



INTERNATIONAL CONFERENCE

# GROUNDWATER, KEY TO THE SUSTAINABLE DEVELOPMENT GOALS

*PARIS - May 18 -20, 2022*



ORGANIZED BY IAH-CFH, UNESCO-IHP, THE FRENCH WATER PARTNERSHIP, UNDER THE PATRONAGE OF THE FRENCH NATIONAL COMMISSION FOR UNESCO AND WITH THE SUPPORT OF THE MINISTRY FOR ENVIRONMENT, SEINE-NORMANDY WATER AGENCY, AND SORBONNE UNIVERSITY

# ABSTRACT INFORMATION

Abstract N°: **223**

Category: **GROUNDWATER RESOURCES FOR FOOD PRODUCTION (IRRIGATION)**

Title: **SHALLOW GROUNDWATER CHARACTERIZATION AND CONTRIBUTION TO LARGE-SCALE AGRICULTURE: CASE OF THE KARFIGUELA PLAIN IN BURKINA FASO**

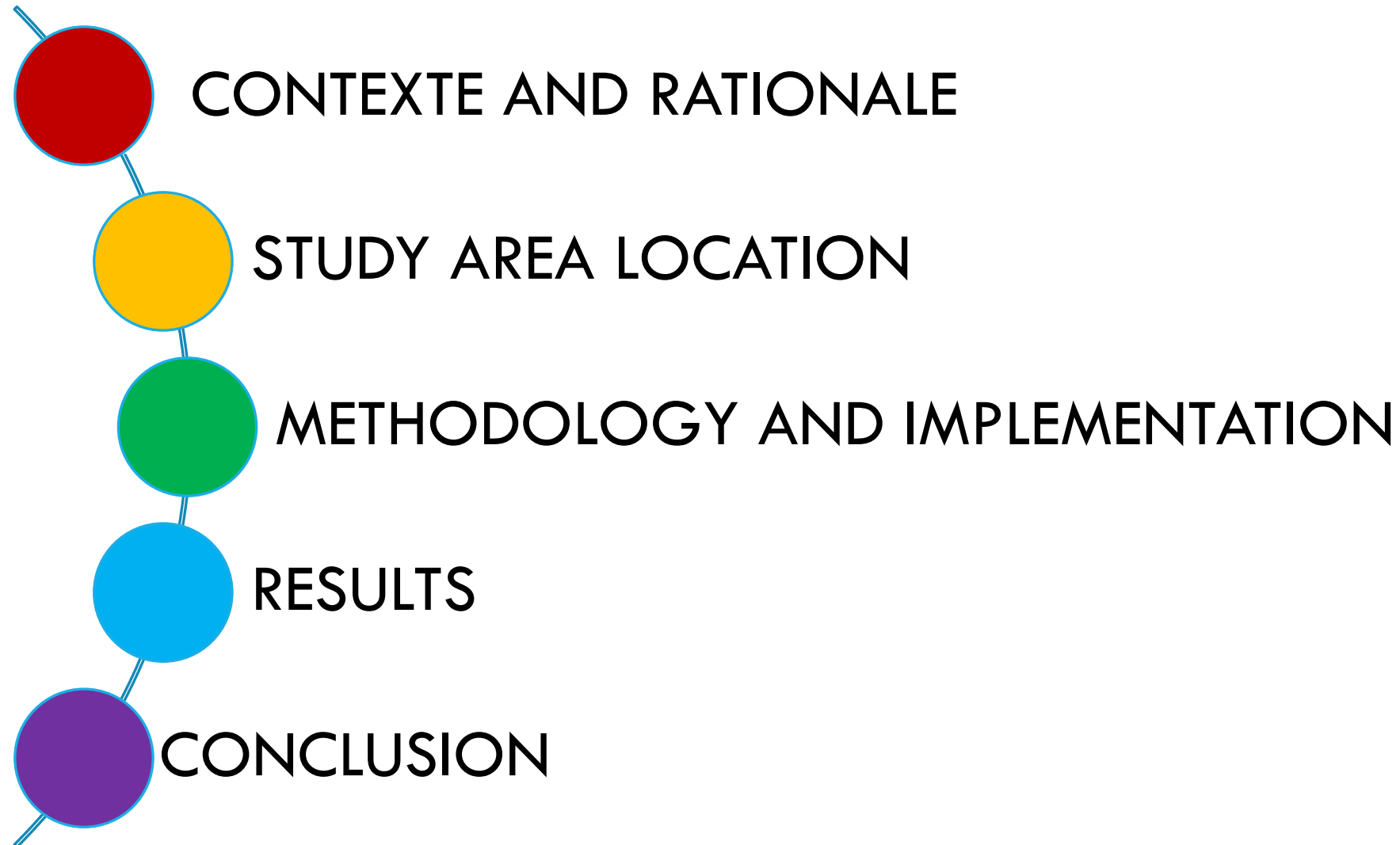
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# Context and rationale

## ❖ Low productivity of agricultural sector

- 80% of the active population
- 35% of the national GDP

(FAO, 2019)



