Earth Observation for Water Resources Management

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Purpose

Part of the initiative of the Water Partnership Program (WPP) dedicated to inform the use of earth observation in the water resources decision-making processes when advantageous and/or facing in-situ data constraints.

Audience

Anyone involved in continental to global water resources management

Goals:

- Review the current use of EO for water related issues
- Describe the current state of the art of water related EO
- Suggest the likely near-future (10 y) developments
- Provide recommendations to the WPP
From water sector societal needs to water issues to earth observation applications

The Water Sector:

- Water supply
  - Rural water
  - Urban water
- Sanitation and hygiene
- Agricultural water management
- Water resources management and environmental services
  - Aquatic Ecosystems
  - Environmental Flows
  - Invasive aquatic plants
- Water resources and climate change
- Hydropower

Water issues:

- Identification of farm dams and reservoirs
- Monitoring reservoir levels
- Monitoring their water quality
- Flood extent mapping and prediction
- Monitoring extent of snow and glacial cover
- Mapping urban and rural infrastructure
- Assessing crop water use and efficiency
- Monitoring irrigation rates and groundwater extraction
- Monitoring crop production
- Drought monitoring and forecasting
- Monitoring water quality of coastal discharge
- Monitoring river flow
- Integrated assessment of water availability under climate change
- Design hydropower facilities
From water sector societal needs to water issues to earth observation applications

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(satellite) earth observation variables
- Precipitation
- Evapotranspiration
- Soil moisture
- Groundwater
- Vegetation cover
- Surface water
- Snow and Ice
- Water quality
- Others (DEMs)
- (modeling)
From water sector societal needs to water issues to earth observation applications to sensors

- (Satellite) earth observation variables
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- Earth observation sensors needed (LEO & where possible Geostationary):
  - VIS-NIR-SWIR (multispectral-preferably hyperspectral)
  - TIR
  - Passive microwave
  - SAR
  - LIDAR
  Fine to coarse spatial resolution
  Highest possible S:N
  Well calibrated (pre-launch; in space, vicarious in situ)
  Well validated products
  Open data access OGC compliant
Drought monitoring forecasting you need:

- Precipitation
- Evapotranspiration
- Soil moisture
- Groundwater
- Vegetation cover
- Surface water
- Snow and Ice
- Others (DEM)
- Integrative assimilation modeling

Earth Observation for water resources management
Monitoring water quality in dams and reservoirs you need:

- Surface water (extent & level)
- Water Quality
The Asia-Pacific Water Monitor uses satellite and on-ground measurements, weather forecasts and a hydrological model to produce near-real time water balance estimates for the Asia-Pacific region. Read more

Maps show precipitation, streamflow, catchment water storage, and actual and potential evapotranspiration. Information is presented as actual values, deciles, anomalies and percentage of average.

Information is available for daily totals and 30-day averages.

For some countries and variables more accurate information is available elsewhere. See list of national water information services.
Daily Precipitation Anomalies (mm) 
01 December 2014

Earth Observation for water resources management
Use input point data instead of grids or averages

Monte Carlo Simulations, ensemble runs

Analyse for longer time periods or use shorter time intervals

Data cubes, data arrays instead of multiple flies

Based on European Climate Computing Environments, Bryan Lawrence [http://home.badc.rl.ac.uk/lawrence/blog/2010/08/02](http://home.badc.rl.ac.uk/lawrence/blog/2010/08/02)
The Traditional Approach Does Not Scale

Petabyte hierarchical archive: Millions of individual scenes
Tape store accessed by robot.

Slide courtesy Geoscience Australia
Looking to the Future of Earth Observation

Value layer
- National assessments and accounts
- Analyses to produce data and information for ABS
- Climate and weather
- Climate and weather tools
- Carbon accounting
- Hazards, risk, resilience, fires, flood, fire history, fuel loads etc
- Community safety
- Water tools
- Water

Big Data
- Time series
- Grid storage
- Standards
- Virtual compute
- Cloud compute

Data acquisition and preparation layer
- Image generation
- Geometric correction
- Calibration
- Data acquisition:
  - Public good data (Landsat, MODIS, GMES Sentinels)
  - Commercial data (DMCii, SPOT, WV2, Geoeye, aerial)

Slide courtesy Geoscience Australia
Data Complexity

Difficulty to Understand & Use

“Raw” Sensor Data

Calibrated “Cubed” Data in AG-DC

Summary Information for Policy Advice

Data Complexity & Volume

Data

Knowledge
Continental Scale Earth Observation Data Sets in the AGDC current and imminent and prospective

• Landsat 5-7-full archive current L 8 imminent
• MODIS A current & T imminent
• ASTER imminent
• AVHRR near future
• MERIS FR imminent
• Himawari imminent

• Prospective:
• Sentinel-1 SAR
• Sentinel-2 high resolution spatial
• Sentinel-3 Inland – Coastal -Ocean Colour
• Etc. SMOS? SMAP?
• ..........
Terrestrial applications of geostationary satellite data for Australia

Luigi Renzullo  Tim McVicar, Tom Van Niel, Randall Donohue, Catherine Ticehurst, Juan Guerschaman

CSIRO Land and Water
Overview

- Derived Products
  - Land surface temperature
    - MTSAT JAMI LST retrievals for Australia
    - Constraining land surface energy balance
    - Evapotranspiration estimation
  - Shortwave radiation
    - Gross primary production

- Application areas
  - Emergency response
    - Flood inundation monitoring
    - Heatwave indicators
    - Dust detection

Spurred by the enhanced radiometric, spatial & temporal characteristics of the Himawari imager (AHI), we will build on & enhance geostationary Earth observation products & expertise, and extend into new application areas for Australia.
Geostationary satellite land surface temperature (LST) as a constraint on surface energy and water balance

- Japan Meteorological Agency’s MTSAT-1R / 2
  - Japanese Advanced Meteorological Imager (JAMI)
  - Australian Bureau of Met. holdings June 2006 – present [data courtesy of Space Based Observations Section]

- Spit-window algorithms (SWA’s)
  - Exploit differential absorption of atmospheric H$_2$O in 11-$\mu$m & 12-$\mu$m bands
  - Most efficient approach for large scale LST retrieval from thermal $T_b$
Summary Terrestrial applications of geostationary satellite data for Australia

- Himawari has the great potential to enhance our water and land monitoring capability in Australia
  - Unparalleled temporal sampling
  - Improved radiometric coverage
  - Improved spatial resolution compared to MTSAT
    - Merging techniques with polar orbiting sat. for < 1-km resolution?

- Uncertainty estimation of LST (among others) products
  - Critical for assimilation into process models (LSM’s and ET models)
  - Absolute versus relative - i.e. diurnal variation more important than absolute accuracy?

- Integrated Water and Carbon cycle monitoring
  - To this end a lot can be achieved with Himawari (ET, soil moisture, GPP, fire scar mapping)
  - Multi-sensor approaches may lead to accurate, integrated modelling program at very high resolution in space & time

- Venturing into new application areas of emergency response & disaster monitoring
  - Working with key partners in Japan, US, Australia (and others)
Let’s think: How to collaborate in the Asia-Pacific?