

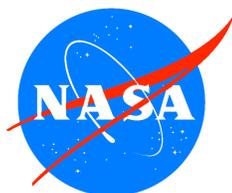
NASA SCIENCE MISSION DIRECTORATE

*Earth Science Division
Applied Sciences Program
Water Management Program Element
FY2007-2011 Plan*



FINAL DRAFT

Date: 11/14/2006



*Expanding and accelerating the realization of economic and societal
benefits from Earth system science, information, and technology*

NASA Earth Science Division - Applied Sciences Program
Water Management Program Element

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The Applied Sciences Program websites contain additional information about the program and this program element:

Applied Sciences Program:	http://science.hq.nasa.gov/earth-sun/applications/
Water Management Element:	http://science.hq.nasa.gov/earth-sun/applications/theme12.htm
Project Tracking & Reporting	http://aiwg.gsfc.nasa.gov

NASA Science Mission Directorate – Applied Sciences Program

Water Management Program Element Plan: FY 2007 - 2011

I. Purpose and Scope

The NASA Applied Sciences Program collaborates with partner organizations to enhance the application of NASA Earth science research results to serve issues of national priority. The desired outcome is for partner organizations to use project results, such as prototypes and benchmark reports, to enable the sustained, operational use of Earth science products and enhance their decision support capabilities.

The Water Management Program Element is one of twelve National Applications elements in the Applied Sciences Program. The goal of the Coastal Management Program Element is to:
Enable partners' beneficial use of NASA Earth science research results to enhance decision support capabilities serving their water management and policy responsibilities and to expand the sustained use of NASA Earth science products within the water management community.

This plan articulates the direction, objectives, and projects for the Water Management Program Element (a.k.a., program) for FY2007-2011. The program supports partners on issues of concern related to water quality and quantity, and the program has organized its activities to focus on the following themes:

- Water Quality
- Water Delivery and Irrigation
- Drought
- Flow and Flood Forecasting

By 2011, the primary goal of the Water Management Program Element is to benchmark the potential improvement of NASA Earth Science research results from at least 7 different sensors and Earth science models to at least 3 different decision support systems related to coastal management.

NASA partners with Federal agencies and regional-national organizations that have water management responsibilities and mandates to support water resource managers. Currently, the primary partners are the U.S. Environmental Protection Agency (EPA), Department of Interior Bureau of Reclamation (BoR), the National Oceanic and Atmospheric Administration (NOAA) and the Department of Agriculture (USDA). The program participates with international organizations on water management activities, usually through a US partner. Some Water Management activities may relate to the Coastal Management, Agricultural Efficiency, Disaster Management, Energy Management, and other program elements. Through its activities, the Water Management program provides results for NASA support to Administration, interagency, and international activities, including the CENR Subcommittee on Water, Climate Change Science Program (CCSP), and Group on Earth Observations (GEO).

The program serves the 2006 NASA Strategic Plan Goal 3, and the 2007 NASA Integrated Budget and Performance Document (IBPD) Mutiyear Outcome 3A.7 Annual Performance Goal 7ESS11.

Measurements from satellites and sensors on Earth Science missions for the Water Management Program Element include: (current) Aqua, Terra, GRACE, TRMM, and CloudSAT; (planned) Global Precipitation Measurement (GPM), Aquarius, and NPP. There are numerous land surface, mesoscale, and GCM Earth science models that provide useful, water-related assessments, including: Land Surface Models (LSMs) Community Land Model (CLM), Mosaic, Noah, and Variable Infiltration Capacity (VIC) supported by the Land Data Assimilation System (LDAS) and Land Information System (LIS); mesoscale models MM5 and RAMS; and GCMs run by GISS, GMAO, GFDL, and NCAR. Project plans associated with the Water Management program articulate the specific project activities to apply Earth science measurements, including specific sensors and models.

II. Objectives: FY2007-2011

In FY07, the program's priority activities focus on:

- Completing benchmark of performance of Terra, Aqua, and LIS products in BASINS
- Benchmarking performance of MODIS & LIS products to AWARDS/Riverware
- Completing agreement with Bureau of Reclamation
- Identifying water management opportunities with USDA
- Initiating use of Solutions Networks on water issues to generate ISS ideas

In FY08-11, the program's priorities focus on

- Supporting NASA & US Contributions to GEO Water Societal Benefit Area
- Validating and benchmarking Decisions04, ROSES05, NEWS projects
- Evaluating and extending products from future sensors (e.g. Aquarius, GPM, others)
- Soliciting projects to begin in FY08-FY11

The Water Management program pursues the following specific, short- and near-term objectives:

QI - II 2007

Complete and benchmark use of MODIS and LIS in AWARDS/ET Toolbox
Puruse proof of concept on NASA products to support water quality assessment in Chesapeake Bay
Initiate ROSES05 projects and complete project plans.
Assess project concepts with USDA, such as SWAT, to identify opportunities
Utilize Solutions Network and RPC activities to generate and test potential ISS activities
Investigate opportunities related to water quality, drought, and renewable energy

QIII - IV 2007

Complete and benchmark use of MODIS and LIS in BASINS
Evaluate potential of OSTM in water management decision support systems
Complete examination of opportunities with US Army Corps of Engineers
Support GEO Water Management meeting
Complete MOU with Bureau of Reclamation

Near-term Objectives (FY07-FY10)

2008

Evaluate potential of Aquarius in water management decision support systems
Publish at least three articles on water applications of Earth science, including at least one in a peer-reviewed journal
Assess and possibly pursue an MOU with USACE.
Investigate use of GRACE data for ground water issue
Complete benchmark report from NEWS04 project & ROSES05 (Hendrickx)

2009

Evaluate potential of GPM in water management decision support systems
Complete benchmark reports from Decisions04 & ROSES05 (Aggett) projects.
Have completed a total of six benchmark reports and conduct at least three results conferences on at least three separate decision support tools and/or water issues

2010

Evaluate potential of NPP in water management decision support systems
Complete benchmark reports from ROSES07 projects.

2011

Evaluate potential of LDCM in water management decision support systems
Complete benchmark reports from ROSES08 projects.
Have completed a total of nine benchmark reports and conduct at least four results conferences on at least three separate decision support tools and/or water issues

III. Water Management Issues, Related Research, and Decision Support Tools

The program currently organizes its activities around 4 themes and a program management function

- Water Quality
- Water Delivery and Irrigation
- Drought
- Flow and Flood Forecasting
- Program Management: Studies and reports, Conference support, Meetings and workshops

(Note: The program seeks a portfolio balance and does not necessarily pursue activities under each theme in every year.)

The program assesses direction and priorities through involvement with Federal partners and participation with several water-related organizations, such as: HELP (Hydrology for Environment, Life, and Policy), WICP-ACWI (Water Information Coordination Program-Advanced Committee on Water Information), UCOWR (Universities Council On Water Resources), AWRA (American Water Resources Association), IGWCO (Integrated Global Water Cycle Observations), and ASCE (American Society of Civil Engineers).

Water Management-related Research

The Water Management website contains a list of water-related research projects that the NASA Earth Science Division has supported. These projects provide insight into emerging research directions, knowledge, capabilities, and products.

Priority Decision Support Tools

The following represent priority Decision Support Tools the program focuses on in the near-term.

Better Assessment Science Integrating Point and Nonpoint Sources (BASINS)

BASINS is a GIS-based environmental analysis system developed by EPA. The watershed simulation models require typical input data on soils, land use, topography and meteorology. EPA operates BASINS to track and assess water quality, by computing the maximum amount of pollution that a water body is allowed to hold, known as Total Maximum Daily Loads (TMDLs). These TMDLs are a standard measure in water pollution control and assessment. The primary BASINS submodel for evaluation is the Hydrologic Simulation Program- FORTRAN (HSPF). HSPF is a watershed scale model for estimating instream concentrations resulting from point and nonpoint sources. BASINS-HSPF requires multiple data inputs, and its performance could be enhanced by several NASA science data products, such as precipitation, evapotranspiration, and runoff. Primary NASA products for evaluation include land cover and surface property products from MODIS and water availability parameters from the NASA Land Information System (LIS). LIS includes inputs from a variety of NASA satellite products, primarily from MODIS, but also TRMM and AMSR.

Agricultural Water Resources Decision Support (AWARDS) and RiverWare

The Bureau of Reclamation operates AWARDS to assess the amount of water available for agriculture. These assessments are used to portion out limited water resources for various agricultural interests while retaining a portion for other uses (ecosystems, recreation, commerce, etc.). Potential NASA data products that can be used as inputs by AWARDS, include snow (liquid water equivalent), evapotranspiration, and soil moisture derived primarily from NASA MODIS and LIS data. RiverWare is a modeling system developed by CADSWES (Center for Advanced Decision Support for Water and Environmental Systems) and supported by Reclamation and the Tennessee Valley Authority. It is used to model water availability in several regions of the U.S., primarily to inform water policy decision makers and water managers on water availability and best management practices.

RiverWare

The BoR RiverWare is a reservoir regulation DSS supported by both BoR and the Tennessee Valley Authority (TVA). RiverWare simulates the routing of the river flow operations through dams and hydropower plants and maintains water delivery contracts to irrigators and to recreational, municipal, and industrial users. Even though BoR uses several hydrological modeling tools for RiverWare, spatially-distributed fields available from NASA such as soil moisture and snowpack are not fully accounted for in their operations. Including NASA fields of soil moisture, evapotranspiration, and snowpack in their operations should help increase the accuracy of Reclamation's water resource accounting.