## ❖ Food insecurity 2020

- 2,151,970 in food Insecurity
- 137,175 in food emergency

(council of ministers, 2020)



## ❖ Perspective of evolution = difficult

- Decrease in Rainfall
- Drought pocket



# Context and rationale

## Groundwater

- Small-scale irrigated agriculture
- **Rainfed large-scale agriculture**

**Karfiguela Paddy Field**  
**in Burkina Faso**  
**350 ha**

## OBJECTIVES

**Global**

**Propose an adequate solution to the problems related to water resources on the irrigated perimeter of Karfiguéla**

**1**

- Hydrogeological characterization of the aquifer

**2**

- Studying Groundwater Hydrodynamics

**3**

- Assessing groundwater contribution to supplemental irrigation

**Climate:** South sudanese

Pan = 1040 mm (1981–2019)

**Hydrography:** Comoe

watershed

Main streams = Comoe and  
Leraba

**Geology and hydrogeology:**

Basement at the south—

Sedimentary at the north

# METHODOLOGY AND IMPLEMENTATION (1/2)

## Aquifer extension

Very Low Frequency  
Electromagnetism  
(VLF-EM)  
ABEM WADI

Electrical sounding

## Hydrodynamics and hydraulics

Piezometric campaign

Pumping tests in  
agricultural wells  
Boulton and Streltsova

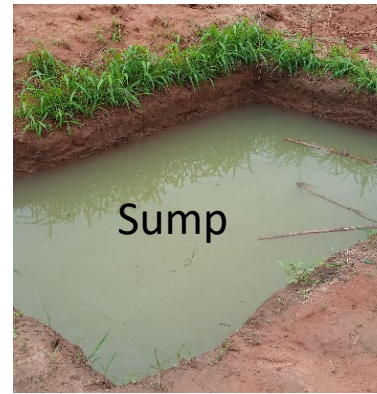
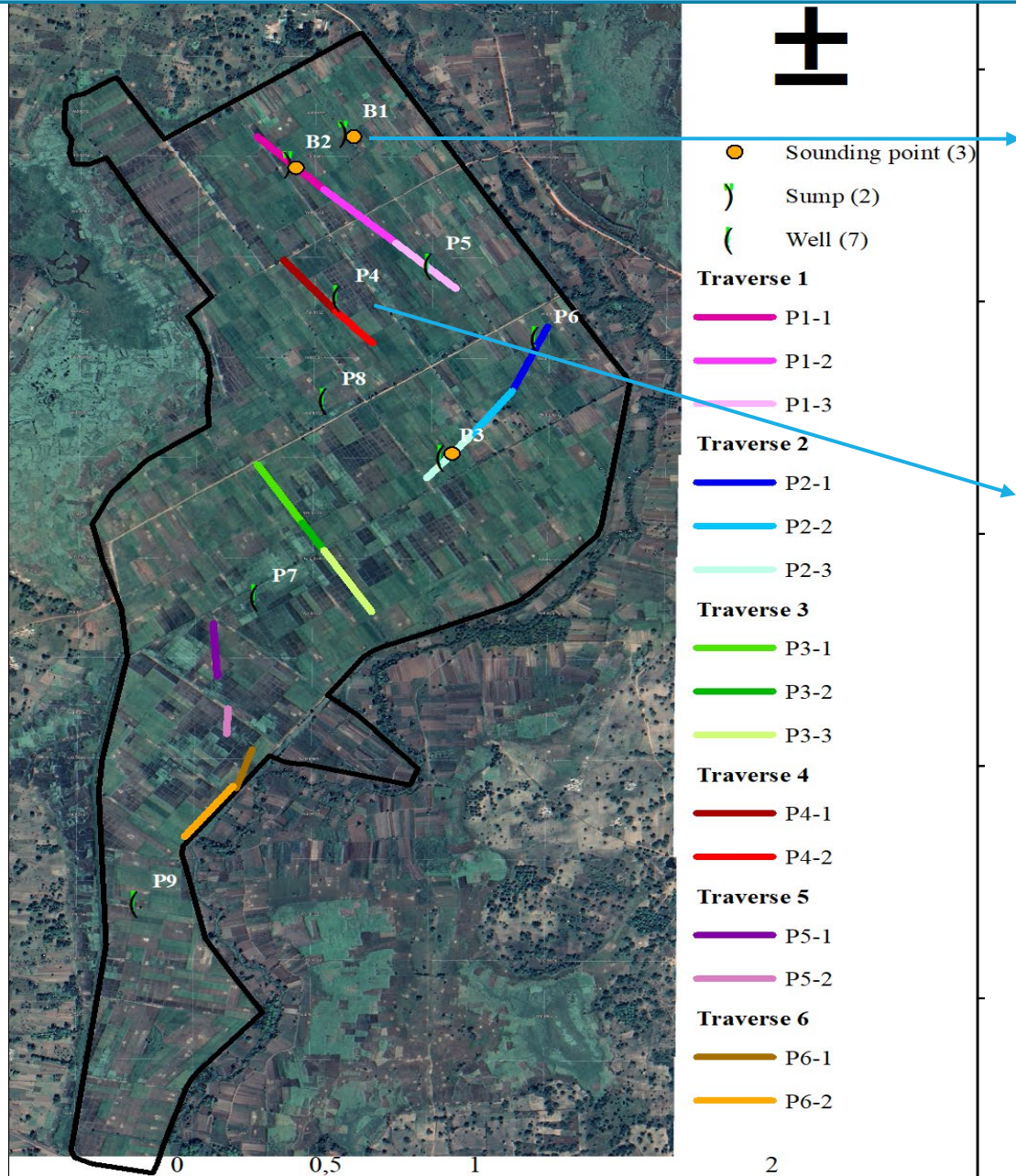
## Crops water deficit and groundwater contribution

