APPLYING HYDRO-CLIMATOLOGICAL RESEARCH TO IMPROVE THE SCIENTIFIC BASIS OF LOCAL WATERSHED DECISION MAKING (NORTH OLYMPIC PENINSULA SOLUTIONS NETWORK PROJECT)

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ABSTRACT

The North Olympic Peninsula Resource Conservation & Development (NOP RC&D) Council proposes to evolve a Solutions Network of local, regional and national organizations to provide watershed management teams with decision support through NASA-funded earth-sun research results. The NOP RC&D Council built a team of eight other major partners for this Project, including the NASA-funded Pacific NorthWest Regional Collaboratory (PNWRC); USDA Natural Resources Conservation Service; Pacific Northwest National Laboratory (PNNL) Idaho National Laboratory (INL); Olympic National Park (ONP); Clallam County; the National Association of RC&D Councils (NARC&DC) in Washington, DC; and Peninsula College (PC). The science portion involves applying hydro-climatological research, through the Hybrid hydrology model, to improve the scientific basis of local watershed decision making, and is associated with NASA's national priority areas in Water Management, Ecological Forecasting, and Agricultural Efficiency. A Solutions Network of User Groups, Research Scientists, and an Operation Center will be developed in the Dungeness and Elwha River watersheds during the first two years of this project. The Dungeness River watershed was selected as a demonstration site for testing and evaluating the proposed Solutions Network in Year One of the Project because local citizens there pioneered one of the state's most cooperative, effective and integrated water, ecosystem and agricultural management teams, the Dungeness River Management Team. In Year Two, the Elwha River watershed was selected in order to bring the Solutions Network developed in Year One to an Elwha River Watershed Team. The Elwha River watershed is also the site of the largest dam removal project ever undertaken in the Nation and therefore posed additional opportunities to collaborate with Peninsula College, Olympic National Park, and the Elwha Research Consortium. In Year Three this Solutions Network will be used to develop a blueprint for extending these activities and results to four other watersheds across the Nation.

INTRODUCTION

In October 2006, the National Aeronautical and Space Administration (NASA) awarded a three-year, $1.6 million grant to the North Olympic Peninsula Resource, Conservation, and Development Council (NOP RC&D) to develop a Solutions Network for the North Olympic Peninsula. The goals of what we will call the North Olympic Peninsula Solutions Network or NOPSN are to:

1. Improve the scientific basis of watershed decision-making related to water management, agricultural efficiency and ecological forecasting.
2. Improve water resource decision-making in the Dungeness River watershed by developing a Hybrid hydrological model that improves river flow predictions and supports existing decision support tools.
3. Evaluate other NASA tools and technologies that can be applied to the Elwha watershed to support research and water management
4. Use the experience gained in the Dungeness and Elwha watersheds to identify the characteristics and attributes of a Solutions Network that are essential for sustained application and use of NASA technology to address water resource issues nationally.
5. Identify candidate RC&D councils and areas in the United States with greatest potential for applying the Solutions Network approach, and assist selected RC&D Councils in developing the new networks.

The team of partner organizations for carrying out the NOPSN is called the Solutions Network Advisory Panel (SNAP) and includes:

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- North Olympic Peninsula RC&D Council
- National Association of RC&D Councils
- USDA, Natural Resources Conservation Service
- USDA, NRCS, National Water and Climate Center
- Pacific Northwest National Laboratory (Sequim and Richland)
- Idaho National Laboratory
- Peninsula College
- USDI, National Parks Service, Olympic National Park
- Clallam County (Dungeness River Management Team & Elwha watershed group)

These organizations represent the three main components of the NOPSN: Researchers, Operators, and Users (Figure 1). The definitions and main activities of these groups are as follows:

- **Researchers** are responsible for identifying appropriate NASA tools and technologies that can be used to support watershed management decisions, and to adapt existing predictive models to utilize NASA data, when possible.
- **Operators** are responsible for overseeing the use of NASA technology, applications and models developed during the project, and making the technology accessible to local and regional resource managers and other interested groups and individuals via an Operations Center.
- **Users** represent groups or individuals that require accurate water resource information to support management decisions in the watershed. Users may include state or federal agencies, non-governmental organizations, tribes, local groups, or individuals.

