



Remote Sensing for Management of Transboundary Aquifers in Africa

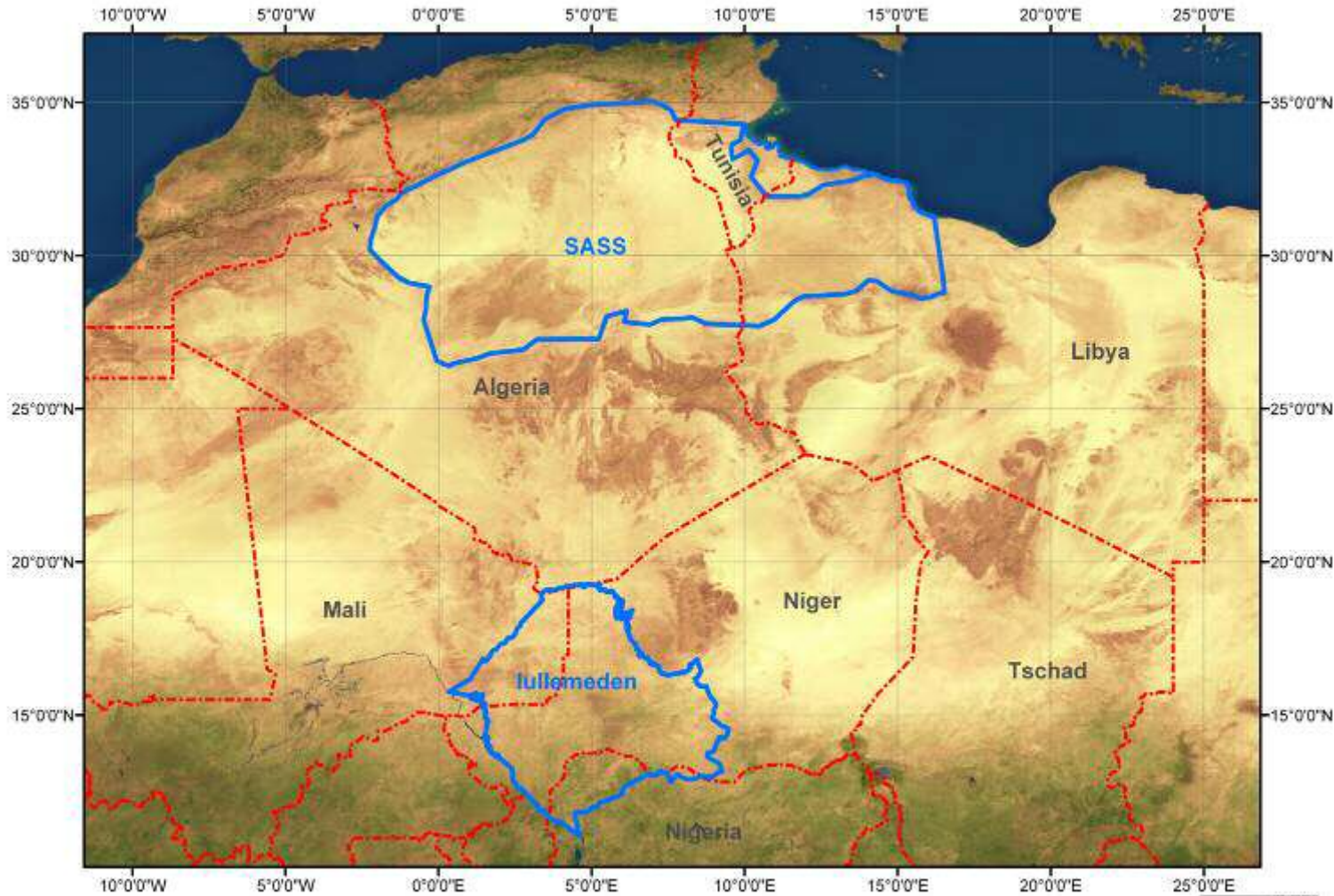
Aquifer Project Presentation

Status February 2006

Stefan SARADETH – GAF AG - Germany



Aquifer - Geographic Scope: Iullemeden and SASS



GAFAG Aquifer Project



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

ESA/ESRIN

EXTERNAL ADVICE



Earth observation – benefits/limitations

1. Assets – pros:

- ▶ Areawide coverage = cost efficient mapping /monitoring on an area-wide basis
- ▶ Is truly transboundary in nature
- ▶ can provide an uniform spatial data layer to correlate/extrapolate isolated field data
- ▶ objective measurement
- ▶ radar: cloud penetrating – all weather