USDA Drought Monitoring and Water Supply Forecasting

The USDA operates several DSSs for water management in the US. One DSS used by the Natural Resources Conservation Service (NRCS) is a water supply forecasting (WSF) tool. WSF currently uses ground-based observations to monitor snow cover and snow water equivalent. NASA data from MODIS, AMSR, and LIS will be evaluated and tested. Potentially useful NASA data products are MODIS/AVHRR snow cover and AMSR snow water equivalent. Another DSS used by USDA is SCAN/NIDIS (National Integrated Droguth Information System). This system uses SCAN (Soil Climate Analysis Network) point-specific measurements of soil moisture to monitor drought conditions. NASA satellite data such as MODIS (land cover) and AMSR (soil moisture) and LIS modeling data could potentially improve spatial accuracy and representation of soil moisture.

National Weather Service River Forecasts System (NWS RFS)

The National Weather Service River Forecast System (NWSRFS) is a robust river and hydrologic forecast system. The system includes all the necessary hydrologic and routing models as well as data handling and presentation systems. The NWSRFS has been in operation for over 20 years and is constantly refined and improved. The NWSRFS is used in the United States and in other countries throughout the world. The U.S. National Weather Service (NWS) provides river and flood forecasts and warnings in the United States for protection of life and property and by providing basic hydrologic forecast information for environmental and economic well-being. The Office of Hydrologic Development supports the NWS hydrologic mission through the design, development, testing, and implementation of a physically-based hydrologic forecasting system - the NWSRFS. Thirteen River Forecast Centers (RFCs) develop hydrologic forecasts for the U.S. The RFCs use the NWSRFS to make short-term forecasts (a day to a week in advance) of river flows and floods and long-term

probabilistic river outlooks (a week to months in advance) in support of water supply management and flood mitigation.

University of Washington West-wide Seasonal Forecasting System

The University of Washington experimental west-wide seasonal hydrologic forecast system produces 6-12 month lead time hydrologic forecasts at approximately 100 forecast points in five major river basins within the western U.S. The system is an outgrowth of the North American LDAS (N-LDAS) project, and uses the NLDAS 1/8 degree spatial grid, as well as N-LDAS vegetation, soils, and other data. The system is based on the University of Washington/Princeton University Variable Infiltration Capacity (VIC) macroscale hydrology model, driven by climate ensembles downscaled from the NCEP Seasonal Forecast Model (SFM), the NASA NSIPP1 global model, and an ensemble version of the CPC official seasonal outlooks (12 month lead time). UW also produces parallel forecasts via the Extended Streamflow Prediction (ESP) method, and a further conditioning of the ESP ensembles by ENSO and PDO state. The primary forecast products are: 1) monthly streamflow distributions and runoff volume statistics at the specified forecast points; and 2) west-wide spatial of monthly forecast ensemble averages for runoff, soil moisture, and snow water equivalent (SWE). UW reports results of initial real-time testing of the system with bi-monthly updates for the Pacific Northwest, and for a larger expanded domain (most of the U.S. west of the Rocky Mountains).

United States Drought Monitor (USDM)

The Drought Monitor provides a weekly overview of where in the United States drought is emerging, lingering, subsiding or forecast. The Monitor is produced jointly by the National Weather Service's Climate Prediction Center, the U.S. Department of Agriculture, and the National Drought Mitigation Center at the University of Nebraska-Lincoln. The three-way partnership is responding to the need for accurate, centralized drought information by developing a map that summarizes information from numerous drought indices and indicators on a single, easy-to-read color map known as the Drought Monitor. To create the map, the partnership blends current information from numerous sources, including the National Weather Service, National Climatic Data Center, Regional Climate Centers, USDA's Joint Agricultural Weather Facility, USDA's National Water and Climate Center, Department of Interior's U.S. Geological Survey and Bureau of Reclamation, as well as many other sources. The map uses a new classification system to show drought intensity and type, similar to the schemes currently in use for hurricanes and tornadoes. The map combines key indices of rainfall and drought to produce the final drought intensity rating. Since drought often affects various activities differently, the map indicates whether drought is affecting agriculture, fire danger, or water supplies. The latest state-of-the-art forecast tools are being used to indicate whether drought will strengthen or weaken significantly over the next two weeks.

IV. Project and Activities

The Water Management Program Element conducts projects to support the program's goal and objectives. The projects fall into three types: Solicited Projects, Directed Projects, and Congressionally-Directed Activities. The respective Project Managers and teams are responsible for developing project plans, managing the activities, and reporting issues and results. Generally, the projects involve the following activities:

- Develop and nurture partnerships with appropriate water management organizations;
- Identify and assess partners' water management responsibilities, plans, and decision support systems and evaluate capacity of Earth science results to support the partners;
- Validate & verify application of Earth science results with partners, including development of prototypes;
- Cooperate with partners to document the performance and value of Earth science results relative to partners' benchmarks and to support adoption into operational use; and,
- Communicate results & partners' achievements to appropriate water resources communities and stakeholders.

Plans, status, and results for each project are available through: <http://aiwg.gsfc.nasa.gov>

A. Solicited Projects

The program selects projects through competitive, peer-reviewed solicitations, including REASoN CAN, Decisions04 CAN, and the Research Opportunities in Space and Earth Sciences (ROSES) 2005 Announcement. The program expects to solicit projects annually in FY07-11 through the ROSES announcement. The program may provide funds to projects identified through other NASA solicitations if the projects have specific ties to the program's objectives. The Water Management team facilitates appropriate partnerships between selected investigators and the NASA Water Management program's partners.

Project: ROSES05 - Water Delivery & Irrigation				Solicitation	
<p>The purpose of this project is to assess the potential for MODIS, Landsat, and VIIRS NPP to improve the performance of BoR AWARDS/ET Toolbox 's and USACE GSSHA used in predicting regional evapotranspiration and river flow(management analyses and actions /decisions) for crop performance, famine prediction, and irrigation system performance. .</p> <p>What is the Value of Integrating Best Estimates of Regional Evapotranspiration into Hydrologic Decision Support Systems?</p> <p>The project seeks to incorporate Landsat, MODIS, NPP, and NPOESS data into two different implementations of the Surface Energy Balance Algorithms for Land (SEBAL). SEBALNM is an adaptation developed at New Mexico Tech and the University of Idaho developed the algorithm Mapping Evapotranspiration at High Resolution with Internal Calibration (METRICTM). The US Bureau of Reclamation (BoR) developed the Agricultural Water Resources Decision Support (AWARDS)/ET Toolbox and the US Army Corp of Engineers (USACE) developed the Gridded Surface/Subsurface Hydrologic Analysis (GSSHA) model to monitor and improve predictions of regional evapotranspiration and river flows. The project seeks to improve BoR's maps showing evapotranspiration of irrigated fields and rangelands to aid in the monitoring of crop performance, to visualize the effects of droughts for famine prediction, to evaluate the performance of irrigation systems, and to improve weather predictions.</p>				<i>Budget (\$K)</i>	
				FY07	221
<i>Project Monitor and Center</i>	<i>Other NASA Centers</i>	<i>Timeframe</i>	<i>Partners</i>	FY08	0
Dave Toll/GSFC		FY07- FY09	BoR, ACE, USGS	FY09	0
				FY10	0
				FY11	0
<i>Principal Investigator(s)</i>		<i>Jan Hendrickx, New Mexico Tech</i>			
<i>Earth Science Products</i>	mission: <i>Terra, Aqua, Landsat, and NPP</i> sensor: <i>MODIS, ETM, VIIRS</i> products: models:			<i>Other Apps.</i>	
<i>Deliverables</i>	<u><i>Description</i></u>	<u><i>End Date</i></u>	<u><i>IBPD Metric #</i></u>		
	Evaluation Report	2/28/2007			
	Design and Implement				
	Verification and Validation	3/30/2009			
	Benchmark Report	9/1/2009			
Two year effort.					
<i>Notes:</i>					

Project: Decisions04 - Water Delivery & Irrigation				Solicitation	
<p>The purpose of this project is to assess the potential for MODIS and AMSR-E satellite data with NASA GMAO forecasts to improve the performance of USDA NRCS and Bureau of Reclamation's RiverWare water supply forecast decision support tools used in predictions of snowmelt runoff processes for reservoir and other water management decisions.</p> <p>Improving Water Resources Management in the Western U.S. through use of Remote Sensing Data and Seasonal Climate Forecasts: This study uses NASA remote sensing data and hydrologic and climate prediction modeling in a partnership with three operational water management agencies – the USDA Natural Resources Conservation Service, which provides seasonal streamflow forecasts over most of the west, the U.S. Bureau of Reclamation, which has decision authority within the Klamath River basin (where there have been ongoing and highly publicized conflicts over water allocation), and the California Department of Water Resources, which has decision authority for much of the Sacramento River basin. NASA research results: 1) EOS remote sensing data products of several types, including MODIS snow cover extent, evapotranspiration (estimates crop water use), and reservoir surface temperature (key to estimate of reservoir evaporation), and AMSR-E snow water equivalent. 2) NASA experimental seasonal climate forecasts produced by the GMAO model, which are already utilized in the UW west wide seasonal hydrologic forecast system. The primary outcome will be improved predictions of snowmelt runoff for reservoir and other water management decisions.</p>				<i>Budget (\$K)</i>	
				FY07	392
<i>Project Monitor and Center</i>	<i>Other NASA Centers</i>	<i>Timeframe</i>	<i>Partners</i>	FY08	399
Dennis Lettenmaier		FY06 - FY08	USDA-NRCS, BoR, CA Dept. Water Resources	FY09	0
				FY10	0
				FY11	0
<i>Principal Investigator(s)</i>					
<i>Earth Science Products</i>	mission: <i>Terra, Aqua</i> sensor: MODIS, AMSR-E products: <i>MODIS snow cover and AMSR-E SWE</i> models: <i>GMAO intra-annual predictions</i>			<i>Other Apps.</i>	
<i>Deliverables</i>	<u>Description</u>	<u>End Date</u>	<u>IBPD Metric #</u>		
	Evaluation Report	12/15/2006			
	Design and Implement				
	Verification and Validation				
	Benchmark Report	8/1/2009			
	Project Plan	12/15/2006			
	V&V Prototype Demo	10/1/2007			
	V&V Operational Demo	2/1/2009			
<i>Notes:</i>					