Crops water  
Requirement  
Crops water deficit

Contribution of  
groundwater in  
irrigation



# METHODOLOGY AND IMPLEMENTATION (2/2)



Well = 1 m diameter  
3 m deep

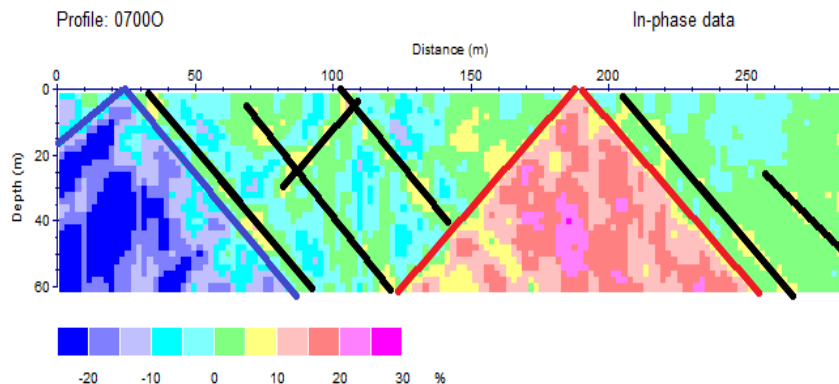
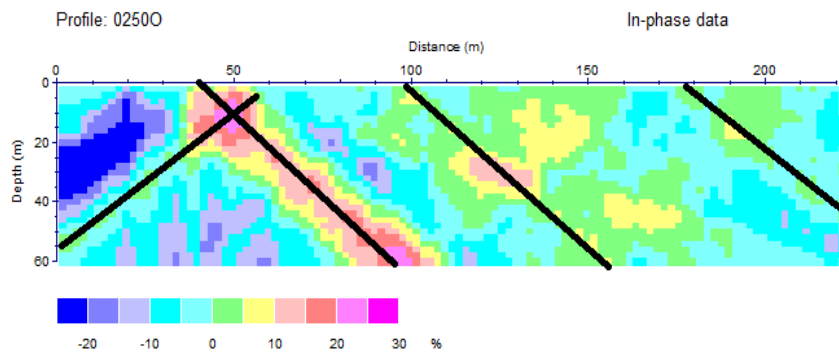
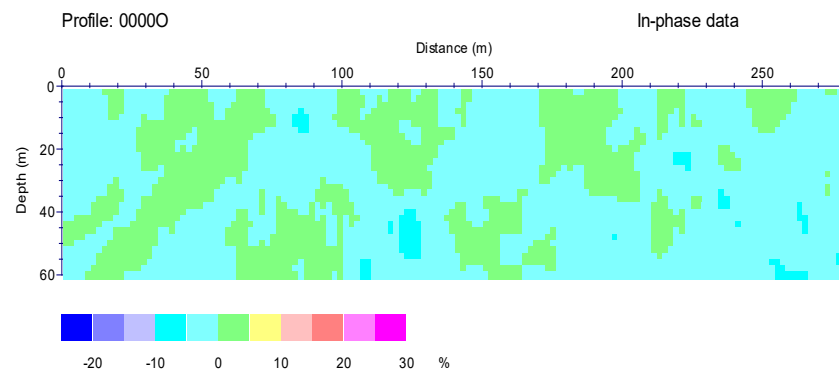
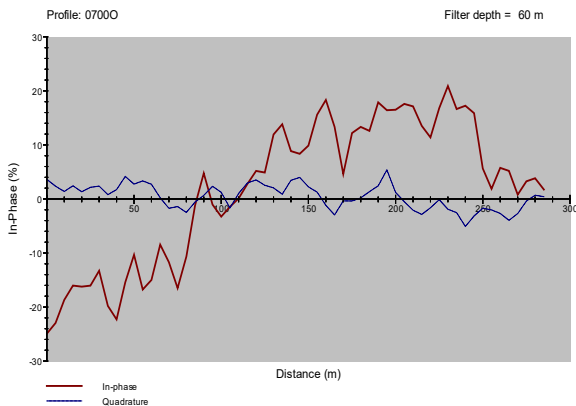
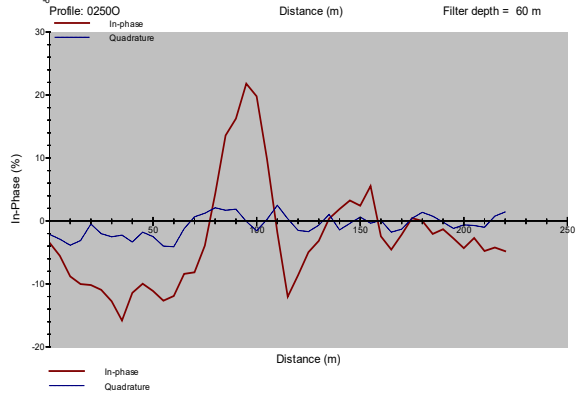
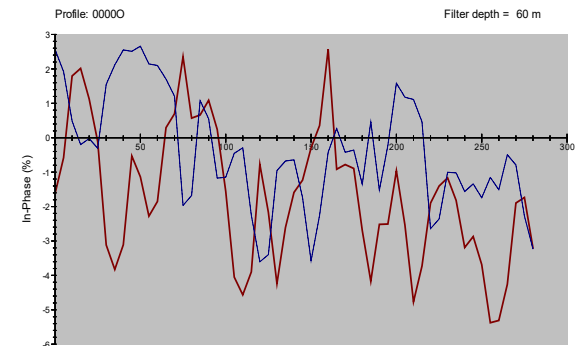
Sump = 2 m width  
3 m length  
3 m deep