2. Cons – caveats:

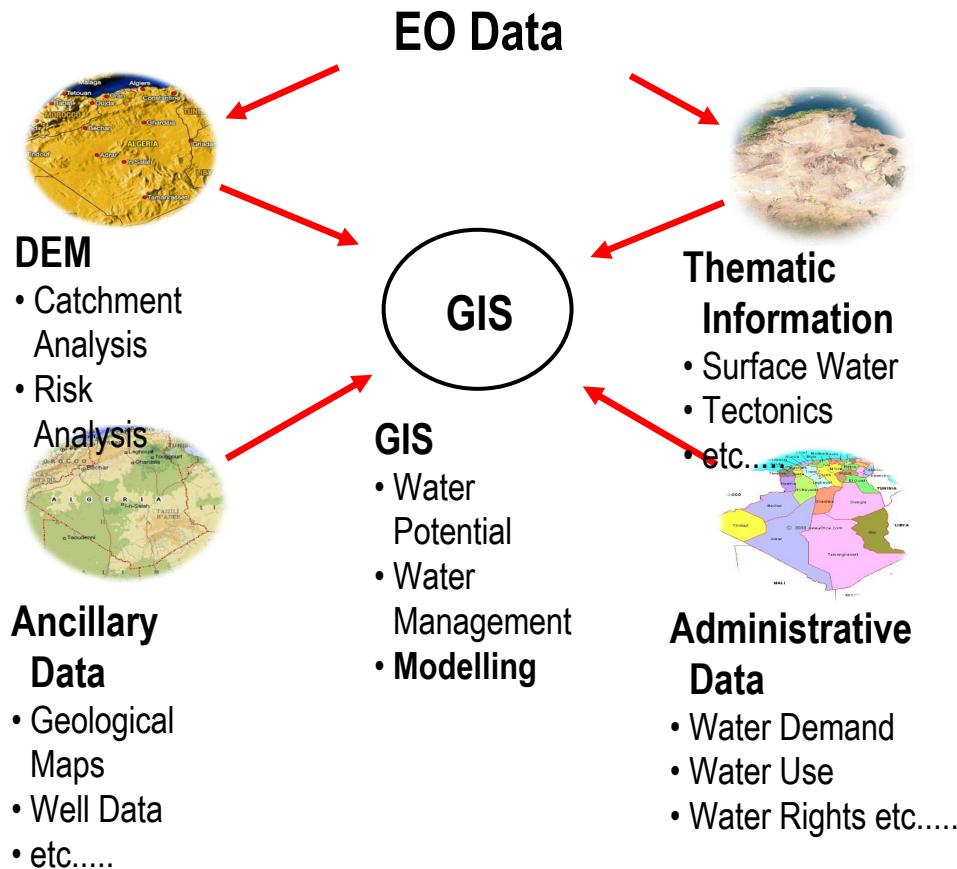
- Require ground truth for calibration
- Require data assimilation - combination with ancillary data - GIS – not a stand alone tool!

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



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 (Iullemeden 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 (Iullemeden)

- 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 (Iullemeden 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 (Iullemeden 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 (Iullemeden)

- 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)

