



# Towards Improved Field Water Management In Gash Agricultural Scheme, Eastern Sudan

**(From Africa to Asia and Back Again Project)**

Managing Soil moisture and field water management



**by**

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## Africa to Asia and Back Again : **Testing Adaptation in Flood-Based Farming Systems**

- The Project builds on an earlier grant of IFAD – Spate Irrigation for Poverty Alleviation and Rural Growth, implemented by UNESCO-IHE and MetaMeta (as conveyors of the spate irrigation network)
- Four country chapter of the Spate Irrigation Network, hosted respectively by Mekelle University (Ethiopia), HRC (Sudan), WEC (Yemen) and SPO (Pakistan).
- The area under FBFS in Africa and Asia is estimated at 20-35 million hectares
- FBFSs are neglected in most countries, with most attention going to conventional perennial irrigation systems or alternatively to rain-fed agriculture.



## What is On-farm Water Management??

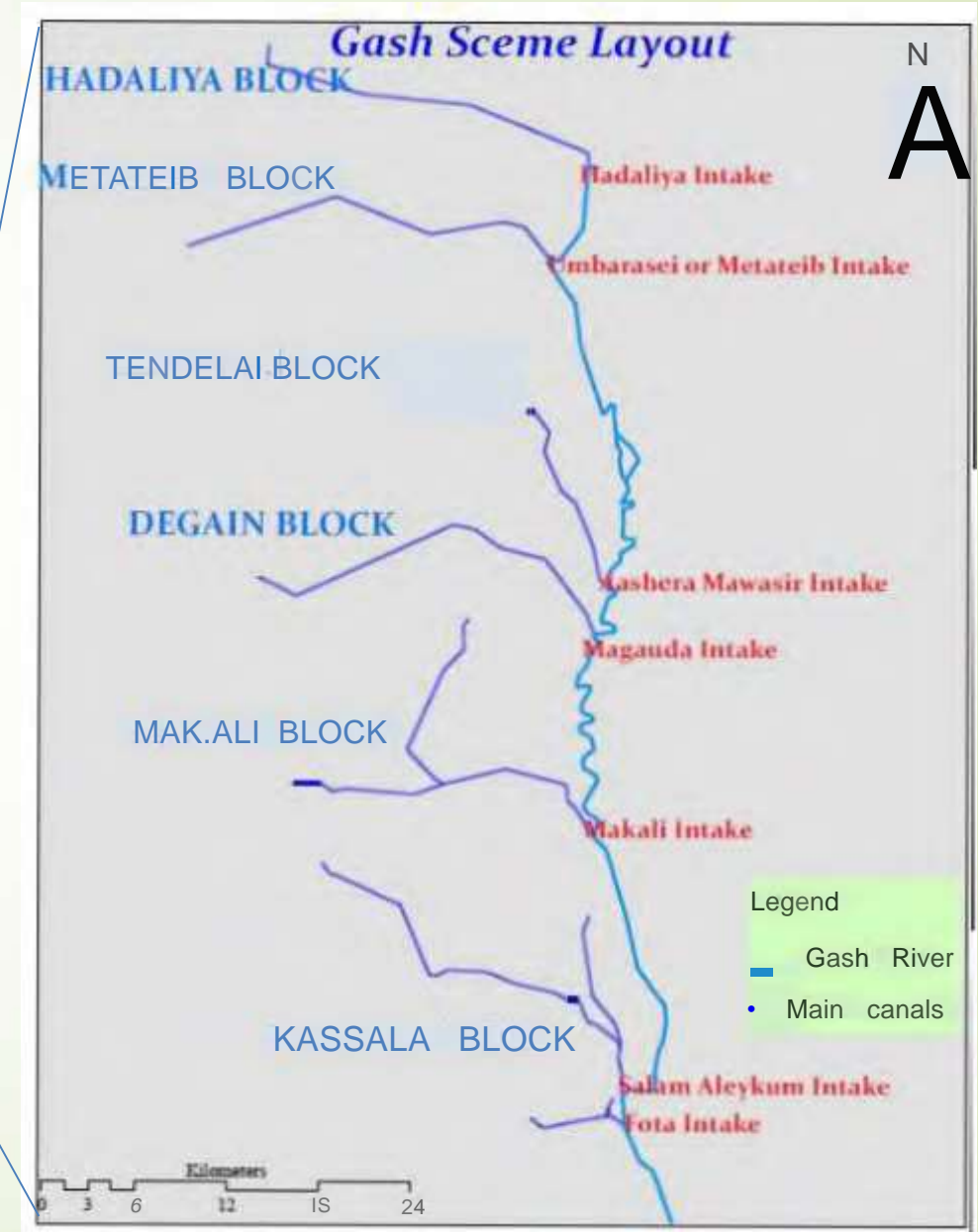
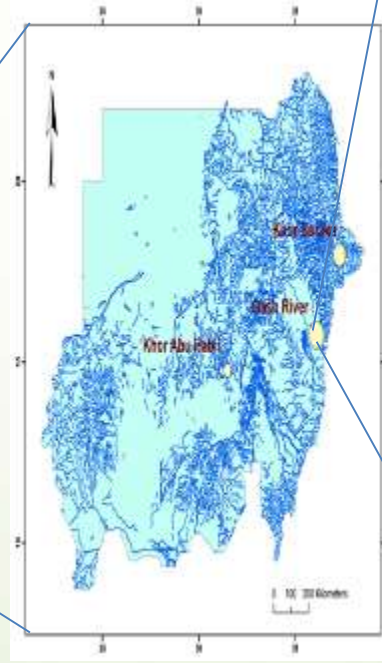