Pumping tests: B1, B2 and P3



# RESULTS: AQUIFER EXTENSION (1/8)



North

Center

South

☐ Means conductivity in the north of the rice land

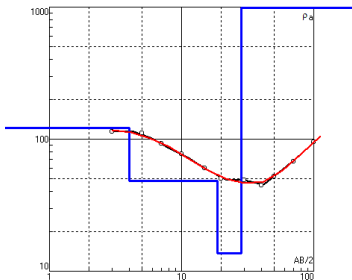
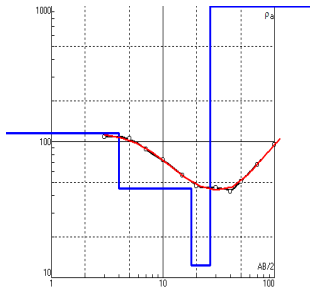
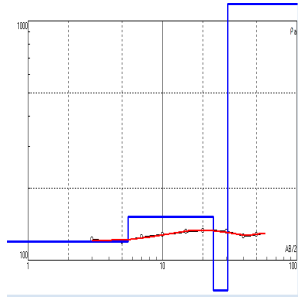
☐ Variable deep

☐ Conductive corridors

☐ Conductive materials

☐ Resistant materials

# CHARACTERIZATION OF SUPERFICIAL DEPOSITS (2/8)



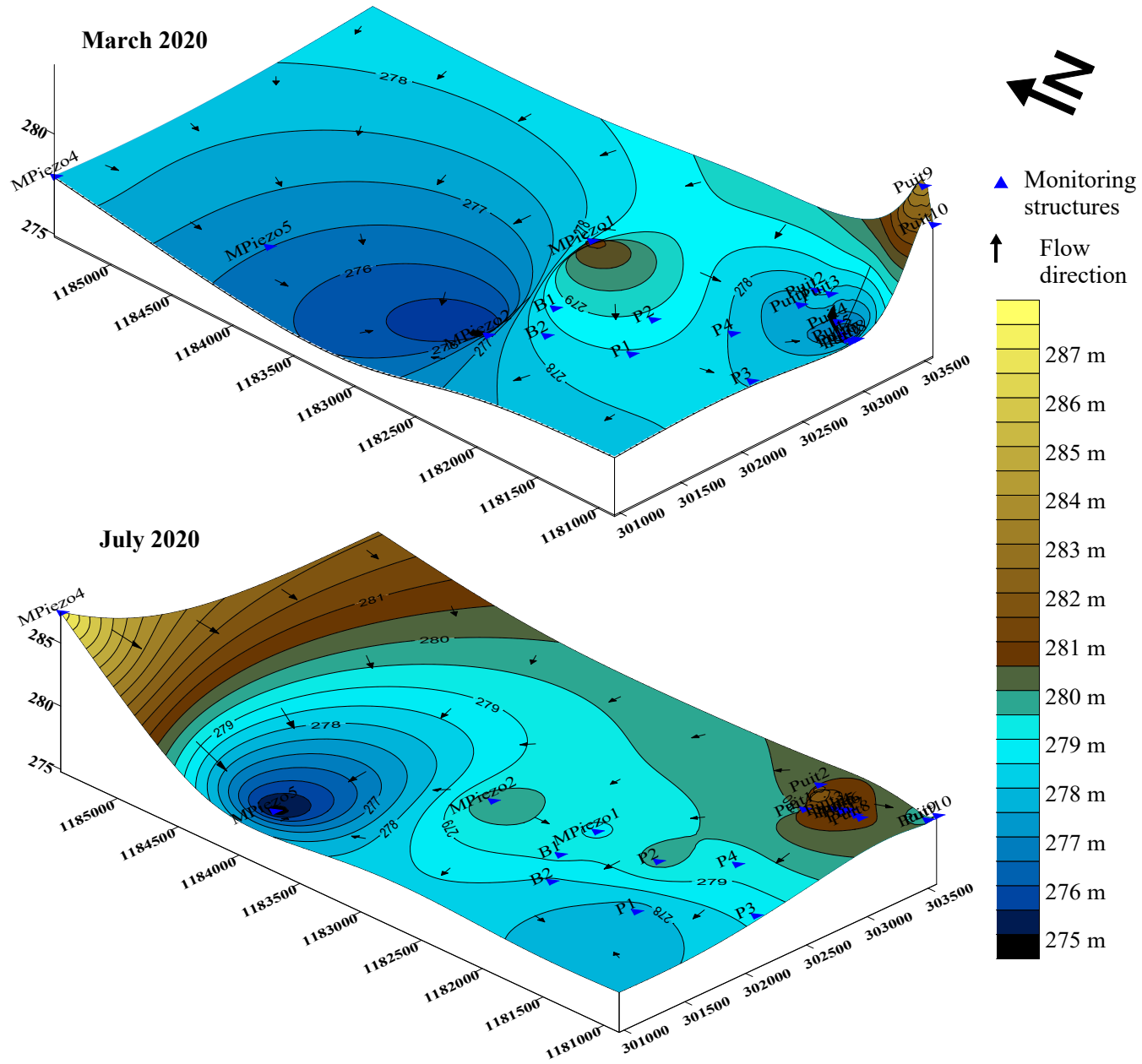
| Points  | Résistivity (Ohm.m) | Nature of geological layers | Thickness of the layer [m] | Aquifer power [m] |
|---------|---------------------|-----------------------------|----------------------------|-------------------|
| S1 (B1) | 120                 | Sandy                       | 6                          | 31                |
|         | 152.1               | Gritty sand                 | 18                         |                   |
|         | 17.68               | Clay                        | 7                          |                   |
|         | 27 206              | Granodiorite bedrock        | -                          |                   |
| S2 (B2) | 116                 | Sandy                       | 4                          | 27                |
|         | 42.2                | Sandy clay                  | 14                         |                   |
|         | 12,3                | Clay                        | 9                          |                   |
|         | 9699                | Granodiorite bedrock        | -                          |                   |
| S3 (P3) | 122                 | Sandy                       | 4                          | 29                |
|         | 48                  | Sandy clay                  | 15                         |                   |
|         | 14                  | Clay                        | 10                         |                   |
|         | 5834                | Granodiorite bedrock        | -                          |                   |

