Irrigation decision support based on a link between pyWPS and IDL/ENVI,

accessing multi-temporal WCS

Michel Le Page, Simonneaux Vincent, Dejoux Jean-François
Centre d'Etudes Spatiales de la Biosphère
Abdelaziz EL FAZZIKI, Belaqziz Salwa
Université Cadi Ayyad – Faculté des Sciences Semlalia Marrakech
Jacquin Marc
Magellium

Introduction

Center for the Study of the BIOsphère from Space

UNIVERSITE PAUL SABATIER TOULOUSE III

4 tutelles

cnes

CNRS

IRD

Institut de recherche pour le développement

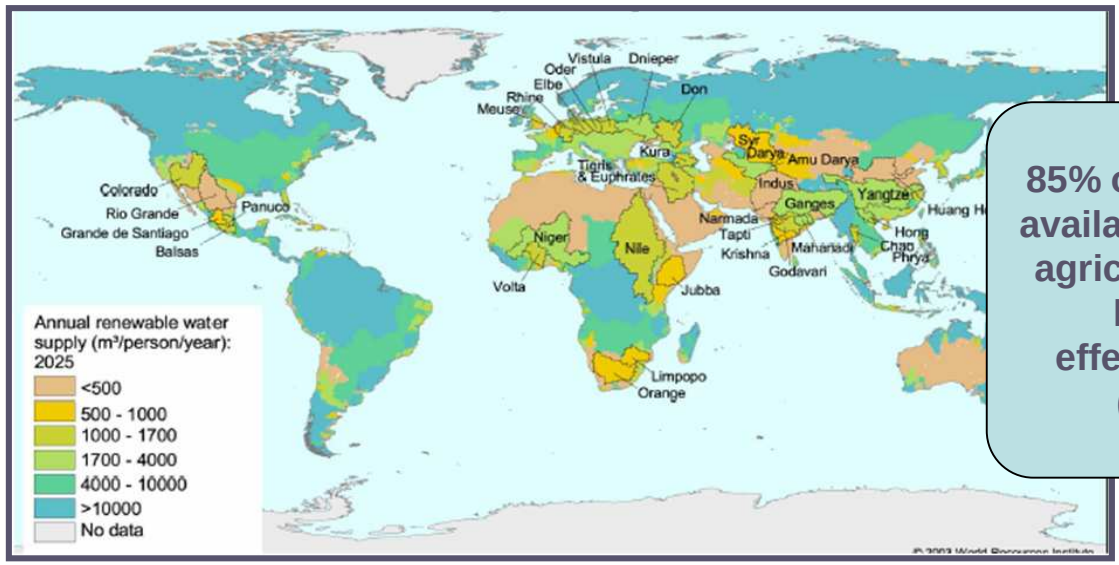
The CESBIO aims to develop knowledge on continental biosphere dynamics and functioning at various temporal and spatial scales

- Research in the domains of observation and modeling of the continental surfaces
- Specification of space missions and the processing of remotely sensed data

Background

Hydro-ecological functionning of irrigated agricultural zones

- needs growth (demography, irrigation extension)
- resources reduced availability (drought and/or climate changes)
- emphasis on arid zones.



85% of the water available used by agriculture with limited effectiveness (FAO).

CESBIO

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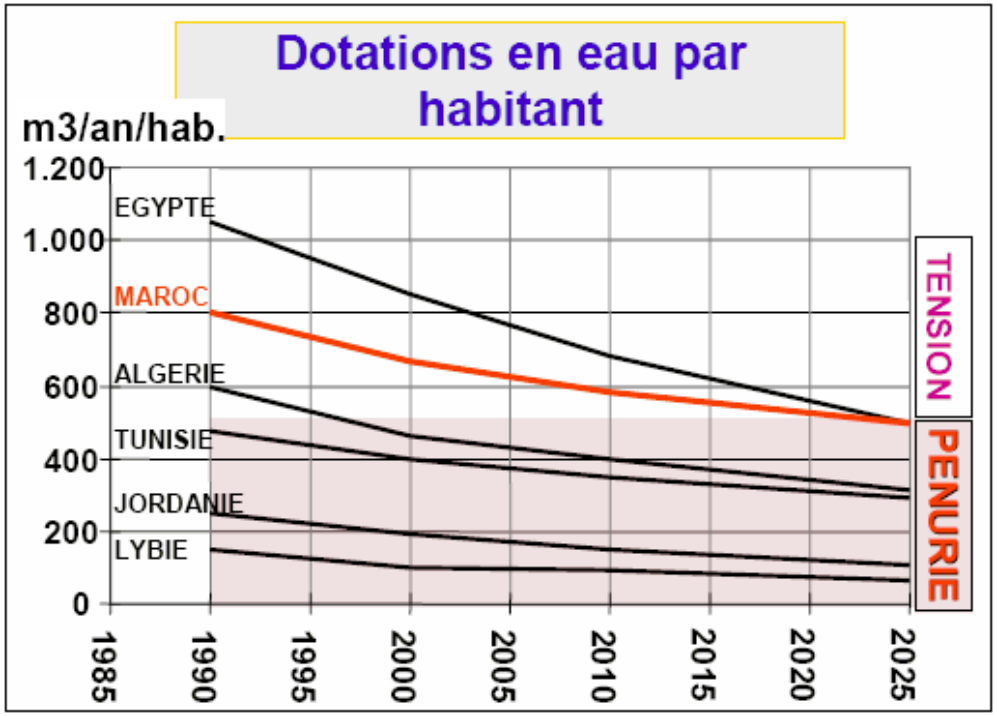
- Arids and semi-arids regions characterized by high vulnerability to climatical variations.
- Water resource now hardly satisfying the demand.



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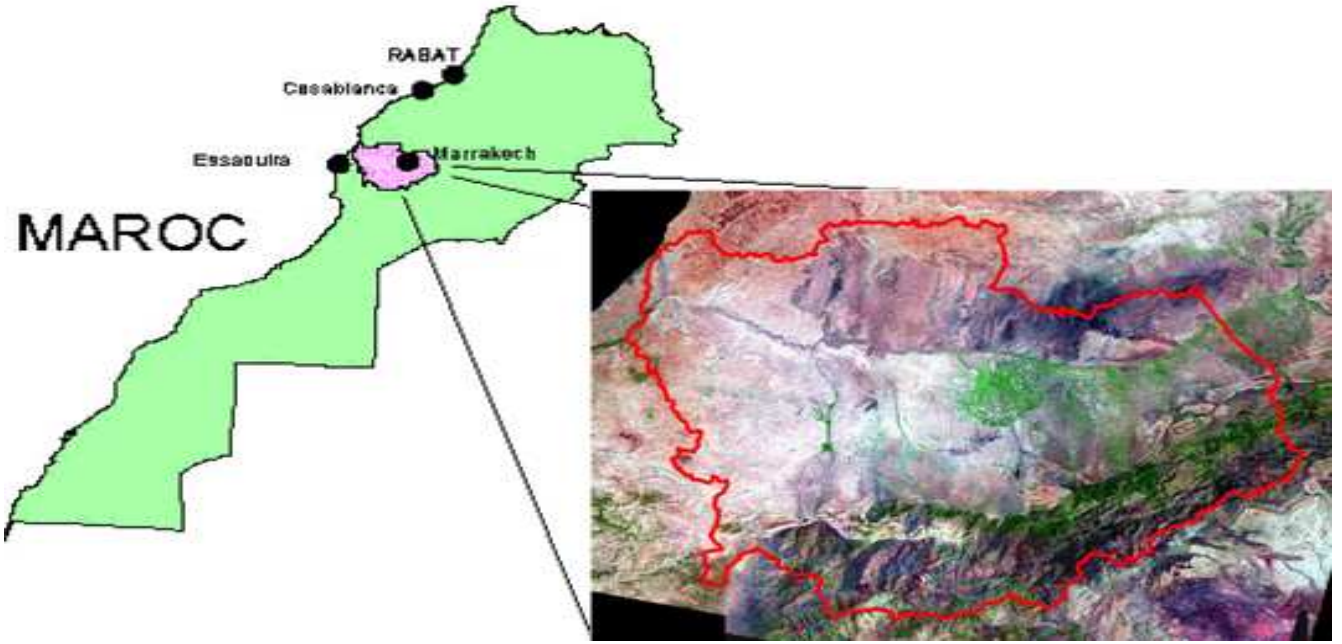