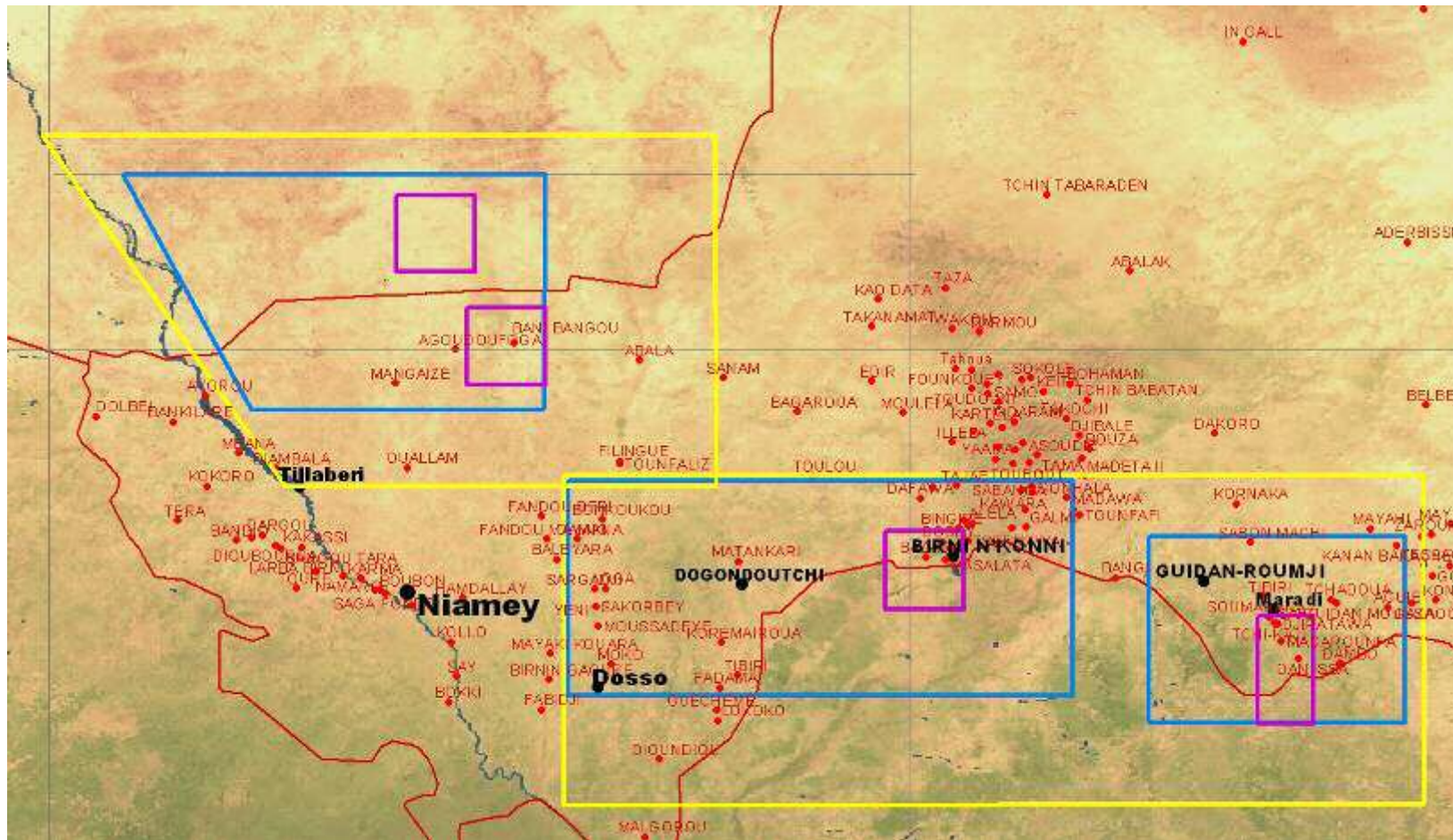
- Identification and mapping of risk areas
- Assessment of changes induced by ground water abstraction
- EO data: ESA ERS - Envisat



Areas of Interest and Prototype Areas - Iullemeden -



Società del Gruppo Finmeccanica



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
2. Digital Terrain Models
3. Water Abstraction Estimation
4. Surface Water Extension and Dynamics

Local Providers/
SCOT-F
Telespazio - I / GAF-D
JR - A
GAF - D

“Science” Products:

5. Refined Land Use Map Product
6. Subsidence Monitoring and Associated Error Maps
7. Refined Water Abstraction Estimation
8. Water Vegetation Monitoring over entire Aquifer
9. ETA and Water Balance