- *Farm management has been defined by Dillon (1980) as " the process by which resources and situations are manipulated by the farm manager in trying, with less than full information, to achieve his [or her] goals. "*
- *On-farm water management can be defined as: A systems approach towards controlling water on a farm in a manner that provides for the beneficial management of water for satisfying the irrigation and drainage needs of a crop under the constraints imposed by the prevailing physical social, governmental, and production systems .*  
(Principles of On-Farm Water Management - Forrest T. Izuno)



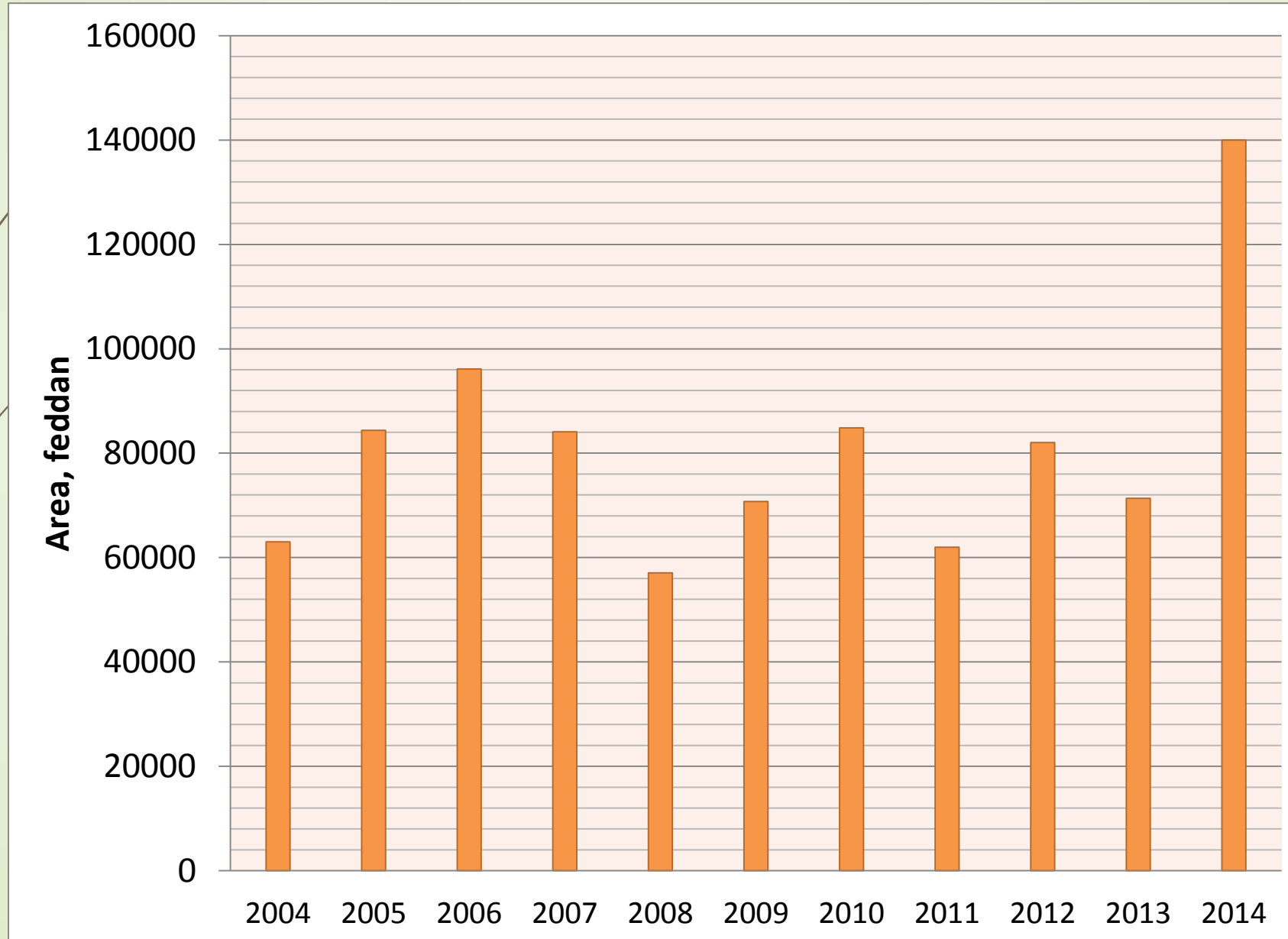
# The Gash Agricultural Scheme

- GAS consist of six blocks
- Total area 120,000 feddans
- Irrigated area 80,000 feddans



