

NASA Water Resources Program International Support Activities

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BACKGROUND

NASA Water Resources Program

The NASA Water Resources Program:

The water resources program addresses concerns and decision processes that are related to water availability, water forecast, and water quality. The goal of the Water Resources theme is to apply NASA satellite data to improve the Decision Support Tools (DSTs) of user groups that manage water resources. The Water Resources theme partners with Federal agencies, academia, private firms, and international organizations.



Water Resources Projects:

The water resources projects are organized into several categories; water quality, water delivery and irrigation, flow and flood forecasting, drought, snowpack and climate and water resources.

Programmatic Activities:

*The program support national and **international** activities to improve skills, share data and applications, and broaden the range of users who apply satellite data and Earth science in Water resource decisions.*



NASA Water Resources Builds on Earth Science and Teams with other NASA Groups



NASA Terrestrial Hydrology Program. Goal: Develop water remote sensing capabilities, as well as observe and understand the interfaces of these water storages and fluxes.



NASA's Energy & Water Cycle Study 'NEWS'

- Addresses the extent climate changes that are related to Earth's Energy and Water cycle and what trends may be predicted in the future



NASA's Modeling, Analysis and Prediction (MAP) Program

- Studies the Earth's climate and weather, with particular emphasis on global



NASA Water Resources Meeting

NASA Emphasis in Applications



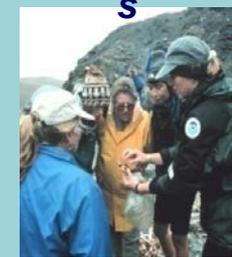
Health & Air Quality



Water Resources



Disasters



Ecological Forecasting



Capacity Building

NASA's Role in International Water Resources

Science to Applications

• Develop Earth Science & Satellite Observations

- NASA \$1.7B (FY2011) Earth Science Budget
- NASA strongly supports a free and open exchange of Earth science data
- Especially useful for developing countries with limited *in situ* data

• NASA Applied Sciences Program

- Accelerates the use of satellite data in to decision support for societal benefit.
- Range of Application Readiness activities including Capacity Building and End to End Projects
- NASA International Application Goals primarily thru US Interests



• Applications & Satellite Data

- Famine early warning and drought monitoring & prediction for food security
- Water resources planning & Management
- Disaster Management (floods & landslides)
- Water quality
- Transboundary and Regional Applications

CLIMATE CHANGE AND WATER

IPCC Climate Change & Water (2008): *‘Observational records and climate projections provide abundant evidence that freshwater resources are vulnerable and have the potential to be strongly impacted by climate change, with wide-ranging consequences ...’*

MEMORANDUM OF UNDERSTANDING

BETWEEN

INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT,
INTERNATIONAL DEVELOPMENT ASSOCIATION

AND

THE G



Global Water Security

C

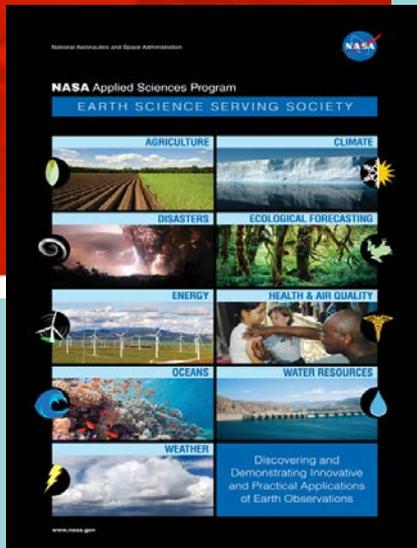
INTELLIGENCE COMMUNITY ASSESSMENT
IC 2012 08, 2 February 2012
This is an Unclassified paper.

US Government & World Bank MoU (2011): *“This agreement leverages the considerable expertise and assets of the two partners to help developing countries achieve water security and improve water quality ...”*

State Department Sponsored Global Water Security (2012): *Bottom line: ‘... many countries important to the U.S. will experience water problems—shortages, poor water quality, or floods—that will risk instability and state failure, increase regional tensions, and distract them from working with the United States’.*
Clinton: *‘This assessment is a landmark document that puts water security in its rightful place as part of national security.’*

NASA Applied Sciences Program: *to demonstrate innovative uses and practical benefits of Earth science and remote sensing data, scientific knowledge, and technology.*

“The wars of the next century will be fought over water.”
– **World Bank Vice President Ismail Serageldin, 1995.**





US GOVERNMENT & WORLD BANK LINKS

Department of State Interagency Water Working Group

- Represent NASA through collaborative meetings, sub-groups (e.g., Nile Basin), and activities. Priority Basins.
- **World Water Forum (WWF) Mar 2012**
 - *NASA Panel: Water Remote Sensing & Modeling for the solution (see upper right)*
 - *NASA Water Resources US Pavilion Exhibit*
- **US Water Partnership (USWP) Mar 2012**
 - *Announced during World Water Day through State Department, NASA joins USWP. Implemented during UNESCO Rio+ 20. (see lower right)*
 - *Working collaboratively with Global Environment & Technology Foundation (GETF) & Other Public and Private Groups*

"NASA Water Remote Sensing and Modeling for the SOLUTION"

Learn how NASA's Models, Current and Future Satellites can be part of the SOLUTIONS for water resource problems. Hear NASA representatives and panelists from the World Bank, USAID and Lebanon.

When: Thursday, March 15, 1315 – 1445
Where: World Water Forum, US Pavilion



NASA Side Panel at World Water Forum (March 2012)



Secretary Clinton at the U.S. Water Partnership announcement with initial partners

NASA Joins USWP

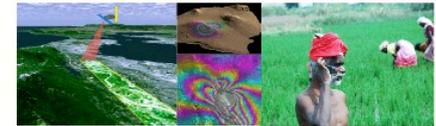
World Bank & US Government 'MoU' on Water

- Remote Sensing Working Group (J. Entin/NASA - Co-Chair)**
 - Promote use of remote sensing to help solve water issues in developing countries*
 - World Bank Grant Near Approval for Remote Sensing Projects*
- Workshops and Training**
 - US Government and World Bank Workshop on Using Remote Sensing for Water Issues (Upper Right)*
 - Training and Capacity Building Building (A. Prados/GSFC & N. Searby/HQ) (Lower Right)*
- Collaborative and Support Activities**
 - Review Team for Coordination in International Waters in Africa (CIWA), GIS portal assistance, Nile Basin demo (Nile Basin Demo), etc.*
 - Summary of USG Remote Sensing Capabilities & Tools for World Bank Application*

Using Satellites for Better Water and Environment Management?