VISTA - D
Telespazio - I
JR - A
Uni Jena - D
VISTA - D

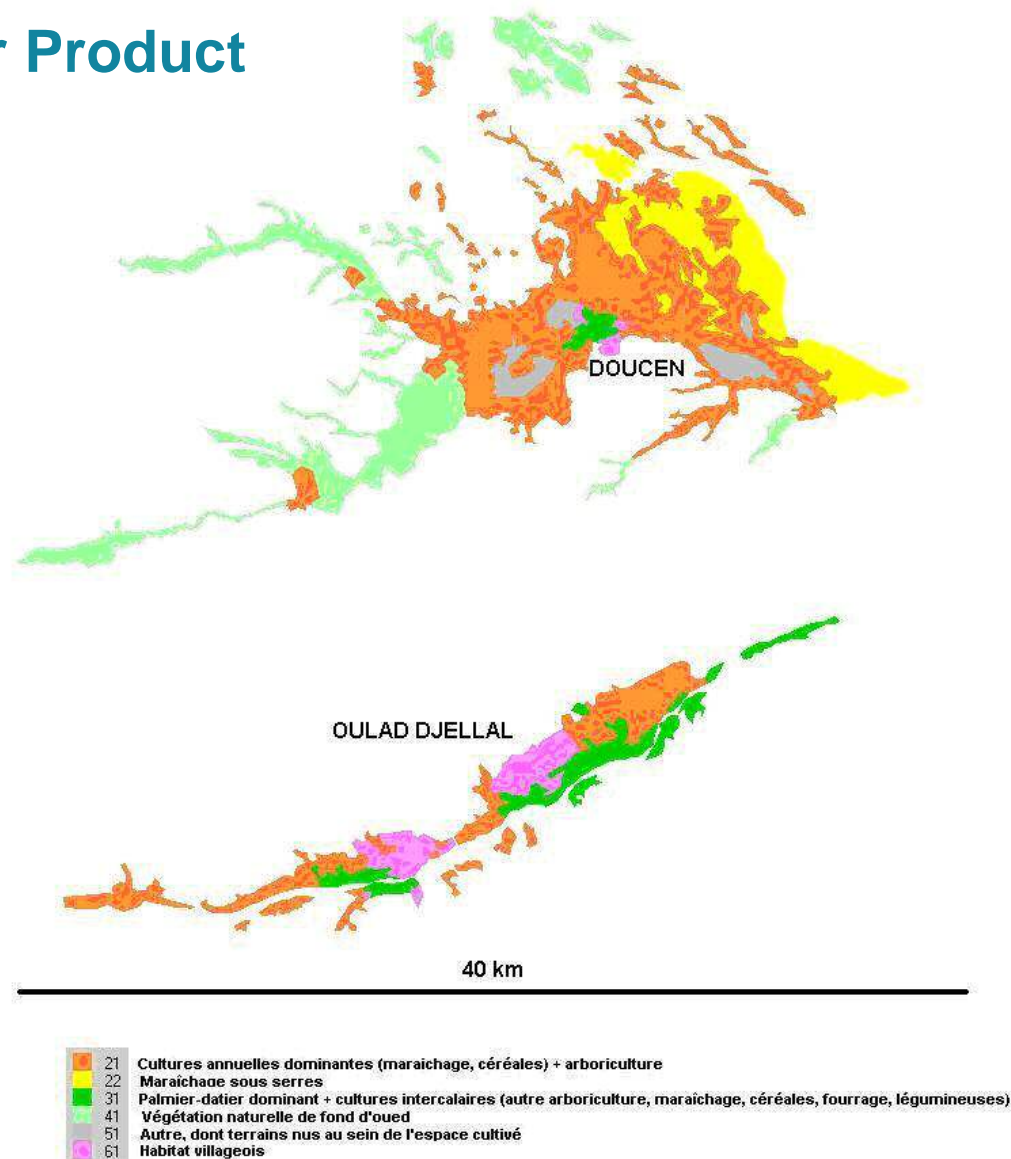


Landuse / Landcover Product

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.





