.

Nania, J., K. Cozzetto, N. Gillett, S. Duren, A. Tapp, M. Eitner, and B. Baldwin (2014), *Considerations for Climate Change and Variability Adaptation on the Navajo Nation*, University of Colorado, Boulder, Boulder, CO.

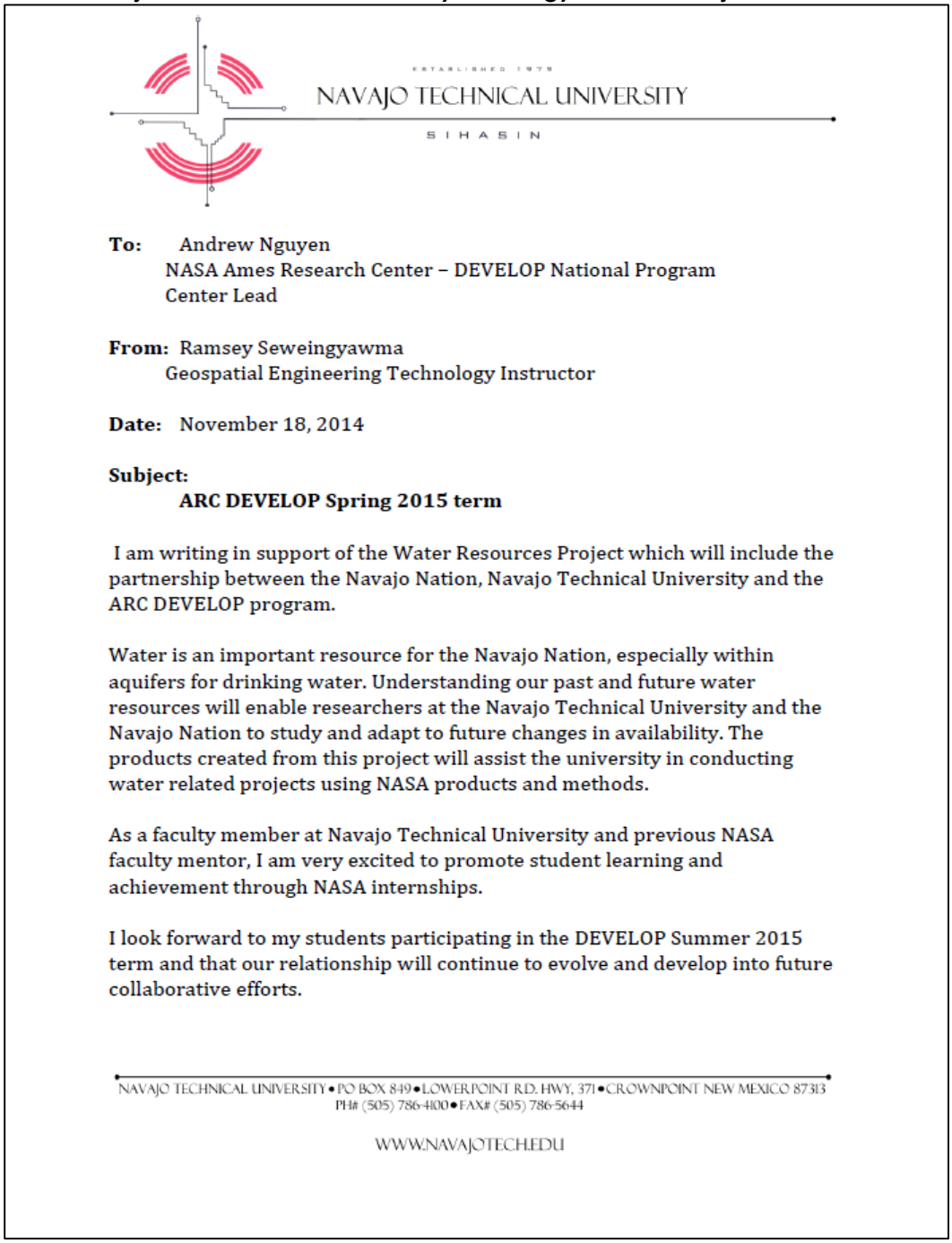
Websites:

Navajo Nation Government - http://www.navajo-nsn.gov/govt.htm

Navajo Nation Department of Water Resources - http://www.frontiernet.net/~nndwr_wmb/

Letters of Support

Ames Navajo Nation Climate – Ramsey Seweingyawma, Navajo Technical University



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SIHASIN

To: Andrew Nguyen
NASA Ames Research Center – DEVELOP National Program
Center Lead

From: Ramsey Seweingyawma
Geospatial Engineering Technology Instructor

Date: November 18, 2014

Subject:
ARC DEVELOP Spring 2015 term

I am writing in support of the Water Resources Project which will include the partnership between the Navajo Nation, Navajo Technical University and the ARC DEVELOP program.

Water is an important resource for the Navajo Nation, especially within aquifers for drinking water. Understanding our past and future water resources will enable researchers at the Navajo Technical University and the Navajo Nation to study and adapt to future changes in availability. The products created from this project will assist the university in conducting water related projects using NASA products and methods.

As a faculty member at Navajo Technical University and previous NASA faculty mentor, I am very excited to promote student learning and achievement through NASA internships.

I look forward to my students participating in the DEVELOP Summer 2015 term and that our relationship will continue to evolve and develop into future collaborative efforts.

NAVAJO TECHNICAL UNIVERSITY • PO BOX 849 • LOWER POINT R.D. HWY. 371 • CROWNPOINT NEW MEXICO 87313
PH# (505) 786-4100 • FAX# (505) 786-5644

WWW.NAVAJOTECH.EDU