- Arid to semi arid climat in the Tensift region
- Agricultural activities development
- Tourism activities development
- Demographic extension

Rational use of irrigation water

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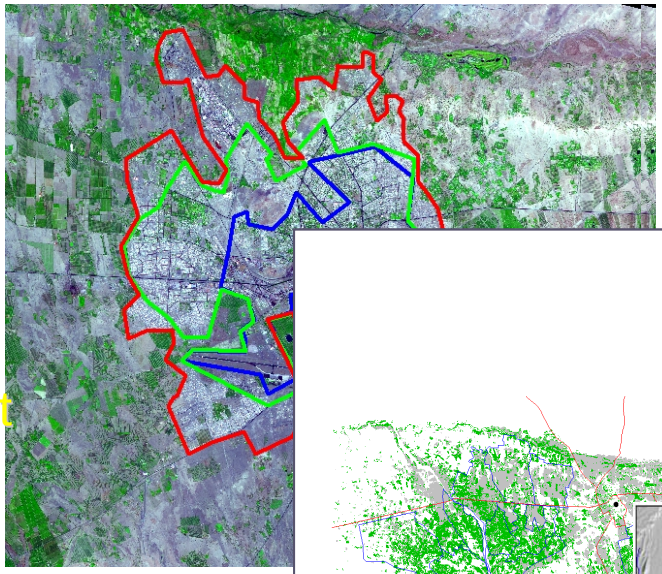
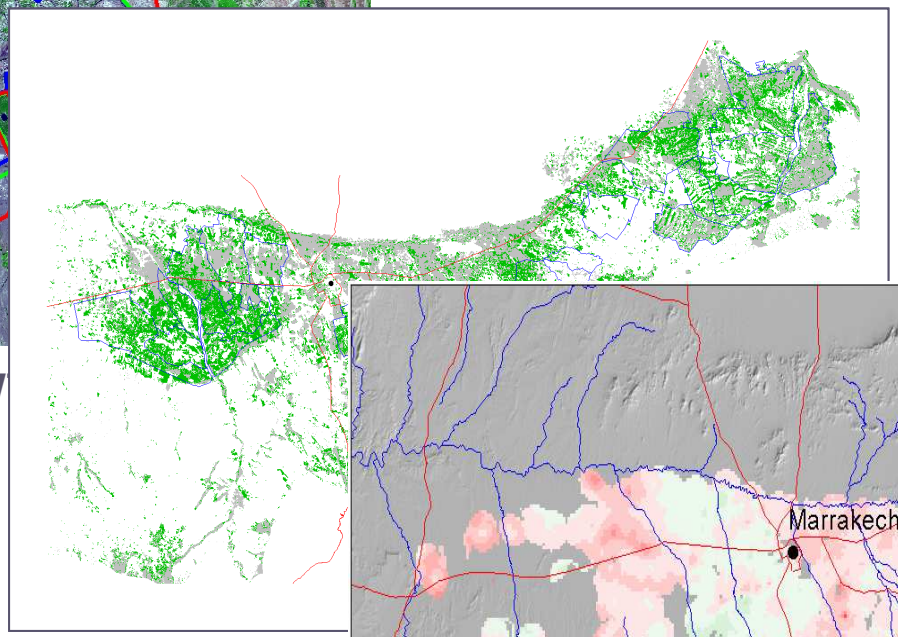
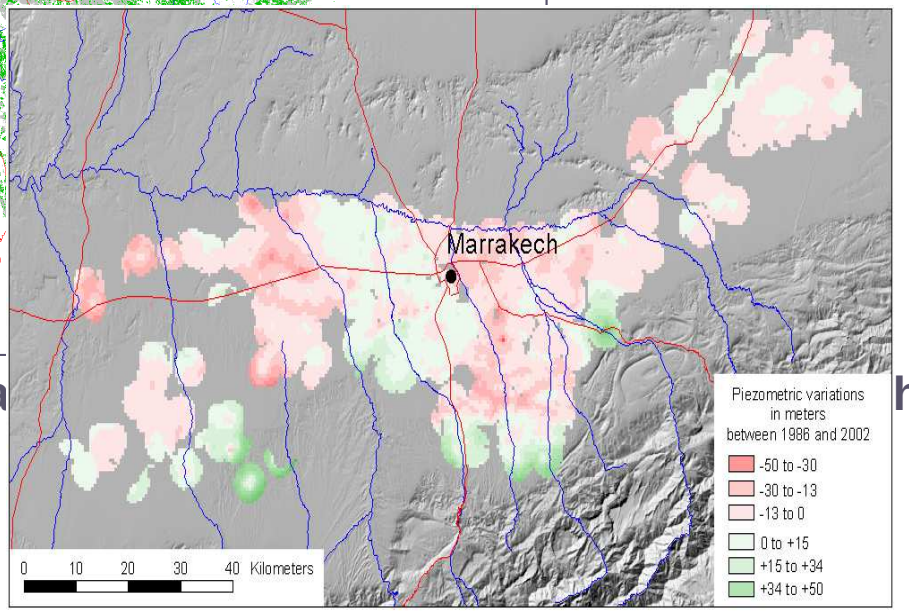


Urban grow



Irrigated surfa



Underground water layer level (1986-20

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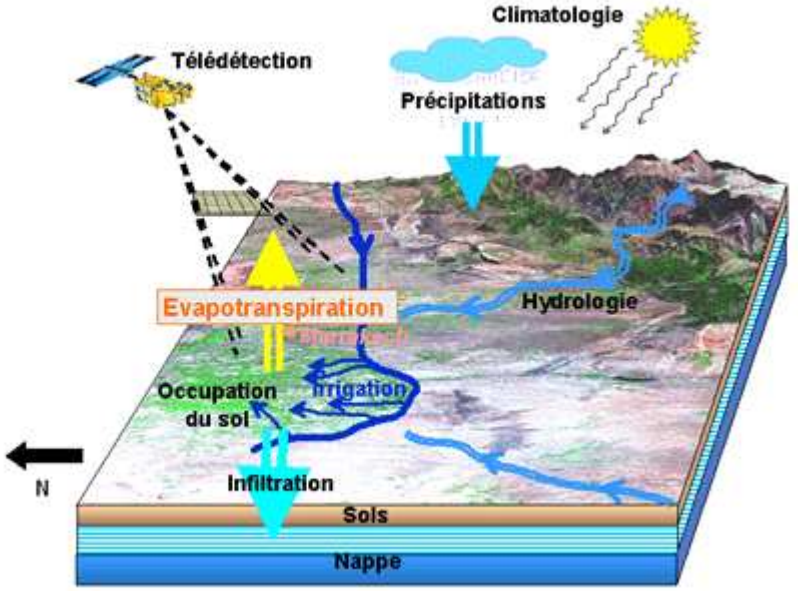
GENERAL OBJECTIVES

✓ To understand, model and predict the integrated hydro-ecological functionning of the



✓ To develop dashboard/indicators/decision-making tools for policies makers and legislators

✓ To develop operational tools for state agencies for enhanced rational management of resources.

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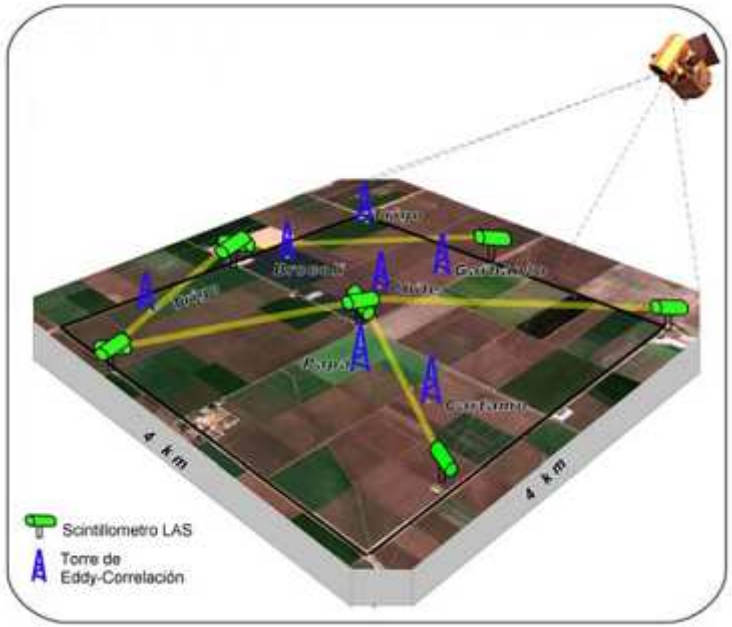
IRD
Institut de recherche pour le développement
IIRD, Institut de Recherche pour le Développement, Paris