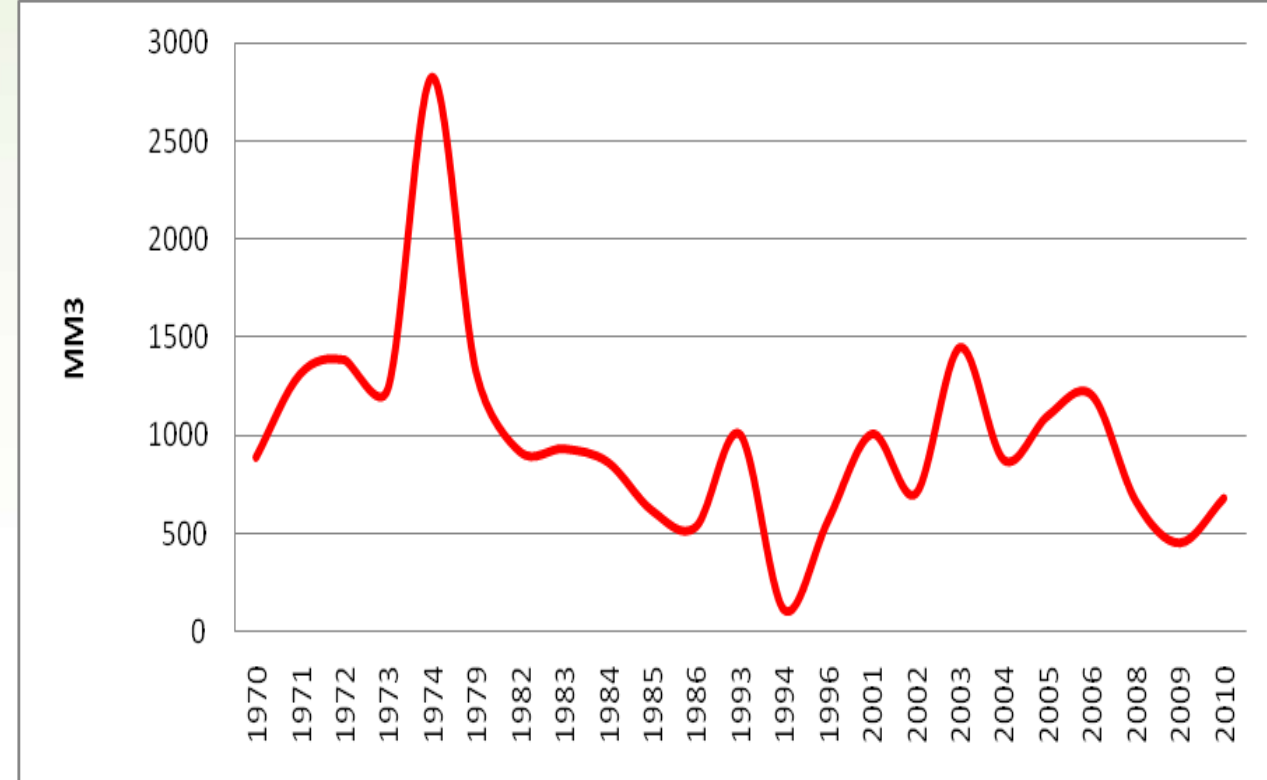


# The Gash Agricultural Scheme





# Gash River







# Research Rationale


## Rationale

- Improving field water management was a key research theme identified by stakeholders in the project Inception workshop in April 2015
- Several previous policy and investment interventions focused on main and secondary systems while largely neglecting the field water management






## Objective

- Evaluate the efficiency of field water management of the current irrigation practice and field layout
