المركز الملكي للاستشعار البعدي الفضائي
CENTRE ROYAL DE TELEDETECTION SPATIALE

UN/Austria/ESA Symposium on Space Applications for Sustainable Development to Support the Plan of Implementation of the World Summit on Sustainable Development

« Water for the World: Space Solutions for Water Management »

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Session: Water Resources Management in Africa

Space Information for Water and Drought Risks Management for Morocco (North Africa)

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Introduction

◎ **Decision-making process requires adequate and sustainable tools and strategies for economy, resource management and environment protection.**

◎ **Water and Drought Risks Management requires working at different scales, as well as repeated observations.**

◎ **In Morocco, although domains of remote sensing applications are numerous and diverse, Water and Drought Risks Management remains more or less limited.**

Solution (CRTS):

- Producing descriptive and significant parameters with precise location and spatio-temporal variation
- Producing and updating data to monitor rapid changes
- Developing capacities for data analysis and interpretation

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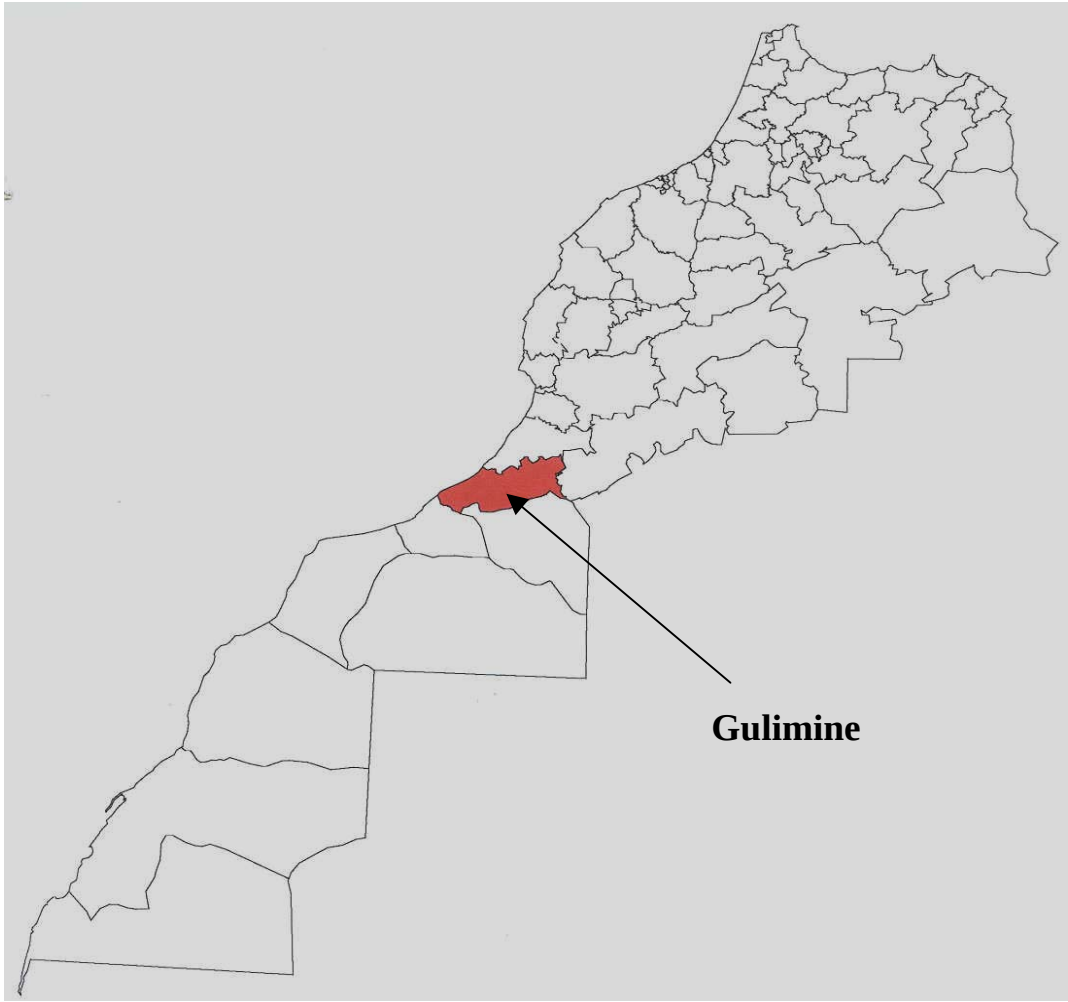
Case studies : Groundwater Exploration in Arid Zones

Region of Gulimine (South of Morocco)



Site:

- Transition zone between semi-humid and arid climate with a high drought risk
- Favorable geomorphological and hydrological contexts
- High interest of irrigated agriculture

∆ Localization of the potential sites for water drillings

1. Groundwater Prospecting:

Space information is operationally used to :

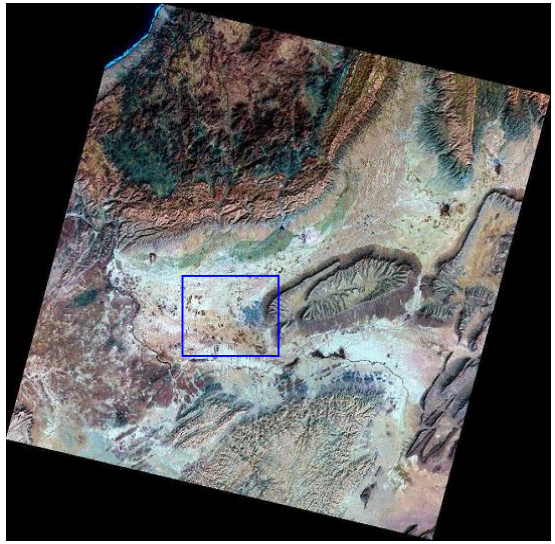
- identify potential reservoirs
- define structural context
- identify and delimit drainage areas
- understand interactions environment

The approach is based on :

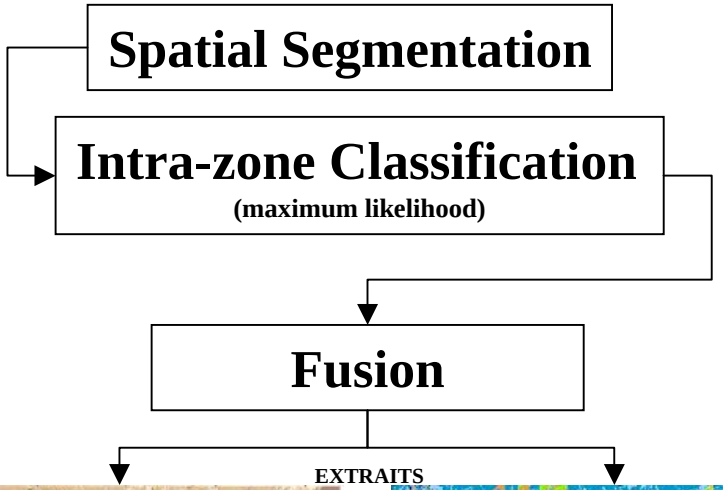
- lineament analysis
- drainage network analysis
- mapping geological features
- land use, vegetation, soil moisture, morphology,...