Understanding Applications of Earth Observation in Agriculture and Irrigation Management, Disaster Risk Management and Drought and Flood Monitoring

Come to a Training Session Jointly Hosted by The World Bank and US Government Agencies Working in Remote Sensing



With Opening Remarks by Ms. Mary Kicza Assistant Administrator of NOAA

29 February 2012 MC C2-131

10:00 am - 12:30 pm (over 15 talks - 4 minutes each!)
 1:00 pm - 4:00 pm (Reception and Exhibition Fair)

* See Reverse for List of Speakers and Exhibits*



<http://wmp.gsfc.nasa.gov>



Capacity Building & Training

Demonstration of Remote Sensing Capabilities for the Nile Basin

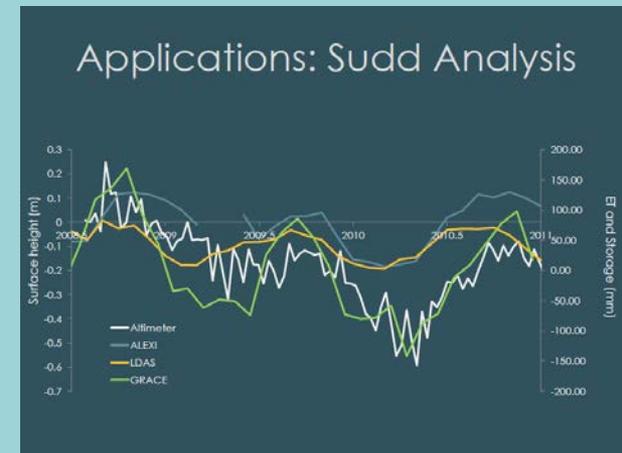
- Working with 'JHU', NASA/GSFC/Science Visualization Systems (<http://svs.gsfc.nasa.gov>), and the World Bank for 'Short Stories' to the Nile

- 1) Nile Water Balance, including water consumption (ET) for the Egyptian Nile & hydro-climatology for entire Nile;
- 2) Nile irrigation and agriculture, including the annual cycle of irrigation along with their productivity and crop types; and
- 3) Sudd wetland case study on hydrology and wetland hydro-dynamics.

- **Sudd Wetland (Nile) Demonstration Activity**
 - Using Remote Sensing to help assess critical Sudd wetland water balance.



NASA SVS – Land Precipitation (March 2012)

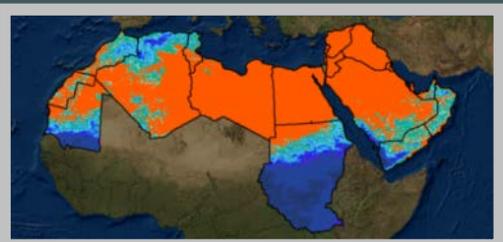


Water Balance Using TWS, ET, Altimeter & Soil Moisture (JHU, USDA)

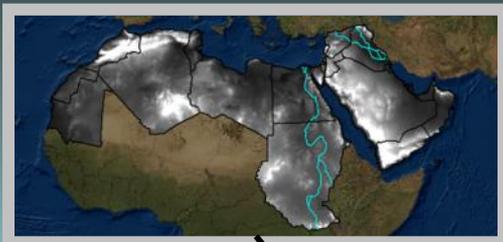


USAID with World Bank Water Availability Using a NASA Land Data Assimilation System (LDAS) for the 'MENA'

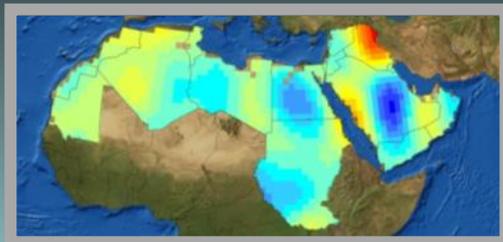
Matt Rodell, John Bolten, David Toll, Shahid Habib (NASA/GSFC), Edwin Engman (NASA/GSFC/SAIC), Joseph Nigro (NASA/GSFC/SSAI), and Mutlu Ozdogan (U. Wisconsin)



