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SMART SURVEYORS FOR LAND AND WATER MANAGEMENT CHALLENGES IN A NEW REALITY



e WORKING WEEK 2021
20-25 JUNE

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Innovative Approach for a Reliable Mapping of the Morocco's Solar Resource

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Innovative Approach for a Reliable Mapping of the Morocco's Solar Resource

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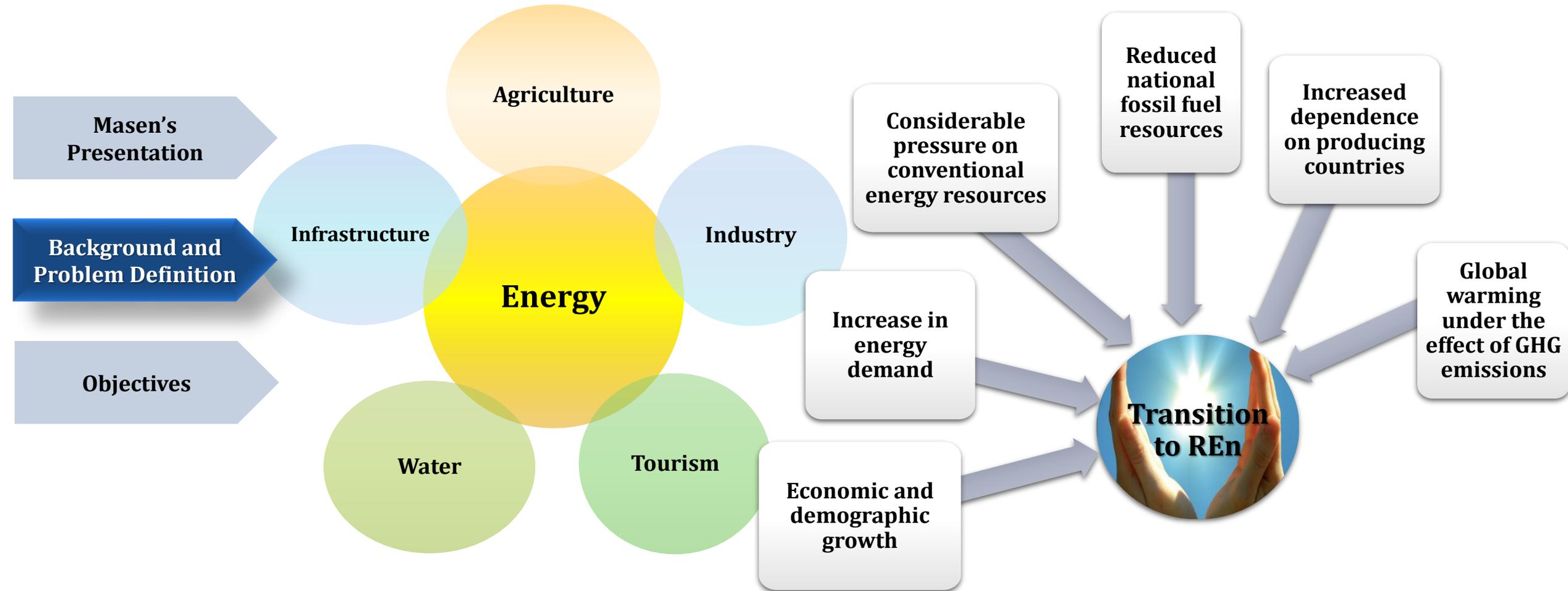
Pr. ETTARID Mohammed, Department of Photogrammetry and Cartography, Geomatics and Surveying Engineering School, Hassan 2nd IAV.

I. Introduction

II. State of the Art of Existing Calibration Methods

III. Calibration of the MSA

IV. Conclusion



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Masen's Presentation

Background and Problem Definition

Objectives

4 OPERATIONAL PROJECTS AND SEVERAL UNDER DEVELOPMENT



NOORo I construction launch



NOORo I inauguration



NOORo II



NOORo III

Solar Energy

The most abundant on Earth and could satisfy all the energy needs of the planet

Inexhaustible (at least during the 4.6 billion years to come ...)