ORMVAH, office de Mise en Valeur Agricole della plaine du Haouz, Marrakech



DREF, Direction Régionale des Eaux et Forêts (Haut Atlas), Marrakech

CESBIO, Centre d'Etudes Spatiales de la Biosphère, Toulouse

UCAM, Université Cadi Ayyad, Marrakech

ABHT, Agence de Bassin de Haouz-Tensift, Marrakech

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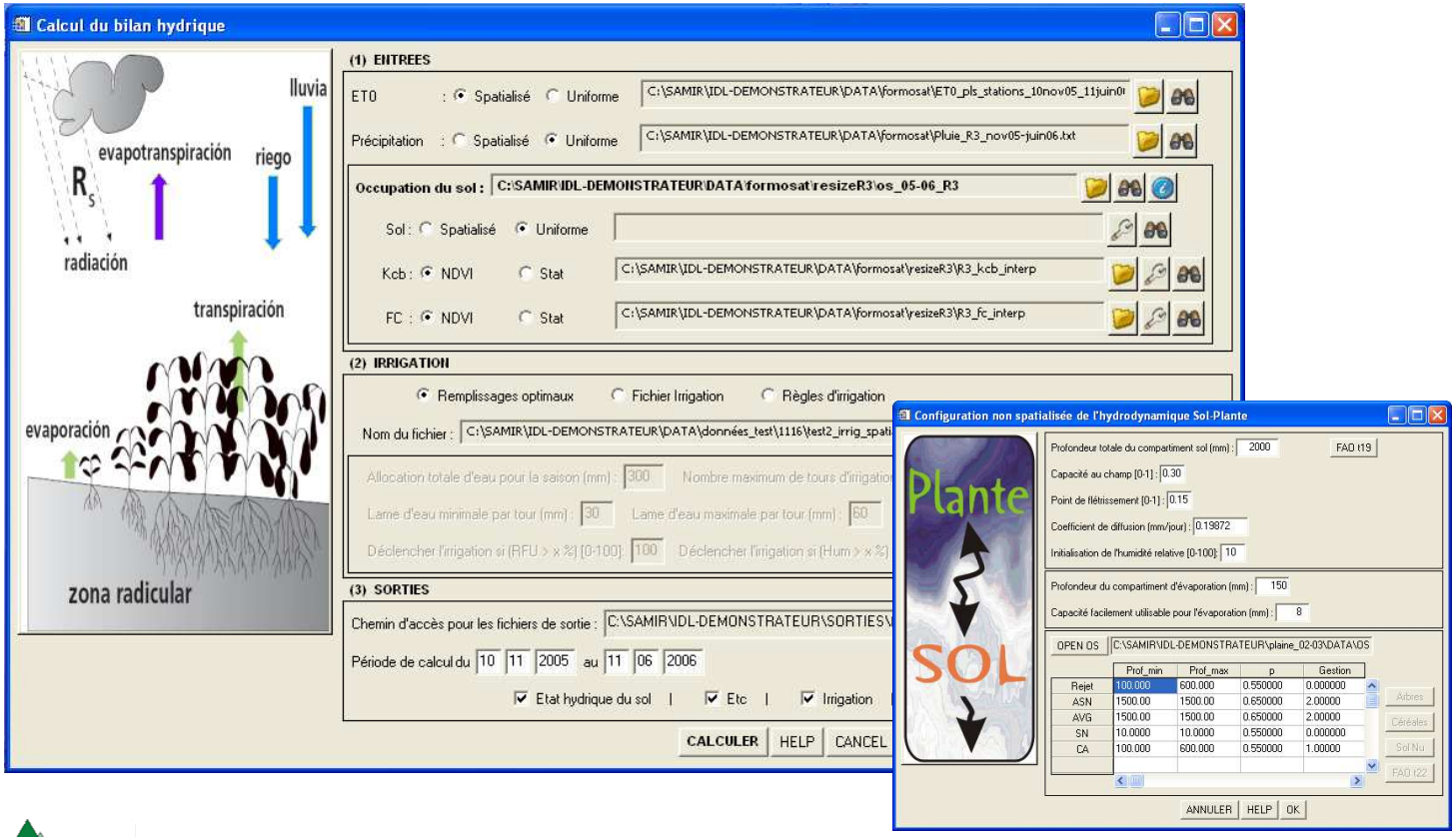
Satellite Monitoring of IRrigation

Software for water requirements evaluation for irrigated zones by remote sensing (IDL/ENVI).



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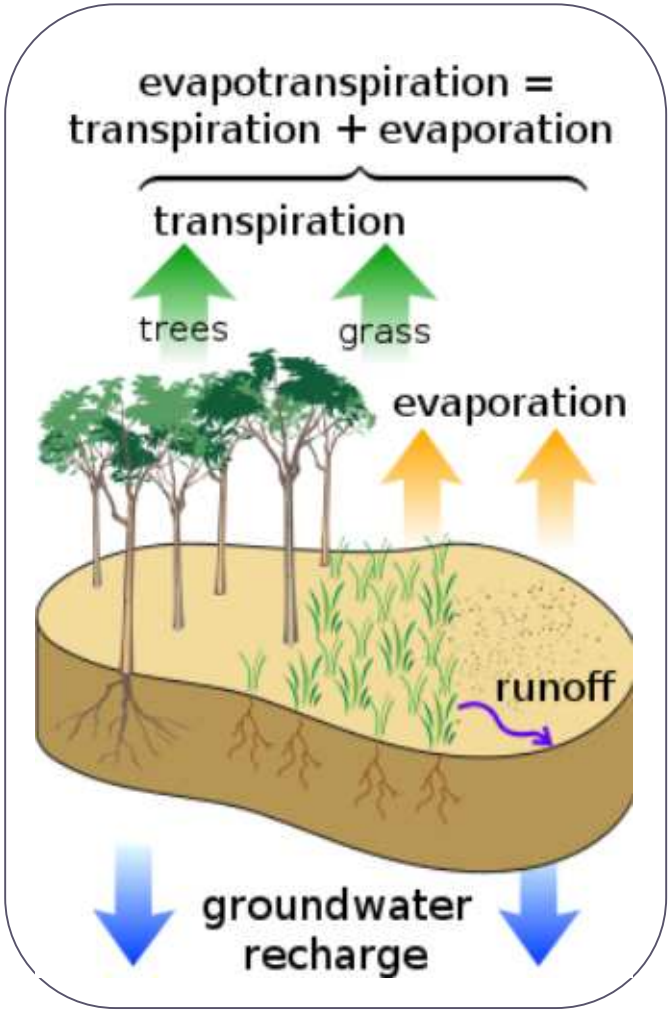
Evapotranspiration is used to describe the sum of evaporation and plant transpiration from Earth's to atmosphere.

Evaporation accounts for the movement of water to the air from sources such as the soil.

Transpiration accounts for the water loss as vapor through its leaves.

Evapotranspiration is an important part of the water cycle.