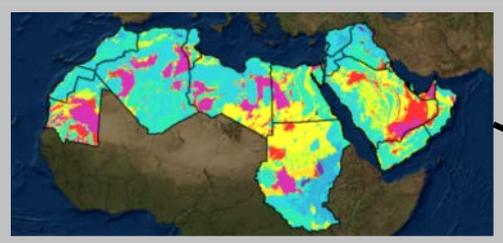
Precipitation



Elevation



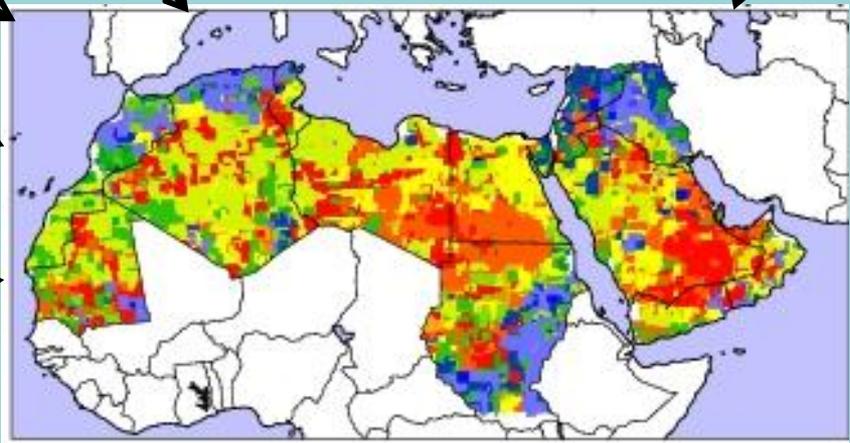
GRACE terrestrial water storage



Soils



Irrigation

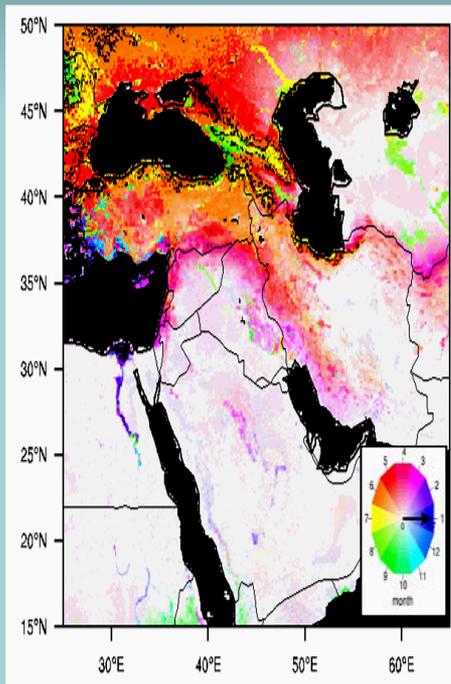


Water availability

NASA, USAID-'OMEP', ICBA (International Center for Biosaline and Agriculture) and regional partners teamed to provide regional water resources assessments Using Satellite Data and Land Data Assimilation Systems.

NASA Water Information System Platforms - WISP's for the 'MENA'

NASA Partnering with the World Bank (GEF), USAID (OMEP) & MENA Countries Using Earth Observation and Modeling Data for the Sustainable Use of Water Resources



Mapping Vegetation and Food Production



5 WISP's Planned for the MENA



Training and Capacity Building

- **Satellite, Modeling, Ground Based Data**
- **Integrative Environmental Systems**
- **Visualizations**
- **Decision Support Tools**
- **Informed Policy Making**
- **Training & Partnership Opportunities**

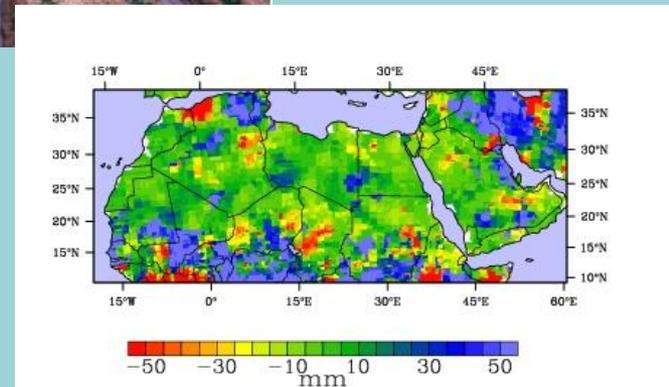
Outcomes

- 1) *Regional (1/8°) to local (1km and finer) water availability maps.*
- 2) *Monitoring & prediction of drought.*
- 3) *Assessment of climate and land use change impacts on water resources.*
- 4) *Crop yield and land cover change mapping.*
- 5) *Satellite based estimates of irrigation and consumptive water loss through evapotranspiration.*
- 6) *Data on ground water and terrestrial water storage changes.*
- 7) *Flood warning and inundation mapping.*

Water Information System Platforms	Egypt	Jordan	Lebanon	Morocco	Tunisia
<i>Evapotranspiration (Consumptive Water Loss)</i>	X	X	X	X	X
<i>Drought</i>	X	X	X	X	X
<i>Flood Detection and Modeling</i>	X			X	X
<i>Climate Impacts</i>	X	X	X	X	X
<i>Irrigation and Crop Mapping</i>		X	X	X	X
<i>Locust Monitoring</i>				X	X
<i>Hydrological Modeling</i>	X	X	X	X	X
<i>Fires</i>	X	X	X	X	X



GRACE Terrestrial Water Storage Changes





NASA WATER RESOURCES WORKSHOPS

***(Includes USG-World Bank Using Satellites
for Better Water and Environmental
Management)***

Key Objectives of the workshop:

- Strengthen GEO Water and Capacity Building activities by launching/strengthening demonstration projects for Latin and Caribbean Americas.
- Space Agency data more readily available to the countries of North, Central, and South America and the Caribbean in near real-time whenever possible.
- Provide hands-on for water resources information, see <http://water.gsfc.nasa.gov>.
- To define mechanisms to encourage access and exchange of data.
- Provide high quality up-to-date information on current and future Earth observation system planning and implementation.



Figure 1: Top: Training Course attendees from Belize, Brazil, Colombia, Chile, Jamaica, and the Center of Oceanographic and Hydrological Research at the Colombian Naval Academy in Cartagena, Colombia. There were 20 who attended the 2-day NASA hand-on training.

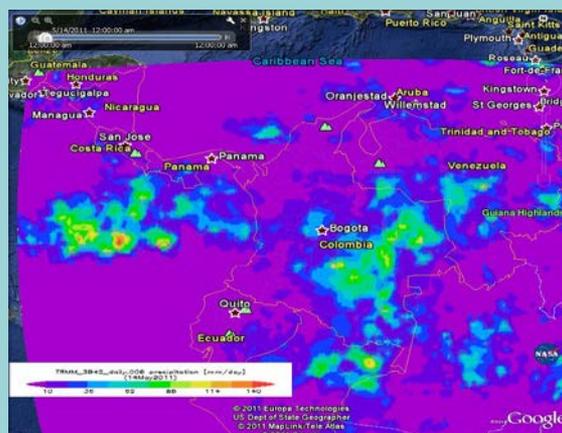


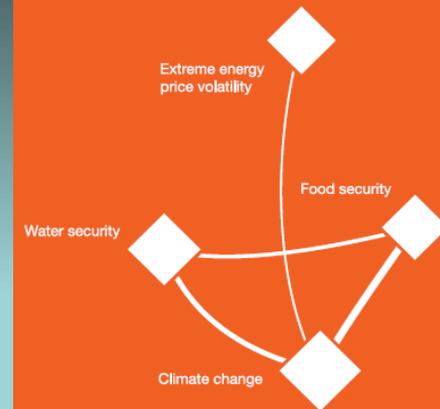
Figure 2: TRMM Precipitation rate image used during a workshop Case Study used by workshop attendees to analyze severe flooding in Colombia in 2011

A conference entitled “Water-Energy-Food Security: New Challenges and New Solutions for Water Management” was held on May 1 to 4, 2012 In Winnipeg, Manitoba. The conference was sponsored by the International Institute for Sustainable Development (IISD), the Global Water System Project (GWSP) and NASA.