To achieve the stated goals, a high degree of communication between Researchers, Operators, Users, and our NASA partner is essential. We will also collaborate with other NASA-funded Solutions Networks during the course of the project to better understand alternative approaches to developing and implementing projects and programs and utilize NASA Earth Science technology.

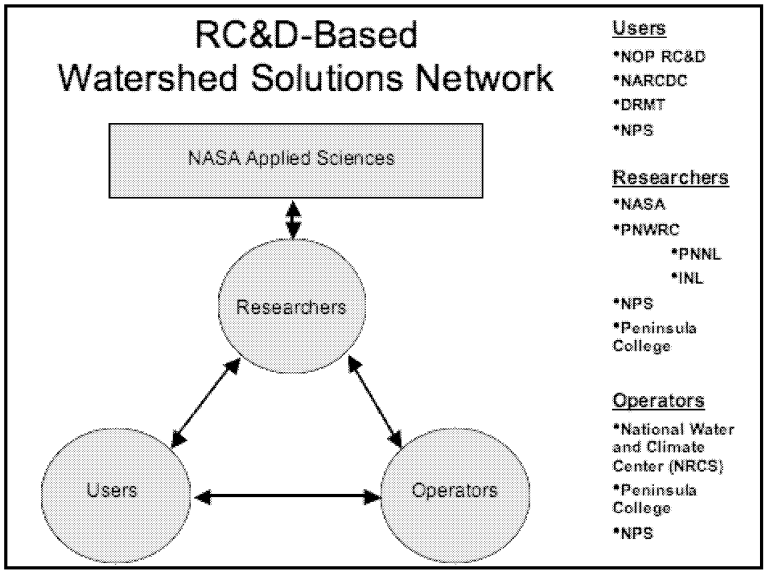

Figure 1. North Olympic Peninsula Solutions Network

During the first year of this program, the emphasis will be on the development of a Hybrid hydrological model that will be used to improve water predictions in the Dungeness River watershed. The Hybrid model will be adapted from an earlier version developed by the Pacific Northwest Regional Collaboratory, another NASA-funded project. The Dungeness Hybrid model will utilize a variety of environmental information, including temperature and precipitation data from real-time sensors and local/regional weather forecasts, snow depth and water quantity from SNOTEL stations on the Olympic Peninsula, and NASA MODIS data, which estimates snow cover using

satellite imagery. The main activities associated with the development of the Hybrid model for the Dungeness watershed will include:

1. Evaluating the existing methods for predicting river flow in the Dungeness watershed to better understand the state of the science.
2. Assessing DRMT needs and preferred model specifications through a series of conference calls and documentation, and review of the current watershed management plan.
3. Developing draft and final model specifications with DRMT input.
4. Evaluating other NASA tools or technologies that might be used to support water resource management decisions in the watershed.
5. Identifying other technical resources or opportunities to address specific DRMT needs that cannot be fulfilled using NASA technology (e.g. watershed grants, state or federal programs, or other emerging technologies).

The result of this collaborative process will be the development of the Dungeness Hybrid model, the transfer of the model to the Peninsula College Operations Center, the use of the model by DRMT and others interested in water resource predictions, and the implementation of associated education and outreach programs in the community. In addition, the NOPSN will identify, if possible, other NASA tools or technologies or external technical resources that enable science-based products to be brought to the North Olympic Peninsula.

EXISTING WATER RESOURCE PREDICTIONS IN THE DUNGENESS WATERSHED

Currently, the Natural Resource Conservation Service (NRCS) issues streamflow probability information from January to June for the upcoming water year, as described in Table 1. The predictions reflect the following timeframes:

- Predictions issued from January to April include a forecast for April-September and April-July.
- Forecasts issued in May cover the period of May-September and May-July.
- Forecasts issued in June cover the period of June-September and June-July.

The forecasts provide probabilities for the total streamflow volume in acre-feet for a specific period of time, ranging from two to six months. The current system cannot predict how the total streamflow volume will occur (e.g., as a steady discharge or as a flood) nor can it provide information at daily, weekly, or even monthly timeframes.