Project: Decisions04 - Drought				Solicitation	
<p>The purpose of this project is to assess the potential for AMSR-E, QuickSCAT/SeaWinds, and MODIS to improve the performance of multi-agency (led by NOAA)'s US Drought Monitor (USDM) and National Integrated Drought Information System (NIDIS) used in drought monitoring and early warning for water supply forecasts.</p> <p>National Drought Monitoring System for Drought Early Warning Using Hydrologic and Ecologic Observations from NASA Satellite Data</p> <p>The overarching objective of this proposal is to assimilate hydrologic and ecologic observations from NASA Earth satellite sensors, including the Advanced Microwave Scanning Radiometer - Earth Observing System (AMSR-E), the QuikSCAT/SeaWinds Scatterometer (QSCAT), and the Moderate Resolution Imaging Spectroradiometer (MODIS), into a national drought monitoring system, specifically the United States Drought Monitor (USDM), an existing national decision support tool used for drought monitoring and drought early warning. We propose a multi-institution collaboration to transition products and research results derived from NASA products into the USDM. NASA satellite products to be evaluated and incorporated include soil moisture, precipitation water on land surface, and vegetation state. These products have the potential to significantly enhance three of the most important indices used in USDM. Moreover, improvements resulting from inclusion of NASA satellite observations, along with an expanded network of observations, will be critical to improving drought and water supply forecasts.</p>				<i>Budget (\$K)</i>	
				FY07	470
<i>Project Monitor and Center</i>	<i>Other NASA Centers</i>	<i>Timeframe</i>	<i>Partners</i>	FY08	462
Dave Toll/GSFC	JPL	FY06 - FY09	NOAA, USGS, USDA	FY09	0
				FY10	0
<i>Principal Investigator(s)</i>		<i>Son Ghiem (JPL) and James Verdin (USGS)</i>		FY11	0
<i>Earth Science Products</i>	mission: <i>Quikscat, Terra, Aqua</i> sensor: <i>AMSR-E, MODIS,</i> products: models:			<i>Other Apps.</i>	
<i>Deliverables</i>	<u><i>Description</i></u>	<u><i>End Date</i></u>	<u><i>IBPD Metric #</i></u>	Disaster Management, Ecological Forecast, Agriculture	
	Evaluation Report				
	Design and Implement				
	Verification and Validation	3/31/2007			
	Benchmark Report	12/31/2008			
<i>Notes:</i>					

Project:					
<p>The purpose of this project is to assess the potential for MODIS, AMSR-E and NASA LIS to improve the performance of NOAA NWS 's River Forecast System at 13 River Forecast Centers used in short-term river flows, including flash floods, and seasonal water supply for a range of public concerns.</p> <p>Improving NOAA/NWS River Forecast Center Decision Support with NASA Satellite and Land Information System Products</p> <p>The overarching goal of the proposed work is the demonstration of improved accuracy in runoff, flow, flood and snow monitoring and simulation from the combination of NASA MODIS and AMSR-E satellite data and NASA LIS modeling information and infrastructure with operational NWSRFS decision support tools. The proposed work will be conducted in 3-phases. Phase 1, NASA/MSFC and NOAA/NWS/OHD researchers will use MODIS cloud cover products to improve potential evaporation estimates. Phase 2 will leverage ongoing NOAA and NASA/GSFC collaboration for integration of NASA LIS and NWSRFS components. Phase 3 of the proposed project will involve an evaluation study of NASA snow cover, SWE and soil moisture in to an integrated LIS-RFS system.</p>				<i>Budget (\$K)</i>	
				FY07	466
<i>Project Monitor and Center</i>		<i>Other NASA Centers</i>		<i>Timeframe</i>	
<i>Partners</i>		FY08		466	
David Toll/GSFC		MSFC & GSFC		2006 - 2009	
				NOAA RFCs and George Mason Univ.	
<i>Principal Investigator(s)</i>				<i>Restrepo et al, see notes</i>	
<i>Earth Science Products</i>		<p>mission: <i>Terra, Aqua</i></p> <p>sensor: <i>MODIS, AMSR-E</i></p> <p>products:</p> <p>models: <i>LIS</i></p>			
<i>Deliverables</i>		<i>Other Apps.</i>			
		<u><i>Description</i></u>		<u><i>End Date</i></u> <u><i>IBPD Metric #</i></u>	
		Evaluation Report		12/1/2006	
		Design and Implement			
		Verification and Validation			
		Benchmark Report		8/1/2009	
		V&V / Prototype Demonstration		10/1/2008	
		V&V / Operational Demo.		3/1/2009	
<p><i>Notes:</i> Principal Investigator(s) Pedro Restrepo NOAA/NWS/OHD, Ashutosh Limaye (NASA/MSFC/USRA) & Christa Peters-Lidard (NASA/GSFC)</p>					

Project: Water Delivery & Irrigation																										
<p>The purpose of this project is to assess the potential for MODIS, Landsat, and ASTER to improve the performance of Bureau of Reclamation 's RiverWare and South Platte Decision Support System used in estimating weekly-seasonal evapotranspiration for improving management of scarce water supplies..</p> <p>Enhancing Water Management Decision Support Systems with High Spatio-temporal Resolution Mapping of Actual Evapotranspiration</p> <p>The Northern Colorado Water Conservation District (NCWCD) and Bureau of Reclamation utilize RiverWare and the South Platte Decision Support System (SPDSS) to estimate real-time evapotranspiration (ET) demand. This project incorporates thermal data from MODIS, ASTER, and Landsat sensors into SPDSS and RiverWare to improve weekly, monthly, and seasonal ET estimates. The NCWCD and the Bureau of Reclamation can use the improved estimates to manage scarce water supplies more efficiently through use of comprehensive real-time information and prediction tools.</p>				<i>Budget (\$K)</i>																						
				FY07	288																					
<i>Project Monitor and Center</i>		<i>Other NASA Centers</i>	<i>Timeframe</i>	<i>Partners</i>	FY08	187																				
Dave Toll/GSFC			FY07- FY09	BoR, Academia	FY09																					
					FY10																					
					FY11																					
<i>Principal Investigator(s)</i>			<i>Graeme Aggett, Riverside Technology, Inc</i>																							
<i>Earth Science Products</i>		mission: <i>Terra, Aqua, Landsat</i> sensor: <i>MODIS, ASTER</i> products: models:			<i>Other Apps.</i>																					
<i>Deliverables</i>		<table border="1"> <thead> <tr> <th><u>Description</u></th> <th><u>End Date</u></th> <th><u>IBPD Metric #</u></th> </tr> </thead> <tbody> <tr> <td>Evaluation Report</td> <td></td> <td></td> </tr> <tr> <td>Design and Implement</td> <td></td> <td></td> </tr> <tr> <td>Verification and Validation</td> <td></td> <td></td> </tr> <tr> <td>Benchmark Report</td> <td>8/1/2009</td> <td></td> </tr> <tr> <td>V&V Prototype Demo</td> <td>10/1/2008</td> <td></td> </tr> <tr> <td>V&V Operational Demo</td> <td>4/1/2009</td> <td></td> </tr> </tbody> </table>				<u>Description</u>	<u>End Date</u>	<u>IBPD Metric #</u>	Evaluation Report			Design and Implement			Verification and Validation			Benchmark Report	8/1/2009		V&V Prototype Demo	10/1/2008		V&V Operational Demo	4/1/2009	
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V&V Operational Demo	4/1/2009																									
<i>Notes:</i>																										

Project: NEWS04 - Flow & Flood Forecast					
<p>The purpose of this project is to assess the potential for MODIS, AMSR and LIS to improve the performance of USGS Modular Modeling System 's and NOAA NWS forecasts used in flash flood predictions for improving lead time forecasts and improving public safety.</p> <p>Improving Flash Flood Prediction Through a Synthesis of NASA Products, NWP Models and Flash Flood Decision Support Systems: The USGS Modular Modeling System (MMS) DST, a prototype flash flood forecast system, will be enhanced to help explore interactions between land surface, precipitation events, and flash floods, and will be used to provide increase forecast lead time and improve public safety. As land surface greatly impacts precipitation events, better initialization of land surface states such as soil moisture, snow pack and soil temperature from NASA products will lead to better NWP precipitation forecasts. This link between precipitation events and land surface conditions will be combined with initializing high-resolution Weather Research and Forecasting (WRF) model simulations with offline land surface conditions derived from a high-resolution NASA Land Information System (LIS), more accurate precipitation forecasts with longer lead times will be produced than conventionally available. By supplying the resulting ensemble precipitation forecasts to the USGS MMS flash flood DSS, the utility of these forecasts for flash flood applications can be assessed, and greater understanding of the effect of hydrologic, land surface, and meteorological input uncertainty on flash flood forecasts will be gained—something which is now only poorly understood.</p>				<i>Budget (\$K)</i>	
				FY07	
<i>Project Monitor and Center</i>		<i>Other NASA Centers</i>		<i>Timeframe</i>	
<i>Partners</i>		FY08		198	
Dave Toll		GSFC		FY07- FY09	
				NOAA & USGS	
				FY09	
				FY10	
				FY11	
<i>Principal Investigator(s)</i>		Brian Cosgrove SAIC at NASA/GSFC			
<i>Earth Science Products</i>		mission: <i>Terra, Aqua</i>		<i>Other Apps.</i>	
		sensor: <i>MODIS, AMSR</i>			
		products:			
		models: <i>LIS</i>			
<i>Deliverables</i>		<u>Description</u>		<u>End Date</u> <u>IBPD Metric #</u>	
		Evaluation Report			
		Design and Implement			
		Verification and Validation			
		Benchmark Report		8/1/2009	
First year of funding was FY06 (late in year so skipped FY07)					
<i>Notes:</i>					

