Remote Sensing for Management of Transboundary Aquifers in Africa

Aquifer Project Presentation

Status February 2006

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Aquifer - Geographic Scope: Iullemeden and SASS
Framework

- **TIGER**
  Aquifer = demonstrator project
  TIGER: ESA/UNESCO initiative with focus: Space – Water – Africa

- **ESA**
  Aquifer funded / embedded into the programmatic framework of ESA – DUE: DATA USER ELEMENT

- **UNESCO SASS**

- **UNESCO IHP**
  Managing Hydrological Risk in the Iullemeden Aquifer System SAI
Aquifer TEAM

USER CO-ORDINATOR
Observatoire du Sahel et du Sahara (OSS)

USER GROUP
Mali: Ministère des Mines, de l'Energie et de l'Eau
Niger: Le Ministère de l'Hydraulique, de l'Environnement et de la Lutte Contre la Désertification
Nigeria: Federal Ministry of Water Resources & Rural Development
Algeria: Agence Nationale des Ressources Hydrauliques
Libya: General Water Authority
Tunisia: Direction Générale des Ressources en Eau

INDUSTRY PARTNERS
GAF AG, Germany
Scot, France
Joanneum Research, Austria
Telespazio, Italy
University of Jena, Germany
Vista, Germany

LOCAL PROVIDERS
The AGRHYMET Regional Centre, Niger
Centre National des Techniques Spatiales, Algeria
Center for Remote Sensing & Space Science, Libya
Centre National de Télédétection, Tunisia

EXTERNAL ADVICE

ESA/ESRIN

AQUIFER Project Summary – Status: February 2006
Earth observation – benefits/limitations

1. Assets – pros:
   - Area-wide coverage = cost efficient mapping/monitoring on an area-wide basis
   - Is truely transboundary in nature
   - Can provide an uniform spatial data layer to correlate/interpolate isolated field data
   - Objective measurement
   - Radar: cloud penetrating – all weather

2. Cons – caveats:
   - Require ground truth for calibration
   - Require data assimilation - combination with ancillary data - GIS – not a stand alone tool!

specifically for Ground water management:
   - Satellite remote sensing is basically confined to the surface:
     - Measure reflectance values of surface features
     - Radar and thermal sensor detect features cm, dm, a few metres below the surface
   - EO works but indirectly (proxies) or has to rely on secondary effects
EO is not a stand-alone tool

EO Data

- DEM
  - Catchment Analysis
  - Risk Analysis

GIS

- Water Potential
- Water Management
- Modelling

Thematic Information

- Surface Water
- Tectonics
- etc.

Ancillary Data

- Geological Maps
- Well Data
- etc.

Administrative Data

- Water Demand
- Water Use
- Water Rights etc.
Aquifer - Project Time Plan

Phase 1 (Sept 2004 - March 2005)
- User requirement consolidation
- Data requirements and acquisition planning

Phase 2 (March 2005 - March 2006)
- Product/service design
- Generation of prototype products / areas
- Verification and validation
- Training and promotion

Phase 3 (March 2006 - May 2007)
- Service delivery
- Science products
- Validation, use and assessment
- Training and promotion ongoing
Summary of Aquifer Products and Services -1/3

1. Land-use/cover maps for current situation and past and change detection (lullemeden and SASS)
   - Support estimate of ground-water extraction
   - monitor soil deterioration, recharge conditions, infiltration/runoff/evaporation conditions, evolution of agricultural sector
   - mapping of salt crust / wetlands
   - determination of risk areas, where pollution can affect ground water
   - EO data: Landsat TM, DMC, Envisat ASAR, AQUIFEREX

2. Estimation of water abstraction (SASS)
   - extent and spatial distribution of water abstraction estimate
   - improved monitoring and planning
   - input to the consultation mechanism - transboundary aquifer

3. Surface water extension and dynamics (lullemeden)
   - mapping and monitoring of mares and wetlands as areas of ground water recharge
   - as surface water resource for cattle
   - EO data: ESA Envisat ASAR
Summary of Aquifer Products and Services -2/3

4. DTM (Iullemaden and SASS)
   - Refining Ground Water Models: regional – national - micro scale models
   - Refining runoff calculations and aquifer recharge (location of ground water recharge areas)
   - areas of flow accumulation (local depressions - mare)
   - catchment delineation, model of water inflow to the mares as main points of recharge
   - EO data: ESA ERS tandem SRTM