Table 1. NRCS Water Availability Prediction System for the Dungeness Watershed

Prediction Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
January												
February												
March												
April												
May												
June												

DRMT REQUIREMENTS FOR ENHANCED WATER RESOURCE PREDICTIONS

Based on discussions with the DRMT, the user needs were identified and organized into general categories, as follows:

Streamflow Forecasting

- Daily predictions rather than weekly or monthly.
- Flow predictions for entire year, not just April – September.
- Incorporation of global climate change scenarios in predictions.
- Incorporation of fine-scale microclimate (weather) data in predictions.
- Streamflow reported as cubic feet per second and acre-feet.
- Predict low-flow and peak-flow episodes.
- Predictions to include low, high, and middle flow events.
- Probabilistic format helpful (e.g., 10-90% chance of exceeding a specified flow, as currently done by NRCS).

Hybrid Model and Groundwater

- Groundwater recharge from streams needed for upper and lower watershed.
- Connection of Hybrid model to existing groundwater model preferred.

Operations Center and Public Outreach

- Web-based access to predictions required, other method should also be considered (e.g. email, local newspapers or radio).
- Include an educational component to web link that describes predictive model development and provides information on water resource management.
- Provide links to other relevant websites (e.g. University of Washington, NOAA).

Meteorological Information

- Additional SNOTEL stations in Dungeness and Elwha watersheds needed.
- Additional wind speed and direction data needed.
- Real-time measurements of rainfall, humidity, and temperature at additional areas in the watershed needed.
- More accurate weather forecasts for NOP microclimates needed.
- Interaction with local and regional weather forecasters (e.g. Climate Impact Group at University of Washington, NOAA).

Other Environmental Information Needed

- Soil moisture content in Dungeness valley.
- Temperature tracking in Dungeness Bay.
- Dissolved oxygen and nitrogen measurements in Dungeness Bay.

Other Issues or Needs

- Analysis to determine improvement in irrigation water supply due to piping and covering irrigation ditches.
- Evaluation of water storage options.

In addition to the DRMT user needs, we also evaluated the goals and needs described in the "Elwha-Dungeness Watershed Plan Water Resource Inventory Area 18 (WRIA 18) and Sequim Bay in West WRIA 17" (May 2005) with an emphasis on the "Future Water Supply Strategies for People and Fish" section of the Executive Summary. (http://www.clallam.net/environment/html/wria_18_draft_watershed_plan.htm)

SOLUTIONS NETWORK APPROACH TO MEETING USER NEEDS

The NOPSN approach to addressing the DRMT user group needs is presented in Table 2. In this table, we assess whether the user needs can be addressed or supported by 1) the Dungeness Hybrid hydrological model, 2) by

the NOPSN Operations Center at Peninsula College, 3) through the use of other NASA technologies or tools, or 4) through other funding opportunities outside of the current NOPSN NASA scope (e.g. by watershed grants, education/outreach programs, or local, state, or federally funded activities). The identification of new funding sources for work outside of the NOPSN scope will be an ongoing process for the duration of the project.

Based on the initial assessment the proposed configuration of the Hybrid hydrological model will address most of the stated DRMT user group needs, including the temporal scale of the predictions and the preferred format for presenting the flow predictions. In addition, the proposed Operations Center at Peninsula College will support the model use, provide direct access to users, and include an educational and public outreach component. Because we are currently investigating the coupling of the Hybrid model with the existing MODFLOW groundwater model used in the Dungeness Valley, the ability to address this user need is unresolved.