Project: ROSES07-ROSES11																													
<p>The purpose of this project is to assess the potential for solicited projects using NASA Earth Science Research (especially models and future sensors) to improve the performance of EPA, NOAA, USGS, USDA, and other's Water Management Decision Support Systems used in Water Quality, Flow & Flood Forecasts, Drought, and Water Delivery and Irrigation for mandated water</p> <p>Water Management Program will participate in Science Mission Directorate ROSES solicitations. Projects are 3-year efforts. Possible topics for the solicitations include: ROSES 2007 (start FY08): Water Quality, Drought ROSES 2008 (start FY09): Water Quality, Flow/Flood Forecast; ROSES 2009 (start FY10): Water Quality, Drought, Flow/Flood Forecast; ROSES 2010 (start FY11): Water Delivery and Irrigation, Flow/Flood Forecast; ROSES 2011 (start FY12): Water Delivery and Irrigation, Drought, Flow/Flood Forecast</p>				<i>Budget (\$K)</i>																									
				FY07	0																								
<i>Project Monitor and Center</i>	<i>Other NASA Centers</i>	<i>Timeframe</i>	<i>Partners</i>	FY08	417																								
Assigned once		FY08 - FY14	Multiple	FY09	750																								
				FY10	1021																								
				FY11	1021																								
<i>Principal Investigator(s)</i>		<i>Dependent on selected projects</i>																											
<i>Earth Science Products</i>	mission: <i>Strong emphasis on use of upcoming NASA</i> sensor: <i>Strong emphasis on use of upcoming NASA sensors</i> products: models: <i>Strong emphasis on use of Earth science models,</i>			<i>Other Apps.</i>																									
<i>Deliverables</i>	<table border="0" style="width: 100%;"> <thead> <tr> <th style="text-align: left;"><u>Description</u></th> <th style="text-align: left;"><u>End Date</u></th> <th style="text-align: left;"><u>IBPD Metric #</u></th> </tr> </thead> <tbody> <tr> <td>Evaluation Report</td> <td></td> <td></td> </tr> <tr> <td>Design and Implement</td> <td></td> <td></td> </tr> <tr> <td>Verification and Validation</td> <td></td> <td></td> </tr> <tr> <td>Benchmark Report</td> <td></td> <td></td> </tr> <tr> <td>ROSES2007</td> <td>9/1/2010</td> <td></td> </tr> <tr> <td>ROSES2008</td> <td>9/1/2011</td> <td></td> </tr> <tr> <td>ROSES2009</td> <td>9/1/2012</td> <td></td> </tr> </tbody> </table>					<u>Description</u>	<u>End Date</u>	<u>IBPD Metric #</u>	Evaluation Report			Design and Implement			Verification and Validation			Benchmark Report			ROSES2007	9/1/2010		ROSES2008	9/1/2011		ROSES2009	9/1/2012	
<u>Description</u>	<u>End Date</u>	<u>IBPD Metric #</u>																											
Evaluation Report																													
Design and Implement																													
Verification and Validation																													
Benchmark Report																													
ROSES2007	9/1/2010																												
ROSES2008	9/1/2011																												
ROSES2009	9/1/2012																												
<p>Notes: *** Total National Apps. funds (planned) *** ROSES 2007: 18M (over 3 years) - Coastal approx. 1.25M (over 3 years) Notes: ROSES 2008: 15M (over 3 years) - Coastal approx. 1.0M (over 3 years) ROSES 2009: 12M (over 3 years) - Coastal approx. 0.8M (over 3 years) ROSES 2010: 18M (over 3 years) - Coastal approx. 1.25M (over 3 years)</p>																													

B. Directed Projects

The program supports directed projects to serve issues of critical strategic and tactical importance, including near-term opportunities with potential for high-return in developing relationships with partner organizations and where timeliness is critical to maintain.

Project: BASINS				Directed Project	
<p>The goal is to verify and validate Earth-Sun System science products, including MODIS products (land cover, LAI) and land surface model products using LIS in EPA's BASINS decision support tool. A regional test project will be initiated to connect LDAS outputs with BASINS, for use to model the Chesapeake Bay Watershed. MODIS data will either be infused into LDAS first, or directly into BASINS. Benchmark metrics are being developed and will be reported at the end of the project. Project will also conduct Rapid Prototyping to further evaluate and develop NASA capabilities.</p>				<i>Budget (\$K)</i>	
				FY07	57
<i>Project Manager and Center</i>	<i>Other NASA Centers</i>	<i>Timeframe</i>	<i>Partners</i>	FY08	10
David Toll, GSFC		FY06 - FY10	EPA	FY09	10
				FY10	0
				FY11	0
<i>Principal Investigator(s)</i>			<i>Other Apps.</i>		
<i>Earth Science Products</i>	mission: <i>Terra, Aqua</i> sensor: <i>MODIS</i> products: models: <i>LDAS/LIS</i>				
<i>Deliverables</i>	<u><i>Description</i></u>	<u><i>End Date</i></u>	<u><i>IBPD Metric #</i></u>	Coastal Management, Ecological Forecasting, Public Health	
	Evaluation Report	1/30/2006			
	Design and Implement	3/31/2006			
	V&V Report	9/30/2006			
	Benchmark Report	9/30/2007			
	Results Conference	9/30/2006			
	Project Plan	10/1/2005			

Project: AWARDS and RiverWare				Directed Project	
The goal of this project is to evaluate, verify and validate, and benchmark NASA Earth science products, especially spacecraft and land surface models, for beneficial, routine use in assessment of water availability for agriculture, hydroenergy, endangered species and public recreation based on large scale assessment (AWARDS) and for river stage condition (RiverWare). RPC will also be incorporated to improve use of NASA products.				<i>Budget (\$K)</i>	
				FY07	57
<i>Project Manager and Center</i>	<i>Other NASA Centers</i>	<i>Timeframe</i>	<i>Partners</i>	FY08	10
Kristi Arsenault	GSFC	FY06 - FY10	BoR	FY09	10
				FY10	0
				FY11	0
<i>Principal Investigator(s)</i>			<i>Other Apps.</i>		
<i>Earth Science Products</i>	mission: <i>Terra, Aqua</i> sensor: <i>MODIS, AMSR-E</i> products: models: <i>LDAS/ LIS</i>				
<i>Deliverables</i>	<u><i>Description</i></u>	<u><i>End Date</i></u>	<u><i>IBPD Metric #</i></u>	Agricultural Efficiency, Energy Management, Disaster Management	
	Project Plan	10/1/2005			
	Assessment & Prototype	2/15/2006			
	Final report (draft)	3/31/2006			
	Final report (incl. partner comments)	9/30/2006			
		9/30/2007			
	Results Conference(s)	9/30/2006			
	International activities report	9/30/2006			

Project: Exploratory Projects. USDA-NRCS, AFWA, ACE and US Army				Directed Project	
The goal of this project is to establish relationships and to evaluate, verify validate and benchmark Earth science products, especially spacecraft products and land models, for improving performance of the USDA NRCS and other agency (ACE, AFWA, US Army) water supply, forecasts and drought monitoring. Staff will also provide RPC work to further explore use of NASA data.				<i>Budget (\$K)</i>	
				FY07	57
<i>Project Manager and Center</i>	<i>Other NASA Centers</i>	<i>Timeframe</i>	<i>Partners</i>	FY08	70
Edwin Engman	GSFC	FY06 - FY10	USDA, ACE AFWA, Army, USGS	FY09	50
				FY10	10
				FY11	0
<i>Principal Investigator(s)</i>			<i>Other Apps.</i>		
<i>Earth Science Products</i>	mission: Terra, Aqua sensor: ASTER, SRTM, MODIS, GRACE products: models: LDAS/LIS				
<i>Deliverables</i>	<u>Description</u> Benchmark Report-HABs Results Conference-HABs FY06-08 Transition Approach Semi-annual reports Project Plan	<u>End Date</u> 10/1/2010			
				Agricultural Efficiency, Disaster Management, Energy	

C. Congressionally-Directed Activities

The program oversees Congressionally-directed activities associated with water management issues. The project teams for Congressionally-directed activities are responsible for developing, managing, and reporting on technically-credible and appropriately-budgeted projects aligned with the NASA Applied Sciences Program objectives. The Water Management program team interacts with the recipients to align their activities appropriately and facilitates interaction with the program's partners and other investigators.

Project: Directed - Water Quality					
<p>Application of NASA Satellite Products and Land Surface Models to Improve the Hydrologic Performance of the EPA's BASINS DST: The purpose of this project is to assess the potential for NASA MODIS land products and NASA LIS evapotranspiration and precipitation to improve the performance of EPA BASINS decision support systems used for monitoring water quality, establishing Total Maximum Daily Loads of contaminants, and identifying sources of pollution for protecting and monitor our nations water supply. The goal of this project is to evaluate primarily NASA LIS water availability products of precipitation and evapotranspiration and MODIS land cover and vegetation index products to improve water quality modeling for the EPA BASINS DST. The strategy being used is to focus on BASINS-HSPF, a continuous watershed model that produces a streamflow hydrograph at specific points in a drainage basin. If we are able to improve the predictive capability of HSPF, the BASINS DST will produce more accurate streamflow and thus concentrations of specific water quality parameters. The spatially distributed precipitation product derived from LIS should produce improved forcing when compared to the gauge only approach currently used by EPA. In addition, work is ongoing to use LIS ET products which should provide a spatially distributed estimate that is superior to the current ET models used in HSPF. Also, both Landsat and MODIS data were effectively shown to model the export of nitrogen deposition in the watershed from the intensity of defoliation via environmental disturbances.</p>				<i>Budget (\$K)</i>	
				FY07	145
<i>Project Manager and Center</i>	<i>Other NASA Centers</i>	<i>Timeframe</i>	<i>Partners</i>	FY08	0
David Toll &	GSFC	FY05 - FY07	Hunter College, Univ. Wisc., EPA OW, EPA CBP,	FY09	0
				FY10	0
				FY11	0
<i>Principal Investigator(s)</i>		<i>David Toll (NASA/GSFC) and Ted Engman</i>		<i>Other Apps.</i>	
<i>Earth Science Products</i>	mission: <i>Terra, Aqua</i> sensor: <i>MODIS</i> products: <i>land cover</i> models: <i>LIS</i>				
<i>Deliverables</i>	<u><i>Description</i></u>	<u><i>End Date</i></u>	<u><i>IBPD Metric #</i></u>		
	Benchmark Report	4/20/2007			