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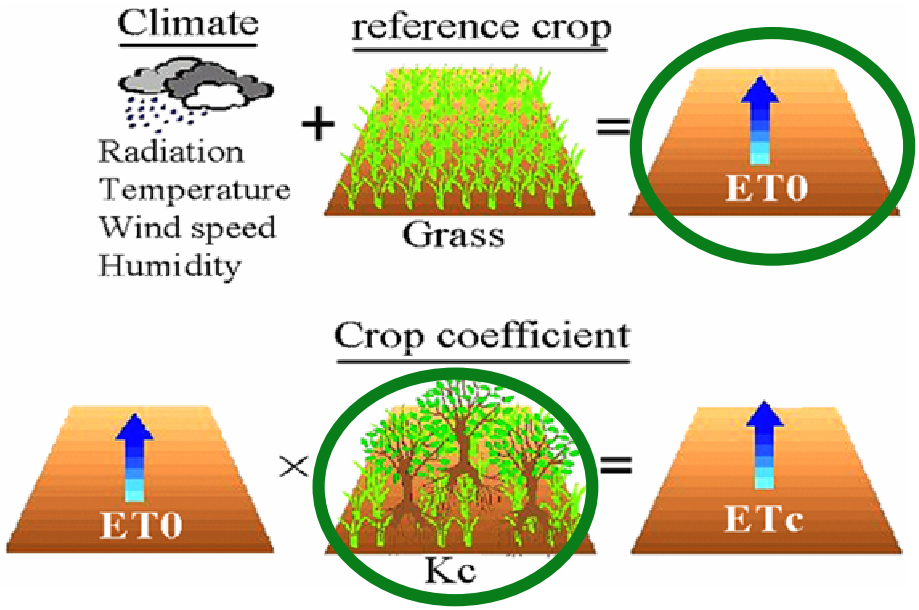
Computation of usable water requirements by the farmers based on FAO method which multiplied a climatic component (ET0 penman) and a farming coefficient (Kc)



Climate = ET0
Given by a weather station

Cultural coeff (Kc)
Estimated on the ground or by satellite by simple methods

(Allen and Al, 1998)

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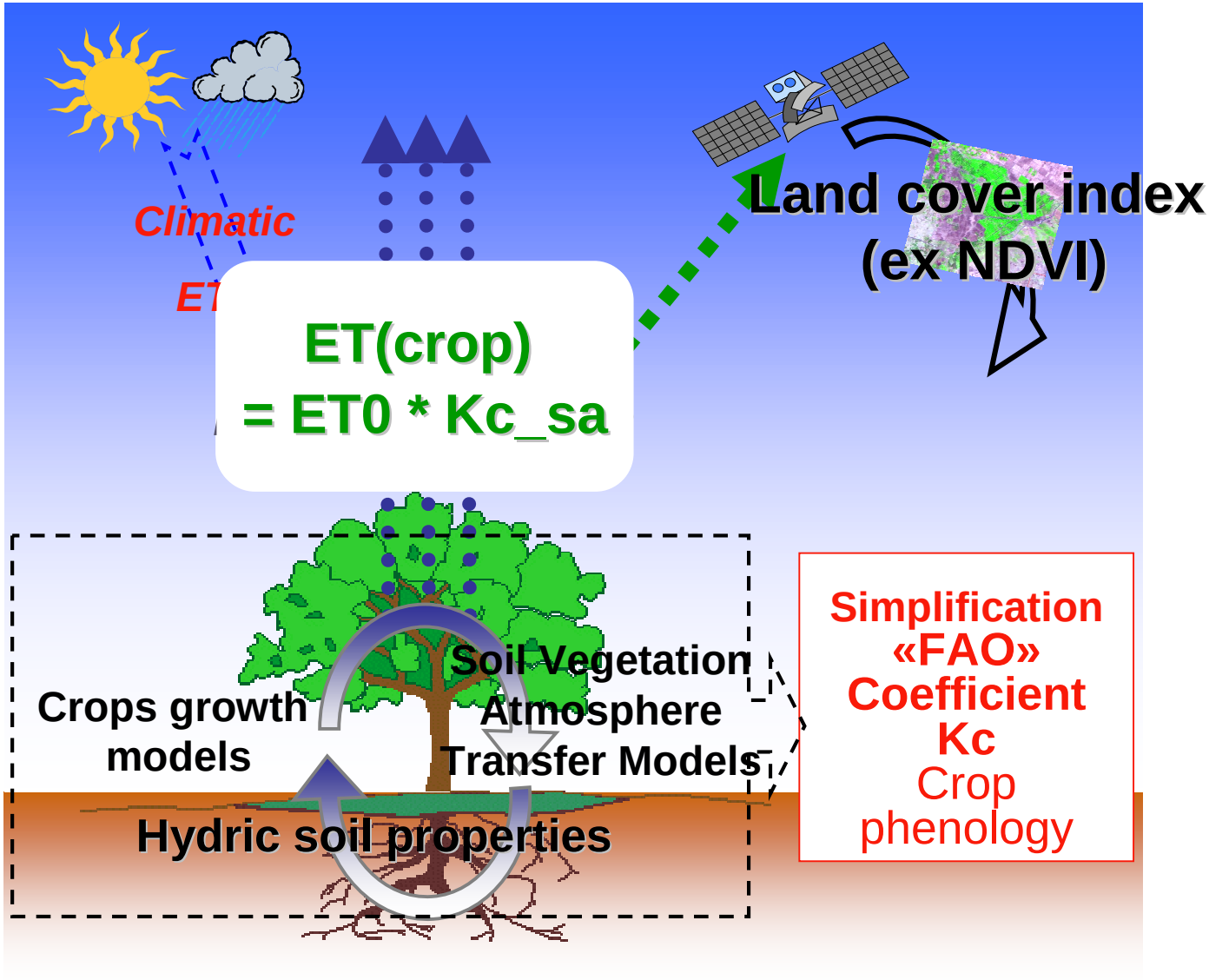

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FAO Penman-Monteith Equation (ET0)

$$ET0 = \frac{0.408\Delta(Rn - G) + \gamma \frac{A}{T_a + 273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34 u_2)}$$

[mm d-1] ou [mm h-1]

ETo reference evapotranspiration [mm day-1],
Rn net radiation at the crop surface [MJ m-2 day-1],
G soil heat flux density [MJ m-2 day-1],
Ta mean daily air temperature at 2 m height [°C],
U2 wind speed at 2 m height [m s-1],
e_s saturation vapour pressure [kPa],
e_a actual vapour pressure [kPa],
(es – ea) saturation vapour pressure deficit [kPa],
□ slope vapour pressure curve [kPa °C-1],
□ psychrometric constant [kPa °C-1].

Meteorological dat

Derived from meteorological dat

A = 900 *(daily step*
A = 37 *(hourly step*

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Kc can be obtained by **visual** estimation

Kc can be provided by remote sensing processing

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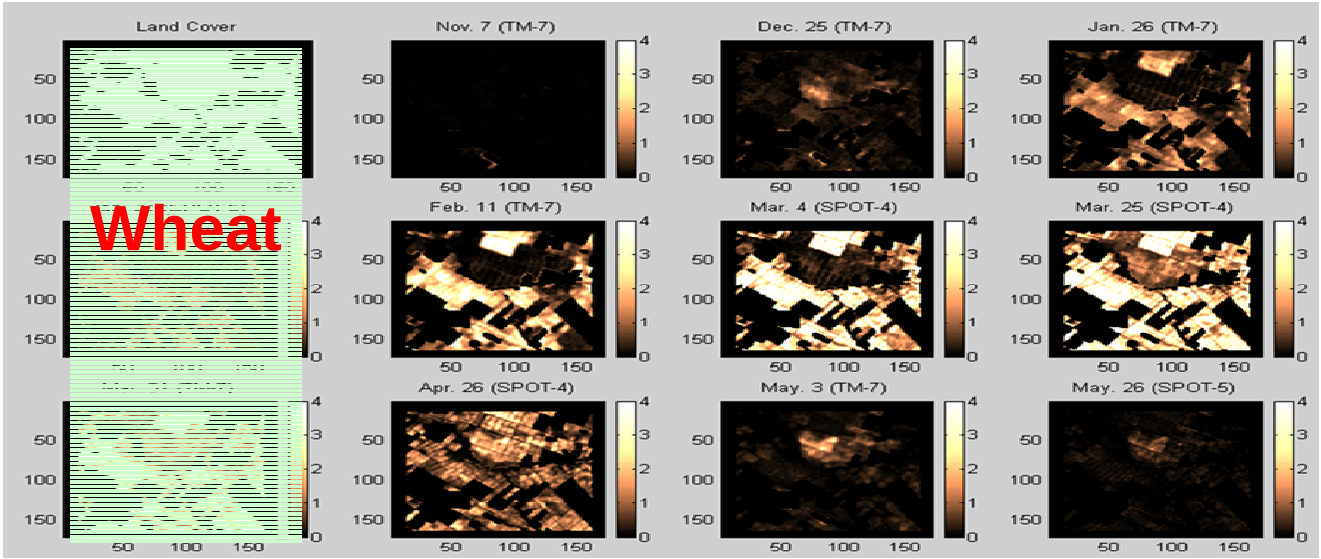
Major input of remote sensing