  - Assess the impact of current field water management on productivity
  - Identify and analyze, alternative practices for improving field water management and productivity
  - Formulate improvement recommendations for interventions on the ground
- 



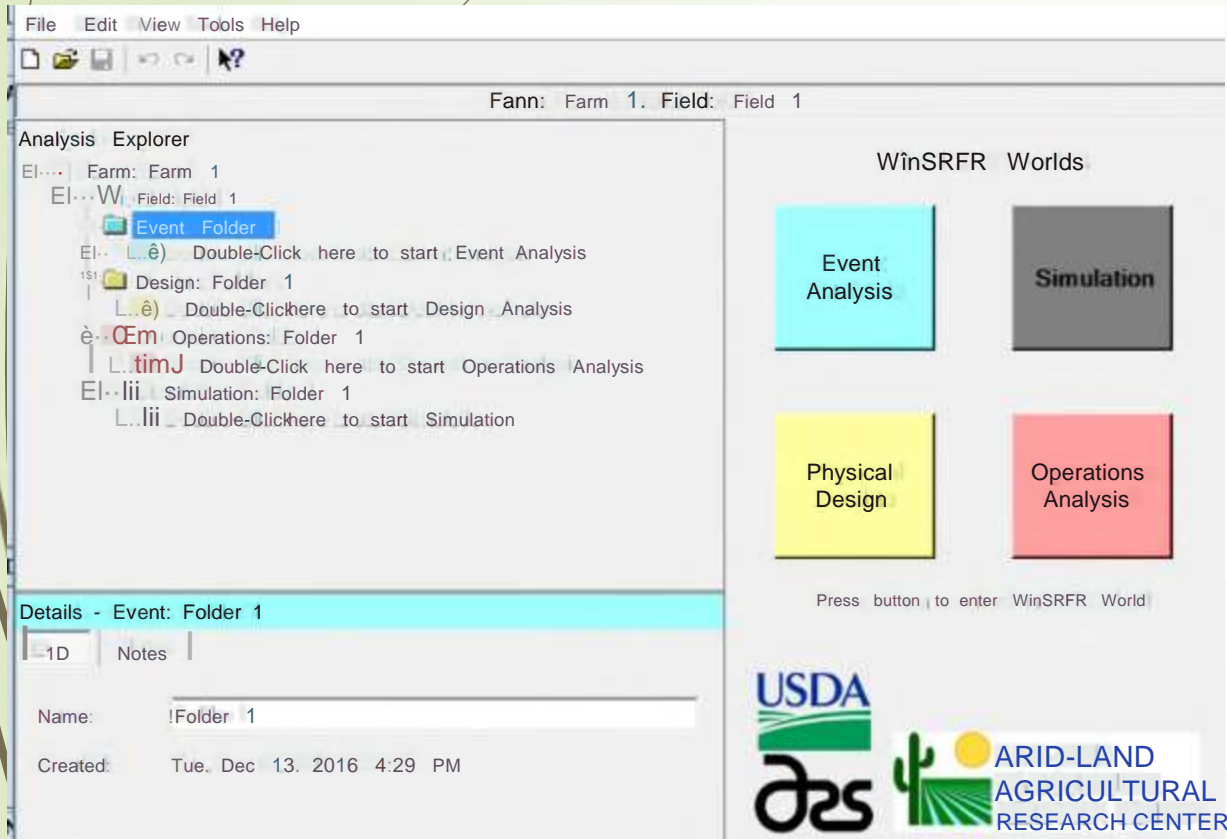


# Methodology

- (2) Mesga selection
  - Pre-season investigation
  - Field survey
  - Flow measurements (Jul.-Aug.)
  - SMC sampling (by **2** methods)
  - Reporting (Phase I)
- 