Project: Directed - Water Delivery and Irrigation					
<p>NASA Products for Improving Reclamation RiverWare and AWARDS ET Tool Box DSTs for Water Availability and Forecasting: The purpose of this project is to study and apply NASA LIS modeling and information with MODIS, and AMSR-E satellite products to improve the performance of Bureau of Reclamation RiverWare and AWARDS ET Tool Box DSTs used in water availability and forecasting for reservoir management and related water management in the western US. The main goals of the collaborative efforts with Reclamation involve developing an integrated observation-based modeling system, LIS, and use of NASA satellite products that meets the water management needs of their regional offices through improvement and evaluation of their RiverWare (reservoir management) and AWARDS ET-Toolbox (water loss and hence water supply for irrigated agriculture) Decision Support Tools. Selected LIS water soil moisture, snow and ET products and satellite MODIS snow cover, ET and land cover products are the primary focus for inclusion in Reclamation's DSTs. Both retrospective studies and near real-time simulations are being evaluated and made available to investigate where monitoring and forecasting of water supply and extreme events, like flooding, may be enhanced. Areas of study for these projects are primarily the Yakima and the Middle Rio Grande River Basins.</p>				<i>Budget (\$K)</i>	
				FY07	145
<i>Project Manager and Center</i>	<i>Other NASA Centers</i>	<i>Timeframe</i>	<i>Partners</i>	FY08	0
David Toll &	GSFC	FY04 - FY07	Bureau of Reclamation TSC and Regional	FY09	0
				FY10	0
				FY11	0
<i>Principal Investigator(s)</i>		<i>Kristi Arsenault (UMBC/GEST)</i>		<i>Other Apps.</i>	
<i>Earth Science Products</i>	<p>mission: <i>Terra, Aqua</i> sensor: <i>MODIS, AMSR-E</i> products: <i>snow cover, land cover</i> models: <i>LIS soil moisture, snow, precipitation & ET</i></p>				
<i>Deliverables</i>	<u><i>Description</i></u> Benchmark Report		<u><i>End Date</i></u> 3/31/2007	<u><i>IBPD Metric #</i></u>	

Project: Directed - Flow & Flood, Drought, Water Quality					
<p>This project focuses on the application of NASA Earth science data to support USDA SWAT model.</p> <p>The program has had several meetings with USDA under the NASA-USDA agreement, and the program has identified a need for a USDA-oriented project related to water management. In FY07, this project is largely focused on investigating opportunities that may exist related to SWAT, which USDA has identified in recent meetings as one of their priority decision support systems.</p> <p>The program may solicit for this topic or may direct fund a project. FY08-10 funding is a placeholder for possible project, depending on FY07 investigation and possible solicited projects.</p>				<i>Budget (\$K)</i>	
				FY07	0
<i>Project Manager and Center</i>	<i>Other NASA Centers</i>	<i>Timeframe</i>	<i>Partners</i>	FY08	50
Pending	GSFC, SSC, JPL, LaRC, MSFC	FY07 - FY010	USDA	FY09	60
				FY10	100
				FY11	0
<i>Principal Investigator(s)</i>		<i>Pending investigation</i>		<i>Other Apps.</i>	
<i>Earth Science Products</i>	mission: sensor: products: models:				
<i>Deliverables</i>	<u><i>Description</i></u>	<u><i>End Date</i></u>	<u><i>IBPD Metric #</i></u>		
	Investigation Findings	4/1/2007			
	USDA-NASA Meeting	2/10/2007			

Project: Directed - Water Quality					
<p>This project focuses on the application of MODIS and other Earth science products related to the Chesapeake Bay and coastal water quality. For the one-year effort, the project focuses on supporting the Chesapeake Bay DSS using Chl a, Kd, TSS, and DO, test proposed techniques, and develop a prototype to determine the potential value.</p> <p>In FY07, this project is largely designed as a proof-of-concept to assess techniques that may help with assessing the health status of coastal waterways. The program may solicit for this topic or may direct fund a project (depending on results of prototype) - FY08-9 funding is placeholder for partial funding.</p> <p>Co-funding from Coastal Management program.</p>				<i>Budget (\$K)</i>	
				FY07	125
<i>Project Manager and Center</i>	<i>Other NASA Centers</i>	<i>Timeframe</i>	<i>Partners</i>	FY08	50
Pending	GSFC, SSC, JPL	FY07 - FY07	Bureau of Reclamation TSC and Regional	FY09	60
				FY10	0
				FY11	0
<i>Principal Investigator(s)</i>		<i>Pending agreement</i>		<i>Other Apps.</i>	
<i>Earth Science Products</i>	mission: sensor: <i>MODIS, ASTER, other sensors and models</i> products: models:				
<i>Deliverables</i>	<u><i>Description</i></u>	<u><i>End Date</i></u>	<u><i>IBPD Metric #</i></u>		
	Project Plan	1/15/2007			
	Prototype Demonstration	7/15/2007			
	Prototype Report	9/1/2007			

Project: Directed - Water Quality						
<p>Water Quality: The program currently has activities related to EPA BASINS and Chesapeake Bay. The program is interested in examining potential for NASA Earth science results to support direct measurements of water quality.</p> <p>In FY07, the program expects to examine opportunities related to water quality and seek SN candidate solutions for potential ISS projects. The program expects to focus on water quality in ROSES solicitations.</p> <p>If there are no water quality projects selected under ROSES, the program is allocating funding in FY08-10 for start-up efforts or projects; the specific topic(s) within this theme will depend on results from investigations and solicitations.</p>				<i>Budget (\$K)</i>		
				FY07	0	
<i>Project Manager and Center</i>	<i>Other NASA Centers</i>	<i>Timeframe</i>	<i>Partners</i>	FY08	125	
Project Monitor	GSFC, SSC, MSFC, LaRC, JPL	FY07 - FY011		FY09	125	
				FY10	125	
				FY11	0	
<i>Principal Investigator(s)</i>			<i>Other Apps.</i>			
<i>Earth Science Products</i>	mission: sensor: products: models:					
<i>Deliverables</i>	<u>Description</u> Project Plan	<u>End Date</u> 11/1/2007	<u>IBPD Metric #</u>			

Project: Directed - Water Delivery and Irrigation					
<p>Water Delivery and Irrigation: The program currently has activities related to BoR RiverWare and AWARDS-ET Toolbox and Western US Season Forecasts. Given the current portfolio, the program plans to focus on other Water Management themes for new projects in the near term. The program will continue to examine the potential for NASA Earth science results to support water delivery and irrigation DSS.</p> <p>In FY09, the program expects to examine opportunities related to water delivery/irrigation and seek SN candidate solutions for potential ISS projects. If there are no water delivery projects selected under ROSES09/10, the program is allocating funding in FY10-11 for start-up efforts or projects; the specific topic(s) within this theme will depend on results from investigations and solicitations.</p>				<i>Budget (\$K)</i>	
				FY07	0
<i>Project Manager and Center</i>	<i>Other NASA Centers</i>	<i>Timeframe</i>	<i>Partners</i>	FY08	0
Project Monitor	GSFC, SSC, MSFC, LaRC, JPL	FY07 - FY011		FY09	
				FY10	125
				FY11	130
<i>Principal Investigator(s)</i>					
<i>Earth Science Products</i>	mission: sensor: products: models:			<i>Other Apps.</i>	
<i>Deliverables</i>	<u>Description</u> Project Plan	<u>End Date</u> 11/1/2009	<u>IBPD Metric #</u>		

Project: Directed - Flow & Flood Forecasting					
<p>Flow & Flood Forecasting: The program currently has activities related to NOAA NWS River Forecast System.</p> <p>Given the current portfolio, the program plans to focus on other Water Management themes for new projects in the near term. The program will continue to examine the potential for NASA Earth science results to support flow and flood DSS.</p> <p>In FY09, the program expects to examine opportunities related to water delivery/irrigation and seek SN candidate solutions for potential ISS projects. If there are no flow/flood projects selected under ROSES09/10, the program is allocating funding in FY10-11 for start-up efforts or projects; the specific topic(s) within this theme will depend on results from investigations and solicitations.</p>				<i>Budget (\$K)</i>	
				FY07	0
<i>Project Manager and Center</i>	<i>Other NASA Centers</i>	<i>Timeframe</i>	<i>Partners</i>	FY08	0
Project Monitor	GSFC, SSC, MSFC, LaRC, JPL	FY07 - FY011		FY09	0
				FY10	130
				FY11	130
<i>Principal Investigator(s)</i>					
<i>Earth Science Products</i>	mission: sensor: products: models:			<i>Other Apps.</i>	
<i>Deliverables</i>	<u>Description</u>	<u>End Date</u>	<u>IBPD Metric #</u>		
	Project Plan	11/1/2009			

