CASE STUDY: Water Exploration in Chad using Remote Sensing & GIS[1]

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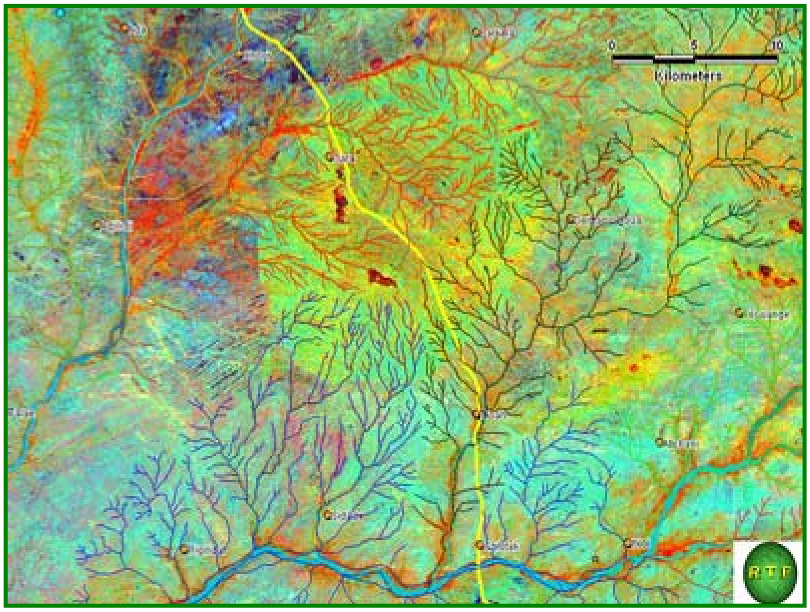
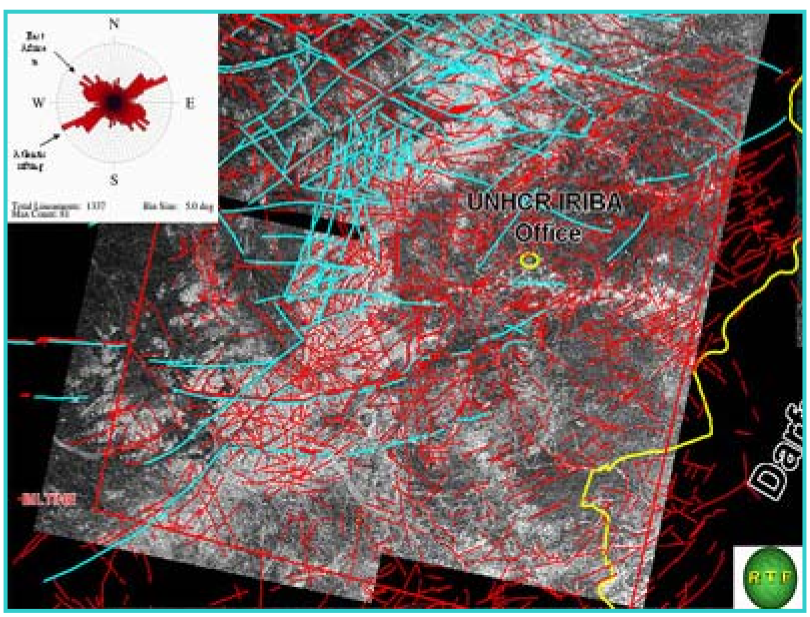
Complex emergencies often require humanitarian agencies to provide vast populations with food, shelter, medical treatment and other basic necessities for survival. But the greatest single need is water: the UNHCR uses a benchmark of 15 litres of water per person per day, but in too many cases this is an unattainable standard. In March 2004, the UNHCR requested UNOSAT (a geomatics consortium) to help it locate groundwater reserves to support Sudanese refugees from Darfur, and to optimize locations for new camps in the region. At that time, the Darfur Crisis had already forced over 180,000 refugees into the deserts of eastern Chad.