Most abundant source of renewable energy in Morocco

High solar radiation of 3000 hours of sunshine / year equivalent to more than 6.5 KWh / m² / day of irradiation

Solar Energy Project Chain of Value

Sites Prospection:

- Resource Assessment
- Site Selection & Qualification
- Land Mobilization

Technical Conception:

- Optimal Technological design
- Appropriate configuration

Financial & Legal Project Structuring & Procurement

Construction

Operation and Maintenance

Masen's Presentation

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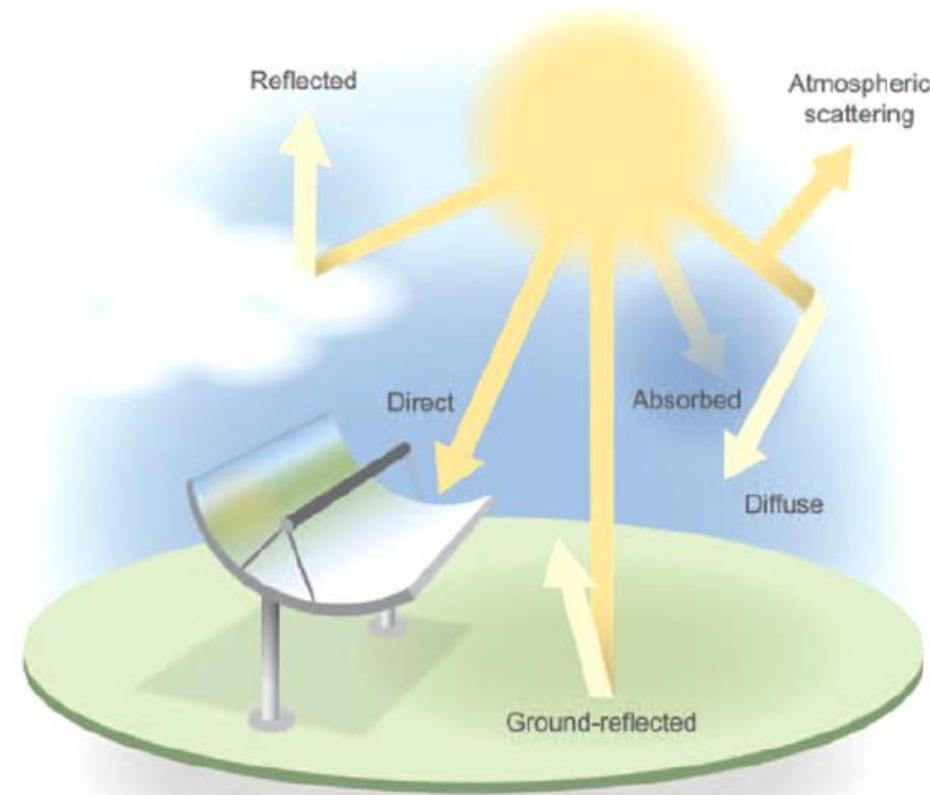
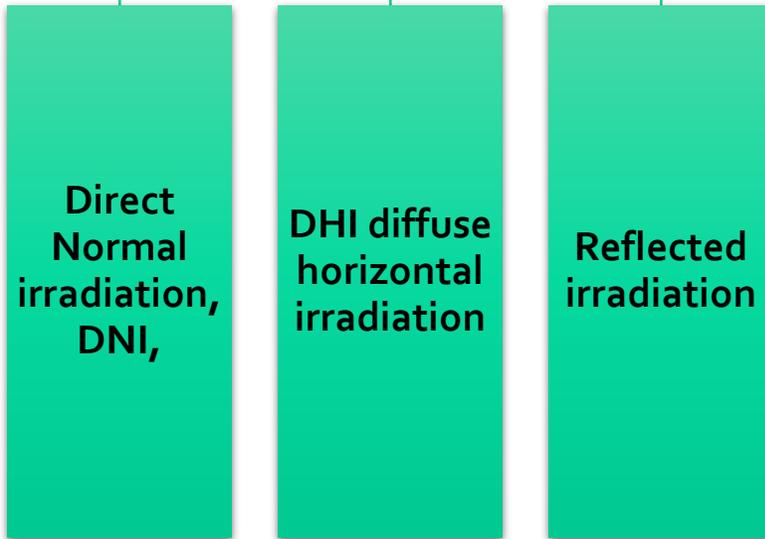
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Global irradiation GHI



Masen's Presentation

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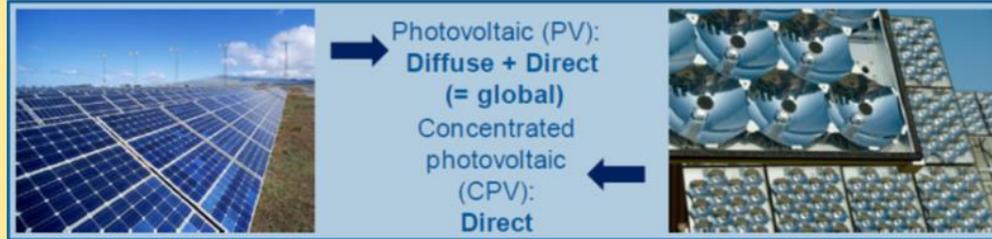
IV. Conclusion