• **Highlights:**

- 80 people from 6 countries attended
- A special session on Earth Observations and the Water-Energy-Food nexus was held (Chaired by Bradley Doorn).
- A conference summary was prepared and circulated at the ICSU Symposium on Science, Technology and Innovation and Sustainability held in conjunction with Rio + 20.
- A conference statement was prepared and distributed at Rio + 20
- This work has also been presented at:
 - + the Stockholm Water Week
 - + the GEOSS S&T Symposium in Bonn Germany
- It will also be presented at the upcoming Global Water System Science Committee Meeting in Vienna Austria.

Risks in focus 3
The water-food-energy nexus



NASA Helps Sponsor “Western States Remote Sensing of Evapotranspiration” Workshop, Boise, ID Oct. 12-13, 2011

“Demonstrating the Successful Remote Sensing of ET in Idaho, Nevada and other Locations to Western States Resources Managers”

- ET can account for 90% of the western US water use and is critical to local economies tied to agriculture, recreation, hydro- power, etc.
- The primary goal was to demonstrate the successes of the remote sensing of ET (led by U. Idaho with NASA, USDA, USGS, DRI and others)
- Participants included representatives from all western states gov'ts (except SD, KA & MT), federal agencies (NASA, NOAA, USDA, USGS) & Western States Water Council. There were 80 + attendees.
- Supported by NASA Topical Workshops, Symposia and Conferences (E.32) & NASA Water Resources. Workshop is a follow-on to NASA-USDA ET Workshop in DC (April 2011).
- Further follow-on and training sessions are planned along with coordination to help promote use of remote sensing technology for western water users.

Landsat derived ET is useful for field scale and water rights evaluation. MODIS ET is useful for regional water resources management.



Figures from U. Idaho





INTERNATIONAL GEO WATER

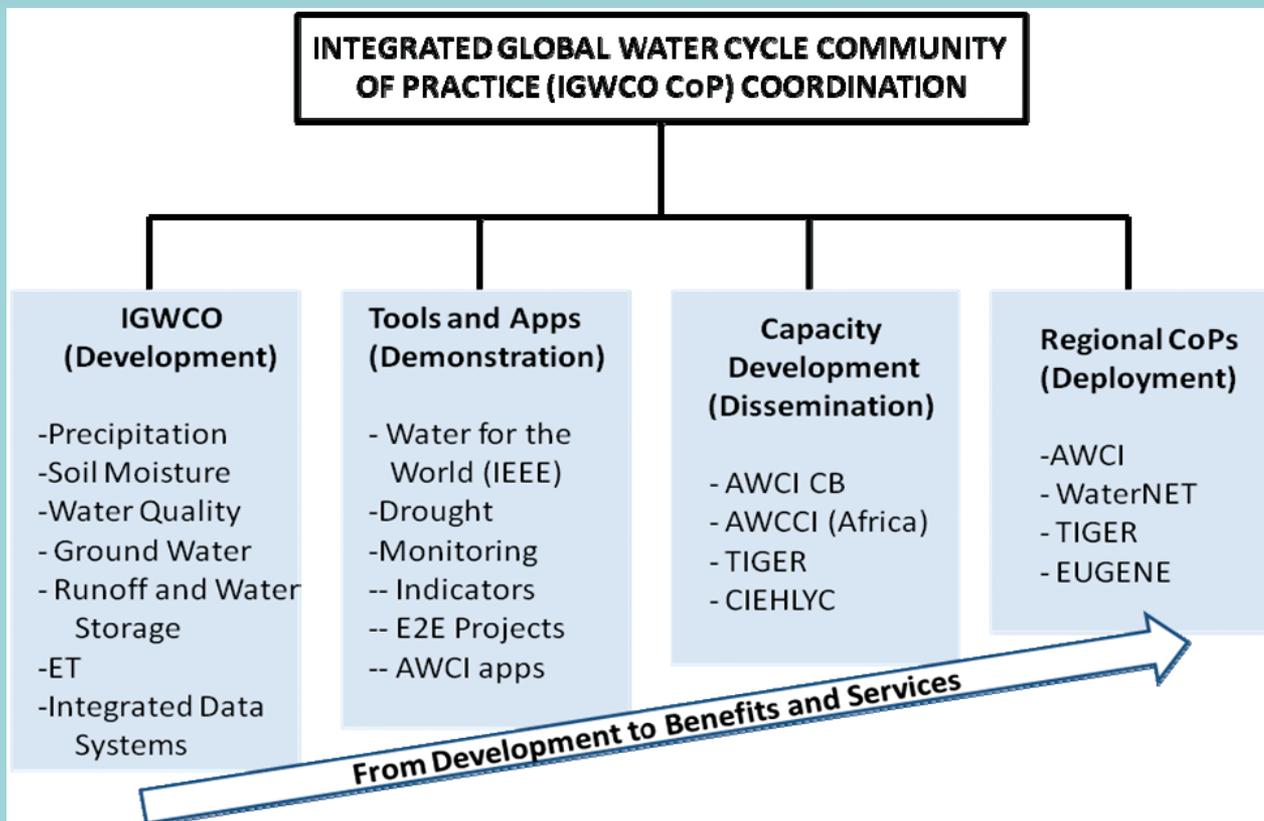
Scope of Task WA-01

Target: By 2015, International GEO aims to produce comprehensive sets of data and information products to support decision-making for efficient management of the world's water resources, based on coordinated, sustained observations of the water cycle on multiple scales.

Components and POCs:

- 1 Integrated Water-cycle Information Products and Services (POC: Rick Lawford)
- 2 Information Systems for Hydrometeorological Extremes (POC: Will Pozzi)
- 3 Cold Region Information Services (POC: Ellsworth Ledrew)
- 4 Global Water Quality Information Products and Services (POC: Steve Greb)
- 5 Data System Development, Implementation and Capacity Building (POC: Angelica Gutierrez-Magness)

The IGWCO COP (now in its 8th year) plays a central role in coordinating the implementation of the GEO WA-01 task and provides a framework for Task development.



NASA contributes to each of the IGWCO areas of activity and supports the CoP chair in the coordination role.

Overall: Adoption of a new GEOSS Water Strategy (Lawford leads with many NASA contributors)

C1: - Reliable precipitation products from GPM data on a regular basis (NASA – Huffman)

- Development of improved ET products in special environments (NASA – Toll)
- Soil moisture products from SMOS and SMAP (NASA – Entin, van Oevelen)

...