Regularity of water assessment for large areas



Monitoring of vegetation by satellite

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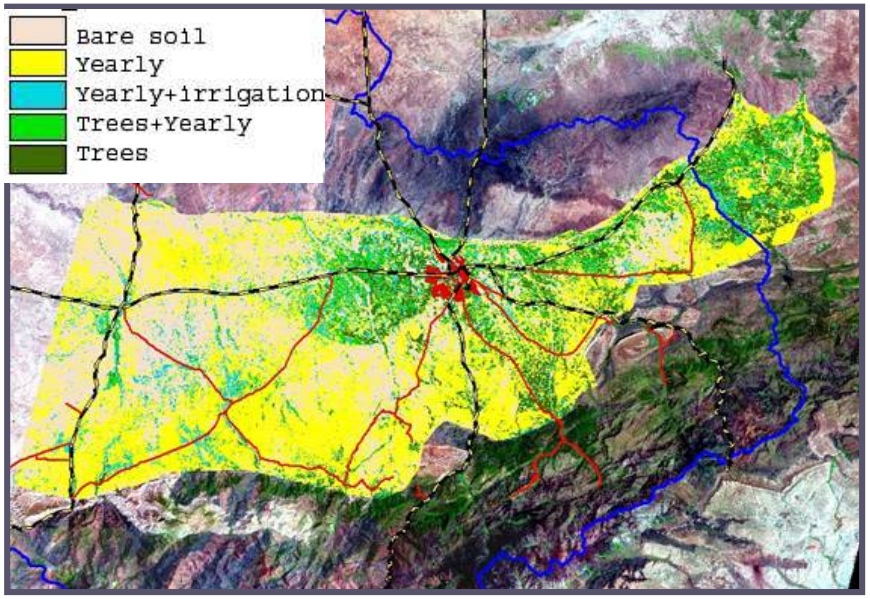
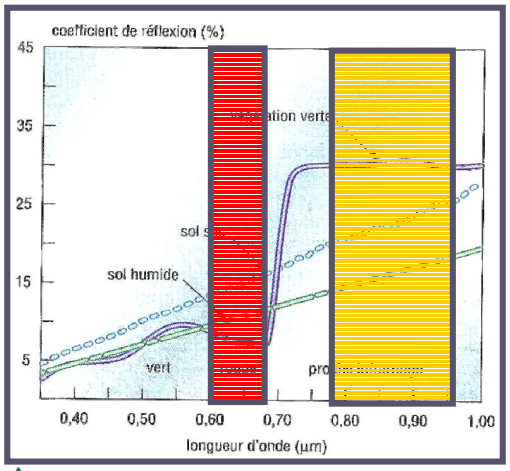
Link NDVI - Kc is done in relation with land cover

Land Cover complex Associated Cultures, and heterogeneous development.

Simplified cartography in 4 classes based on NDVI profiles





$$NDVI = \frac{(\rho NIR - \rho red)}{(\rho NIR + \rho red)}$$

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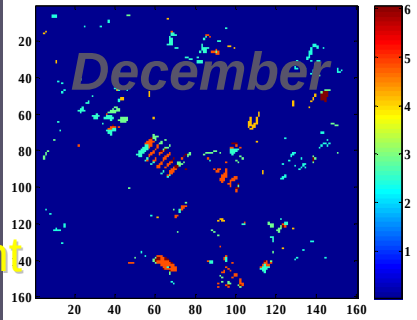
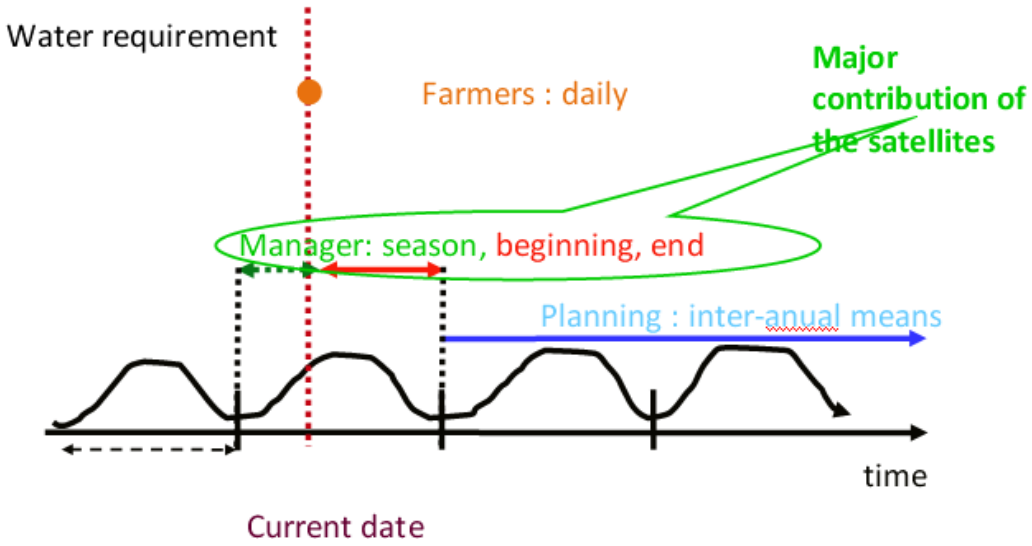
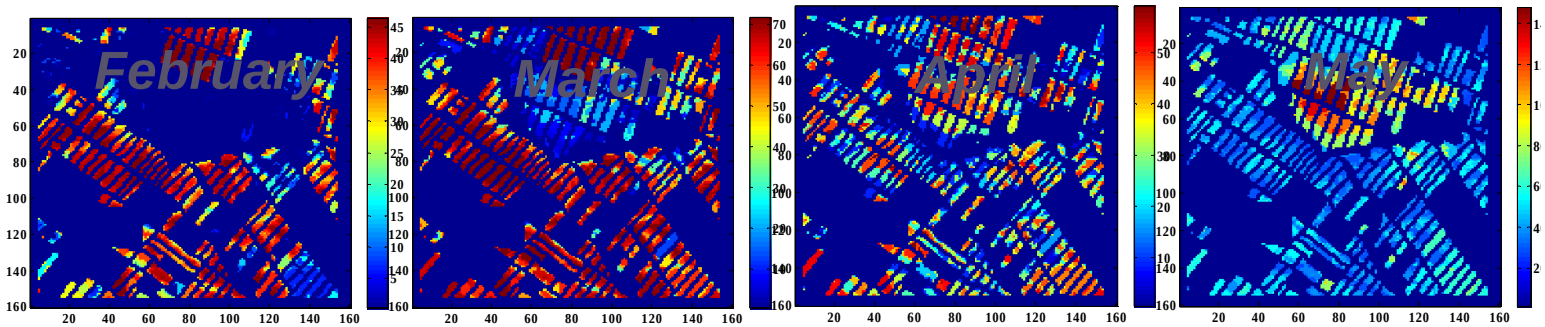
Outputs : Evapotranspiration time series