Masen's Presentation

Background and Problem Definition

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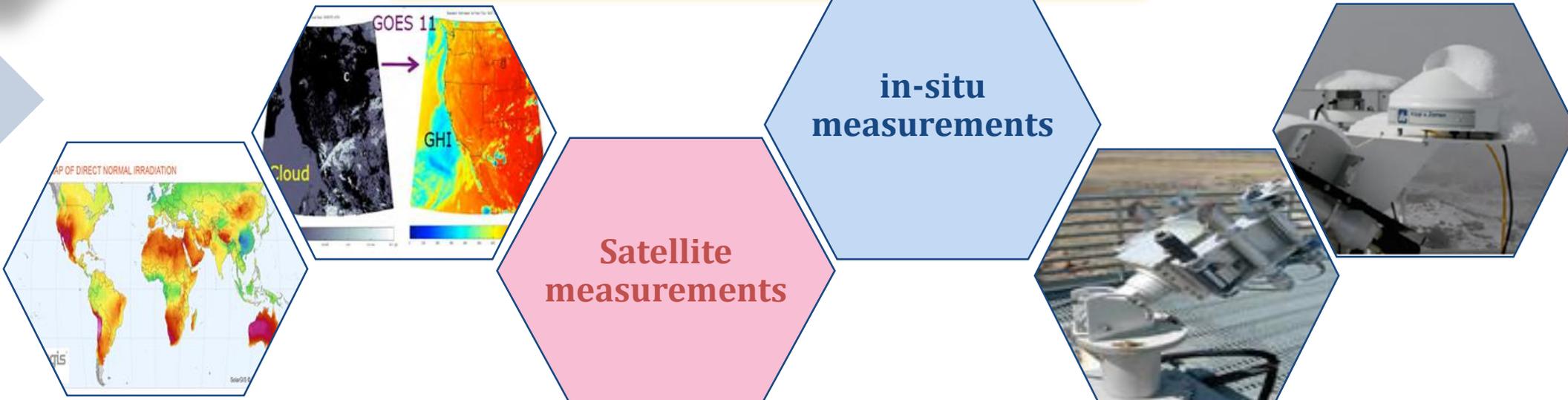
PV Technology



CSP Technology

in-situ measurements

Satellite measurements

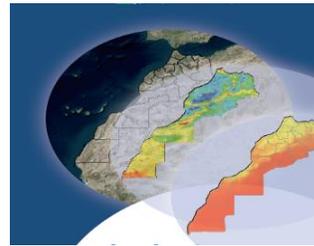


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Solar Atlas



Masen's
Presentation

A series of average annual and monthly GHI and DNI solar irradiation maps of high spatial resolution (250 m for Morocco)

Background and
Problem Definition

Objectives

Interactive decision support tool for national energy strategies:

- **Determine, in a rational and quantitative way, the suitable sites for the implementation of solar energy production systems**
- **Size and evaluate the profitability of a project reliably**
- **Serve as a basis for energy policy planning**



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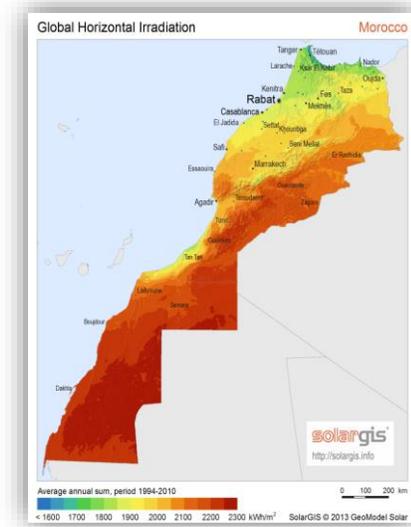
Background and Problem Definition

Objectives

Tendency for underestimation and overestimation of solar irradiance values actually received at ground level, by modeled solar irradiance data



Need to calibrate these data and adapt them to ground values based on in-situ measurements more accurate than satellite models.