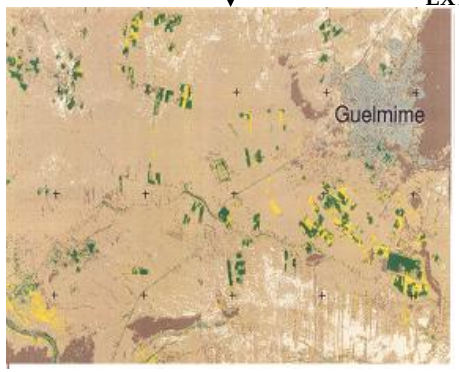
Methodology : Spot images

- Land use map and infiltration capacities

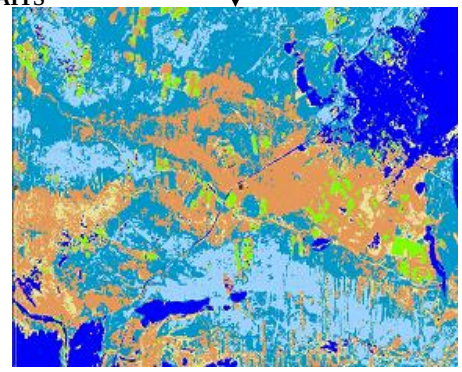


Spot Image





Land use map



Infiltration capacities

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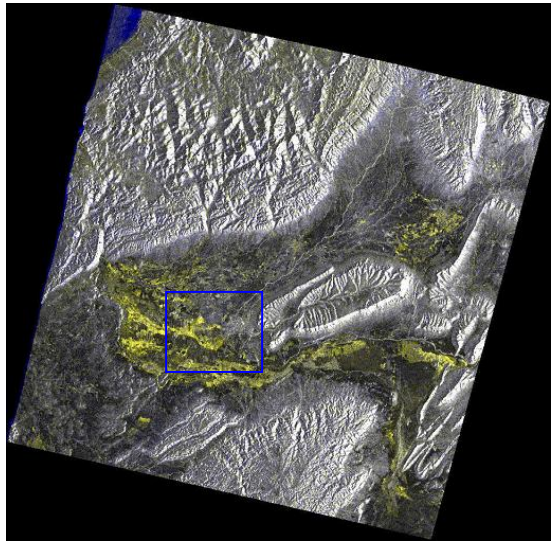
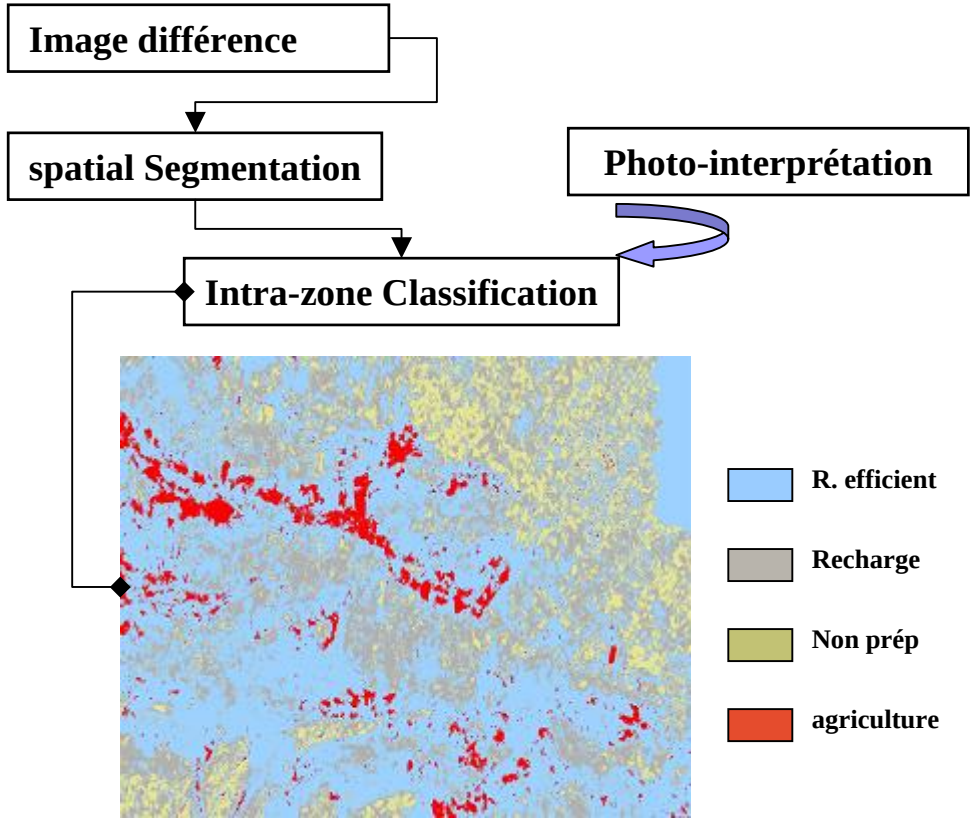
Methodology : ERS images

- Recharge map



RVB composition of ERS images (95/96).



Recharge map

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Methodology : Spot and ERS images

- **Fault and drainage network map:**
- Lineaments are support of preferential groundwater drainage
- Hydrographic network for surface drainage