Objectives

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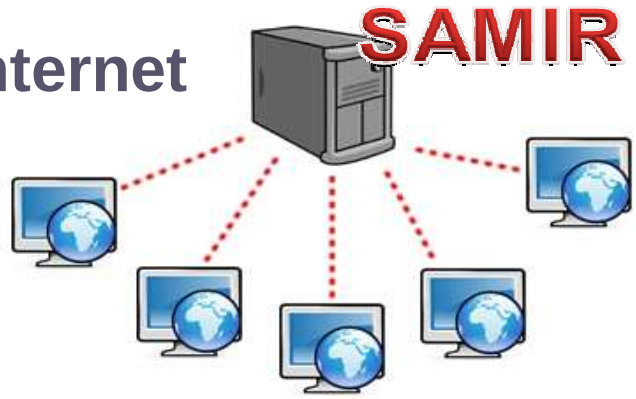
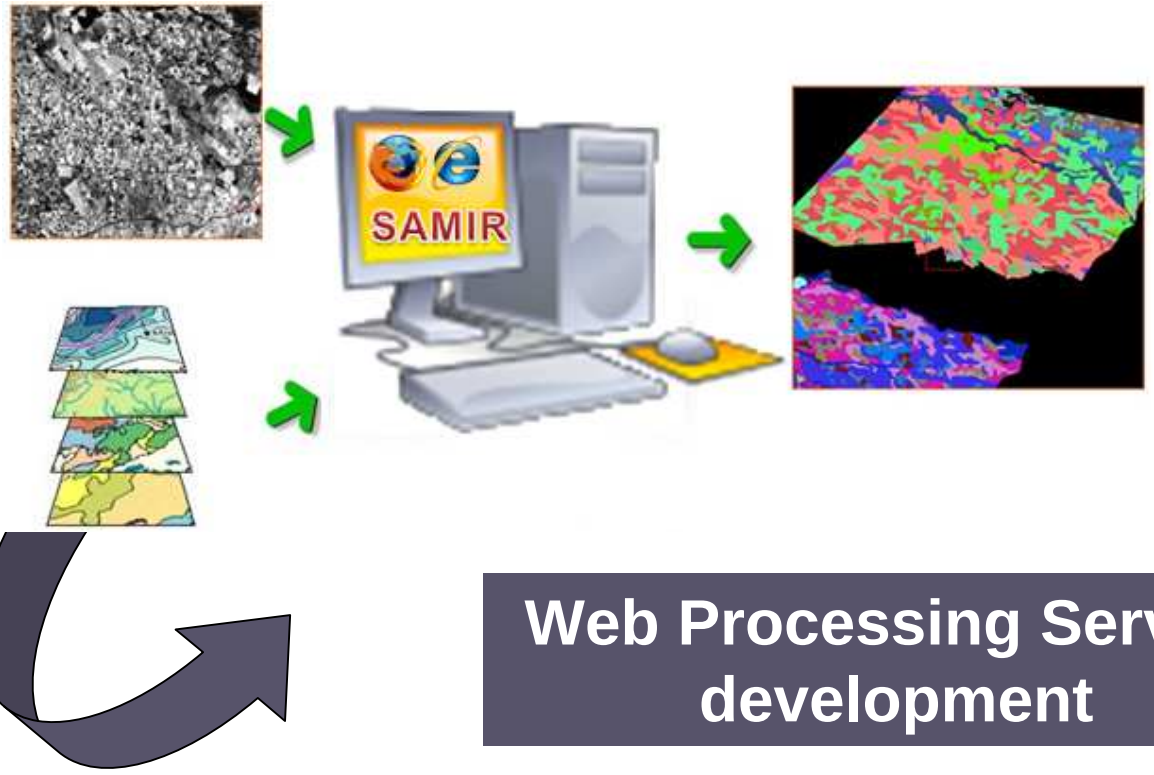
Access SAMIR through Internet





Web Processing Service development

Web Processing Service

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✓Spatial data is available on the web through OGC web services (WFS, WCS)

✓Network & computational capacity available

Processing on the web is the next logical ste

1. Inputs can be web-accessible URLs or embedded in the request.
2. Outputs can be stored as web-accessible URLs or embedded in the response.
3. It supports multiple input and output formats.
4. It supports long-running processes.
5. It supports SOAP and WSDL.

PyWPS

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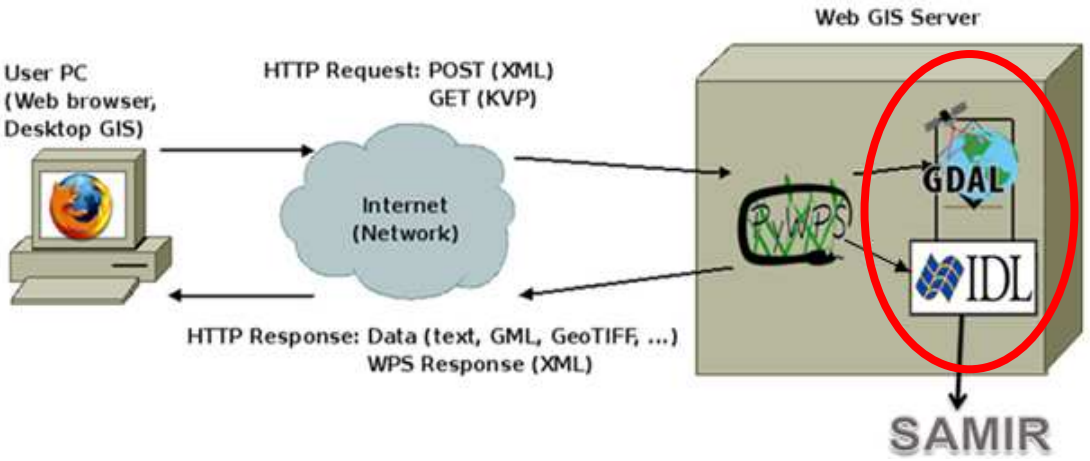
- SAMIR is still under development, need to directly access the IDL/ENVI programs. The solution was to use pyWPS and IDL on a Linux platform.
- PyWPS (3.1.0) implement OGC's Web Processing Service standard
- Operable with any other tool or just with Python itself even without GRASS GIS in the background
- PyWPS does not process the data by it self. IDL,GRASS GIS, GDAL, PROJ, R and other programs can be used.



Regional Spatial Observatory

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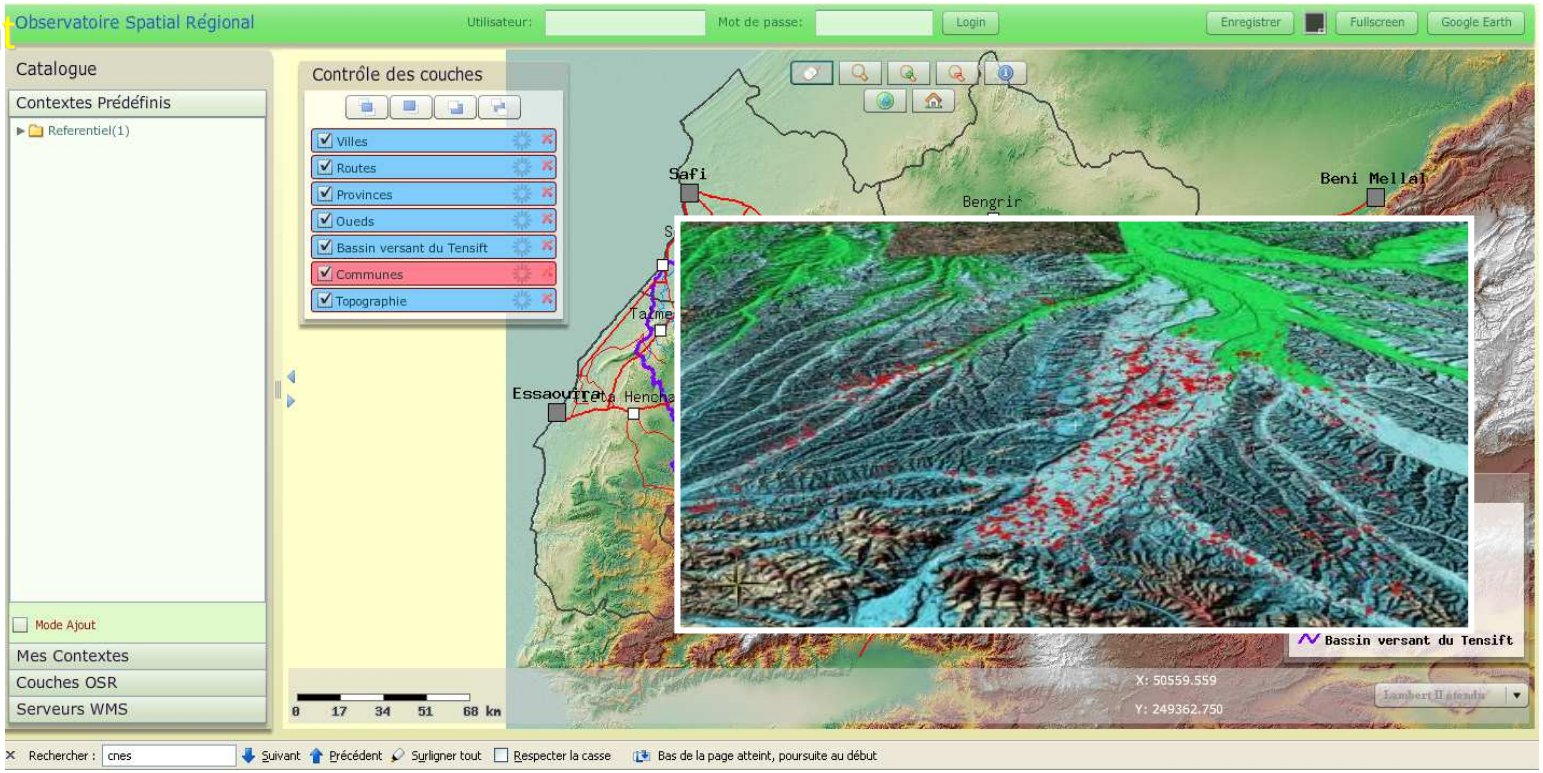
- Information needed to assess water needs is not centralized
- The OSR project (Regional Spatial Observatory), implements OGC services (WMS, WFS ,WCS).
- Long-term monitoring of experimental sites : collect, production, measurements dissemination management