Study Area Geology enhanced by processing *(Source: RTF)*

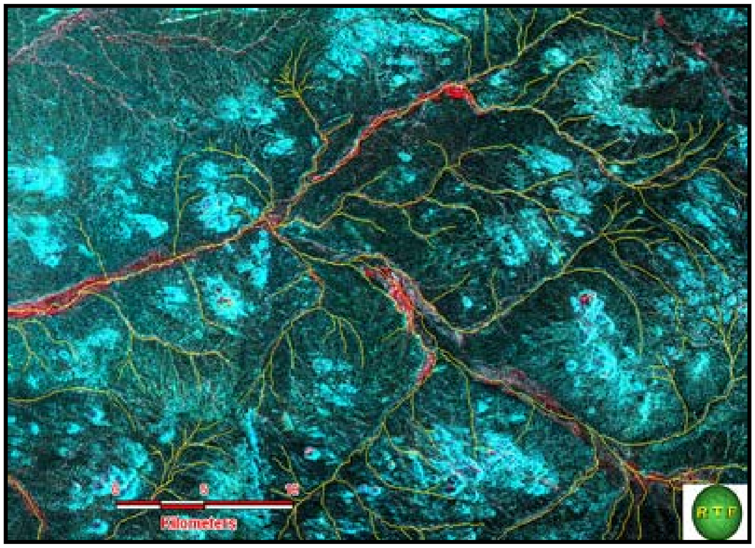
"They asked us to address this major problem of obtaining water for refugees, and working with consultant firm Radar Technologies France (RTF) we designed a solution," said Olivier Senegas of UNOSAT. "By the beginning of July 2004 we supplied water target maps covering over 22500 square kilometres of territory around the refugee camps of Oure Cassoni, Touloum and Iridimi." By the end of July, the team had successfully confirmed their remotely derived target maps with ground truthing; this was followed by detailed *in situ* geophysical analysis that is necessary to assess the actual potential/productivity of such water sources. The entire process was much more efficient and timely compared to using ground survey techniques alone.



Radar structural Analysis of Study Area *(Source: RTF)*

RTF's technique involved merging information from several satellites such as multi-spectral optical imagery from Landsat-7, C-band and L-band radar imagery. In order to orthorectify the imagery for terrain distortion and earth curvature, a Digital Elevation Model (DEM) derived from NASA's Space Shuttle Radar Topography Mission (SRTM) was used to spatially-correct the images so that they could be used together with other data.

Landsat was used to develop a basic understanding of the vegetation and surface water conditions of the region, and to map basic geology. Radar C band was then used to map



Buried Water Resources (red areas) *(Source: RTF)*

surface and near-surface topography, including geological structures such as faults, dikes, and buried drainage channels (known as *wadis*) that often yield water supplies. Then L Band radar imagery, which has the ability to penetrate the desert sand even deeper than C band thanks to its longer microwave signal wavelength, was used to map sub-surface water structures.

The technique to create water potential maps in the region was based upon that employed for oil, gas and mineral exploration. According to Dr. Alain Gachet of RTF, "the optical imagery shows you the surface; C band sees to a depth of about 50 cm down, and L band goes down to a maximum 20 metres, so with them all together you obtain a kind of cross-sectional model of the landscape." Because microwaves are highly sensitive to the dielectric properties of water, multi-temporal images over an area can be used to detect underground humidity anomalies.

RTF has developed *WATEX,* a specialized groundwater exploration processing system that can produce, over extended areas in very short time, ground water target maps displaying geomorphology, geology, soil, slope, land use, drainage, drainage density, lineament, faults orientation and density, runoff isolines, watershed limits, water quality, ground water depth.[2] WATEX enhances humidity by removing roughness effects on radar images.

Once the success of the technology was proven, the UNHCR requested the project scientists to optimize the location of seven new camps, an addition to the nine camps already operating in the region. Suitable locations were selected based upon water potential, access to transportation routes, and topography. Much of this work was done within a Geographic Information System: GIS enables spatial analysis of layers of information, including satellite intelligence, topographic maps, UN activity, population statistics, land cover, and lines of communication.[3]

It's saved us months of running around and drilling test wells," says Geoff Wordley, a senior UN emergency officer in Chad. Without Gachet's data, he adds, "We might as well be using divining rods."[4] Using RTF target maps in Chad improved the drilling success rates from 42% to 89%. These figures are based on statistics from over 544 wells and boreholes.[5]

Interestingly, the maps being used to support refugees may also be used by Chadian farmers in the future. "The third aspect is, we hope, to benefit local people beyond this current crisis," said UNOSAT's Senegas. "Only up to 30,000 people live here ordinarily, but they have shared what little they have with the refugees. These maps can help them in a lasting way, telling farmers, if you dig in this area here, you will be more likely to find water for your fields.

A rudimentary GIS centre has also been proposed in Chad as a long-term contribution to the sustainable development of the region.

[1] Case study adapted from ESA website story, *Satellites guide aid workers sinking water wells for African refugees*, September 7, 2004, posted on: www.esa.int/export/esaEO/SEML5G0XDYD_index_0.html (last accessed April 25, 2005).
[2] From the RTF website: www.radar-technologies.com/s_watex.htm (last accessed April 29, 2005)
[3] Personal communication with Dr. Alain Gachet, Principle Scientist – Radar Technologies France (RTF), August 15, 2004, November 25, 2004, and April 15, 2005.
[4] McLaughlin, A. *A Frenchman who can see water beneath the Sahara*, from Christian Science Monitor, September 20, 2004.
[5] Gachet, A. "Hydro geologic synthesis and target map of Eastern Chad-Ouaddaï", Radar Technologies France Report, February 2005.