NASA’s Contribution to Water Research, Applications, and Capacity Building in Africa

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Capacity-building: Enable the effective use of water management tools in the US and internationally

Applied science research: Build water resource management tools

How do we build the capacity to impact decisions and society?

- **SERVIR**: regional and in-country government stakeholders
  - Geographic Areas: US, East Africa, Mesoamerica, Hindu Kush Himalaya

- **DEVELOP**: regional and US/state/local government stakeholders and future workforce
  - Geographic Areas: US, Colombia, Mexico, Nepal

- **Gulf of Mexico Initiative (GOMI)**: regional stakeholders
  - Geographic Areas: US, Mexico

- **Applied Remote SEnsing Training (ARSET)**: regional and US/state/local government stakeholders
  - Geographic Areas: US, Colombia

Applied science research: NASA Energy and Water Cycle Study

- **Water Quality and Resources Monitoring**
- **Flood Forecasting**
- **Agriculture: Water Delivery and Irrigation**
- **Snowpack Monitoring and Management**
- **Climate Impacts**
- **Drought Monitoring**

Basic science research: NASA Energy and Water Cycle Study

- **Soil Moisture Assessment (AMSR-E/SMOS/SMAP)**
- **Precipitation Assessment (TRMM/GPM)**
- **Evaporation Estimation (LDCM)**
- **Change in Groundwater Storage (GRACE)**
- **Snowpack and Melt Assessment (AMSR-E/MODIS)**
- **Improved Seasonal Forecasting (AQUARIUS/MERRA)**
- **Integrated Water Cycle Assessment (NEWS)**

What processes drive the cycle of water and energy on Earth?
NASA’s Water and Energy Satellites

Water Cycle Missions

- ICESat
  - Ice elevation
  - Cloud height

- GRACE
  - Column water-content

- TRMM and GPM
  - Global precipitation

- SMAP
  - Global Soil Moisture

Water and Energy Cycle Missions

- EOS-Aura
  - Atmospheric humidity
  - Clouds

- EOS-Terra
  - Snow and ice
  - Vegetation

- CALIPSO
  - Cloud properties

- CloudSAT
  - Cloud profiler

- EOS-Aqua
  - Atmospheric humidity
  - Water storage
  - Clouds
  - Snow and ice

Energy Cycle Missions

- TOMS
  - Total column ozone

- SORCE
  - Total Irradiance measurements

- SAGE
  - Air quality
  - Climate change

- UARS
  - Carbon management
  - Air quality

Planned
- SWOT (Streamflow)
- SCLP (Snowpack)
- GRACE-II (Groundwater)
- HyspIRI (Water Quality, Land Surface Hydrology)

Complementary Water and Energy Cycle Missions

- QuikSCAT
  - Sea-surface wind velocity

- EO-1 LANDSAT and NMP EO-1
  - Land cover

- NPOESS
  - Global environmental conditions

- GOES
  - Weather

- Aquarius
  - Global sea surface salinity
The Future…

The Soil Moisture Active Passive (SMAP) Mission
- Global observations of mapped soil moisture and freeze/thaw data with unprecedented accuracy, resolution, and coverage
- Planned Launch for 2014

The Global Precipitation Mission (GPM)
- International network of satellites that provide the next-generation global observations of rain and snow
- Planned Launch of Core Observatory for 2014
Goal: Integrating Remote Sensing Data with Modeling for Local to Global Assessment of Water Resources
Example: Land Information System (LIS)

Figure 1: Snow water equivalent (SWE) based on Terra/MODIS and Aqua/AMSR-E. Future observations will be provided by JPSS/VIIRS and DWSS/MIS.

Figure 2: Annual average precipitation from 1998 to 2009 based on TRMM satellite observations. Future observations will be provided by GPM.

Figure 3: Daily soil moisture based on Aqua/AMSR-E. Future observations will be provided by SMAP.

Figure 4: Changes in annual-average terrestrial water storage (the sum of groundwater, soil water, surface water, snow, and ice, as an equivalent height of water in cm) between 2009 and 2010, based on GRACE satellite observations. Future observations will be provided by GRACE-II.

Figure 5: Current lakes and reservoirs monitored by OSTM/Jason-2. Shown are current height variations relative to 10-year average levels. Future observations will be provided by SWOT.

Peters-Lidard, NASA/GSFC
NASA Water Information System Platforms (WISP’s) for the ‘MENA’

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

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

Mapping Vegetation and Food Production
5 WISP’s Planned for the MENA
Training and Capacity Building
NASA Project Nile

**Goal:** improved hydrometeorological information for research, planning, and water management

**Components:**
1. Land cover mapping and simulation
2. Satellite-derived evapotranspiration
3. Optimized models for hydrological analysis
4. Decision Support and Capacity Building
Famine Early Warning System Network (FEWS-NET)
Satellite Assisted Data Products

- NASA satellite products such as from MODIS are key inputs into FEWS-NET
- Vegetation density (‘NDVI’) & precipitation
- Evapotranspiration or Consumptive Water Loss
- Modeled Food Production

Verdin/USGS
The Famine Early Warning Systems Network (FEWS-NET)

- Using NASA Land Information System (LIS) to Help Extend Coverage beyond Sub-Sahara
- Satellite Precipitation
- Satellite Snow Cover and Snow Water Equivalent
- Satellite Vegetation Greenness
- Yield Forecasting
What is ‘SERVIR’

A NASA and USAID collaboration with countries and stakeholders to improve environmental management and resilience to climate change by strengthening the capacity to integrate Earth observations and geospatial technologies into development decision-making. Three international SERVIR nodes with plans for additional nodes.