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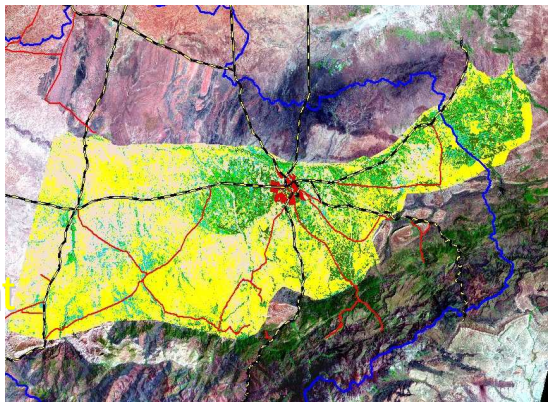
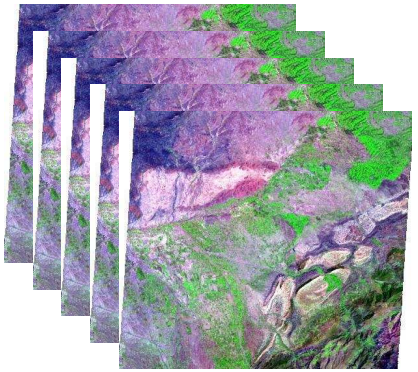
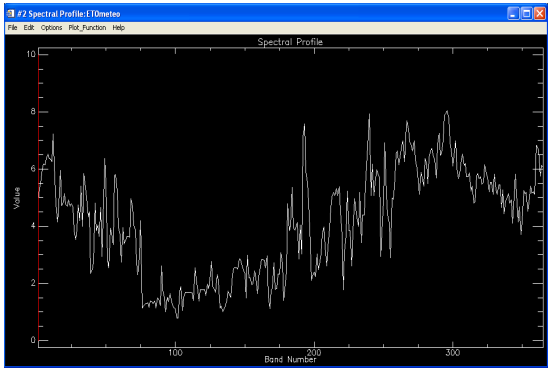
Inputs



Land Cover



NDVI time series



ET0 Daily time series

Computation parameters

- Bounding Box
- Starting and ending dates

Process parameters

Relation Kc-Ndvi

In relation to land cover

	titre character var	valeuros double precis	akcb real	bkcb real
1	ASN	1	0.5303	0.2205
2	CA	3	1.64	-0.226
3	SN	4	0	0

Architecture

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Cultural coefficient Kc : Kc = a * NDVI + b

Land cover images

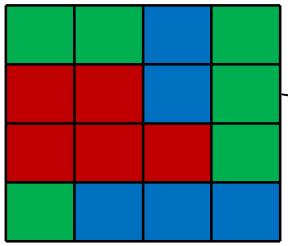
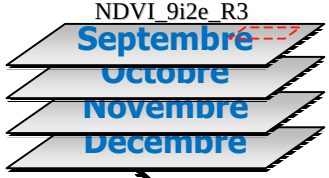
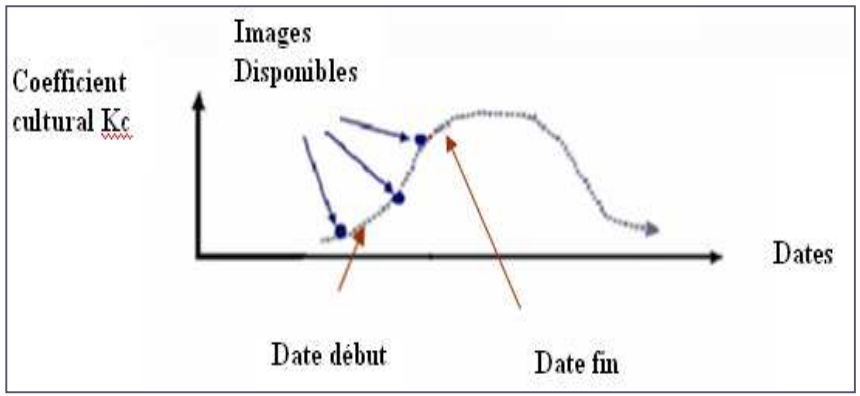


Table Postgres

	titre character var	valeuros double precis	akcb real	bkcb real
1	ASN	1	0.5303	0.2205
2	CA	3	1.64	-0.226
3	SN	4	0	0




```
LAYER
    NAME "NDVI"
    STATUS OFF
    UNITS METERS
    TRANSFORM TRUE
    DEBUG ON
    TYPE RASTER
    TILEINDEX "NDVI_index"
    PROJECTION
                        "init=epsg:26191"
    END
    DUMP TRUE
    METADATA
      "wcs_name"    "NDVI"
      "wcs_label"   "NDVI R3"
      "wcs_rangeset_label"  "bands"
      "wcs_rangeset_axes" "bands"
      "wcs_formats" "gtiff,envi"
      "wcs_srs"    "EPSG:26191"
      "wcs_extent" "279728 114867 296168 125307"
      "wcs_resolution" "30 30"
      "wcs_timeitem" "_date"
      "wcs_timeposition" '2002-09-01,2002-11-
07,2002-12-25'
    END
END
```



Kc = a* NDVI + b

Image Kc
n bandes

Daily Interpolation between processed dates

Example

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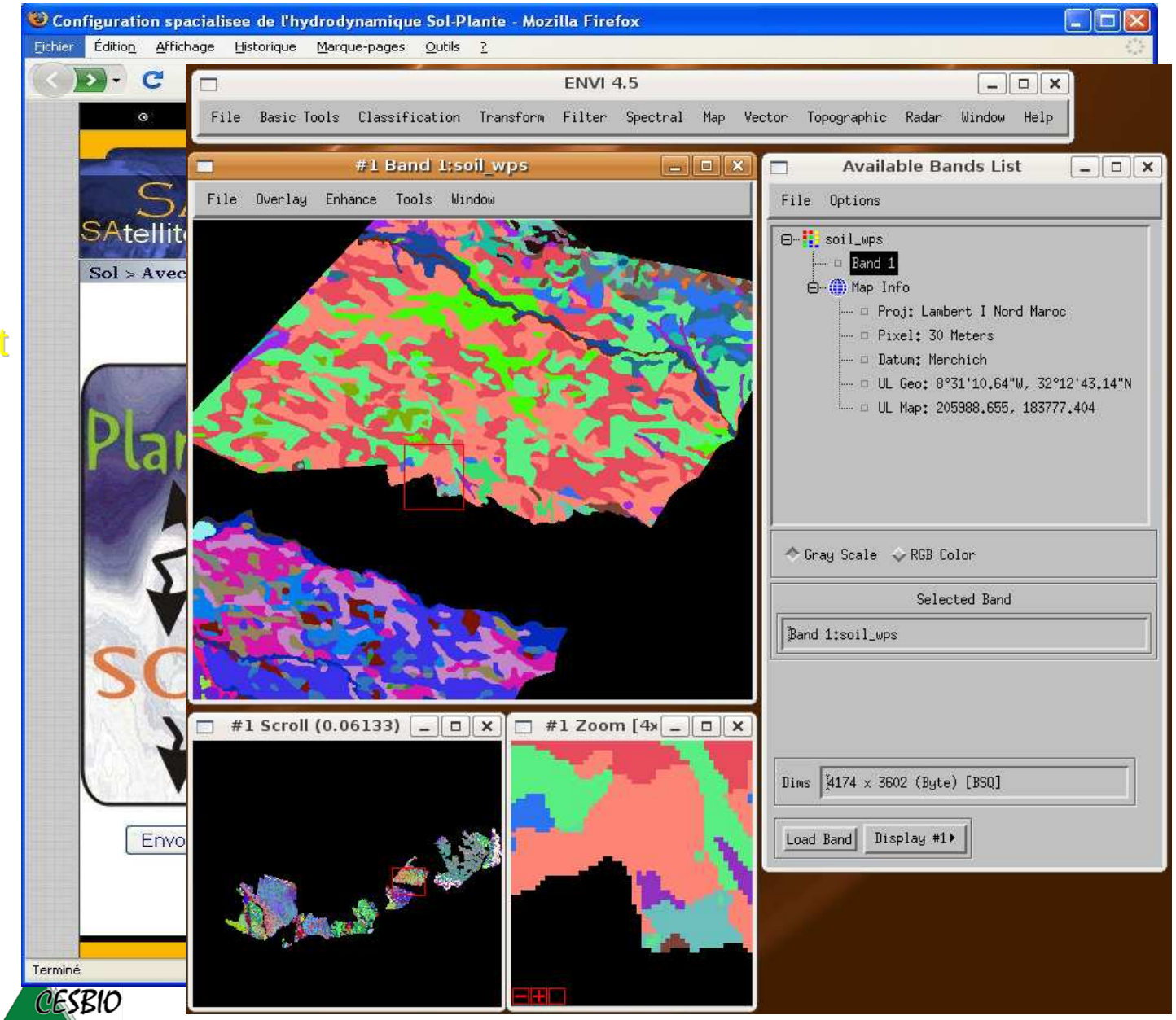