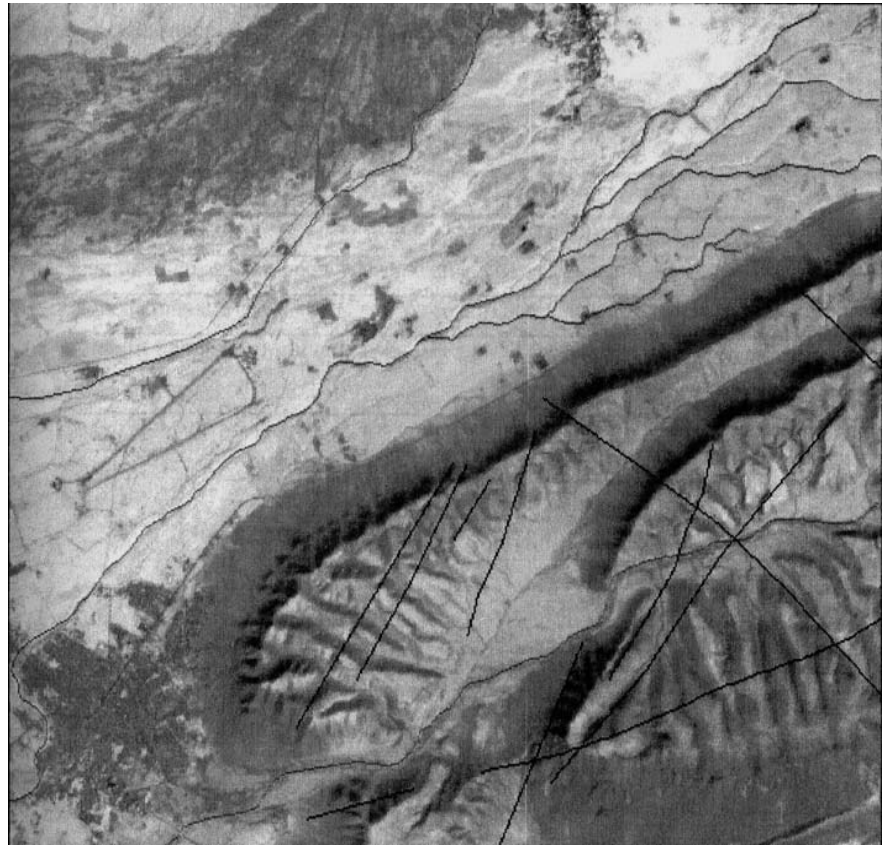
Spot XI Image filtring

ERS Images filtring

DTM Spot

Photo-interpretation and vectorization

Drainage Map



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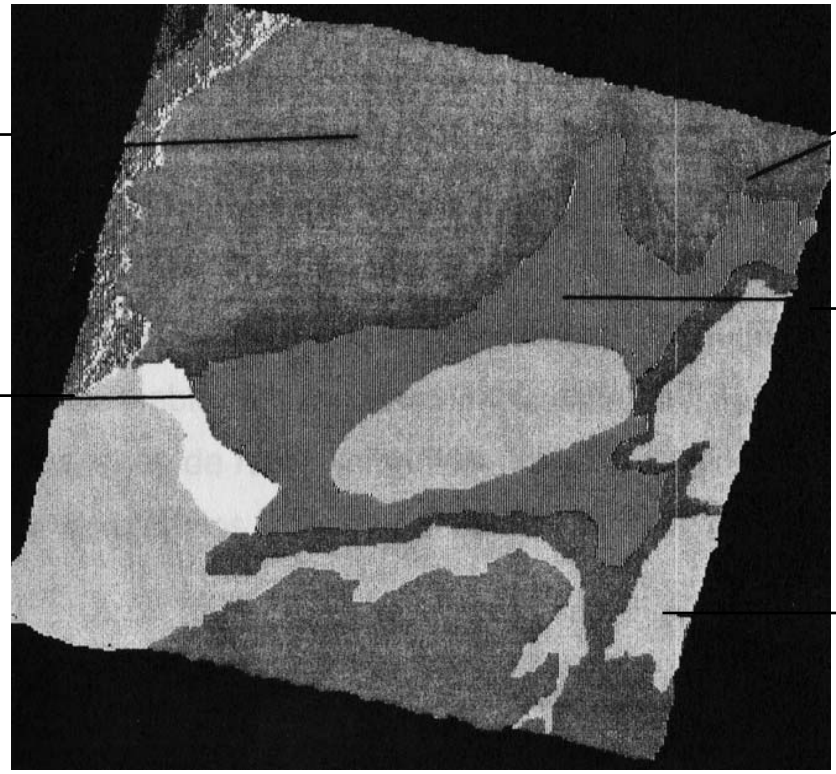
Localization of potential sites (geophysical study)

1- Hydrogeological context: Stratigraphy, Lithology, Superficial Aquifer



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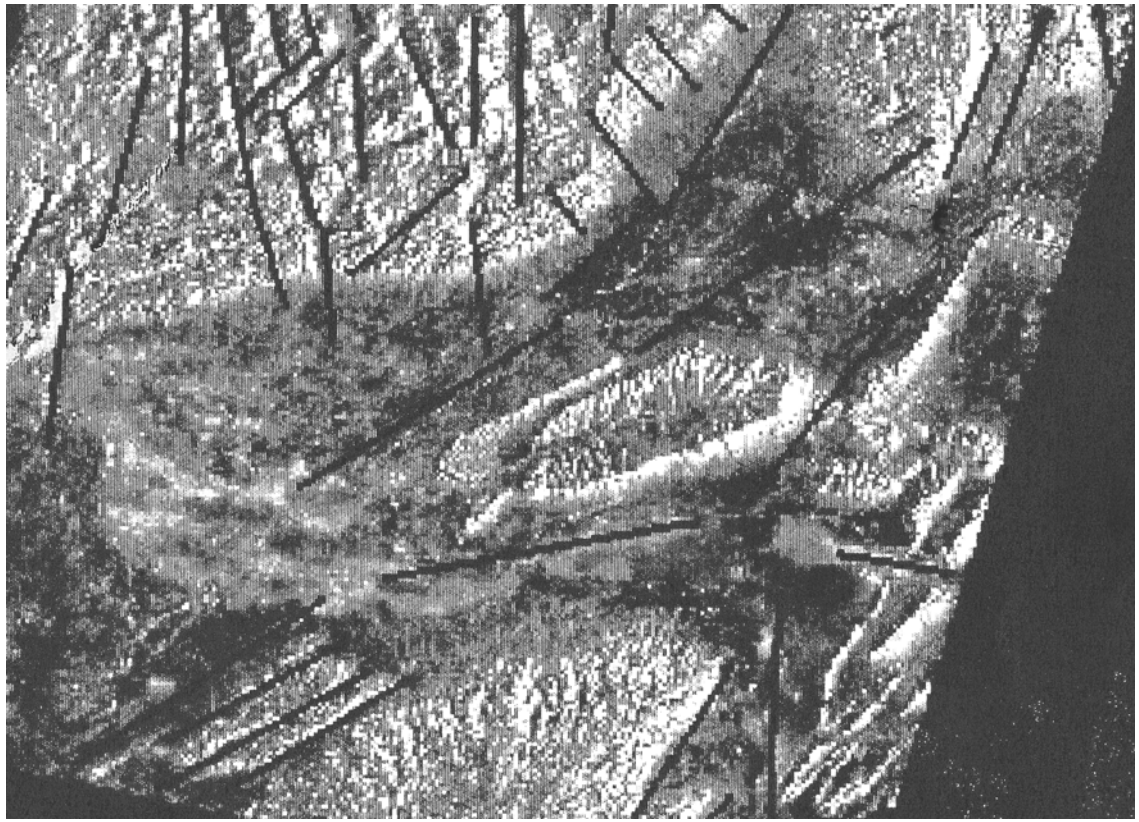
Localization of potential sites (geophysical study)

2- Geomorphological context:

- Geosynclinal Structure
- Hydrothermale activity
- Conjugated faults directions (N70 and N160)