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Masen's Presentation

Background and Problem Definition

Objectives

🎯 Presentation of the different methods used in the solar energy industry to calibrate modelled data at the ground level

🎯 Application of selected approaches based on the state of art of existing calibration methods

🎯 Implementation of an innovative protocol for the generalization of calibration to cover the entire Moroccan territory



Purpose: Quantify the solar resource in the most accurate and reliable way across the Kingdom based on a solar atlas calibrated to in situ measurements



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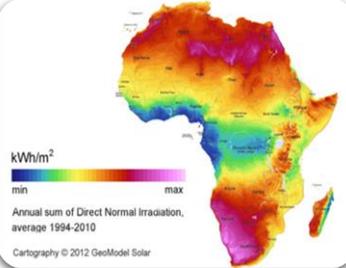
III. Calibration of the MSA

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Used Datasets

Methodology

Results & Discussion



MSA

- Raster data
- Resolution: 1km²
- Annual and monthly means of DNI and GHI over 19 years

Long-term time series of irradiation

- 19-year data from the satellite DB SolarGIS®
- Pace: 10 min, 15 min and monthly
- Punctual values taken from 7 locations near meteo stations





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Validation of the Calibration Model

Local calibration of long-term satellite data to short-term in situ data (at the station scale)

Collection of meteo data and quality control

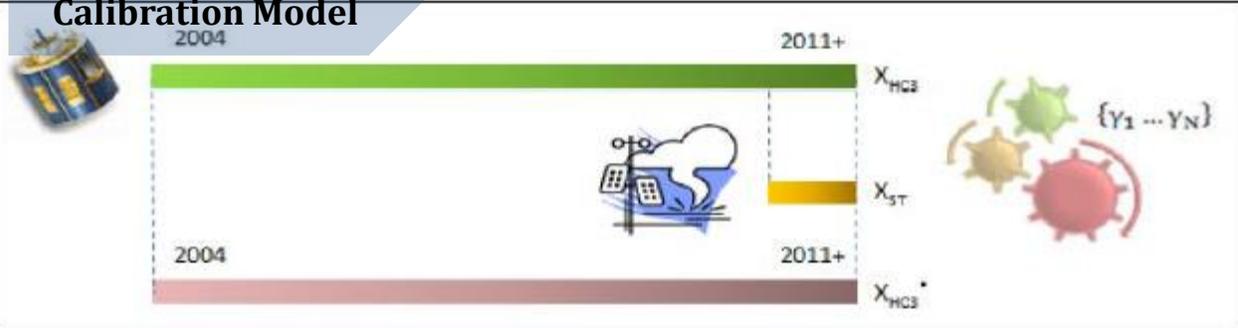
Exploratory statistical analysis and identification of differences between measure and model

Identification of the correction parameters for the common period between the 2 datasets

Applying the same correction to the complete series of modeled data

Generalization of calibration at the scale of a territory

Analysis of the results and validation of the approach



Used Datasets

- The satellite database produces highly correlated GHI and DNI estimates with in-situ measurements but is usually systematically overvalued

Methodology

- The overall discrepancies hide a great variability of satellite estimation performance, both spatial and temporal

Results & Discussion

Although overall concordance is good, seasonal variations exist and require a seasonal approach of calibration

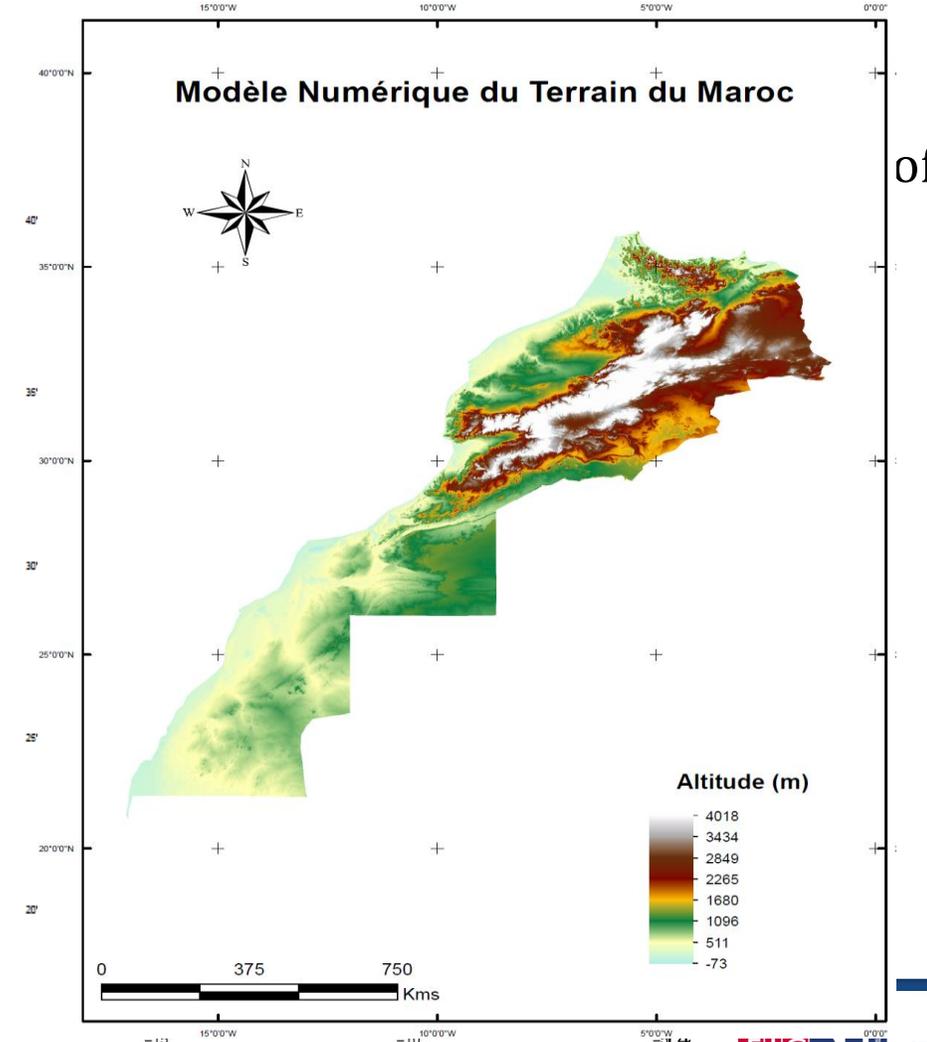
Development of a Global Calibration Model

