Remote Sensing for the Study and Management of Water Resources in Mediterranean Landscapes (Tensift Watershed, Marrakech, Morocco)

**The Tensift Watershed (Marrakech, Maroc)**

- A typical South Mediterranean hydro-system
- Satellite monitoring
- An irrigation recommendation images and meteorological
- Snow cover monitoring
- Tools for irrigation management
- Decision support system for water distribution inside irrigated perimeters
- Integrated watershed modeling for groundwater management

**Monitoring water resources in mountains**

- Snow cover monitoring with VIS-NIR data (Sentinel-2, Landsat, etc.)
- Improving the functioning of hydrological models
- Satellite monitoring compensate for gaps in the ground observation network

**Soil surface moisture monitoring**

- DISPATCH Soil Moisture Product Available since 2010

**Monitoring the water budget of cultivated areas**

- Principle: exploiting synergies between sensors to monitor crops functioning
- Research oriented towards operational applications
- Tools for irrigation management
- Integrated watershed modeling for groundwater management

**Objectives of the TREMA Laboratory**

- Understanding the hydrological functioning of semi-arid watersheds to design management tools and study the impact of global changes

**The Tensift hydro-meteorological observatory**

- Around 10 complete meteorological stations
- Crop fluxes stations, 2 to 3 campaigns each year
- Remote, pleiometry, rainfall (ABHT, ORMVAH)
- One photometer (Aeronet network)

**Land cover mapping**

- Exploiting the repetitivity of sentinel-2 time series
- Robust methods to cope with the strong vegetation variability
- Decision trees based on expert rules (no annual training required)

**Tools for irrigation management**

- Sat-IRR (satellite for irrigation scheduling)
- SAMIR (Satellite Monitoring of Irrigation)

**Integrated watershed modeling for groundwater management**

- Linking all watershed fluxes
- Snow cover monitoring
- Groundwater model (ex MODFLOW)

**Examples of the Haouz aquifer (Marrakech, Morocco)**

- Water heads in boreholes
- Groundwater extraction monitoring
- Differences between sensed and satellite estimated water inputs are mainly due to groundwater extraction

**Soil Water Content (85%)**

- Use => decrease ~1m/annum
- Agriculture impact
- Difference between known input and actual consumption
- Pumps or Recharge

**Decision support system for water distribution inside irrigated perimeters**

- Time to next water turn...
- Water head to be input...
- Groundwater model (ex MODFLOW)

**Land cover mapping**

- Bare soil
- Vegetables
- Trees deciduous
- Trees evergreen
- Peas
- Equal
- Winter cereal
- Fallow

**Vegetation of the Forecast**

- For the
- Trees deciduous
- Trees evergreen
- Peas

**Evaporation**

- "loss"
- Physical exchanges
- Optical remote sensing (ex Sentinel-2)
- Microwave remote sensing (ex Sentinel-1)

**Processes monitoring**

- Groundwater processes
- Vertical exchanges at surface
- Observation of processes

**Remote Sensing**

- Synergy
- Complementary
- Spatialized and repeated observations
- Remote Sensing specializing Ground reference (calibration)

**The scientific approach**

- Remote Sensing
- Observation processes
- Processes modeling
- Outlet Runoff
- Surface water distribution (ex WEAP)

**Monitoring the hydro-meteorological observatory**

- 228 km²
- Agence du Bassin Hydraulique du Tensift (ABHT, ORMVAH)
- 2 to 3 campaigns each year
- 1- Analyzing the efficiency of irrigated systems
- 2- Designing tools for irrigation water management

**Authors**

- Chehbouni2, A. Benkaddour1, Y. Tramblay5, A. Dezetter5, M.H. Kharrou6, B. Berjamy7, M. Alaouri8, F. Raibi9, S. Zkhiri1, M. Khalki1, O. Bennani1, Z. Rafi3, J. El Farkh3, N. Ouaadi3, E. Bourras3, S. Kherrou1

**Institutions**

- (1) Université Cadi Ayyad (UCAM), Marrakech, Maroc
- (2) Centre d’Etudes Spatiales de la BIOsphère, Toulouse, France
- (3) Faculté des Sciences Semlalia (FSS), Université Cadi Ayyad (UCAM), Marrakech, Maroc
- (4) Ecole Nationale des Sciences Appliquées de Safi, Université Cadi Ayyad (UCAM), Maroc
- (5) Observatoire de la Recherche en Vide Optique (ORMVAH), Marrakech, Maroc
- (6) Laboratoire d’Hydraulique Hydrique (LHH), Marrakech, Maroc
- (7) Agence de Bassin Hydraulique du Tensift (ABHT), Marrakech, Maroc
- (8) Direction de la Météorologie Nationale (DMN), Casablanca, Maroc
- (9) Laboratoire de l’Eau et de la Climatologie (LEAC), Rabat, Maroc

**References**

- Remote Sensing for the Study and Management of Water Resources in Mediterranean Landscapes (Tensift Watershed, Marrakech, Morocco)

**Keywords**

- Remote Sensing
- Groundwater extraction monitoring
- outlet Runoff
- Surface water distribution (ex WEAP)