N160 Faults seam to have an Important role in Gulimine groundwater alimentation



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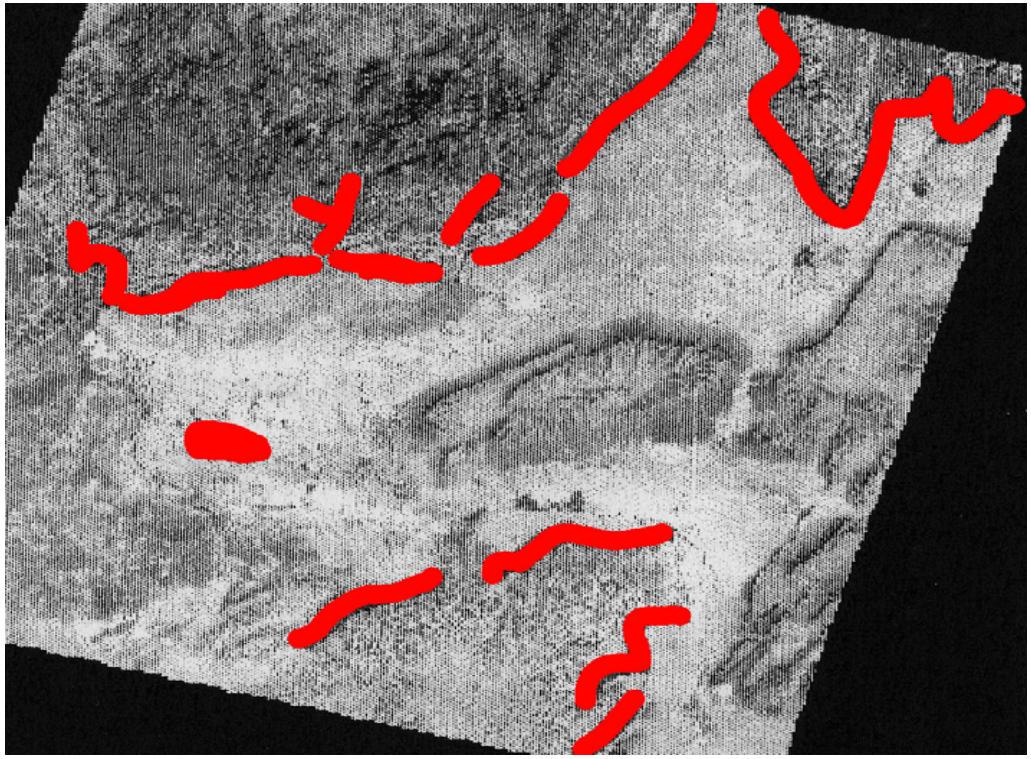
Localization of potential sites (geophysical study)

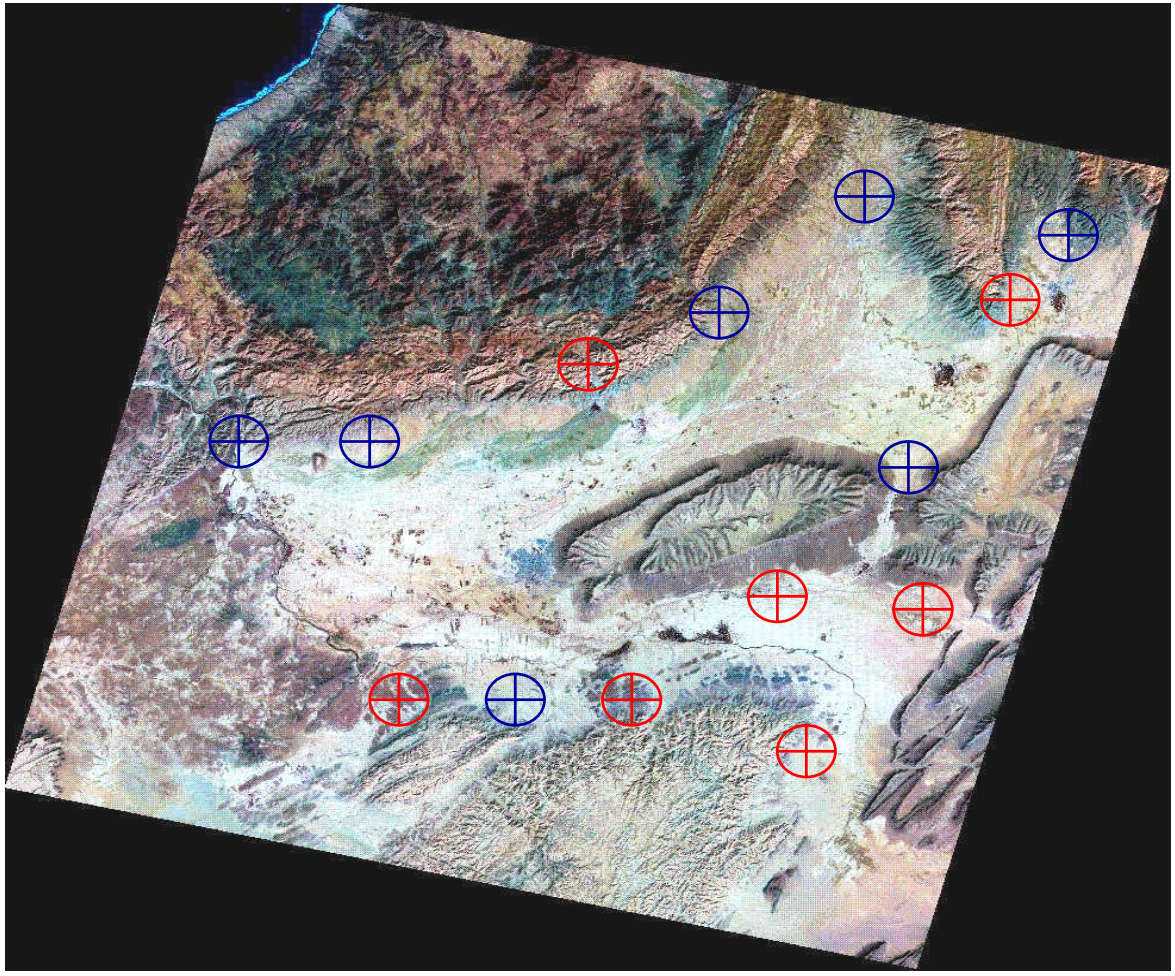
3- Land use map analysis :

- Proximity of potential site to urban center
- Proximity of potential soils (agriculture)
- Accessibility (equipment)



1. Groundwater Prospecting:

Result:



⊕ High Cost

⊕ Low Cost

Based on these criteria tow types of sites were identified

Conclusion:

	Conventional method	Approach using Remote sensing data
Nber of seismic profiles *Cost*	5 338 000 $US	3 104 000 $US
Nber of drillings *Cost*	19 889 975 $US	7 104 775 $US
Cost of RS (data, processing, expertise,...)	-	50 000 $US
Total	1 227 975 $US	522 775 $US (42% of the initial cost)