C2: - Develop and implement a Global Drought Information System based on the NIDIS Global Drought Monitor (Portal) (GDMP).

- Develop a Global Drought Observing System based primarily on remote sensing.
- Implement a Drought Forecasting system.
- Implement GloFAS (Global Flood Awareness System)

C4 - Develop improved satellite derived water-quality datasets. (US Lead – NASA support)

C5: Capacity Building

- *L&CA: To develop the Americas component of the Global Drought Information System*
- *Asia, Africa, L&CA: Develop competencies among end users through demonstration projects.*
- *Asia, Africa: Develop information systems to promote integrated water resources management (IWRM), transboundary river basin management, and water information sharing.*
- *Africa: Coordinate African Water activities (TIGER, SERVIR, GMES Africa, NASA, WISP Africa, SERVIR, RBO) as they relate to the AfWCCI framework (NASA – Toll, Lawford)*
- *Enhance user engagement to capture user-feedback on water data and estimate value of water data and information. (NASA – Lawford, Doorn)*
- *Conduct pilot projects for improved water discovery and quality in cooperation with local, regional, and national groups.*

C5: Capacity Building (Cont'd)

NASA is considering three other contributions including:

- 1) An African initiative in the Nile that could be a contribution to the AfWCCI*
- 2) An African Capacity Building workshop in 2013*
- 3) A portal to list all of the capacity building and demonstration projects occurring around the globe.*

Recent Progress and Key Outputs for 2012

C5: - Two statements developed for RIO+20 from Libreville (AfWCCI) and Tokyo (A-P GEOSS and AWCI)



GLOBAL SOIL WATER PROJECT

Global Soil Water Project Integrated Water Resources Management

Importance of Water Energy Food Nexux

SPECIAL INTERESTS

Climate change

Governance & adaptation Strategies

1. **Global Scale Initiative:**
Ranking of threats to the GWS, States and Trajectories of Change
2. **Global Catchment Initiative: *The GCI 2 Initiative***
Bringing the global perspective to river basin research & management
3. **Global Water Needs Initiative: Humans and Nature**

Simulation modelling & scenarios
Observations

METHODS & TOOLS

Policy Outreach & Capacity Building

GWSP Shared Basin Survey

Some of the information needed to address these issues is implicit in The four questions that were used in the design of a questionnaire.

Four core science questions or hypothesis that will be considered in this study include:

*How are issues related to the integrated water-energy-food (W-E-F) security issues affecting major river basins? **(How important is the issue?)***

*How are major river basins being managed in order to address the emerging challenges arising from water-energy –food security issues and the effects of changes in the climate, demographics and economies of the world? **(How are basins being managed to increase W-E-F tradeoffs?)***

*How do water-energy-food security strategies/mechanisms link separate and remote river basins and affect their physical, socio-economic, ecological and governance status? **(How far-reaching are effects in one basin?)***

*How well are current approaches to governance and management addressing the W-E-F issues and does a basis exist for recommending changes for the future? **(Do we need to change our approaches to water management?)***

Observations Based on Survey responses from 11 basins:

Some key issues arising from the analysis of survey results:

- The Challenge of Integration*
- The Political and Policy Interface*
- The Changing Role of Rivers*
- Monitoring Change in the Basins*
- Implications of Energy and Food Production and Consumption*
- Data Issues and Integrated data systems*
- Advancing IWRM (or Integrated Approaches to WM) and Political Cooperation through Technical Cooperation*
- The influence of scale on Implementing IWRM*
- Water Management for the Bio & Energy Economy*

Agriculture and the Water Dilemma in the Lake Winnipeg Basin:

- In order to maintain high production rates farmers often add excess fertilizer to their crops. These nitrates and phosphates enter the rivers, especially in times of large runoff and find their way to Lake Winnipeg.*
- Over the past two decades the effects have been an increasingly large algal bloom on Lake Winnipeg during the summer. While the agricultural industry reaps the benefits of this intensive agriculture it is the public who must pay for the cleanup*



***In 2007, the bloom covered
15,000 km² on Lake Winnipeg***



UNESCO

- *International Hydrology Program – NASA participation with other US Government agencies*
- *International Center for Integrated Water Resources Management (ICIWaRM) is a UNESCO Category 2 water center, Category 2 centers are provided for and provided by the host nation, but are under the auspices of UNESCO. ? NASA help lead a Category 2 Remote Sensing Center for Water.*
- *UN Committee on Peaceful Uses of Outer Space (COPOUS). Contributed to Agenda Item 12, 'Space and Water'.*

FY13 Planned Workshops

- *Water Cycle Missions Workshop: Application support to future water mission working groups.*
- *Water Indicators Workshop: demonstrate the relevance of NASA data for assessing water scarcity and water use, explore the role of these data in flood and drought impact assessments.*
- *African Water Cycle and Capacity Building Workshop*

Public Outreach

- Project web site (<http://wmp.gsfc.nasa.gov>). Undergoing updates currently.
- Newsletters (2-GEWEX articles on ET and Drought, Drought newsletter under preparation, BAMS article on Water – Food – Energy Nexus.

National Aeronautics and Space Administration



REMOTE SENSING & TECHNOLOGY FOR INTERNATIONAL WATER RESOURCES MANAGEMENT
NASA Applied Sciences Program: Including Water Resources, Natural Disasters, Air Quality, and Ecological Forecast



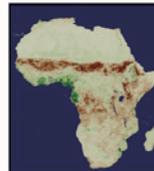
NASA's Applied Sciences Program delivers satellite-based and modeled data to water managers, researchers, and communities throughout the world, especially benefiting developing nations and data limited regions.

- Approximately \$1.7B of the FY11 NASA budget supports Earth science technology, research, and applications.
- NASA and Earth observing remote sensing based observations are valuable to developing countries with sparse *in situ* data. NASA tools for combining satellite data with existing *in situ* networks can effectively fill observational gaps and are powerful for decision makers.
- NASA strongly supports a free and open exchange of its Earth science and satellite data throughout the world.
- The invaluable Earth and related information—satellite data, tools, ground measurements, and models—provided by NASA is a vital resource for addressing societal benefits such as:
 - water resource planning and management,
 - famine early warning and drought monitoring & prediction for food security,
 - disaster management including floods and landslides, and
 - water quality and transboundary water issues.

www.nasa.gov

REMOTE SENSING & TECHNOLOGY FOR INTERNATIONAL WATER RESOURCES MANAGEMENT
NASA Applied Sciences Program: Including Water Resources, Natural Disasters, Air Quality, and Ecological Forecast

Famine Early Warning System

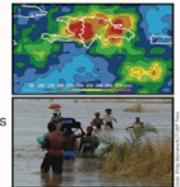


1984 Africa Drought Anomaly

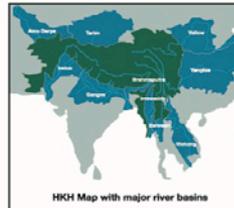
NASA provides critical information such as near real-time precipitation, lake level, and vegetation information to the USAID-sponsored Famine Early Warning Systems Network relevant to crop production, rangeland condition, and food security. NASA products and technology are helping FEWS NET expand its service from 21 countries to numerous additional developing countries.