## Aquifer power

27 – 31 m

- Sand
- Gravel
- clay

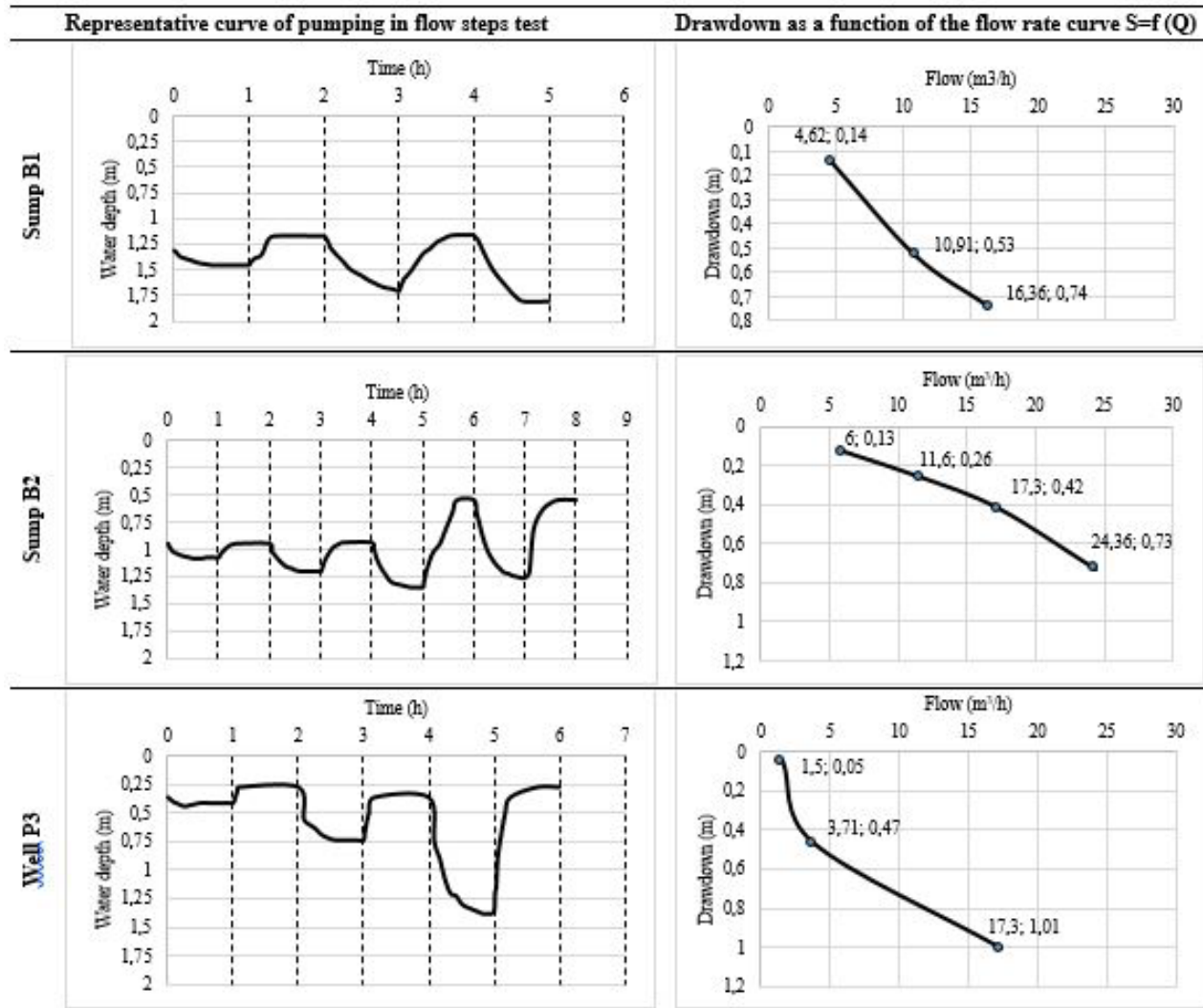
# PIEZOMETRIC MONITORING (3/8)