AGRHYMET



telespazio

Società del Gruppo Finmeccanica



Water Abstraction Estimate

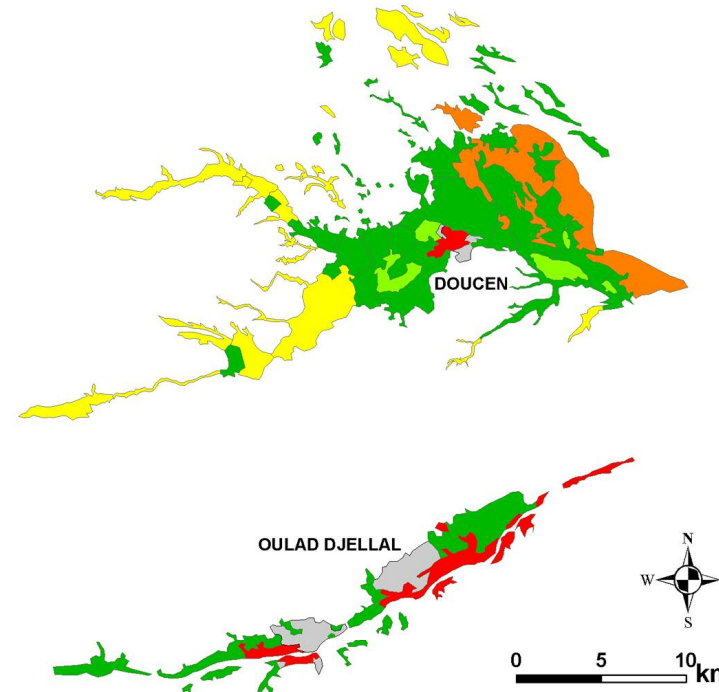
The product: “Water Abstraction Estimation” is an estimation of the **optimal amount** of water to be extracted and applied to the irrigation scheme to satisfy the crop water demand during the growing season 2005.

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

Future input for the consultation mechanism of a transboundary aquifer.

Water abstraction estimation

Preliminary result of PA1 Ouest des Zibans, SASS
based on EO, climate and crop data



Legend

Mean annual Water Abstraction Estimation for Irrigation [l/s/ha]

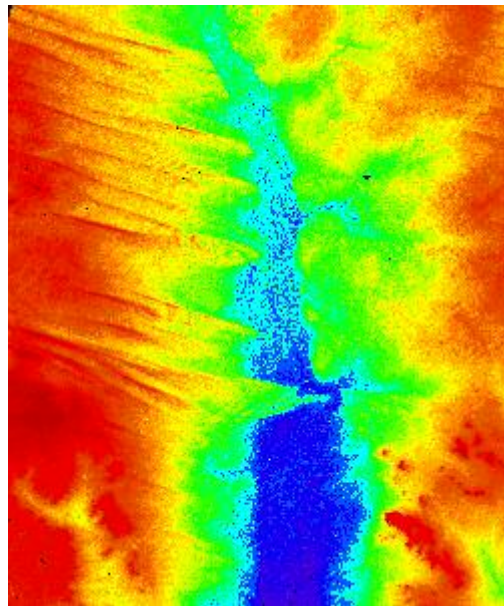
water requirement needed to satisfy crop water demand, based on LU/LC, Climate and Crop data