Project: Directed - Drought					
<p>Drought: The program currently has activities related to the US Drought Monitor.</p> <p>The program plans to include Drought in upcoming ROSES solicitations, and the program will continue to examine the potential for NASA Earth science results to support drought DSS.</p> <p>The program expects to examine opportunities related to water delivery/irrigation and seek SN candidate solutions for potential ISS projects. If there are no flow/flood projects selected by ROSES10, the program is allocating funding in FY11 for start-up efforts or projects; the specific topic(s) within this theme will depend on results from investigations and solicitations.</p>				<i>Budget (\$K)</i>	
				FY07	0
<i>Project Manager and Center</i>	<i>Other NASA Centers</i>	<i>Timeframe</i>	<i>Partners</i>	FY08	0
Project Monitor	GSFC, SSC, MSFC, LaRC, JPL	FY07 - FY011		FY09	0
				FY10	0
				FY11	180
<i>Principal Investigator(s)</i>					
<i>Earth Science Products</i>	mission: sensor: products: models:			<i>Other Apps.</i>	
<i>Deliverables</i>	<u>Description</u>	<u>End Date</u>	<u>IBPD Metric #</u>		
	Project Plan	11/1/2010			

Project: Directed - Water Management Program Labor					
Program personnel – Civil Servant time and on/near-site contractors. Monitor projects, support interagency, national, regional, and international working groups. Develop joint development plans, studies, and white papers. Prepare journal articles. FY07: Deputy Prog. Man. 0.4FTE; Support (GSFC or elsewhere) 0.4 WYE FY08: Deputy Prog. Man. 0.4FTE; Support (GSFC or elsewhere) 0.4 WYE FY09: Deputy Prog. Man. 0.4FTE; Support (GSFC or elsewhere) 0.4 WYE FY10: Deputy Prog. Man. 0.4FTE; Support (GSFC or elsewhere) 0.4 WYE FY11: Deputy Prog. Man. 0.4FTE; Support (GSFC or elsewhere) 0.4 WYE				<i>Budget (\$K)</i>	
				FY07	120
<i>Project Manager and Center</i>	<i>Other NASA Centers</i>	<i>Timeframe</i>	<i>Partners</i>	FY08	125
Dave Toll	GSFC, SSC, MSFC, LaRC, JPL	FY07 - FY011		FY09	130
				FY10	135
				FY11	140
<i>Principal Investigator(s)</i>			<i>Other Apps.</i>		
<i>Earth Science Products</i>	mission: sensor: products: models:				
<i>Deliverables</i>	<u><i>Description</i></u>		<u><i>End Date</i></u>	<u><i>IBPD Metric #</i></u>	

V. Program Management & Crosscutting Solutions Support

A. Program Management Activities

The Water Management program conducts activities that contribute to the overall management, advocacy, and success of the program. Activities include studies and assessments in informal planning, interagency working group participation, publications and journal articles, support for conferences and workshops, program team meetings, and other related endeavors.

Project: Studies, Reports and Assessments				Project Management	
<p>The purpose of this activity is to identify important water management issues and evaluate associated management responsibilities and decision support tools to determine opportunities the program element may support. The information and analysis will identify possible applications of Earth system science research results to support the partners as well as help the application develop and structure partnerships.</p> <p>A. Investigations for Strategic Planning FY07: Investigation of opportunities related to drought, hydropower, SWAT, and USACE. FY09: Study on priority topics mentioned in Federal Water Management Agencies Strategic Plans</p> <p>B. Mission reports FY07-11: Succint, thorough assessments of upcoming Earth observation sensors relating to Water Management application activities and potential benefits. 15K each.</p> <p>FY07: OSTM FY08: Aquarius FY09: OCO FY10: LDCM FY11: GPM</p> <p>FY08: Studies dependent on solicitation efforts.</p>				<i>Budget (\$K)</i>	
				FY07	70
<i>Project Manager and Center</i>	<i>Other NASA Centers</i>	<i>Timeframe</i>	<i>Partners</i>	FY08	22
Dave Toll/GSFC	GSFC, SSC, MSFC, JPL, LaRC	FY07 - FY11	Multiple	FY09	23
				FY10	15
				FY11	15
<i>Principal Investigator(s)</i>			<i>Other Apps.</i>		
<i>Earth Science Products</i>	mission: sensor: products: <i>Portfolio evaluation, Program Element Strategic</i> models:				
<i>Deliverables</i>	<u>Description</u>	<u>End Date</u>	<u>IBPD Metric #</u>		
	Establish Working Group Design and Implement Verification and Validation Report Benchmark Report Project Plan Meeting Reports Pre-eval ESS prods for other DSSs	6/1/2006			

Project: Communications & Conferences				Project Management	
Sponsor workshops/conferences and support conference booths. Annual: AWRA (support a booth) Also, support to water management targets of opportunity and conferences that arise and other opportunities to communicate the plans and results of the NASA Water Management Program.				<i>Budget (\$K)</i>	
				FY07	15
<i>Project Manager and Center</i>	<i>Other NASA Centers</i>	<i>Timeframe</i>	<i>Partners</i>	FY08	15
Lawrence Friedl, HQ	GSFC, SSC, MSFC, JPL, LaRC	FY07 - FY11		FY09	15
				FY10	15
				FY11	15
<i>Principal Investigator(s)</i>			<i>Other Apps.</i>		
<i>Earth Science Products</i>	mission: sensor: products: models:				
<i>Deliverables</i>	<u>Description</u>	<u>End Date</u>	<u>IBPD Metric #</u>		
	Communications Plan Annual Reports	12/15/200			

Project: Committees and Water Working Group				Project Management	
<p>The program interacts with numerous Federal agencies, and the program is developing greater activities with key Water Management organizations, such as AWRA and HELP.</p> <p>On a periodic basis, the program meets with the Water Management team meeting and Water Man. Working Group to discuss status, issues, progress, results, and opportunities for the NASA Water Management program.</p> <p>Support GEO Coastal Community of Practice and User Interface Committee. The program also interacts with national and international water management related groups such as GEWEX, ESIP, CCSP, IWGEO, WICP-ACWI, IGWECO, etc..</p> <p>This funding supports possible involvement in the organizations and committees and/or organization of the WM Working Group.</p>				<i>Budget (\$K)</i>	
				FY07	5
				FY08	5
<i>Project Manager and Center</i>	<i>Other NASA Centers</i>	<i>Timeframe</i>	<i>Partners</i>	FY09	5
Lawrence Friedl, HQ	GSFC, SSC, MSFC, JPL	FY07 - FY11	Water related organizations	FY10	5
				FY11	5
<i>Principal Investigator(s)</i>			<i>Other Apps.</i>		
<i>Earth Science Products</i>	mission: sensor: products: models:				
<i>Deliverables</i>	<u>Description</u>	<u>End Date</u>	<u>IBPD Metric #</u>		
	Meeting Reports				

B. Crosscutting Solutions Support

The program consists of functional elements that contribute to all of the National Applications activities. The intention is to have the performance of these functions leverage accomplishments, and therefore the apparent resource investment, to the greatest extent possible into the National Applications partnerships. These functions are: Geoscience Standards and Interoperability, Human Capital Development, Integrated Benchmark Systems, and Solutions Networks. Examples of leveraged activities are:

Integrated Benchmark Solutions

A Rapid Prototyping Capability to support NASA and partners in reducing uncertainty and testing the validity of NASA research results in decision support tools.

FY07:

Water Quality; Drought

FY08: Drought; SWAT

FY09: SWAT; Water Delivery

FY10: Irrigation

FY11: Drought; Water Quality

Solutions Networks

The Water Management program plans to work with the Solutions Network activity to identify configurations of specific research results that may be candidates for Integrated System Solutions and/or priorities for Rapid Prototyping activities. In FY07, the program is pursuing specific studies and it encourages SN candidate solutions in similar areas of: Water Quality, Drought, SWAT, USACE.

DEVELOP

A student-based, human capital development program for building capability in entry level participants in the community of practice while developing solutions for state and local applications.

FY07:

Water Quality

FY08: Hydropower (with Energy Management)

FY10: Water Delivery and Allocation

GIO

The Water Management program plans to support interagency efforts and results from several NASA-supported projects and efforts may require interoperability tools developed and prototyped under ES Gateway.

FY07: GEO NTO NIDIS; BASINS, RiverWare, AWARDS

FY08: GEO NTO NIDIS; Water Quality

FY09: NOAA Flash Flood & River Forecast System

FY10: Water Delivery & Irrigation

FY11: Flow & Flood Forecasting

VI. Budget: FY07-11

The following table lists the Water Management Program budget for FY2007 - FY2011:

Project	FY07 (\$K)	FY08 (\$K)	FY09 (\$K)	FY10 (\$K)	FY11 (\$K)
ROSES05 - WD&I Hendrickx	221	0	0	0	0
ROSES05 WD&I Aggett	288	187	0	0	0
Decisions04 - WD&I Lettenmaier	392	399	0	0	0
Decisions04 - Drought Nghiem/Verdin	470	462	0	0	0
Decisions04 - Flow/Flood Restrepo/Limaye	466	466	0	0	0
NEWS04 - Flow/Flood Cosgrove	0	198	182	0	0
ROSES07-11 Solicitations	0	417	750	1021	1021
Direct - WD&I BoR RiverWare & AWARDS	145	0	0	0	0
Direct - Water Quality BASINS	140	0	0	0	0
Direct - Water Quality Ches.Bay POC	125	50	60	0	0
Direct - Flow/Drought/WQ SWAT	0	50	60	100	0
Water Delivery & Irrigation	0	0	0	125	130
Flow & Flood Forecasting	0	0	0	130	130
Water Quality	0	125	125	125	0
Program Management Labor	120	125	130	135	140
Program Management - Studies & Reports	70	22	23	15	15
Program Management - Communications and Conferences	15	15	15	15	15
Program Management - Committees and Water Working Group	5	5	5	5	5
Total = \$	2457	2521	1350	1671	1456

VII. Schedule and Milestones for Water Management

<i>Project</i>	<i>Start Date</i>	<i>Deliverable</i>	<i>End Date</i>
BASINS	FY05	Project Plan	10/1/2005
		Evaluation Report	12/30/2006
		Design and Implement	3/31/2006
		V&V Report	9/30/2006
		Benchmark Report	9/30/2007
		Results Conference	9/30/2006