# Research Approach and Methods

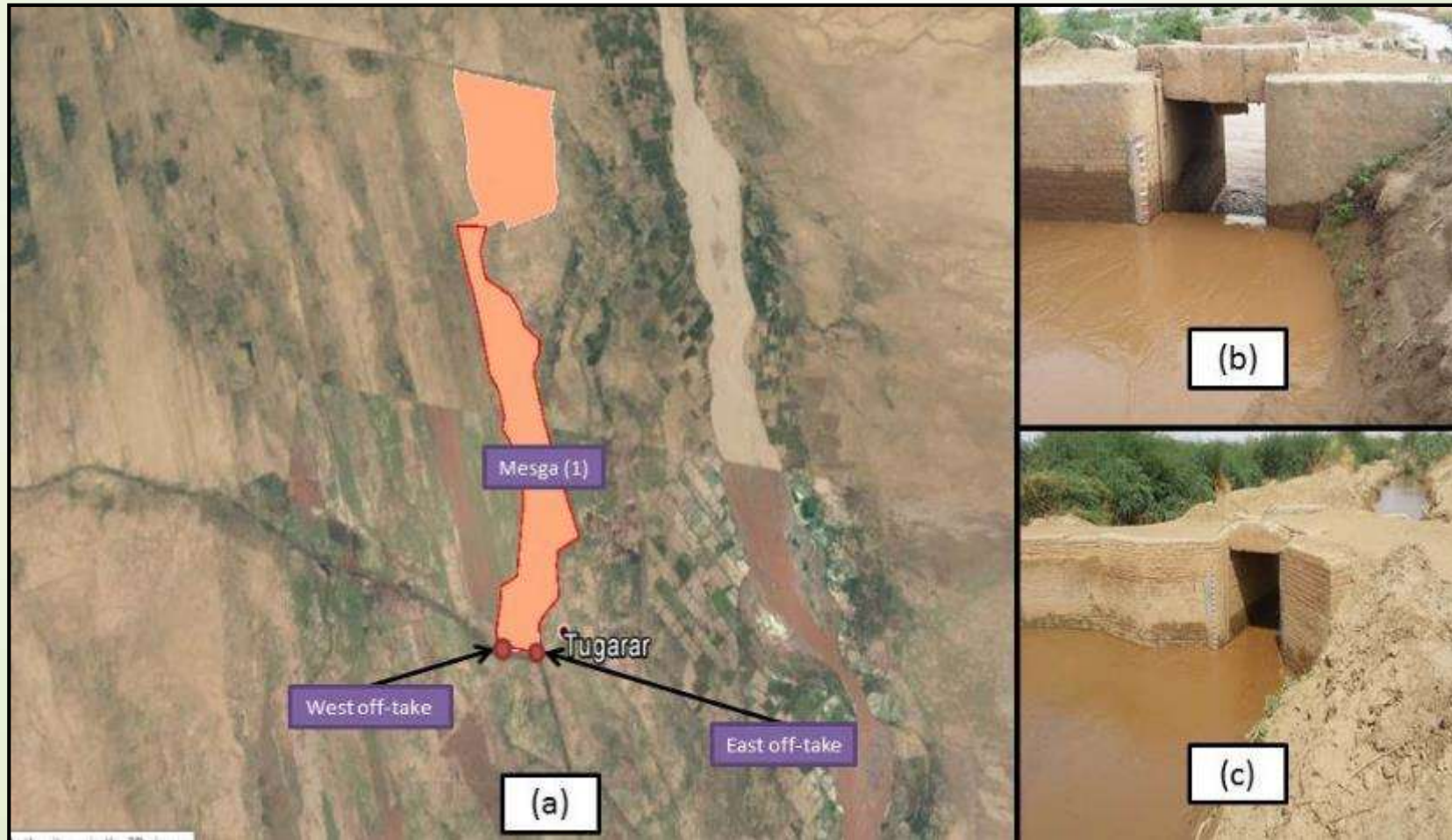


- WinSRFR programme: Simulation of field water application efficiency (%)
- Current meter & float: inflow ( $\text{m}^3/\text{s}$ )
- Surveying:
  - Field topography (m/m or %)
  - Field dimension ( $\text{m}^2$ )
- Soil texture (silt to clay): Infiltration rate