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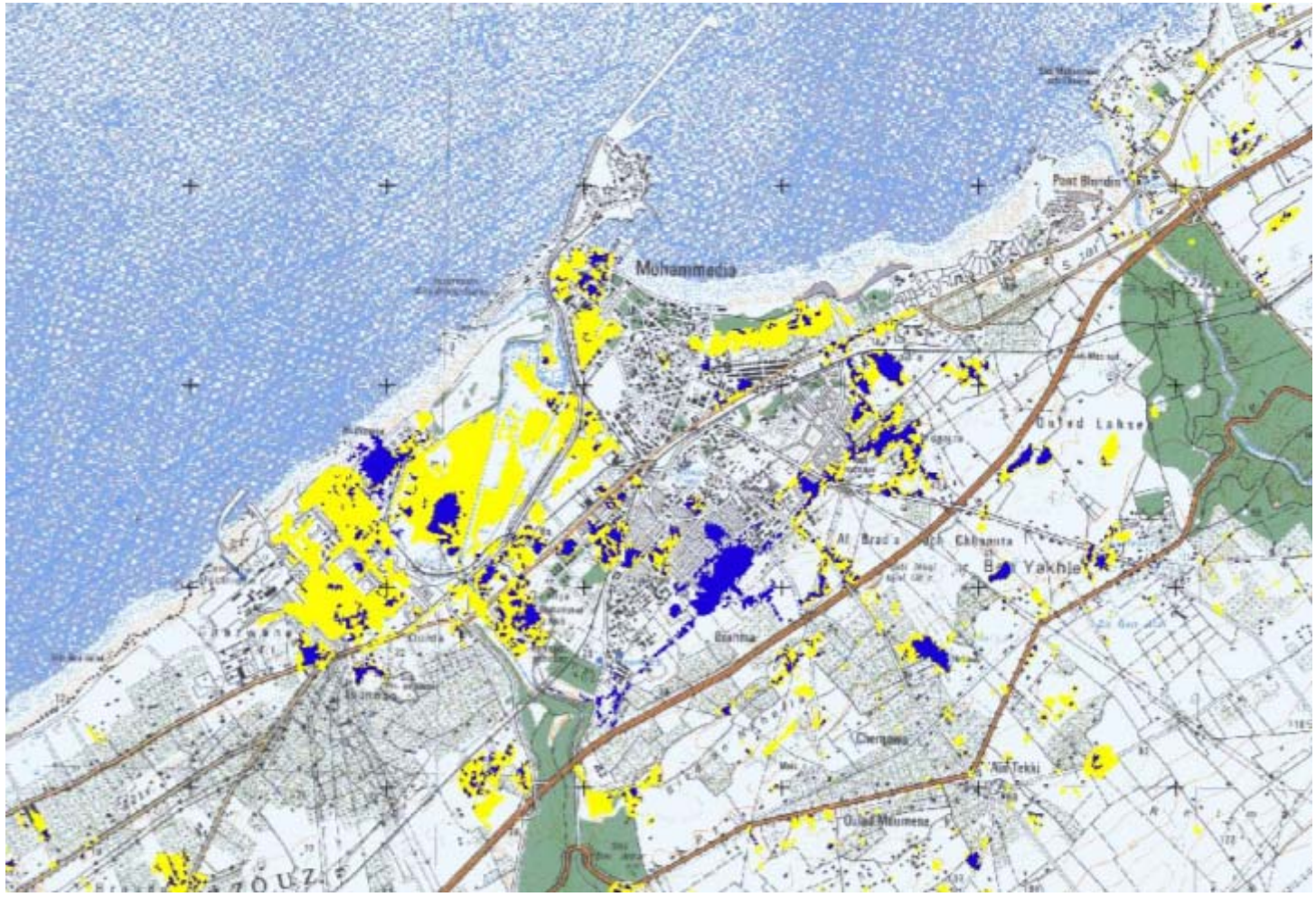
Case studies: Flood Monitoring

Mohammedia city: 27 November 2002 to 08 December 2002
- CRTS contribution was in tow periods (during and post-crisis)



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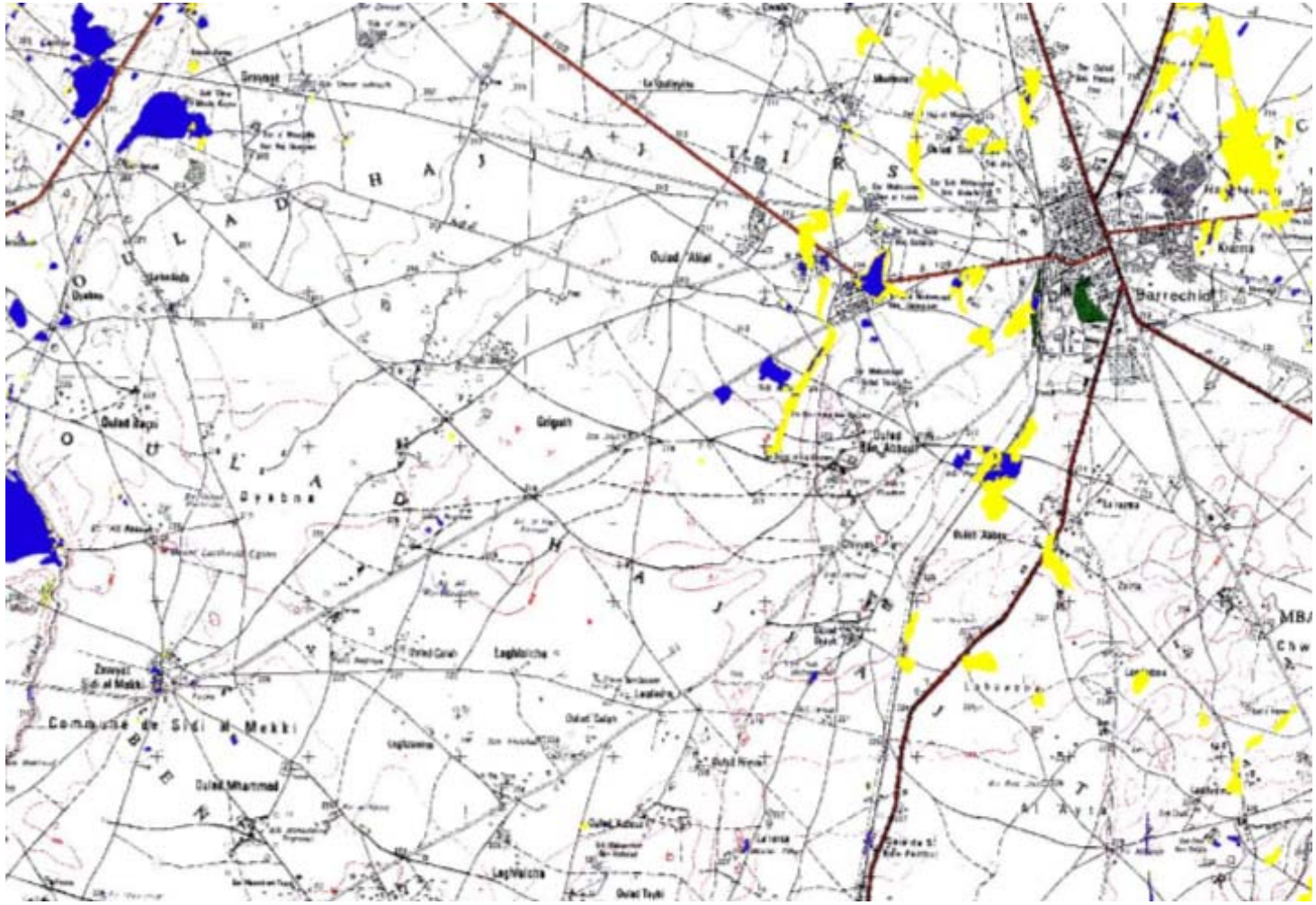