Global Rains, Floods, & Landslides

Floods and associated rainfall-driven landslides account for the largest number of natural disasters. NASA satellite data on rainfall and surface characteristics are used to inform, understand, and predict flood and landslide hazards globally. The goal is to produce operational systems providing near real-time data.



HIMALAYA: Climate Impacts on Glaciers in the Himalaya Region



HKH Map with major river basins

This project uses NASA's satellite remote sensing and modeling to focus on climate and water resources in Himalayan glacier-fed rivers in Asia. The objectives of HIMALAYA are to provide potable and integrated water resources management information and projections of climate change impacts.



MENA Regional Water Assessment

Water Information System Platforms (WISPs)

NASA, in collaboration with USAID and the World Bank, is developing WISPs in water critical water limited countries of Morocco, Tunisia, Egypt, Lebanon, and Jordan. These will address a

multitude of issues dealing with water resources, aquifer & streamflow transboundaries, agriculture planning, flood management and early warning, and overall water balance. With these data, decision makers will be better able to address these issues in the future.



On the Web

Water Resources Applied Science <http://wmp.gsfc.nasa.gov/>
<http://appliedsciences.nasa.gov/>

Summary of Additional NASA Water International Projects

REGION	ACTIVITY
World	Lake Level Monitoring: Satellite microwave data are used to provide near real-time global water level data for lakes and reservoirs (currently 75, soon for 600+) important for assessing drought and food production. http://www.pecad.fas.usda.gov/cropeplorer/global_reservoir
Africa, Asia, Central America	SERVIR (to serve): Visualization and monitoring systems are used for environmental status in data limited parts of the world (currently in Panama & Kenya, plans for Nepal & West Africa) - also includes 'Climate One Step'. http://www.servir.net
Africa & Latin America	Capacity Building in Latin America and Africa: NASA is working in cooperation with other groups to help overcome problems developing countries have with the collection, training, and analysis of water-related geo-information. http://wmp.gsfc.nasa.gov
Nile Basin	Distributed Hydrological Data for Nile Basin: To improve water resource decision support systems for the Nile Basin, satellite observations and modeling are used to promote improved water management and data sharing between countries. http://wmp.gsfc.nasa.gov
India	Groundwater Monitoring in India: NASA scientists have applied satellite observations in combination with a hydrological modeling system to quantify the depletion rate of aquifers in the Indian states of Rajasthan, Punjab, and Haryana (including Delhi). http://www.nasa.gov/topics/earth/features/india_water.html
South America	Integrating NASA Products into Decision Systems for Agriculture and Water Management: NASA remote sensing and modeling products combined with surface observations at various scales (sub-country to continental) are used to improve decisions support systems in agriculture, drought, and water resources management. http://wmp.gsfc.nasa.gov
Iraq	Agriculture for Pre-War and Post-War Iraq: NASA is mapping agriculture before and after the Iraq War with the US Army to assist with improved food production. http://wmp.gsfc.nasa.gov
Catchment to Global	Hydrology for Life Environment and Policy (HELP): NASA supports HELP (under UNESCO) to aid in bridging the gap between scientific hydrology and the various other stakeholders involved in comprehensive basin management decisions. http://www.unesco.org/water/ihp/help/