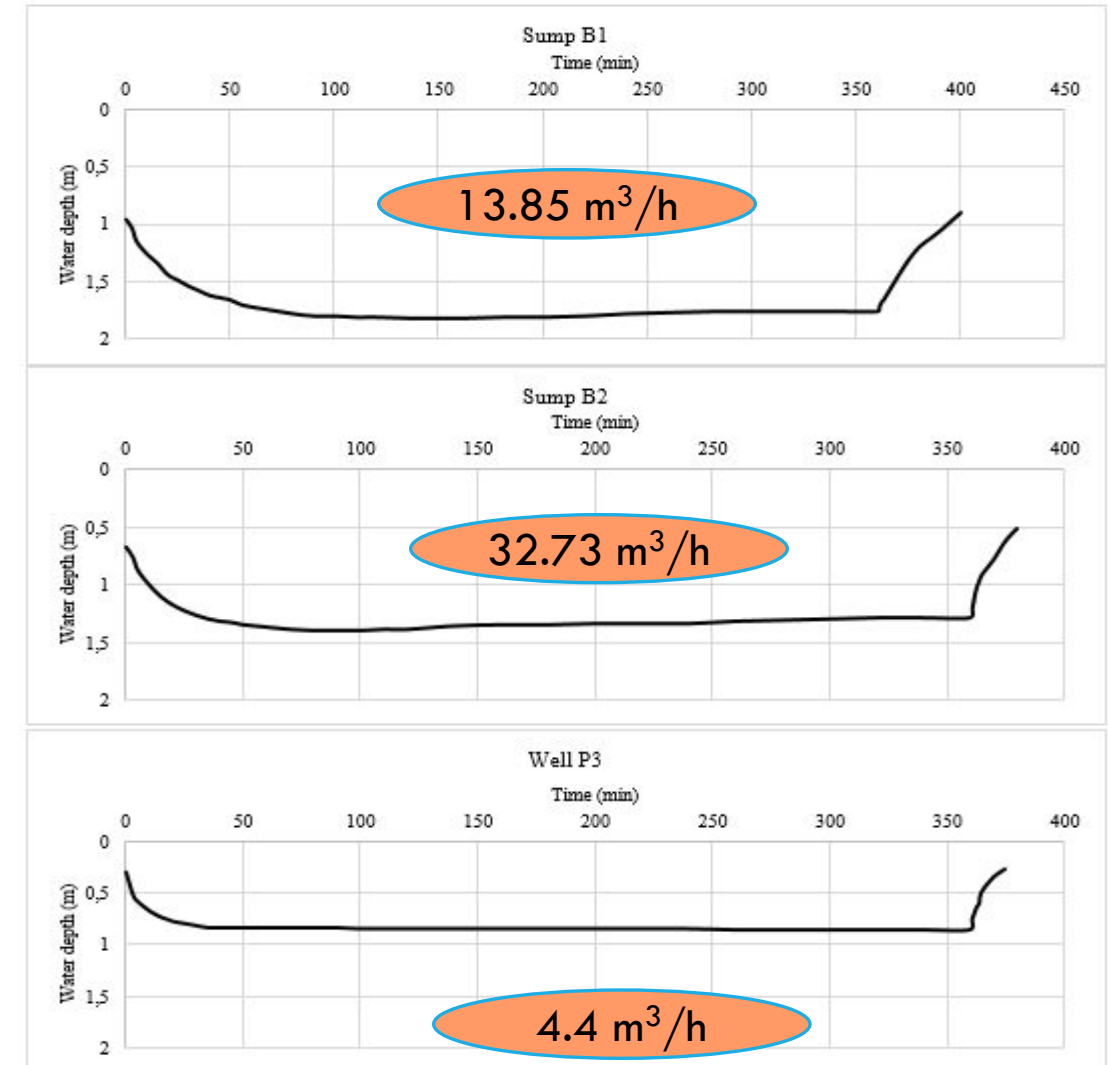
- **Very variable piezometry**
- **Very shallow groundwater**
  - 1.5 m—7 m in March**
  - 0 m—2.6 m in July**
- **Fast recharge:**
  - 5 m in one month of rain**
- **Outcrop of water table**