Used Datasets

Methodology

Results
&
Discussion

- Introduction of the parameters having a st the irradiation:
 - ✓ Humidity
 - ✓ Latitude (location)
 - ✓ Altitude



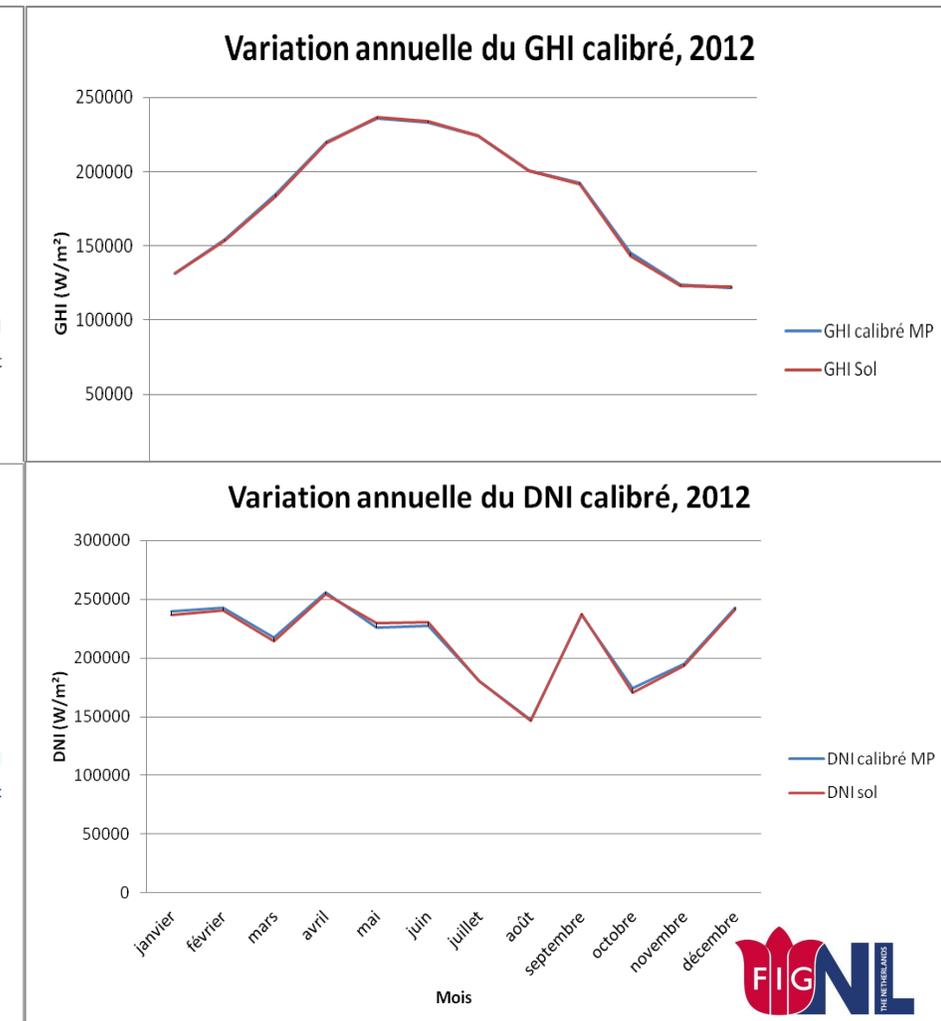
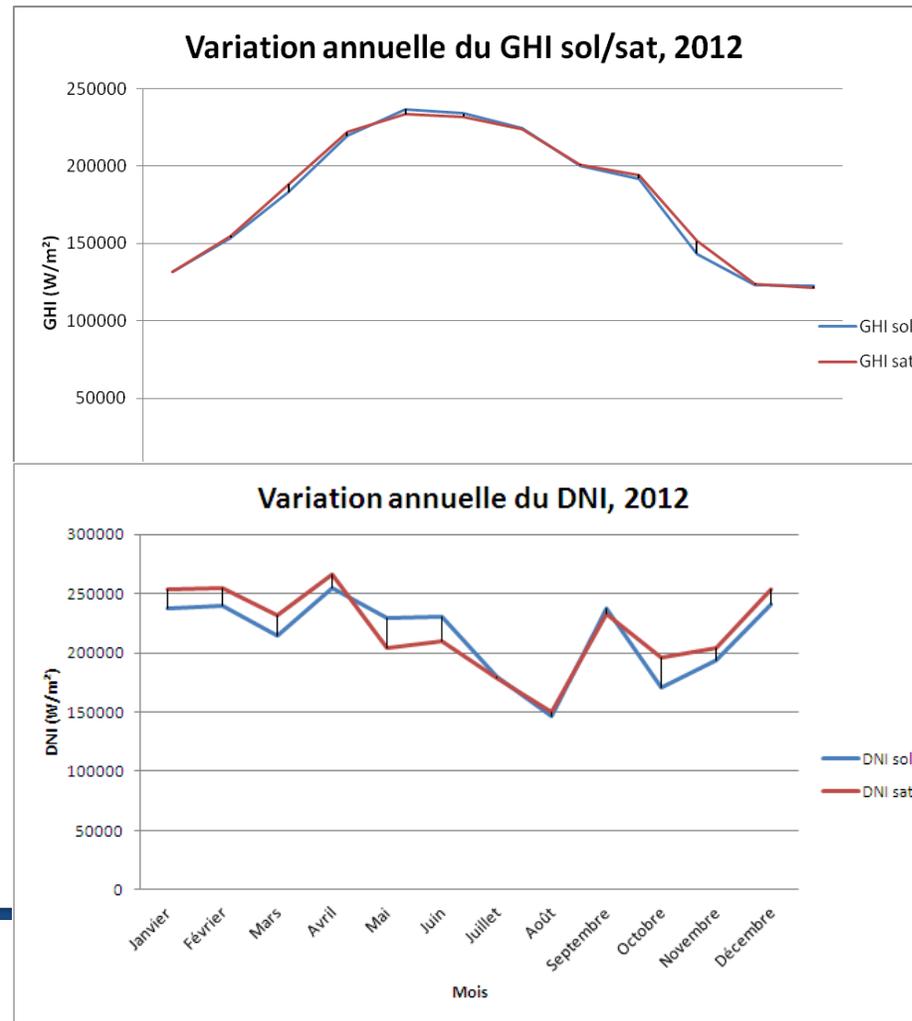
Local Calibration of Satellite Data to Ground Measurement

i. Results of Adaptation for the Common Period

Used Datasets

Methodology

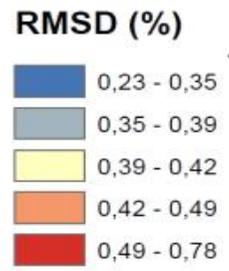
Results & Discussion



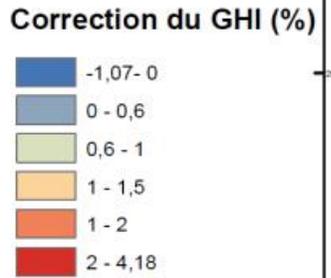
Correction apportée a



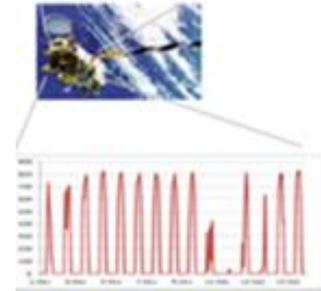
Précision de la calibration de l'atlas solaire du DNI en juillet