<i>Project</i>	<i>Start Date</i>	<i>Deliverable</i>	<i>End Date</i>
AWARDS and RiverWare	FY05	Project Plan	10/1/2005
		Evaluation Report	12/30/2005
		Design and Implement	3/31/2006
		V&V Report	9/30/2006
		Benchmark Report	9/30/2007
		Results Conference(s)	9/30/2006
		International activites report	9/30/2006

<i>Project</i>	<i>Start Date</i>	<i>Deliverable</i>	<i>End Date</i>
USDA NRCS WSF and SCAN/NIDIS	FY05	Project Plan	10/1/2005

<i>Project</i>	<i>Start Date</i>	<i>Deliverable</i>	<i>End Date</i>
Program Planning	FY05	Meeting Reports	NULL
		Evaluation Reports on Issues and	NULL
		Exploration of pre-evaluation of	NULL
		Establish Working Group	6/1/2006

<i>Project</i>	<i>Start Date</i>	<i>Deliverable</i>	<i>End Date</i>
Program Alignment	FY05	Society planning and priority	NULL
		Reports on issues, DST for	NULL

<i>Project</i>	<i>Start Date</i>	<i>Deliverable</i>	<i>End Date</i>
NOAA NCEP Eta	NULL	Project Plan	10/1/2005
		Evaluation Report	NA
		Design and Implement	NULL
		V&V Report	9/30/2005
		Benchmark Report	9/30/2005

<i>Project</i>	<i>Start Date</i>	<i>Deliverable</i>	<i>End Date</i>
Improving NOAA/NWS River Forecast Center Decision Support with NASA Satellite and Land Information System Products	12/1/2005	Revised Proposal	10/30/2005
		Pending procurement	11/30/2005

<i>Project</i>	<i>Start Date</i>	<i>Deliverable</i>	<i>End Date</i>
Improving Water Resources Management in the Western US through the Use of Remote Sensing Data and Seasonal Climate Forecasts	12/1/2005	Pending procurement	11/30/2005

<i>Project</i>	<i>Start Date</i>	<i>Deliverable</i>	<i>End Date</i>
National Drought Monitoring System for Drought Early Warning using Hydrologic and Ecologic Observations from NASA Satellite Data	12/1/2005	Revised Proposal	10/31/2005
		Pending procurement	11/30/2005

VIII. Program Measures

The Water Management team uses measures to track progress within and across projects to ensure the program meets its goal and objectives. The measures are in two categories: Program Management measures are internally-focused to assess how the program conducts its activities, including the inputs, outputs, production, quality, and efficiency of projects. Performance measures are externally-focused to assess if the program's projects and activities are serving their intended purpose. The management team analyzes these measures retrospectively in order to make adjustments proscriptively to the program approach and objectives.

Program Management Measures (Internally-focused):

Range of platform, sensors, models, and products used in Solicited projects

Range of platform, sensors, models, and products used in Directed projects

Number of studies delivered on or ahead of schedule

Number and range of sensors, models, products considered and identified in strategic studies

Performance Measures (Externally-focused):

Water Quality – value of NASA products in BASINS

Irrigation & Water Delivery - change in BOR metrics for RiverWare and AWARDS ET Toolbox

Flow & Flood - improvement in flash flood predictions

Percentage of projects with published paper associated with its activities

In addition to the stated measures, the Water Management program periodically requests an assessment of its plans, goals, priorities, and activities through external review. The National Academy of Sciences National Research Council is reviewing the Applied Sciences Program (including the Water Management program) in FY06-07. The program expects another review of the program in the FY10 timeframe.

Appendix A: Program Element Partners

A. Program Management

Lawrence Friedl, Program Element Manager (Acting)

NASA-Headquarters

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Jared Entin, Former (and assisting) Program Element Manager

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NASA-GSFC

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B. Water Management Network & Partners

The program element maintains a network of organizations and points-of-contact associated with Water Management activities.

NASA Applied Sciences Program and NASA Centers:

Water and Energy Cycle Focus Area.....	Jared Entin, NASA HQ
Climate Change & Variability Focus Area	Don Anderson, NASA HQ
Weather Focus Area.....	Ramesh Kakar, NASA HQ
Atmospheric Composition	Phil DeCola, NASA HQ
Climate Modeling	Don Anderson, NASA HQ
Earth Surface and Interior.....	John Labreque, NASA HQ
Carbon and Ecosystems.....	Diane Wickland, NASA HQ
Computation.....	Tsengdar Lee, NASA HQ

Federal Partners (partial):

US EPA Office of Water.....	Amy Neuman
.....	Ed Partington
US EPA Office of Research and Development	Barbara Levinson
Bureau of Reclamation.....	Chuck Hennig
US Geological Survey Water Resources	Robert Hirsch
.....	William Kirby
NOAA Office of Hydrologic Development	Pedro Restrepo
NOAA Office of Global Programs Climate Prediction	
Projects for the Americas	Jin Huang
NOAA National Operational Hydrologic Remote	
Sensing Center	Donald Cline
NOAA National Weather Service.....	Ken Mitchell
Department of Agriculture (USDA)	
Agricultural Research Service	Dale Bucks
.....	Tom Jackson
Natural Resources Conservation Program.....	Phil Pasteris
.....	Garry Schaefer
State Department.....	Robert Senseney
Army Corps of Engineers.....	Kathleen White

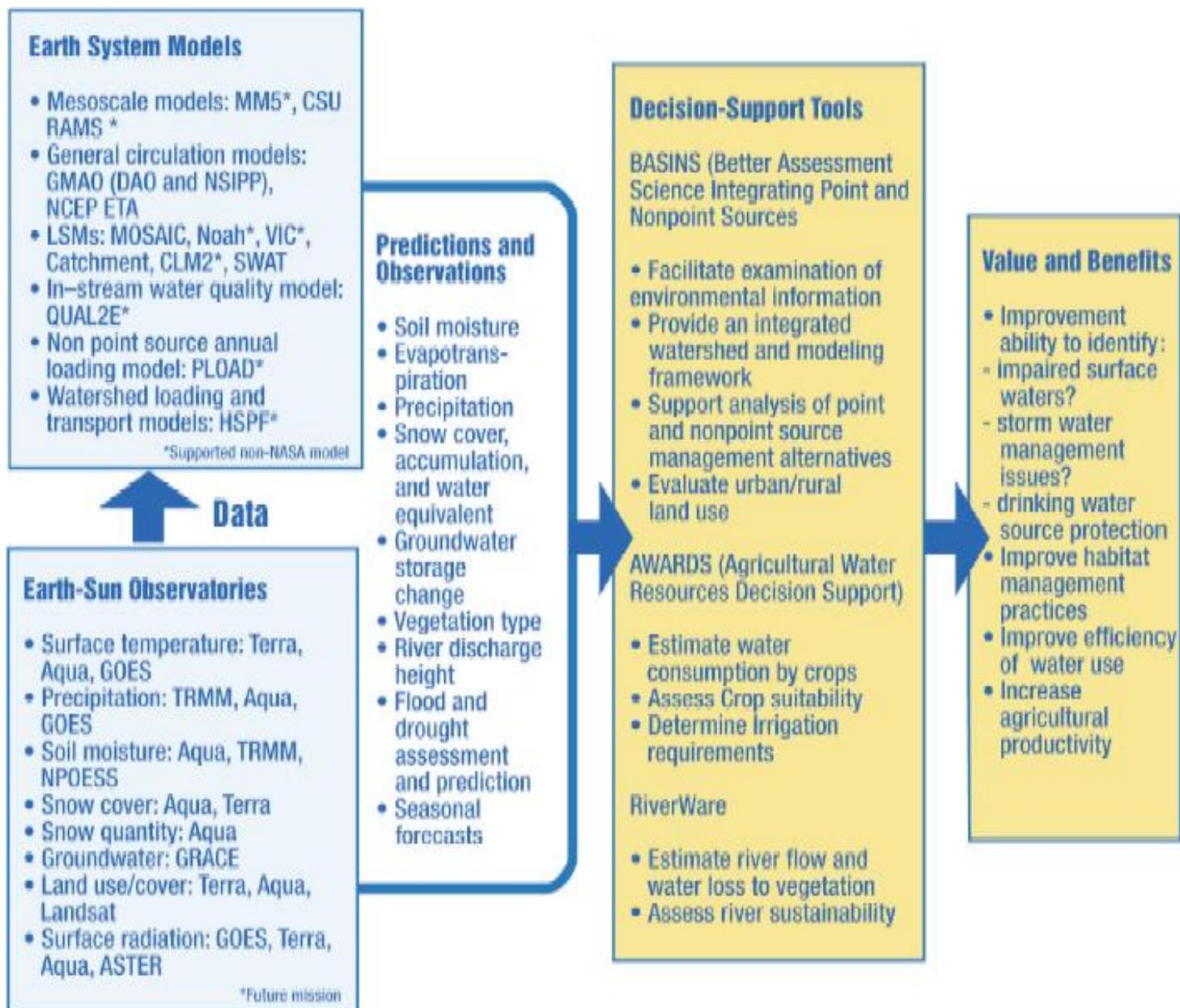
International, National and Regional Organizations:

ASCE (American Society of Civil Engineers)	
AMS (American Meteorological Society)	
AWRA (American Water Resources Association)	
GEWEX: Global Energy and Water Cycle Experiment (Rick Lawford)	
HELP: Hydrology for the Environment, Life, and Policy (Jonathan Triggs)	
IGOS: Integrated Global Observing Strategy (Rick Lawford)	
GWSP: Global Water Systems Project (Charles Vörösmarty)	
IFPRI: International Food Policy Research Institute (Mark Rosegrant)	
USGS ACWI-WICP: Advanced Committee on Water Information	
– Water Information Coordination Program (Don Frevert)	
IGWCO: Integrated Global Water Cycle Office (Rick Lawford)	