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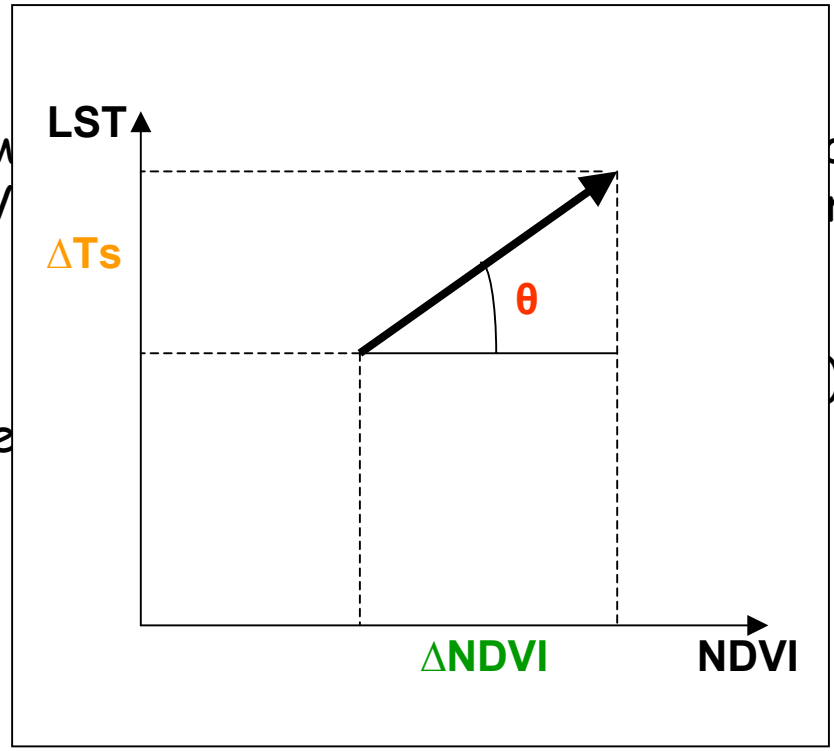
Indicators

Definitions



📖 This method w ctor of Land Cover Dynamic (V rino (2001),

📖 One indicator), the second indicator (Module

$$Module = \sqrt{(NDVI^{\max} - NDVI^{Ts\_\max})^2 + (T_s^{\max} - T_s^{NDVI\_\max})^2}$$

$$Slope = \frac{180}{\pi} \times \arctan\left(\frac{T_s^{\max} - T_s^{NDVI\_\max}}{NDVI^{\max} - NDVI^{Ts\_\max}}\right)$$

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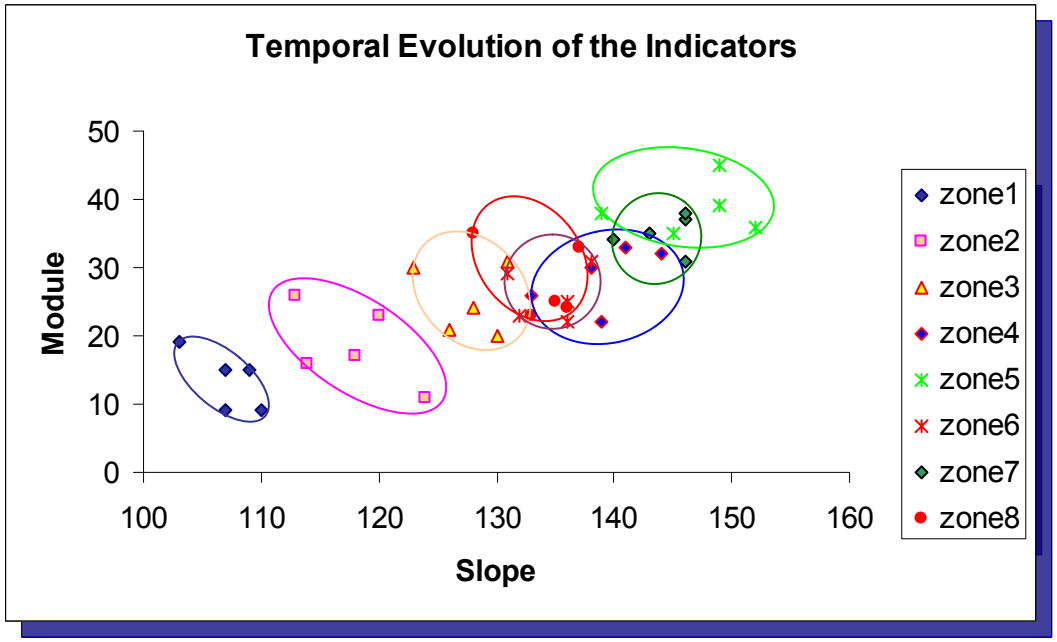
Indicators

Temporal Evolution



❶ The classes from the zoning present a good separation between them,
❷ The increasing order between the values of the indicators and the order of the classes of zoning puts in evidence a quasi linear dynamic of these indicators,
❸ Certain classes present an important intra-class dynamic.