# HYDRODYNAMIC PARAMETERS AND GROUNDWATER PRODUCTIVITY (4/8)

## Flow steps test



## Constant rate pumping test



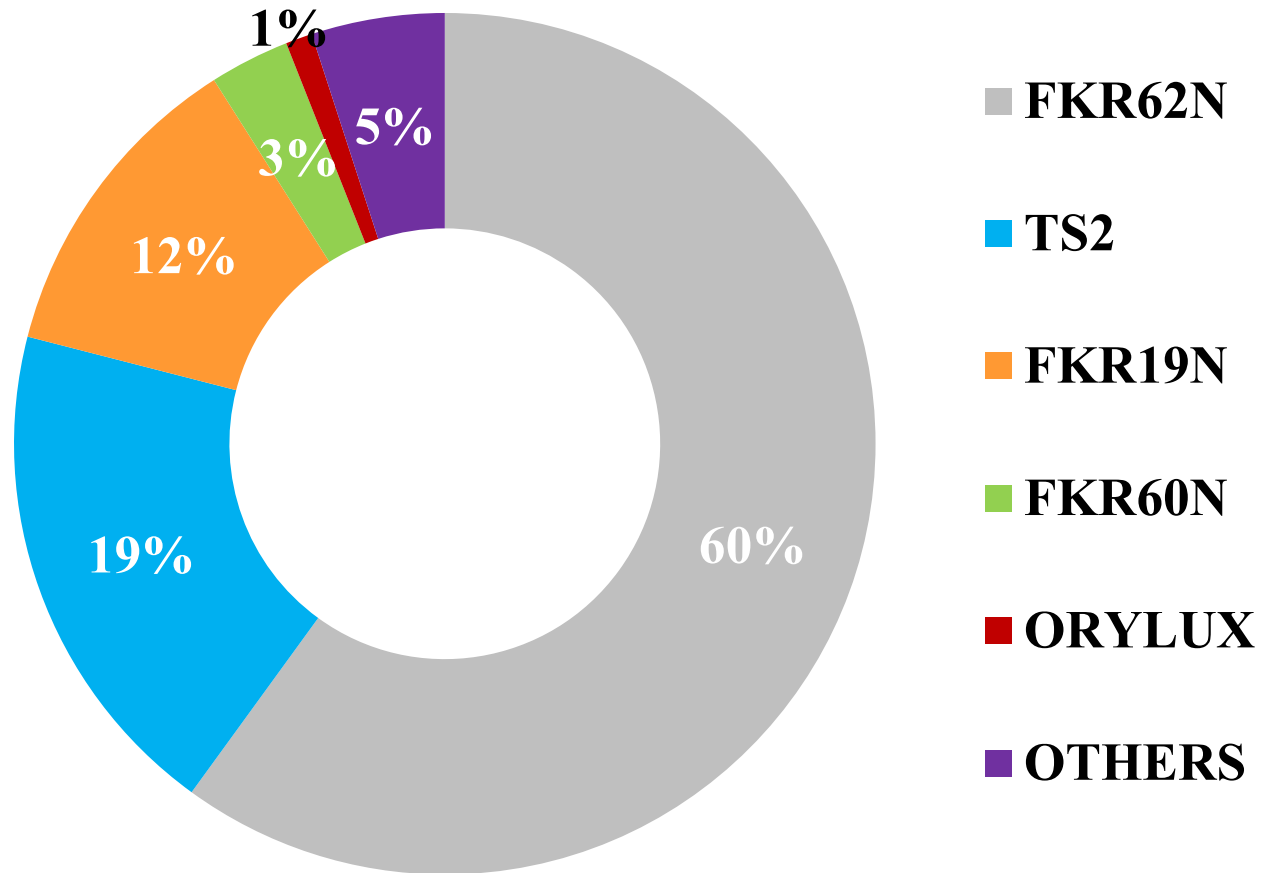


# HYDRODYNAMIC PARAMETERS AND GROUNDWATER PRODUCTIVITY (5/8)

| Well    | Pumping rate<br>[m³/h] | Pumping duration<br>[h] | Ascent<br>[h] | T [m²/s]  | K [m/s]   | Sy        | Specific flow<br>[m³/h/m] |
|---------|------------------------|-------------------------|---------------|-----------|-----------|-----------|---------------------------|
| B1      | 13.85                  | 6                       | 0.7           | 2.73 E-03 | 8.81 E-05 | 3.50 E-01 | 19.24                     |
| B2      | 32.73                  | 6                       | 0.3           | 8.20 E-03 | 3.04 E-04 | 7.90 E-01 | 38.06                     |
| P3      | 4.4                    | 6                       | 0.3           | 5.10 E-03 | 1.76 E-04 | 2.45 E-01 | 8.00                      |
| Moyenne | 17                     | 6                       | 0.4           | 5.34 E-03 | 1.89 E-04 | 4.62 E-01 | 21.76                     |