- Remote Sensing Data/Models
- Integrated with other Geo Data
- Visualizations
- Decision Support
- Training/Capacity Building
- Partnerships

Flood Potential in Africa (NASA/GSFC)

Training and Capacity Building

Flood Monitoring and Post-Disaster Assessments

SERVIR Network
The Agricultural Model Intercomparison and Improvement Project (AgMIP) is a major international effort to evaluate model performance and climate impacts on the agricultural sector utilizing a cutting-edge climate, crop, and economic modeling framework enabling the assessment of future food security.

- Launched in 2010, AgMIP’s global activities include 5 regional research teams performing integrated assessments in Sub-Saharan Africa.

- AgMIP is building connections between the climate, hydrology, water systems, agricultural, and economics communities and plans to improve the representation of water resource challenges in future assessments.

For more information, contact Alex Ruane: alexander.c.ruane@nasa.gov
Also see [www.agmip.org](http://www.agmip.org) and Rosenzweig et al., 2012 (Ag and Forest Meteorology)
Observations from NASA’s Gravity Recovery and Climate Experiment (GRACE) mission provide estimates of terrestrial water storage variability (the sum of groundwater, soil water, surface water, snow, and ice).

Source: Matt Rodell, NASA GSFC
Lake and Reservoir Monitoring

Current Lakes Monitored by Jason-1 and Potential Lakes Monitored by ENVISAT

http://www.pecad.fas.usda.gov/cropexplorer/global_reservoir
The integration of Aqua AMSR-E soil moisture estimates into the USDA Foreign Agricultural Service (FAS) crop forecasting system provides better characterization of surface wetness conditions which enables more accurate crop monitoring in key agricultural areas.

Figure 1: NASA/USDA blended soil moisture product
Hydrospheric and Biospheric Sciences Laboratory

Figure 2: Soil moisture error reduction (red) or increase (blue) over the continental U.S.

Figure 3: Soil moisture error reduction (red) or increase (blue) over West Africa
Global Agriculture Monitoring Using NASA MODIS Satellite Data

GLAM Global Croplands Map derived from MODIS Time Series

C. Justice/UMd
SUMMARY & NEXT STEPS

• NASA has a free and open exchange of its satellite data
  + Over 40 current projects on international water activities with an estimated value of $21M.
  + Numerous data products (e.g.'s precipitation, land cover, vegetation indices, 'LDAS', 'NPP', etc.)
  + Many products provided in real time (vegetation indices, fire products & precipitation)

• NASA has several ongoing African projects
  + NASA/USAID African SERVIR
  + Nile Basin Remote Sensing and Modeling Project
  + NASA assisted USAID Famine Early Warning System Network (FEWS NET)
  + NASA/World Bank/USAID MENA-Water Information Systems Project
  + Greater Horn of Africa Drought Project (NASA/GSFC with USGS)
  + Several global projects ('Flooding', 'Drought', 'GLDAS', 'GLAM') may be optimized for Africa.

  ▪ Strengthen African Partnering w/ GEO, USAID, World Bank, stakeholders, etc.

• Possible Next Steps with GEO and AfWCCI
  + Coordinate Geo-Water Portal activities
  + Expand and coordinate training and public outreach efforts
  + Coordinate with GEO on African basins and countries where possible
  + African SERVIR engagement with AfWCCI activities
THANK YOU
A Summary of NASA-supported Water Activities in Africa

- North Africa – Water Information Systems Platform (WISP)
- Nile Basin – Project Nile
- Sub-Saharan – FEWS-NET
- East & South Africa – SERVIR
- West Africa – SERVIR MyCOE
- Africa - AgMIP
- Global
  - Water availability
  - Lake & reservoir monitoring
  - Flooding and droughts
  - Water for food & ecosystems
USAID FEWS-NET Food Security Outlooks

Current FS status
Climate Forecasts
Livelihoods
Other info: Trade, Conflicts, Health...
Seasonal Calendar

Areas of concern identification & Analysis
Current FS
Seasonal Forecasts
Climate Ahead
Agro- & Hydro- Scenario's
Livelihood zones & Profiles

Regional & National FSO Scenario’s & Updates
In agricultural economies, the majority of residents get some or all of their income from agricultural activity. In these regions, food security is highly related to weather-related food production deficits.

NASA satellite data and models are key input variables for organizations such as the USAID’s Famine Early Warning Systems Network (FEWS NET). FEWSNET is a key resource for monitoring food aid needs and supporting food deficit countries.