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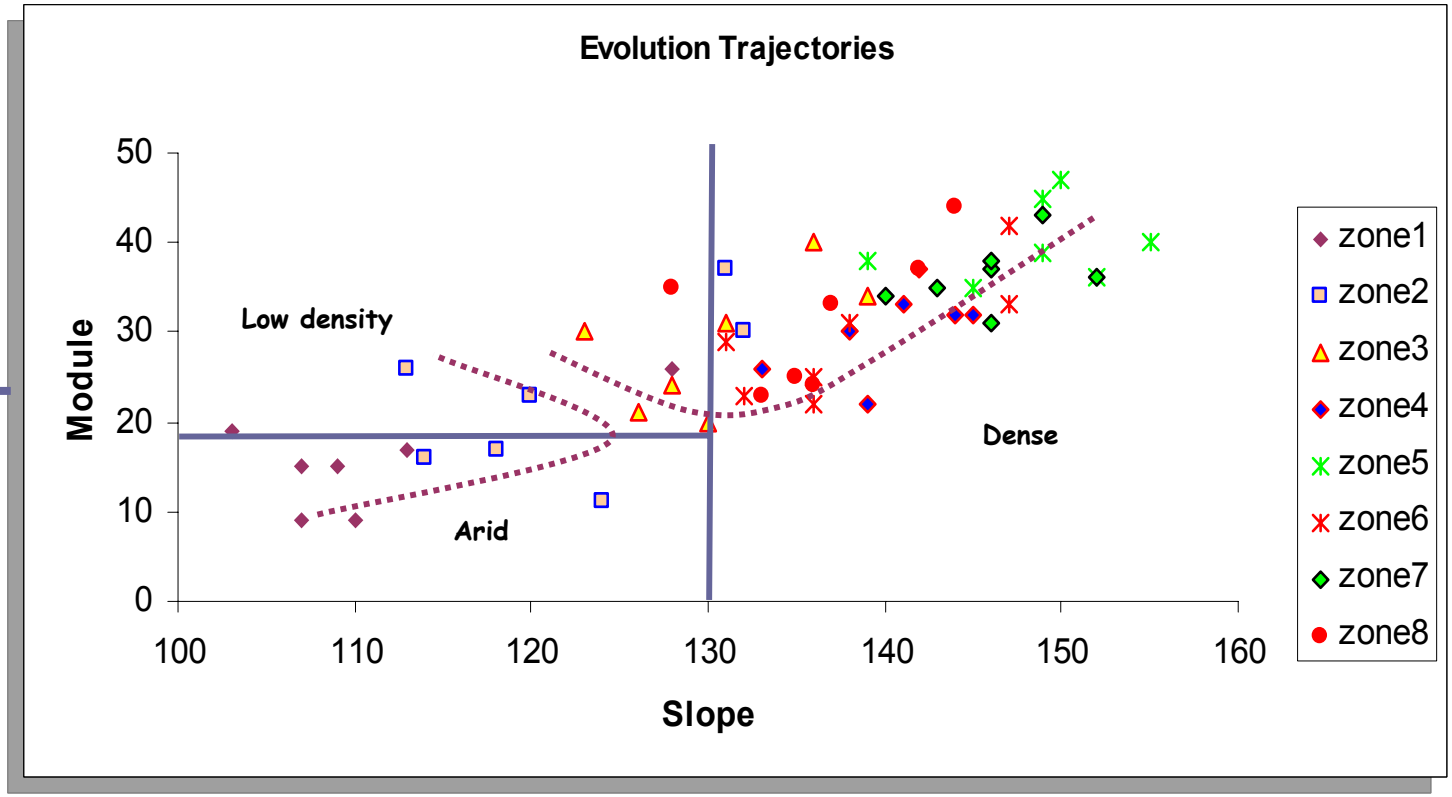
Indicators

Temporal Evolution



Possible evolution trajectories :

- Positive Evolution : from arid to the Low density region and from the Low density to the dense,
- Negative Evolution : from dense to the Low density region and from the Low density to the arid.

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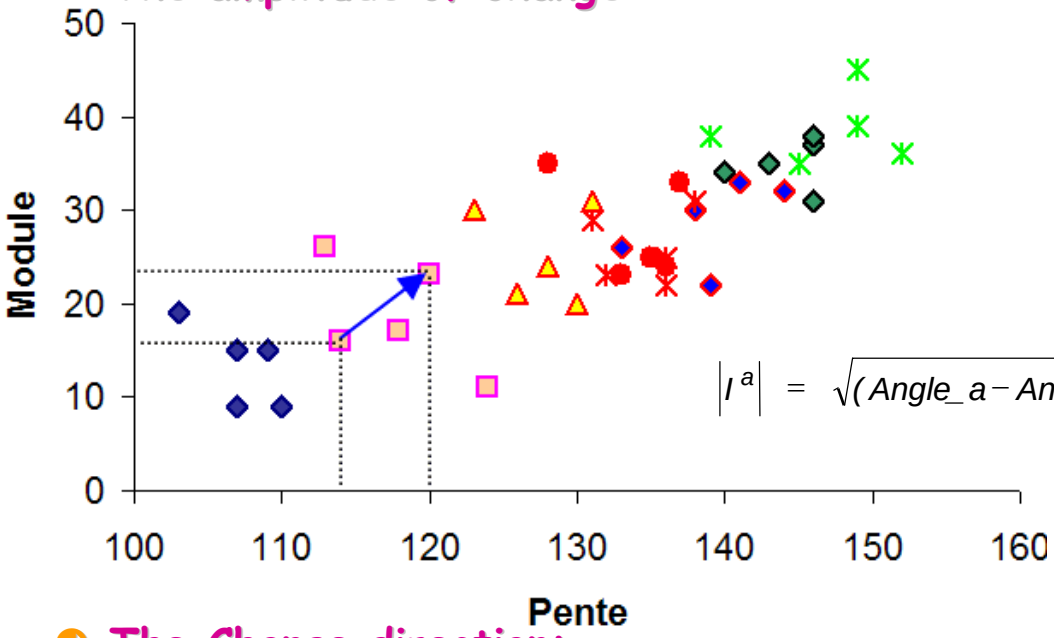
Change Analysis

Definitions

The amplitude of change:



$$|I^a| = \sqrt{(Angle\_a - Angle\_ref)^2 + (Module\_a - Module\_ref)^2}$$

The Change direction:

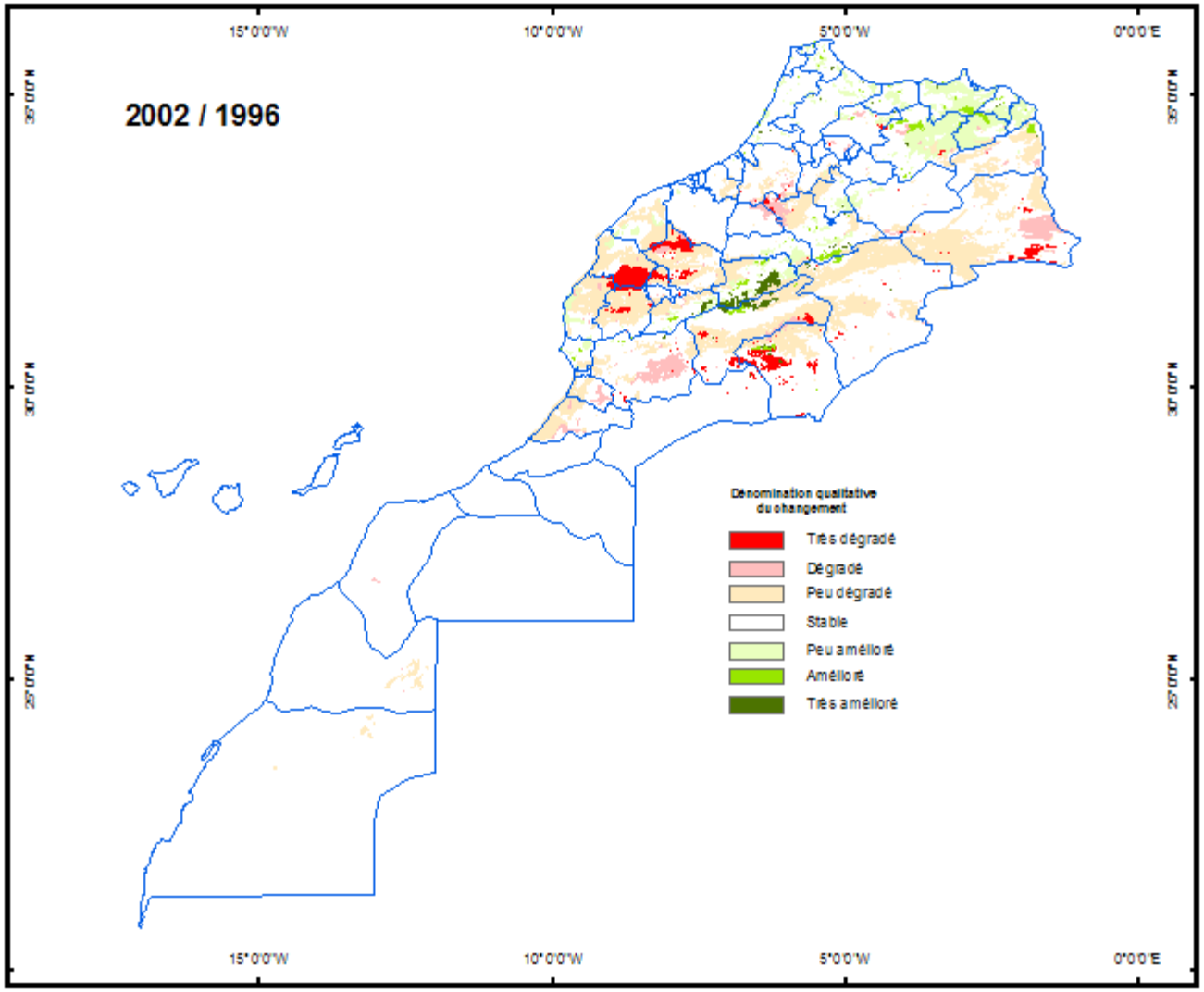
It's calculated from the difference between the average NDVI representing the year studied and the one of the year of reference. This average has been calculated from the months that materialize the natural state of the vegetation during the year.

$$I^a = \frac{|I^a| \times (NDVI_a^{max} - NDVI_a^{Ts\_max} - (NDVI_{ref}^{max} - NDVI_{ref}^{Ts\_max}))}{|(NDVI_a^{max} - NDVI_a^{Ts\_max} - (NDVI_{ref}^{max} - NDVI_{ref}^{Ts\_max}))|}$$

3. Global Vegetation Change Monitoring

Change Analysis

Inter annual change maps



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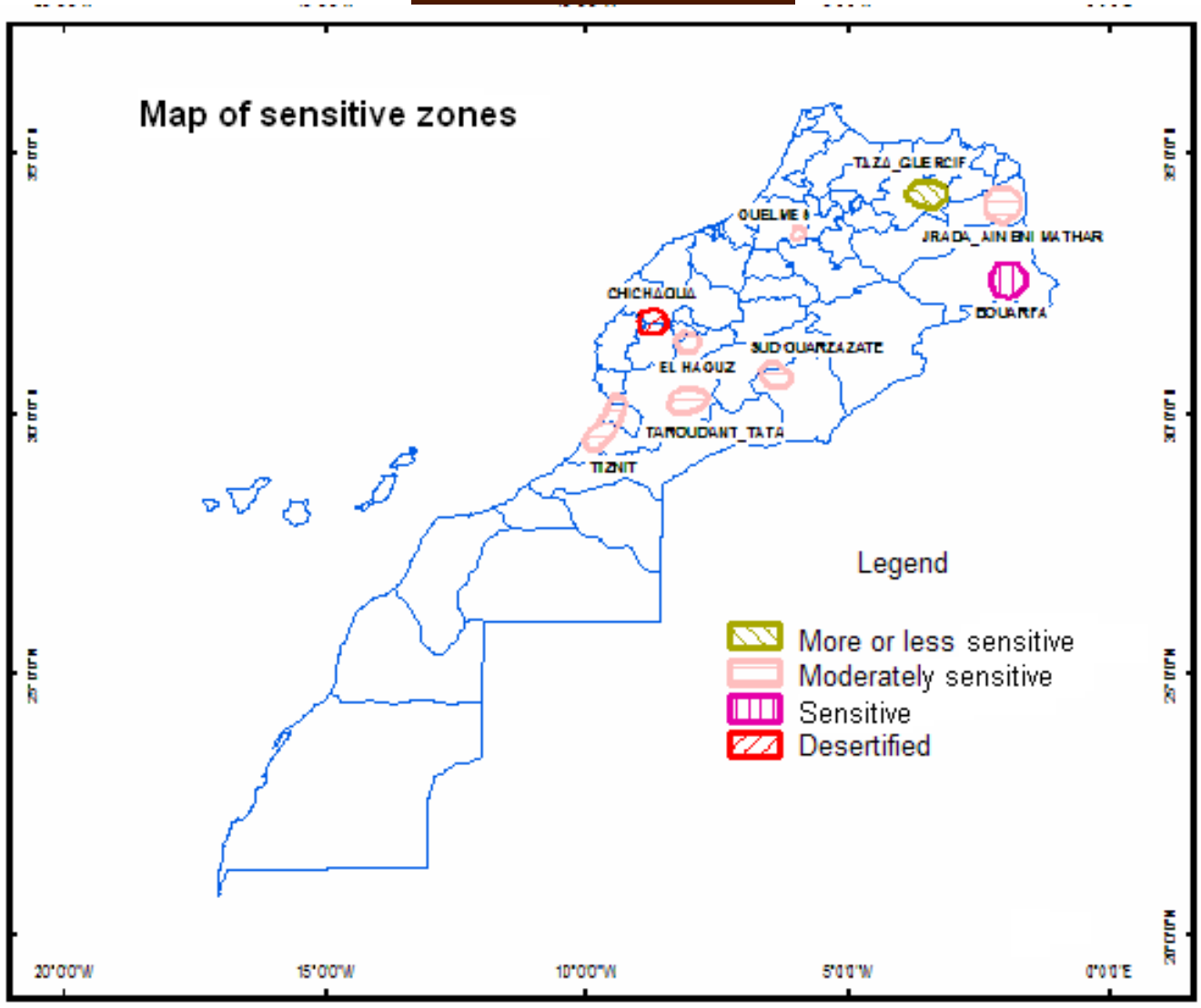
Result:

Map of Sensitivity



→ The needs are clearly stated

→ The benefits of space information are clearly demonstrated

↘ What is missing to enable developing countries to benefit from this technology?