NP-2010-6-152-GSFC

US Gov't Remote Sensing - Water Projects

PI & Organization	NASA Program	Title with bullets when available	Application Link
Dan Irwin, Nancy Searby and Ashutosh Limaye	NASA ASP Capacity Building	The NASA SERVIR Program Providing Hydrologic Modeling and Remote Sensing Tools <ul style="list-style-type: none"> • SERVIR is a joint NASA-USAID project, enabling countries in SERVIR regions to use NASA data for environmental decision-making. SERVIR has two active Hubs, in East Africa and in Himalaya. A hub in Mesoamerica was in operation from 2005-2011, and initiated by several partners, including the World Bank. • SERVIR-East Africa is running a distributed hydrologic model (CREST) in near real time to compute streamflow using NASA TRMM rainfall data in close collaboration with the Kenya Meteorological Department. SERVIR-East Africa has also run the CREST model for the TRMM historical archives. SERVIR-East Africa plans to engage water resources departments in neighboring countries in a similar fashion. • SERVIR-Himalaya ran CREST to quantify the impacts of climate change in Wangchu watershed in Bhutan, which provides water to an economically important hydroelectric power plant. The Bhutan Ministry of Water Resources provided historic rainfall and streamflow data. • Also includes many new international water activities from the recently announced SERVIR Science Team 	East Africa, Meso America and Hindu- with plans for extension to other areas, including Africa. Numerous Capacity Building water applications available for developing countries.
Juan Valdes (Univ. Arizona)	NASA ASP Capacity Building	SERVIR West Africa Water Team	Water management, flood and drought analysis
Pietro Ceccato Columbia Univ.	NASA ASP Capacity Building	Development and Implementation of Flood Risk Mapping, Water Bodies Monitoring and Climate Information for Disaster Management and Human Health (Integration Within SERVIR)	Integration of remote sensing and Earth science satellite data for Malaria early warning
Stephanie Granger JPL	NASA ASP Capacity Building	East Africa Drought and Agricultural Productivity Assessment and Prediction	Water and food and drought monitoring using remote sensing and modeling
Jeff Kargel Univ. Arizona	NASA ASP Capacity Building	Interdisciplinary Science Applications to Glacier and Alpine Hazards in Relation to Development and Habitation in the Hindu Kush-Himalaya: SERVIR Science Team Project	Hindu-Kush Himalaya region for flooding from snowpack and glacier melting
Franklin Robertson NASA MSFC	NASA ASP Capacity Building	Leveraging CMIP5 and NASA / GMAO Coupled Modeling Capacity for SERVIR East Africa Climate Projections	NASA Modeling for climate change assessment for SERVIR region
James Verdin USGS	NASA ASP Capacity Building	A Long Time-Series Indicator of Agricultural Drought for the Greater Horn of Africa	Leveraging FEWS-NET and USGS remote sensing and modeling for assessment of East African Drought
Dalia Kirschbaum	NASA ASP Capacity Building	Landslide Hazard Assessment and Forecasting System Using Near Real-Time Remote Sensing Information Over SERVIR-Mesoamerica	Remote sensing and Earth science data for SERVIR region landslide monitoring and forecasting
Faisal Hossain (Tennessee Tech University)	NASA ASP Capacity Building	A Satellite-based Early Warning, Mapping and Post-Disaster Visualization System for Water Resources of Low-lying Deltas of the Hindu Kush-Himalayan Region	Water management, flood and drought analysis
James Verdin (USGS), Christa Peters-Lidard (NASA/GSFC) and Molly Brown (NASA/GSFC)	NASA ASP Water Resources	Detection and Monitoring of Agricultural Drought for Famine Early Warning <ul style="list-style-type: none"> • USGS with NASA has supported USAID/FEWS NET with remote sensing for monitoring agricultural drought for over 5-years through several projects • Vegetation indices, satellite rainfall estimates, and land surface temperatures provide the basis for a convergence of evidence • Field scientists in Africa and Central America assist food security analysts in applying remote sensing to their assessments 	USGS has teamed with NASA and others to provide remote sensing and modeling for primarily to the Sub-Saharan of Africa and is in the process of extending to many developing countries in Asia and Latin America to assist with famine early warning and water availability information.
Ben Zaitchik (JHU), S. Habib (NASA/GSFC), M. Ozdogan (U. Wisc.) and M. Anderson (NOAA)	NASA and Johns Hopkins U.	Using Remote Sensing and Modeling for Adapting to Climate Change and Improved Water Management <ul style="list-style-type: none"> • Project Nile leverages multiple independent satellite and modeling methodologies to evaluate climate variability, water resources, and agricultural. • In the Nile basin--and elsewhere--satellite and in situ observations can be applied to climate model evaluation and to generate high resolution climate projections with regionally-specific uncertainty estimates. 	Nile Basin project including water availability, aquifer monitoring, agriculture mapping, and evapotranspiration mapping.
Shahid Habib (NASA/GSFC)	NASA GSFC (Primary) and NASA HQ	The NASA Water Information System Platforms for the MENA <ul style="list-style-type: none"> • Providing remote sensing based platforms for water managers to Morocco, Tunisia, Jordan, Lebanon and Egypt. • Developing tools for water availability, agriculture, drought, floods, ground water and climate change with an emphasis on semi-arid to arid systems that can be transported to other areas of the world 	Developing NASA Water Information System Platforms for semi-arid to arid region of the MENA that may be extended to other water stress systems in the world.
Fritz Policelli (NASA/GSFC)	NASA R & A Program	Towards development of a Radar Flood Mapping Capability <ul style="list-style-type: none"> - Complements NASA MODIS inundation mapping with an all-weather capability 	Will provide improved water resources management and aid assistance to developing countries.
Robert Adler, F. Policelli & D. Kirschbaum	NASA ASP Disasters	Near Real Time Flood and Landslide Monitoring, Prediction & Mapping <ul style="list-style-type: none"> • Real-time global estimation of floods and landslides through use of satellite rainfall and hydrological models and algorithms—running routinely • Same day mapping of flooded areas through automated analysis of MODIS data • Potential for improvement in products through improved precipitation estimation through coming GPM mission, improved models and use of additional remotely sensed data. • Information can be used for damage/impact assessment and mitigation planning and education/training 	Global flash flood, flood, inundation mapping and land slides applicable anywhere. Near real time capability.
Jay Famiglietti (UC Irvine) and Matthew Rodell (NASA/GSFC)	NASA GRACE Science Team	Terrestrial Hydrology from GRACE: Freshwater Storage Changes, Flux Estimates and Groundwater Depletion <ul style="list-style-type: none"> • Identifying areas of water stress from satellite-based groundwater storage anomalies. • Quantifying groundwater depletion using observations from the Gravity Recovery and Climate Experiment (GRACE) 	Looks at global aquifer depletion and recharge under a changing climate and an increase in demand for water
Matthew Rodell (NASA/GSFC)	NASA Terrestrial Hydrology Program	Downscaling of GRACE Terrestrial Water Storage Observations and Application to Global Drought Monitoring <ul style="list-style-type: none"> • Using NASA Land Surface Modeling to downscale the coarse GRACE satellite data for water resources applications having 25 km grids • Optimizing GLDAS for water availability and drought monitoring assistance globally • Drought monitoring is critical for developing country food production and famine early warning 	Aquifer monitoring using GRACE satellite data to 25 km when assimilated with land surface modeling
Molly Brown (NASA/GSFC)	NASA Applied Sciences Program	NASA Project Himalaya: Remote Sensing and Modeling for Snowpack & Glacier Change on Water Resources <ul style="list-style-type: none"> • Using NASA remote sensing and modeling for assessing snow and icepack to water resources • Assess climate change on Himalayan snow and ice pack for long term water availability 	Snowpack oriented activity critical for water supply to Himalayan with application to be extended to other snowpack basins of the world affecting developing nations water supply. Also important analysis of long term water availability under climate change and dwindling glacial water.