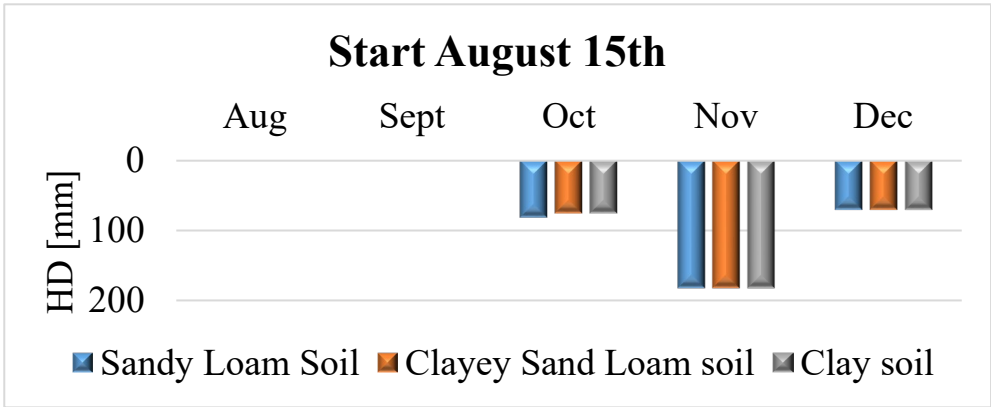
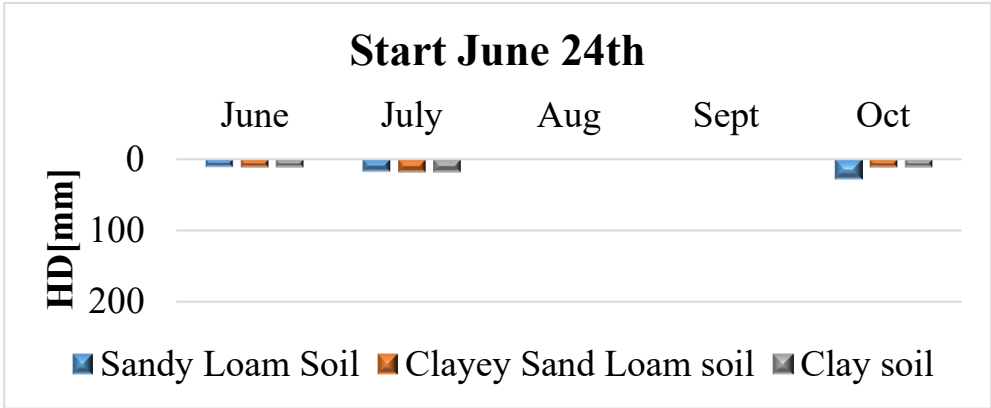
- Productive aquifer
- Maximum drawdown= 0.86 m
- Rising while pumping after maximum 3 h of pumping

## Hydro-Agricultural Survey



- **FKR62N 60%**
- **Cycle of 120 days**
- **3 main dates of cultivation start**
  - ✓ **June 24**
  - ✓ **15 July**
  - ✓ **15 August**
- **Soil texture**
  - ✓ **clayey sandy loam (34%)**
  - ✓ **sandy loam (26%)**
  - ✓ **clay (18%)**

# CROPS WATER DEFICIT AND GROUNDWATER CONTRIBUTION (6/8)



**WD = 10 – 27 mm**

**WD = 108 – 131 mm**

**WD = 330 mm**

**Groundwater contribution: pumping duration = 6 h  
pumping flow = 17 m<sup>3</sup>/h**



| Starting date | Irrigable area [ha] |                 |                      |
|---------------|---------------------|-----------------|----------------------|
|               | Loam Sand soil      | Sandy Loam soil | Sandy Loam Clay soil |
| June 22nd     | 6.92                | 10.04           | 10.04                |
| July 15th     | 3.18                | 3.81            | 3.81                 |
| August 15th   | 1.31                | 1.33            | 1.33                 |

# OBSERVATION PLOTS



**Plot which is irrigated with groundwater during drought periods**

**At the same time, a neighboring plot which the nursery turning yellow**



# CONCLUSION

**Good lateral and vertical extension**

- 27 m - 31 m deep

**Productive groundwater**

- $T = 5.34 \cdot 10^{-3} \text{ m}^2/\text{s}$        $S = 0.46$

**Quantitative capability to  
complementary irrigation in paddy  
field**

- 1.3 ha—5.3 ha





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French  
water  
partnership



partenariat  
français  
pour l'eau



Organisation  
des Nations Unies  
pour l'éducation,  
la science et la culture



sous le patronage  
de la Commission  
nationale française  
pour l'UNESCO



MINISTÈRE  
DE LA TRANSITION  
ÉCOLOGIQUE

Liberté  
Égalité  
Fraternité



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