au GHI annuelle brute au Maroc



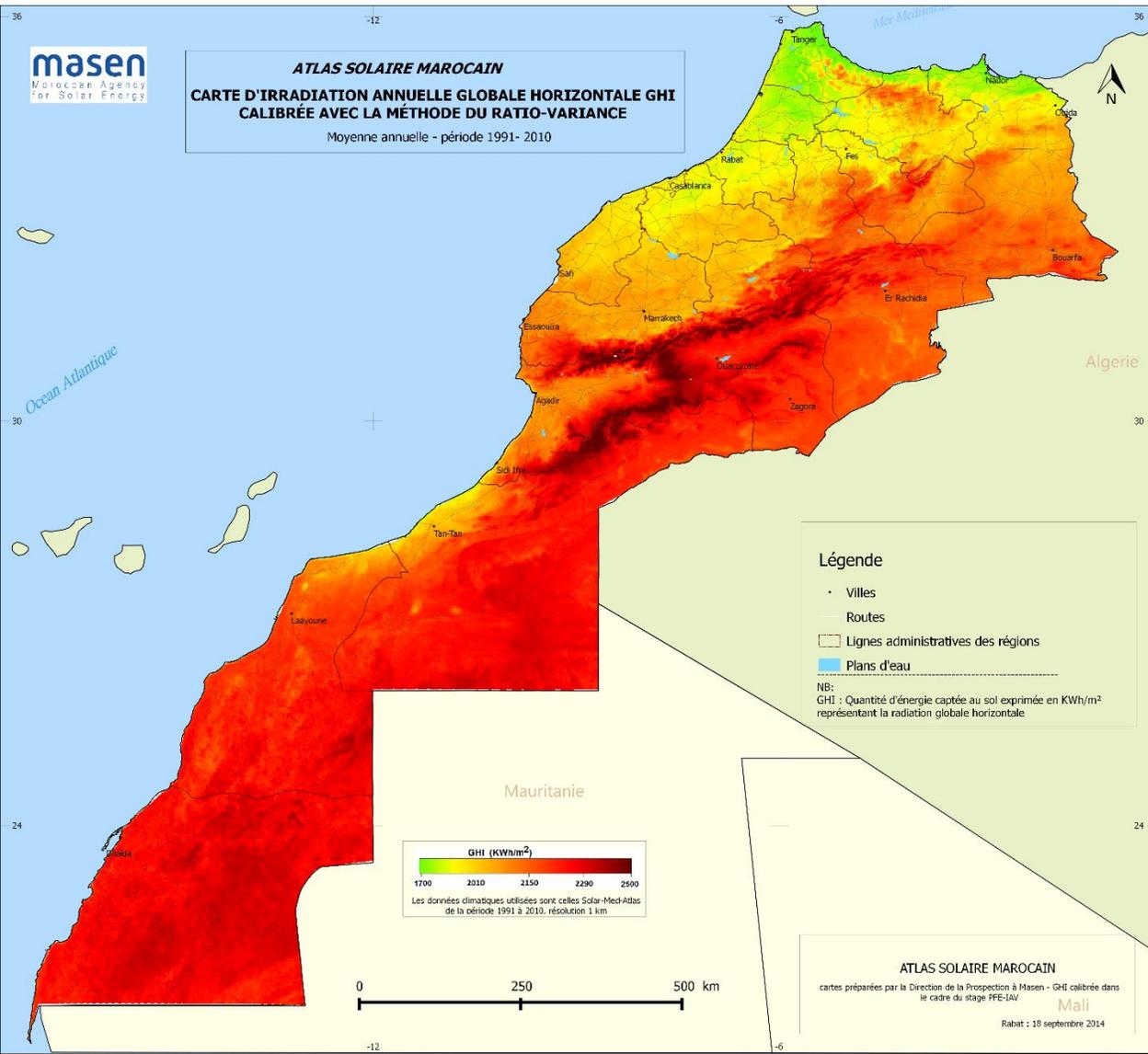
- The evaluation of the solar resource is a safe investment.
- In order to obtain solar maps that correspond to the local conditions in Morocco, we have chosen to calibrate the satellite estimates to the in situ data available for the area.
- Our study comes to highlight the problems with the assessment of the solar resource and to stress the concept of the calibration of satellite data (Meteosat) to ground measurements (site-specific adaptation).
- The existence of a solid and reliable database is essential both for the design, development and for the evaluation of the performance of solar energy systems
- The accuracies provided by the two calibration methods applied are very satisfactory and quite equivalent with higher performances for the hot and sunny months of the year It is around 0.6% for the GHI and 0.5% for the DNI
- The MSA has undergone a correction of 0.9% for the GHI and -6.6% for the DNI



