Best Practices for Risks Reduction
Rapid Response Mapping

New Remote Sensing Technologies for groundwater emergency situations
The WATEX System

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SAR is a penetrating tool

\[ \delta_p = \frac{\lambda_0 \nu \varepsilon' / 2 \pi \varepsilon''}{v} \]

Penetration depths calculated as a function of volumetric moisture for C-, L-, and P-band assuming a sandy loam soil consist 51.5% sand, 35% silt and 13.5% clay (Ulaby et al., 1986).
Exploration in Sudan, in the ancient kingdom of Meroe, near the 5th cataract of the Nile
Landsat (7,4,2) reveals a suture zone near Méroé
Radar multi frequency application
Penetration under the sand cover
Progressively reveals buried structures
Details which confirm existence of a shear zone with potential base metals mineralization
This is the way we rediscovered the old gold mines of the Black Pharaohs of Meroe Kingdom.
Radar is very sensitive to soil moisture
Leaks detection on the Great Mad Man river in Libya in 2002
Optic image of the Great River in the Syrt desert
Water Leaks from the buried pipe were detected only by radar
Leak covering 2 700 km²
Corresponding to a water loss of several billion of m³
This experience launched the WATEX™ System
What is the WATEX© System?

• WATEX is a hydrological tool designed to detect buried aquifers and soils in desert areas, invisible at ground level.

• WATEX is a GEOSCANNEER operated by satellite which can cover entire countries in few weeks, anytime, anywhere.

• WATEX is an instrument used for quick mapping for emergency situations in crisis areas
The WATEX SYSTEM integrates two modules

Traditional Water Resources Management system + The WATEX Imagery system

- Land use
- Topography & Watershed
- Hydrologic data
- Structural geomorphology
- Geology
- Climate data

- Aquifers over 20 m
- Aquifers in fractures
- Aquifers below 20 m
- Micro-dams location

This module tells you where to drill according to the geologic context and where to build microdams to create sustainable aquifers.
WATEX is needed to detect buried aquifers not visible from the surface.

Phase II: the WATEX process
- Needed to discover deeper and sustainable aquifers
- New generation of Optic sensors
- Radar multi frequency/Polarity
- Radar Interferometric data
- Ground Penetrating Radar
- Magnetic and gravimetric data
- Seismic echographies (Oil Exploration)
- Deep wells data (Oil exploration)
- Hydrological modeling in 3D

Detection and mapping of:
- Deep aquifers down to 3000 m
- Recharge areas
- Conductive fractures
- Soil hydromorphy
- Soils for agriculture
- Microdam sites for aquifer recharge
WATEX© System is a unique technological breakthrough

WHY?
WATEX Processing sequence can remove roughness
And enhance soil moisture signal

WATEX removing roughness

Transmitted Energy

Return Energy

Dry sand

(several meters thick)

Nubian sandstone bed-rock

Aquifer

Buried wet interface

Rough surface

15 to 20 m

40 to 50 m

Aquifer buried in a paleo-channel covered by dry sand
WATEX© is a GEOSCANNER
1-We start from commercially available radar images where soil moisture is hidden by surface obstacles (roughness effects)
2- WATEX© imagery penetrates through the surface in order to detect buried aquifers down to a depth of 20 meters
3- WATEX© is a 3D Geo-scanner which removes all surface obstacles in order to enhance soil moisture effects.
4- WATEX© allows the instant visualisation of the active drainage system, above and under ground over broad surfaces.
5- WATEX© thanks to fractures allows mapping of storage, infiltration and flow transfers, far below 20 meters.
6- WATEX© eliminates false signals linked to clay deposits (green) using slope maps combined with Radar backscattering
WATEX® technology for Groundwater and soils. Success stories since 2004

**Sudan**, for US States Department (emergency for IDP in Darfur)

**Chad**, for UNHCR (emergency for Darfur refugees in Chad)

**Angola**, for US NGO (Post war reconstruction)

**Afghanistan** for USGS (refugee camps)

**Oman** for Shell (soil mapping for agriculture)

**Gabon** for Eni Gabon (Social program)

**IRAQ** for UNESCO (Post War Reconstruction)
All the aquifers and microdams have been recorded in the « Darfur Drilling Hand Book » used by NGO since 2004
Ground truth in Darfur-Sudan
Welcome on Planet Mars
Cattle killed by drought near dry wells

Photo: Alain Gachet
Incineration to prevent epidemics

Photos Helene CAUX
250,000 refugees spread on a front of 650 km between Chad and Sudan in July 2004.
Major humanitarian crisis
Photos Helene CAUX
WATEX has detected in 4 months over 200 000 km² all alluvial aquifers of Darfur and detected the best locations for refugee camps
WATEX in Darfur led the drillers to the right spots on alluvial aquifers, avoiding dry areas or low productivity.