Architecture

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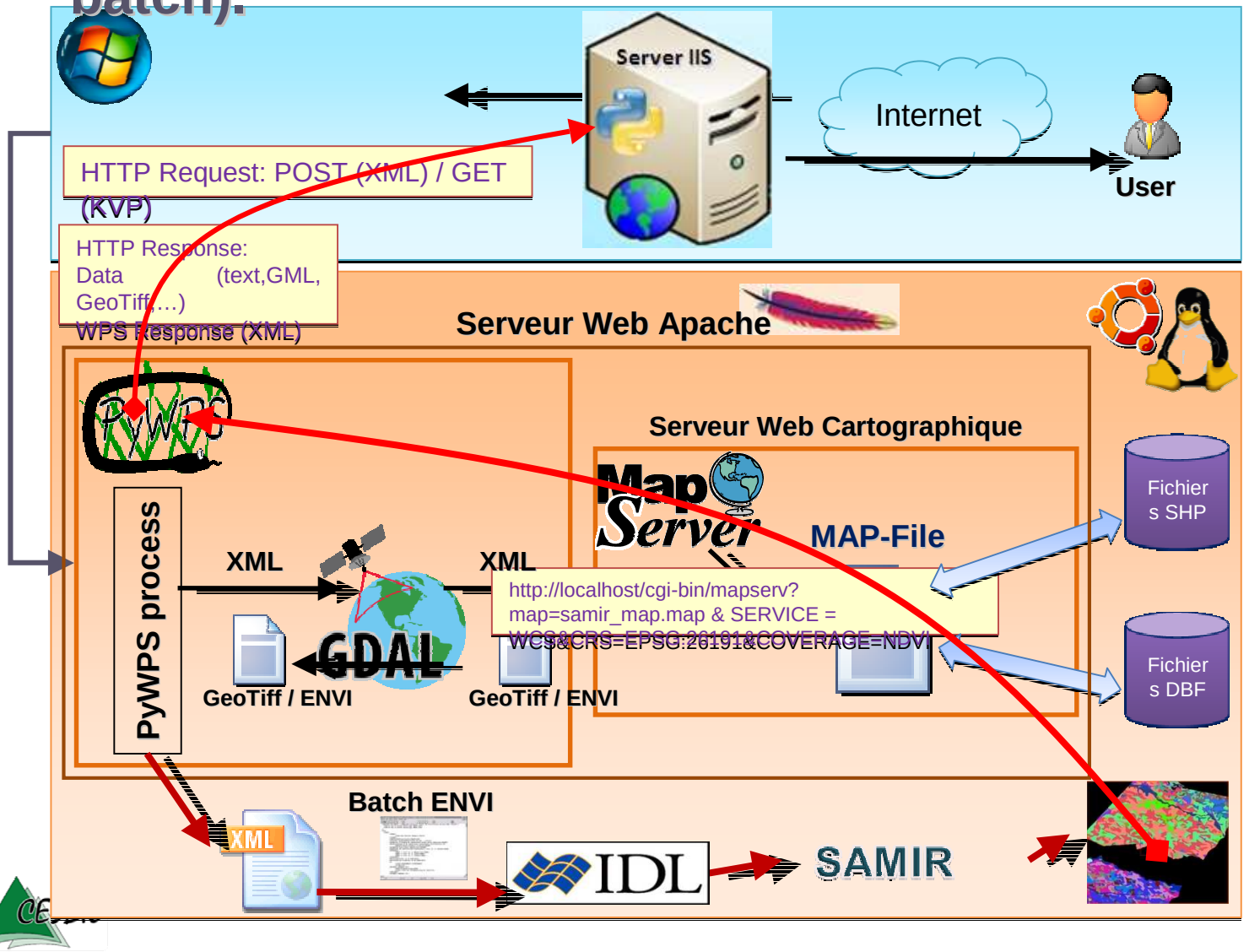
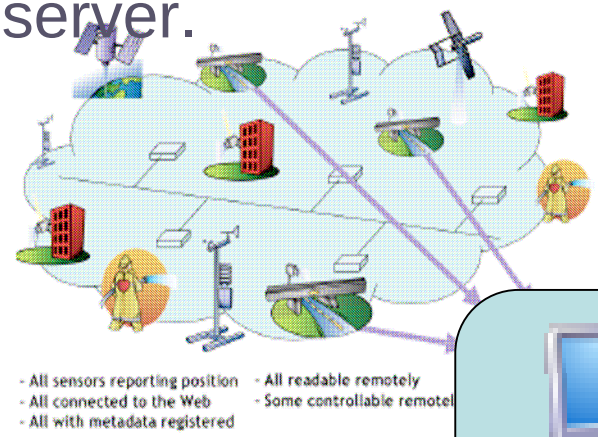
IDL/Envi server in different machine server (for batch).

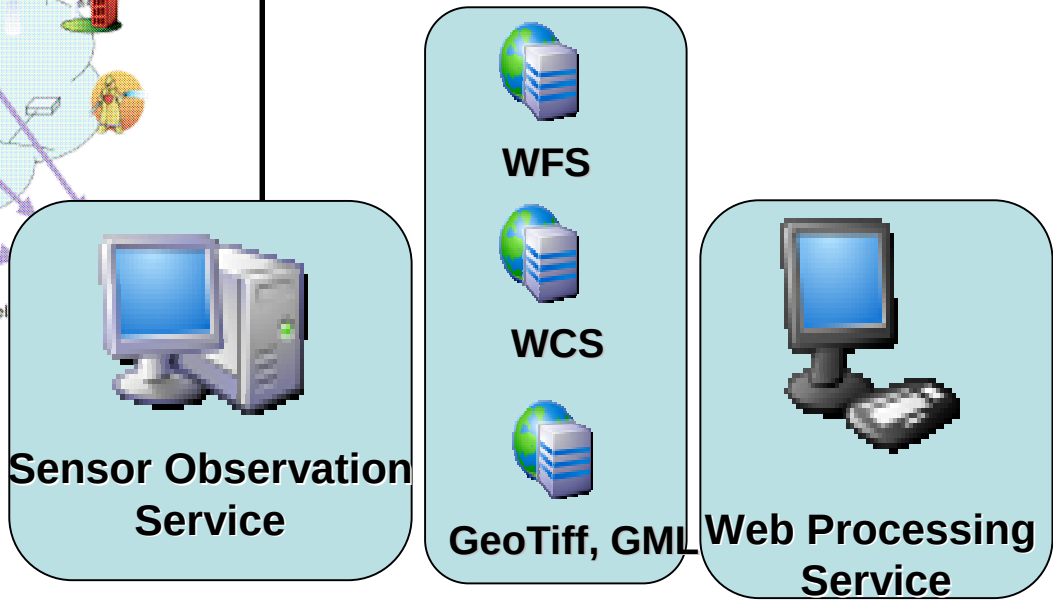


Perspectives

Due to the capability of WPS that allows to access distributed geospatial data across the network (such as WCS and WFS).

It is possible to utilize the observation from SOS server.





Thanks