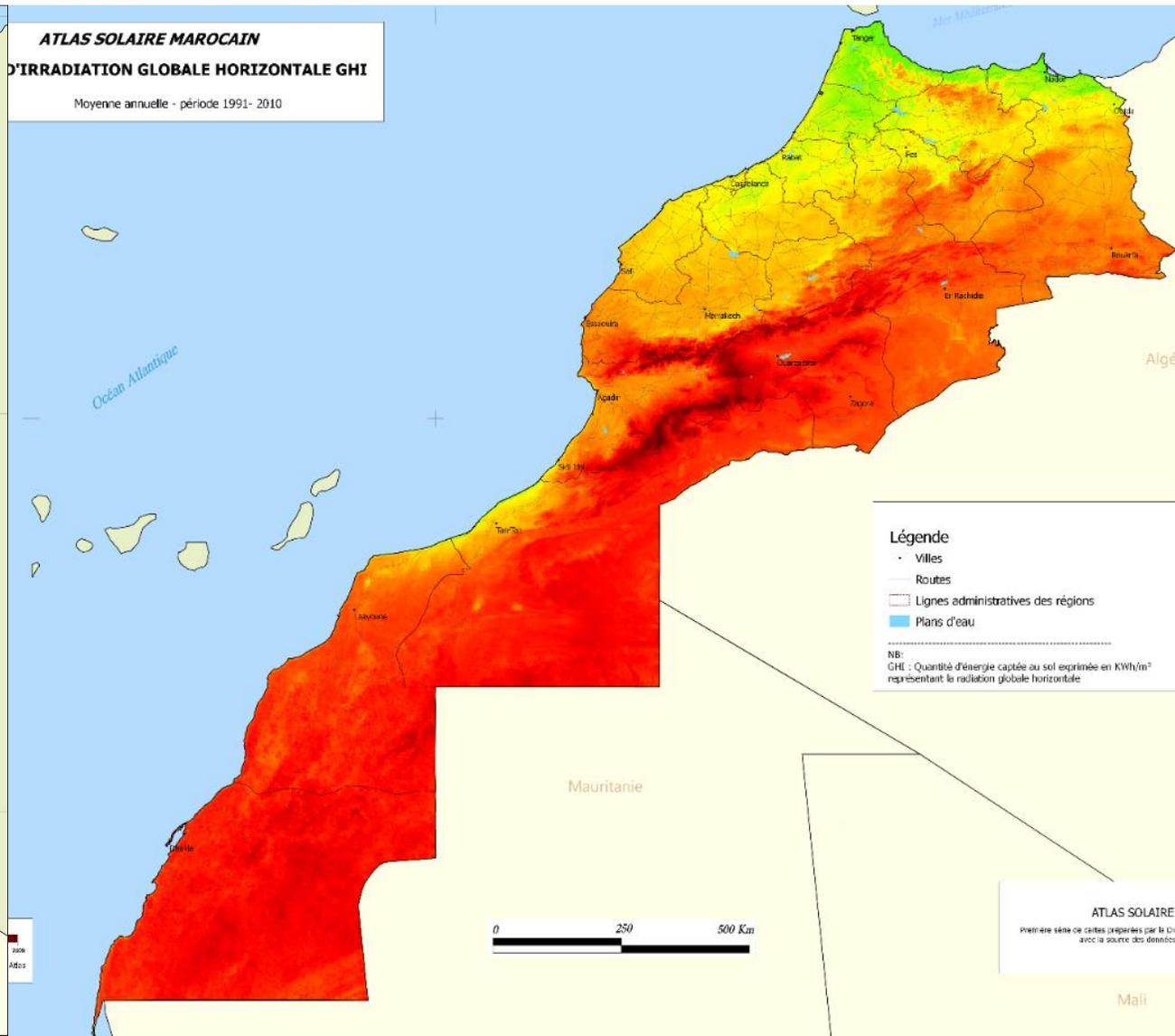
Long-term time series
(>10 years)



ATLAS SOLAIRE MAROCAIN
CARTE D'IRRADIATION ANNUELLE GLOBALE HORIZONTALE GHI
CALIBRÉE AVEC LA MÉTHODE DU RATIO-VARIANCE
Moyenne annuelle - période 1991- 2010



ATLAS SOLAIRE MAROCAIN
D'IRRADIATION GLOBALE HORIZONTALE GHI
Moyenne annuelle - période 1991- 2010





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AND WATER MANAGEMENT

CHALLENGES IN A NEW REALITY



masen

endless power for progress

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