- not evaluated
- 0.38
- 0.49
- 0.62
- 0.8
- 0.94

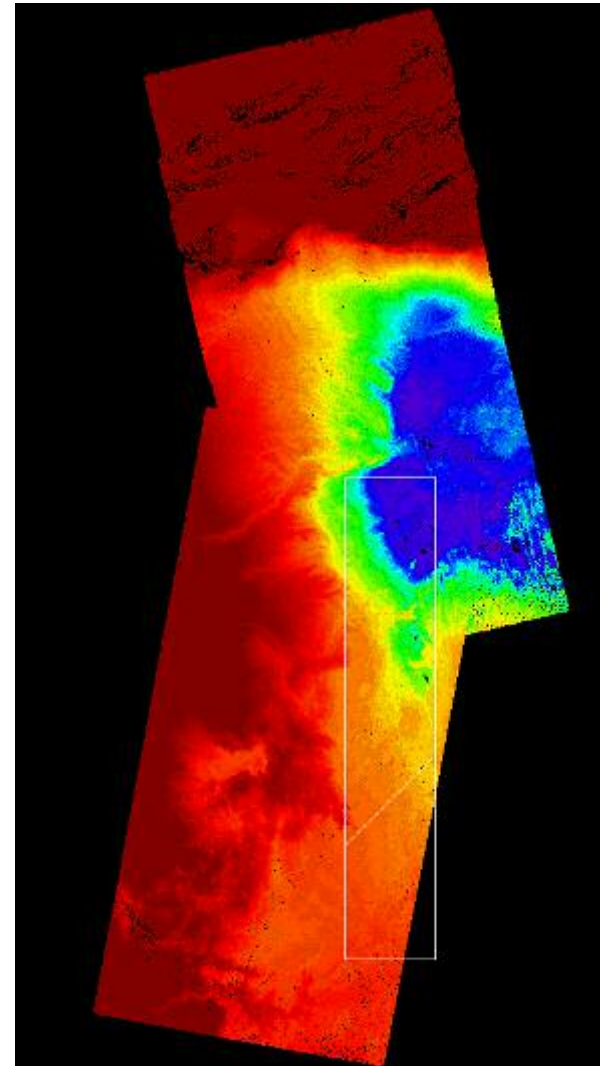


JOANNEUM
RESEARCH

Digital Elevation Models (SAR interferometric) – colour coded



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

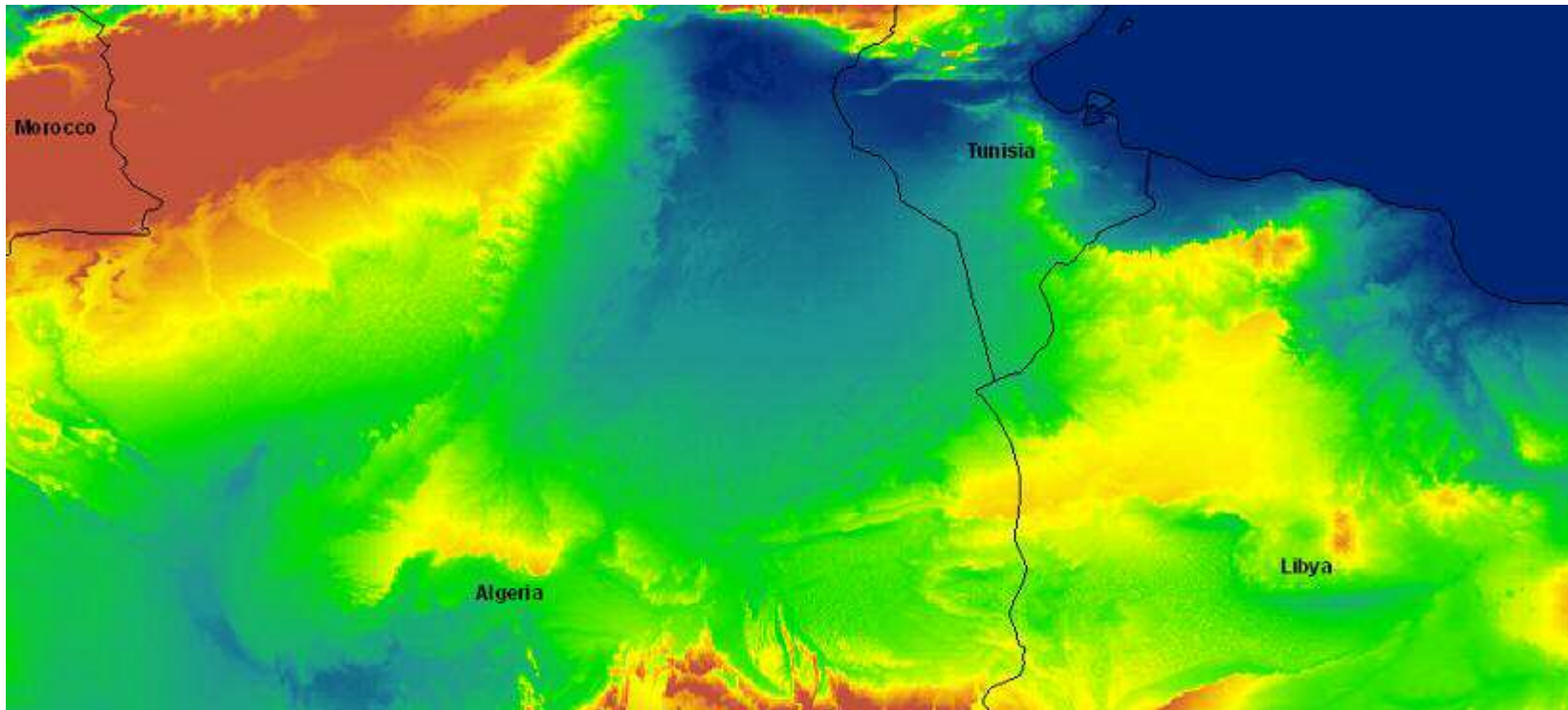


DEM - Qued Rhir
 ALGERIA
 5000 km**2



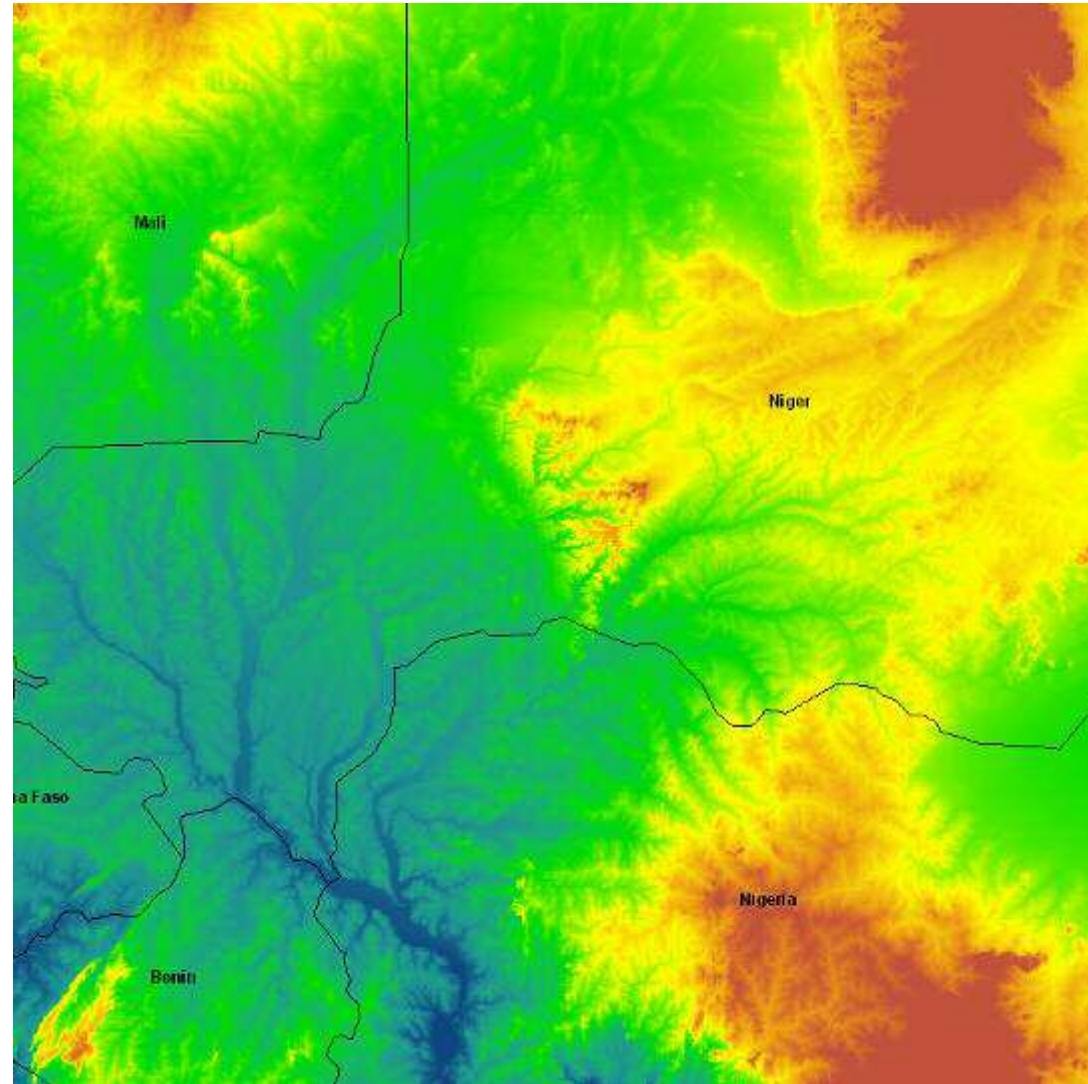