Appendix B: Roadmaps

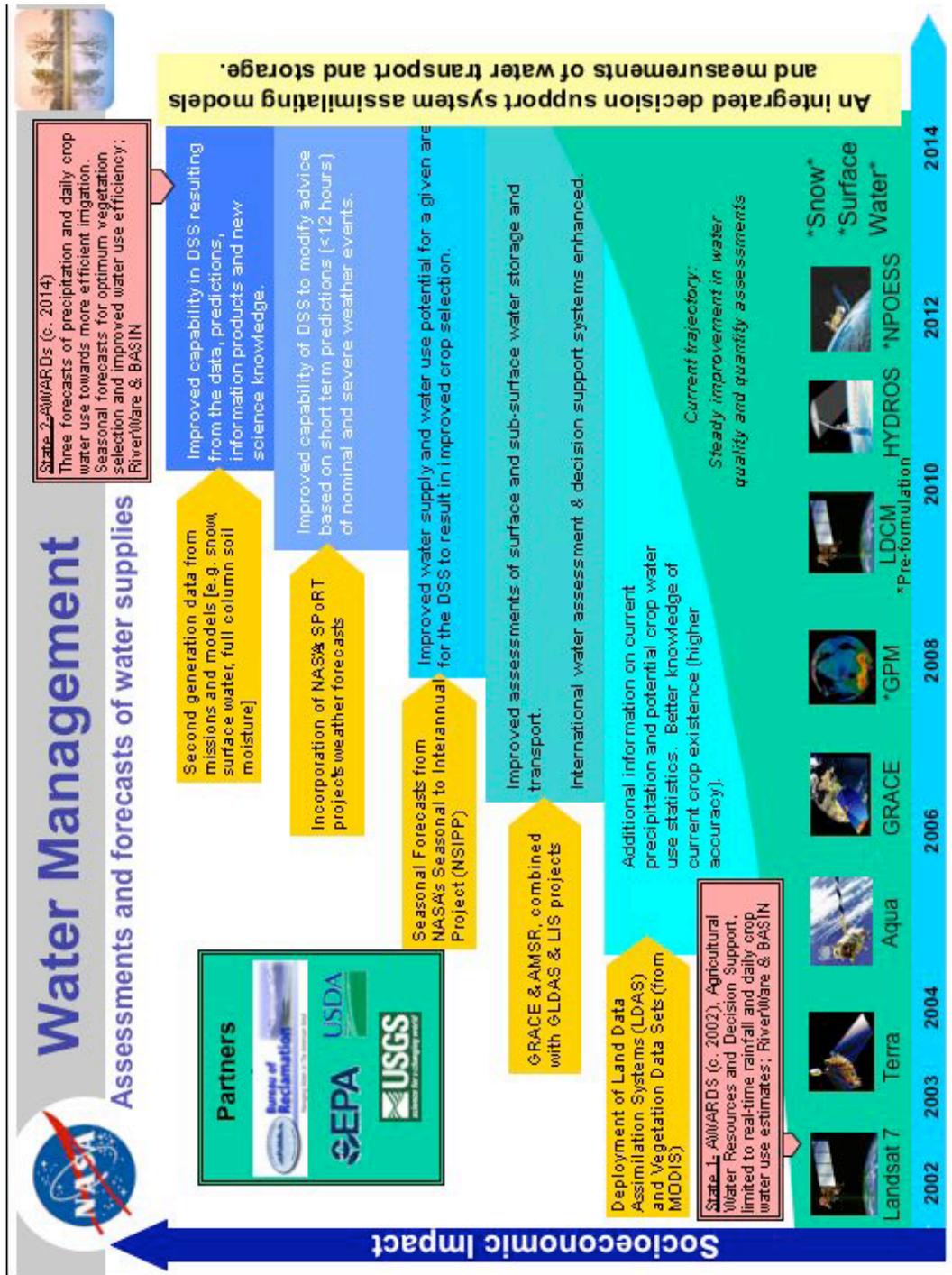
A. Integrated Systems Solutions Diagram

The figure below illustrates how Science measurements, model products, and data fusion techniques support the Water Management Program's partners and their decision support tools and shows the value and benefits of Science to society.



B. Roadmap

The following roadmap shows the direction of the program over the next ten years. It illustrates the current state of Water Management DSTs and the projected state of those DSTs with the infusion of NASA Earth-Sun system science research results. The Water Management program plan deals in detail with the first five years of the roadmap.



Appendix C: Acronyms

ACWI	Advanced Committee on Water Information
ACRIM	Active Cavity Radiometer Irradiance Monitor Satellite
AHPS	Auxiliary Hydraulic Power supply
AIRS	Airborne Infrared Sounder
AIRS	Alliance Icing Research Study
ASCE	American Society of Civil Engineers
AMSR-E	Advanced Microwave Scanning Radiometer-EOS (Japanese)
AWRA	American Water Resources Association
Aqua	EOS Spacecraft
Aquarius	Mission to measure global Sea Surface Salinity
ARC	Ames Research Center
AVHRR	Advanced Very High Resolution Radiometer
AWARDS	Automated Weather Acquisition and Retrieval System
BASINS	Better Assessment Science Integrating Point and Non-point Sources
BOR	Bureau of Reclamation Department of Interior
CCSP	Climate Change Science Program
CLM	Center for Naval Amylases
CloudSAT	A NASA Earth System Science Pathfinder Mission
DAAC	Distributed Active Archive Center (Data Active Archive Center)
DOI	US Department of the Interior
DSS	Decision Support Systems
DST	Decision Support Tool
EO-1	Earth Observing-1
EOS	Earth Observing Systems
EPA	US Environmental Protection Agency
ESA	Earth Science Applications
ESIP	Earth Science Information Partners
ESTO	Earth-Sun System Technology Office
FEA	Federal Enterprise Architecture
FEMA	Federal Emergency Management Agency
FY	Fiscal Year
GCM	Global Climate Model
GES	Geospatial Extension Service
GEWEX	Global Energy and Water Cycle Experiment
GFDL	Geophysics Fluid Dynamics Laboratory
GIG	Global Information Grid
GISS	Goddard Institute for Space Studies
GMAO	Global Modeling and Assimilation Office
GMES	Global Monitoring for Environment and Security
GPM	Global Precipitation Measurement
GRACE	Gravity Recovery and Climate Experiment
GSFC	Goddard Space Flight Center
GWSP	Global Water Systems Project

HELP	Hydrology for Environment, Life, and Policy
IBPD	Integrated Budget and Performance Document
IFPRI	International Food Policy Research Institute
IGARSS	International Geophysical Remote Sensing Society
IGOS	Integrated Global Observations Strategy
IGWCO	Integrated Global Water Cycle Observations
IMPACT	Interactive Modeling Project for Atmospheric Chemistry and Transport
IWGEO	Interagency Working Group on Earth Observations
JCSDA	Joint Center for Satellite Data Assimilation
JPIP	JPEG2000 Internet Protocol
JPL	Jet Propulsion Laboratory
LaRC	Langley Research Center
LDAS	Land Data Assimilation System
LIS	Lightning Imaging Sensor
LSM	Lightning Mapper Sensor
LP	Land Processes
MIT	Massachusetts Institute of Technology
MM5	Mesoscale Model
MODIS	Moderate Resolution Imaging Spectroradiometer
MOU	Memorandum of Understanding
MSFC	Marshall Space Flight Center
NASA HQ	NASA Headquarters
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NESDIS	National Environmental Satellite Data Information Service
NEWS	NASA Energy- and Water- cycle Study
NIP	New Investigator Program
NOAA	National Oceanic and Atmospheric Administration
NOAH	A Land Surface Model
NPOESS	National Polar-Orbiting Operational Environmental Satellite System
NPP	NPOESS Preparatory Project/Net Primary Productivity
NRA	NASA Research Announcement
NSF	National Science Foundation
NWS	National Weather Service
OAR	Office of Oceanic and Atmospheric Research
OMB	Office of Management and Budget
OSSE	Observing System Simulation Experiment
OSTP	Office of Science and Technology Policy
PART	Program Assessment Rating Tool
R2O	Research to Operations Network
RAMS	Regional Atmospheric Modeling System
REASoN	Research, Education, and Applications Solutions Network
SEA	State Enterprise Architecture
SPoRT	Short-term Prediction Research and Transition Center
SSC	Stennis Space Center
SWAT	Soil and Water Assessment Tool

TERRA	Not an Acronym
TMDL	Total Maximum Daily Loads
TRMM	Tropical Rainfall Measurement Mission
UAV	Unmanned Aerial Vehicles
UCAR	University Corporation for Atmospheric Research
UCOWR	University Council on Water Resources
UMUC	University of Maryland University College
USDA	US Department of Agriculture
USGS	United States Geological Survey
VIC	Variable Infiltration Capacity (Macroscale Model)
WCIP	Water Information Coordination Program

NASA Science Mission Directorate
Earth Science Division - Applied Science Program
Water Management Program Element

This document contains the Water Management Program Element Plan for FY 2007-2011.

This plan derives from direction established in the NASA Strategic Plan, Earth Science Enterprise and Space Science Enterprise Strategies, Earth Science Applications Plan, and OMB/OSTP guidance on research and development. The plan aligns with and serves the commitments established in the NASA Integrated Budget and Performance Document.

The Program Manager and the Applied Sciences Program Leadership have reviewed the plan and agree that the plan appropriately reflects the goals, objectives, and activities for the Program Element to serve the Applied Sciences Program, Earth Science Division, NASA, the Administration, and Society.

Lawrence Friedl
Program Manager, Water Management
Applied Sciences Program
NASA Earth Science Division

Date

Lawrence Friedl
Lead, National Applications
Applied Sciences Program
NASA Earth Science Division

Date

Teresa Fryberger
Director, Applied Sciences Program
NASA Earth Science Division

Date