5. Water and vegetation monitoring over entire aquifer (Iullemaden and SASS)
   - Support the trilateral decision making and future treaty verification
   - Mapping and monitoring of wetlands – mares – desertification
   - transboundary management of the whole Aquifer
   - EO data: ESA Envisat Meris
Summary of Aquifer Products and Services -3/3

6. Actual evapotranspiration and precipitation (lullemeden)
   – central components of the water balance
   – provided for the entire basin in low spatial resolution as basic input information for aquifer management
   – EO data: Meteosat – MSG

7. Refined Land use/cover mapping
   – 2 testsites in Tunisia
   – with AquiferEx (hyper spectral / Radar) data

8. and 9. Subsidence mapping & monitoring and refined water abstraction (SASS)
   – Identification and mapping of risk areas
   – Assessment of changes induced by ground water abstraction
   – EO data: ESA ERS - Envisat
Areas of Interest and Prototype Areas
- lullemeden -

Selected 3 Areas of Interest (blue) and 4 Prototype Areas (pink)
**Product and Service Responsibility**

**“Operational” Products and Services:**
1. Land Use/Land Cover Maps and Change Maps  
   - Local Providers/SCOT-F
2. Digital Terrain Models  
   - Telespazio - I / GAF-D
3. Water Abstraction Estimation  
   - JR - A
4. Surface Water Extension and Dynamics  
   - GAF - D

**“Science” Products:**
5. Refined Land Use Map Product  
   - VISTA - D
6. Subsidence Monitoring and Associated Error Maps  
   - Telespazio - I
7. Refined Water Abstraction Estimation  
   - JR - A
8. Water Vegetation Monitoring over entire Aquifer  
   - Uni Jena - D
9. ETA and Water Balance  
   - VISTA - D
Landuse / Landcover Product

SASS:

Used for determination of ground-water extraction (cropped area, area of irrigation).

Change maps used to monitor soil deterioration and evolution of agricultural sector.
Water Abstraction Estimate

The product: “Water Abstraction Estimation” is an estimation of the optimal amount of water to be extracted and applied to the irrigation scheme to satisfy the crop water demand during the growing season 2005.

Direct use for analysing water abstractions from an internationally shared aquifer.

Future input for the consultation mechanism of a transboundary aquifer.
Digital Elevation Models (SAR interferometric) – colour coded

DEM - Bani Bangou - NIGER – 3000 km**2

DEM - Qued Rhir
ALGERIA
5000 km**2
Digital Elevation Models (Basin Wide) - SASS 1.000.000 km²
– colour coded

SRTM c-band
Digital Elevation Models (Basin Wide) – lullemeden colour coded

90m resolution
SRTM c-band – lullemeden
~ 525,000 km²
Open Water Dynamics and Extension (Iullemaden)

Identification of water bodies using ASAR/SAR data

Visual Interpretation of the extent and dynamics of open surface water bodies
AQUIFER Training - Workshops

Training and on-site cooperation (joint on the job work) has been performed with Water Management Organizations as well as Remote Sensing Institutes in Algeria, Libya, Mali, Niger and Tunisia.
Ground Truth Campaigns

First ground truth campaigns were performed by Aquifer Users and Local Providers with participation from experts from Europe – up to now in Libya, Algeria, Tunisia
The AQUIFER project is one of the TIGER individual demonstrator projects. It is embedded into the programmatic framework of the Data User Element (DUE), which is focussed on bringing together the scientific research community working on pilot projects and the operational service suppliers providing EO products and sustainable services corresponding to the operational needs of the wider user community.

The main objective of the AQUIFER project is to support the involved national authorities and international institutions with Earth Observation (EO) based technology to better manage internationally shared water resources and aquifers as well as to strengthen overall and integrated water management practices.
Conclusion and Outlook for phase 3

- **Role of Earth observation**
  - can be a supporting tool
  - is not stand alone – requires groundtruth, ancillary data and GIS

- **Role of Aquifer user organisations**
  - Increased involvement:
    - Assess results – provide feedback
    - furthergroundtruth for better calibration and assessment

- **Extension of the works**
  - All products (include the „science“ products)
  - Geographically – prototype areas -> areas of interest (100k km**2 – basin wide)
  - Training – joint on-the-job work
  - Evaluation of the AquiferEx data (airborne: hyperspectral-radar)
Thank you!

For your questions - please contact:

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