Digital Elevation Models (Basin Wide) - SASS 1.000.000 km² – colour coded



SRTM c-band

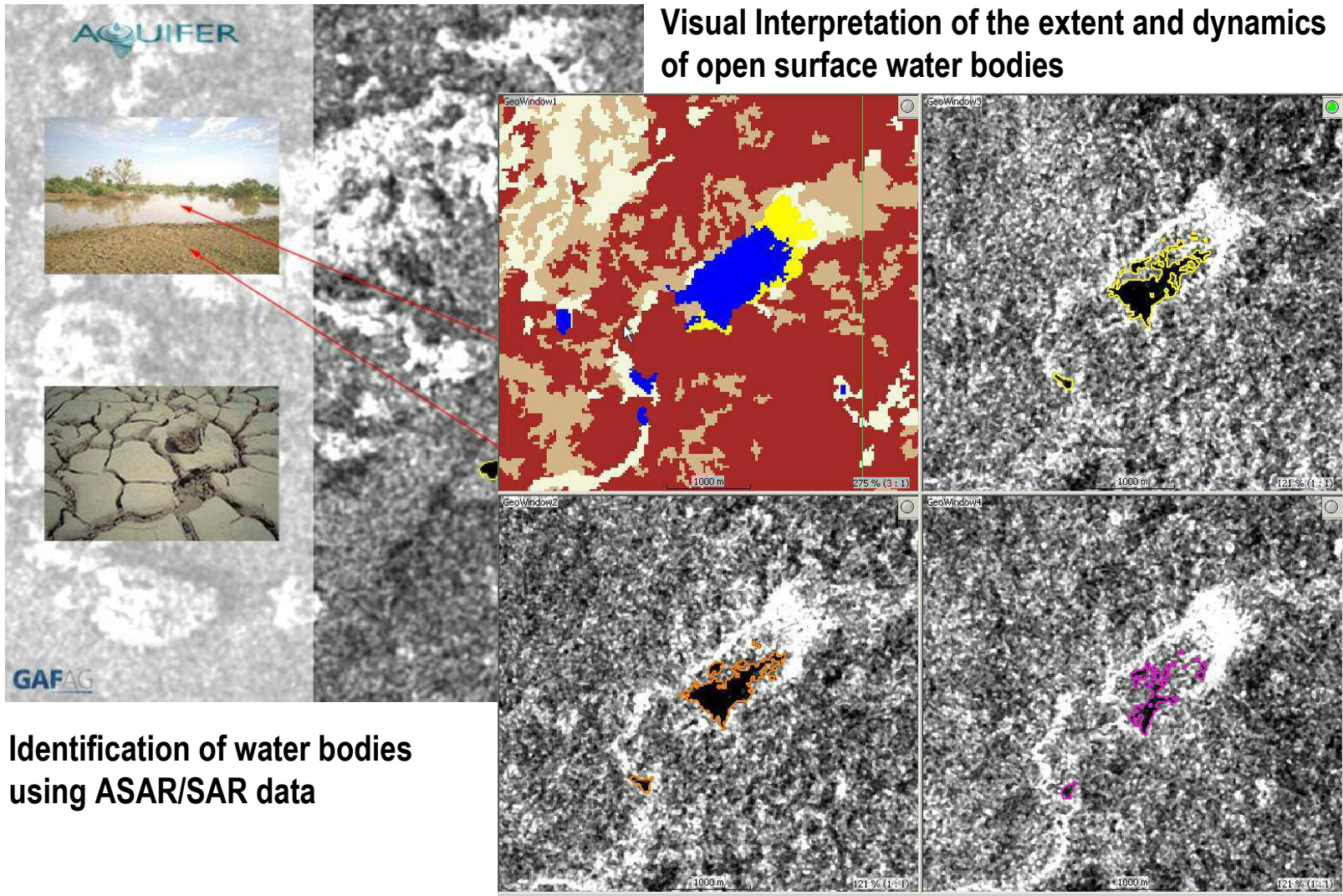
Digital Elevation Models (Basin Wide) – lullemaden colour coded



90m resolution
 SRTM c-band – lullemaden
 ~ 525.000 km²



Open Water Dynamics and Extension (Iullemeden)



Identification of water bodies using ASAR/SAR data

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.



Società del Gruppo Finmeccanica



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



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
 - further groundtruth 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:

email: aquifer@gaf.de

Internet: www2.gaf.de/Aquifer