Table 2. Solutions Network Approach to meeting user needs

DRMT USER NEEDS AND SPECIFICATIONS		NOPSN ACTIVITY			OTHER ACTIVITY
Need Category	**Requirement or Specification**	**Hybrid Model**	**Operations Center**	**Other NASA Technology**	**Other Program or Technology**
Streamflow Forecasting	Daily predictions	Addresses	Supports	-	-
	Predictions for all months	Addresses	Supports	-	-
	Units in cubic-feet-second acre-feet	Addresses	Supports	-	-
	Predictions include low moderate and high flow, and probabilities of exceedance	Addresses	Supports	-	-
	Predictions incorporate extreme weather events and global climate change scenarios	Addresses	Supports	-	-
	Predictions incorporate micro-climate data	-	-	Investigate	Investigate
Hybrid Model and Groundwater	Use model output to estimate groundwater recharge in upper and lower watershed	Investigate	Investigate	-	Investigate
	Couple model to current MODFLOW model for lower Dungeness	Investigate	Investigate	-	Investigate
Operations Center and Public Outreach	Web-based access to predictions	Supports	Addresses	-	-
	Email radio, TV, newspaper updates	Supports	Investigate	-	-
	Educational component on website describing model and principles of water resource management	Supports	Addresses	-	-
Meteorological Information	Add new SNOTEL stations to Dungeness and Elwha watersheds	The addition of a new SNOTEL site to the Elwha watershed is currently under review			-
	Additional wind speed and direction data	-	-	-	Investigate
	Improve microclimate predictions in watershed by adding more sensor packages that measure rainfall, humidity, wind speed, wind direction and temperature.	-	-	Investigate	Investigate
	Coordinate meteorological data with U of W Climate Impact Group and others	-	Investigate	Investigate	Investigate
Other Environmental Information	Need real-time soil-moisture content data at locations in the Dungeness Valley	-	-	Investigate	Investigate
	Need real-time temperature data for Dungeness Bay	-	-	Investigate	Investigate
	Need real-time dissolved oxygen and nutrient data for Dungeness Bay	-	-	Investigate	Investigate
Other Issues and Needs	Develop analysis tools to determine water conservation associated with piping or covering irrigation canals	-	-	-	Investigate
	Evaluation of water storage options in Dungeness watershed	-	-	-	-
Elwha-Dungeness Watershed Plan WRIA 18 May 2005 **Future Water Supply Strategies for People and Fish**	Emphasize water conservation	Supports	Supports	Investigate	Investigate
	Protect in stream flows	Supports	Supports	Investigate	Investigate
	Continue irrigation water management	Supports	Supports	Investigate	Investigate
	Emphasize public water supply	-	-	-	-
	Limit exempt wells, use public water service	-	-	-	-
	Regionalize West WRIA 18 water supply	-	-	-	-
	Availability of water for future appropriation	Supports	Supports	Investigate	Investigate
	Water reclamation and reuse	Supports	Supports	Investigate	Investigate
	Study new storage	Supports	Supports	Investigate	Investigate

Because of the limited number of weather telemetry stations on the North Olympic Peninsula, it is not possible to configure the Hybrid model to incorporate weather information for small portions of the Dungeness watershed (e.g. use of micro-climate weather data). We recognize the need for additional meteorological data within the Dungeness watershed, and will partially address this need by the placement of a new SNOTEL station in

the Elwha watershed. Investigations will be also be conducted to determine if new weather stations could be added to the Dungeness watershed over the next few years using other funding sources. A similar approach will be taken to respond other user needs, including real-time soil-moisture measurements in the valley and watershed, the collection of water quality data in the Dungeness River and Bay, and the identification of tools or techniques that can be used to evaluate the success of water conservation measures.

Based on the goals and activities described in the "Elwha-Dungeness Watershed Plan Water Resource Inventory Area 18 (WRIA 18) and Sequim Bay in West WRIA 17" (May 2005), it appears the NOPSN will support many of the strategies that are proposed to address future water supply needs for people and fish. The NOPSN Hybrid model and Operations Center will help support strategies that deal with water conservation, use, availability and management, and the Solutions Network approach of identifying other NASA tools and technologies or alternative funding sources may provide additional support to watershed managers as the project progresses.

SUMMARY

Based on our initial assessment of DRMT user needs and the strategies and goals of the Elwha-Dungeness Watershed Plan, it appears the NOPSN can directly address or support many water resource management issues and challenges. In addition, the SNAP will employ a Solutions Network approach to identify existing or emerging NASA tools or technologies that can be used to support water resource management activities. Throughout this project, we will also look for additional funding sources that can be used to address key user needs that fall outside of the NOPSN NASA scope.