US Gov't Remote Sensing - Water Projects

	PI & Organization	NASA Program	Title with bullets when available	Application Link
16	Matthew Rodell (NASA/GSFC)	NASA Terrestrial Hydrology Program	Downscaling of GRACE Terrestrial Water Storage Observations and Application to Global Drought Monitoring <ul style="list-style-type: none"> Using NASA Land Surface Modeling to downscale the coarse GRACE satellite data for water resources applications having 25 km grids Optimizing GLDAS for water availability and drought monitoring assistance globally Drought monitoring is critical for developing country food production and famine early warning 	Aquifer monitoring using GRACE satellite data to 25 km when assimilated with land surface modeling
17	Molly Brown (NASA/GSFC)	NASA Applied Sciences Program	NASA Project Himalaya: Remote Sensing and Modeling for Snowpack & Glacier Change on Water Resources <ul style="list-style-type: none"> Using NASA remote sensing and modeling for assessing snow and icepack to water resources Assess climate change on Himalayan snow and ice pack for long term water availability 	Snowpack oriented activity critical for water supply to Himalayan with application to be extended to other snowpack basins of the world affecting developing nations water supply. Also important analysis of long term water availability under climate change and dwindling glacial water.
18	Chris Justice - University of Maryland	NASA ASP Water Resources	Using Remote Sensing for Drought and Agriculture Assessment <ul style="list-style-type: none"> Extending the Global Agriculture Monitoring (GLAM) for agriculture, drought and environmental information Strong emphasis on using NASA MODIS data, including in near-real time data for WB environmental applications 	Global ag and drought monitoring including GEOGLAM and JECAM sites.
19	Wade Crow (USDA/FAS) and J. Bolten (NASA/GSFC)	USDA/ARS	Prospects for improving global agricultural drought monitoring using microwave remote sensing <ul style="list-style-type: none"> A lack of root-zone soil water availability is the key early indicator for impending agricultural drought. Existing global soil moisture monitoring systems have clear shortcomings – especially in regions of the world prone to food insecurity. These shortcomings can be effectively mitigated using remote sensing and data assimilation approaches. 	Uses satellite derived soil moisture data with data assimilation for assessing and predicting rain fed agriculture and rangeland production. USDA and NASA collaborative project. Typical spatial resolution is 25 km.
20	Christa Peters-Lidard	NASA/GSFC	Using the NASA Land Information System for Improved Water Management <ul style="list-style-type: none"> Uses multi-model approach in a data integration and assimilation scheme with an emphasis on satellite data to provide water availability information Water information can be provided regionally to less than 1 km resolution to regional and global to less than 1 hour time steps. May be used for near real time, historical and future (weekly to decadal) with hourly time steps 	Integrates NASA remote sensing and modeling information for water availability information. Current projects with FEWS-NET, Air Force Weather Agency and NOAA.
21	Ana Prados	NASA/UMBC	Building Capacity to Integrate NASA Earth Science into Water Resources Management Applications <ul style="list-style-type: none"> The NASA Applied Remote Sensing Training program works directly with end-user agencies to develop hands-on and online workshops on access, visualization, and application of NASA remote sensing and model products, applicable to flood, drought, agriculture and climate change. The program develops training modules and Case Studies tailored to individual countries and environmental management priorities. All materials are publicly accessible at http://water.gsfc.nasa.gov Past and present topics: Rain and snow cover monitoring in Latin America available in English and Spanish. Also applicable to other countries. Future Topics : Evapotranspiration, vegetation, ground water. 	New element from the NASA Capacity Building and training program with a current emphasis on Water Resources.
22	Charon Birkett (Univ. of Maryland)	NASA ASP Water Resources	Monitoring Global Water-level Status for Flood, Drought and Water Resources Applications <ul style="list-style-type: none"> Stage/Elevation information for ungauged or poorly gauged basins Techniques applicable to lakes, reservoirs, water holdings/tanks, wetlands, and rivers Collaboration via grant assistance to University of Maryland for researchers and contractors. 	Very good potential for drought monitoring and indicator of amount of water for agriculture
23	Jasmeet Judge	NASA ASP Water Resources	South America Agriculture Drought	Soil moisture from soil moisture for food production
24	Enrique Vivoni	NASA ASP Water Resources	South-North America Visualization of Drought Information	State of the art visualizations using remote sensing for the Americas
25	Cynthia Rosenzweig (NASA- GISS)	NASA ASP Water Resources	Central America - Climate and Agriculture Modeling	NASA Modeling for climate change and food production.
26	Brian Wardlow Univ Nebraska, National Drought Mitigation Center	NASA ASP Water Resources	The Quick Drought Response Index (QuickDRI): An Integrated Approach for Rapid Response Agricultural Drought Monitoring <ul style="list-style-type: none"> Program provides a range of national and international projects promoting the free and open exchange of water information over five thematic areas: 1) drought; 2) streamflow; 3) water quality; 4) consumptive water loss through evapotranspiration; and 5) climate impacts on water resources Remote sensing tools for water availability, aquifer monitoring, agriculture assessment and evapotranspiration mapping. 	Near real time response drought monitoring for the US that can be extended globally
27	Jeff Dozier (UC Santa Barbara)	NASA ASP Water Resources	Snowmelt to Afghanistan and Hindu Kush	Water availability information using satellite and modeling information for the Himalaya Region
28	Brad Doorn (NASA HQ)	NASA Terrestrial Hydrology Program and ASP Capacity Building and Water Resources	The NASA Water Resources Programmatic International Activities <ul style="list-style-type: none"> Within the NASA Applied Sciences Program to accelerate the use of NASA and other Earth science products to benefit decision making. Program provides a range of national and international projects promoting the free and open exchange of water information over five thematic areas: 1) drought; 2) streamflow; 3) water quality; 4) consumptive water loss through evapotranspiration; and 5) climate impacts on water resources Remote sensing tools for water availability, aquifer monitoring, agriculture assessment and evapotranspiration mapping. 	Program provides direct support for NASA to work with the US Water Partnership. Will link NASA Water activities with the World Bank, UNESCO-IHP, GEO-Water with the USWP
29	H. Berberry (Univ. of MD) and L. de Goncalves (INPE-CPTEC)	NASA ASP Water Resources	Integrating NASA Earth Science Results into Decision Support Systems for Agriculture and Water Management in South America	Regional water availability mapping and assesment of water for food. Also includes estimations of consumptive water loss (evapotranspiration) from satellites
30	D. Cline (NOAA) and C. Peters-Lidard (NASA-GSFC)	NASA ASP Water Resources	Benchmarking NASA Snow Research Results in NWS Hydrological Decision Support	Includes water availability and snowpack monitoring Central Asia
31	Jared Entin and others	NASA Water Missions in Support of International Water Resources	NASA's current and planned water missions in support of water resources management <ul style="list-style-type: none"> Emphasis of poster is on the new NASA Soil Moisture Mission, 'SMAP' Looking for global early adopters and work with WB staff to validate SMAP data with collaborations with NASA scientists 	New NASA soil moisture data, especially applicable for African flooding and rainfed agriculture assessment