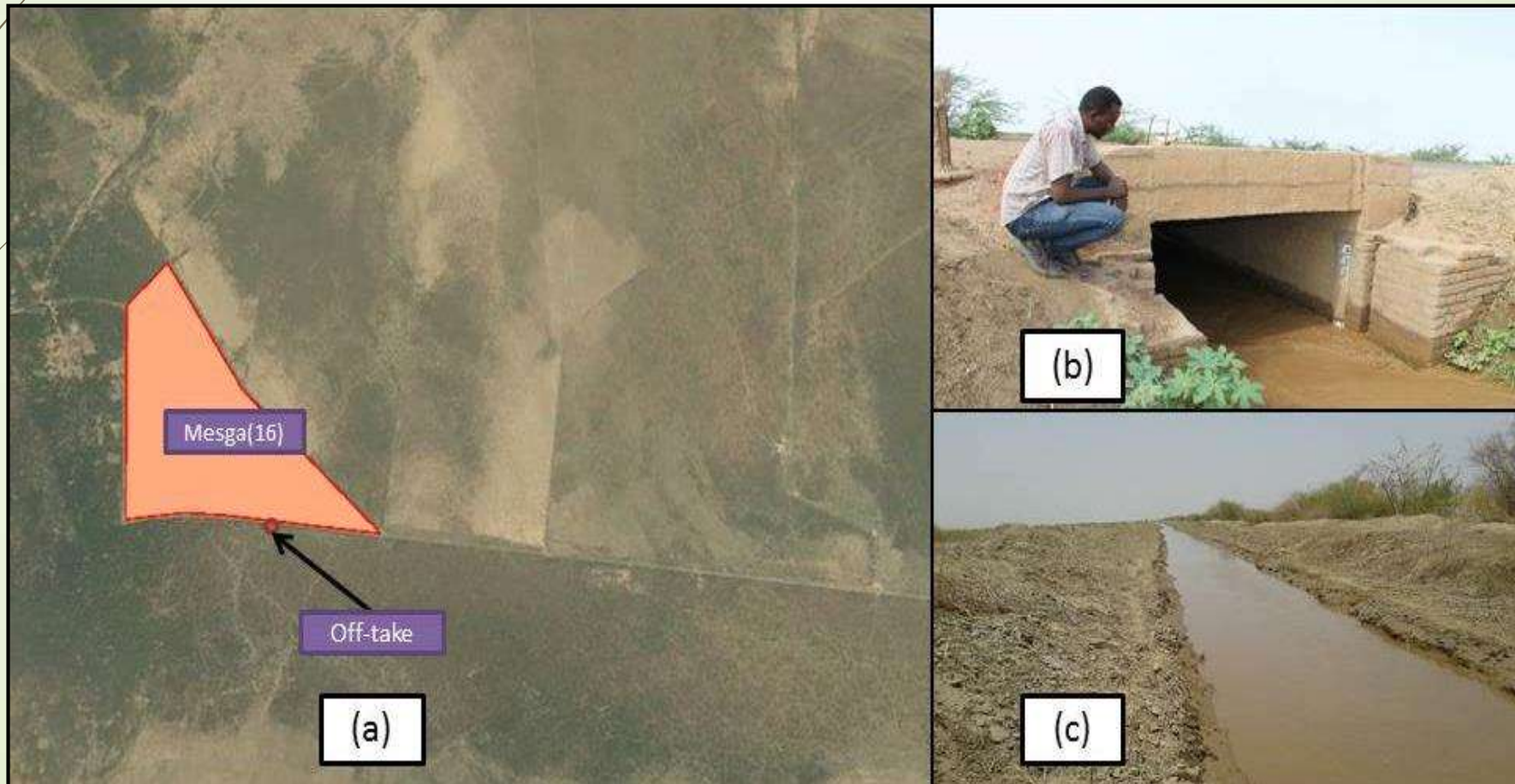
## Pilot farms selection

Kassala Block – Mesga 1 (2000 feddans)





## Haddaliya Block – Mesga 16 (300 feddans)





# Field work



collecting soil sample using hand-auger



Installing gauge staff



Flow measurements



Maintaining control structure D/s of Megra\_2



Stopwatch



Float method

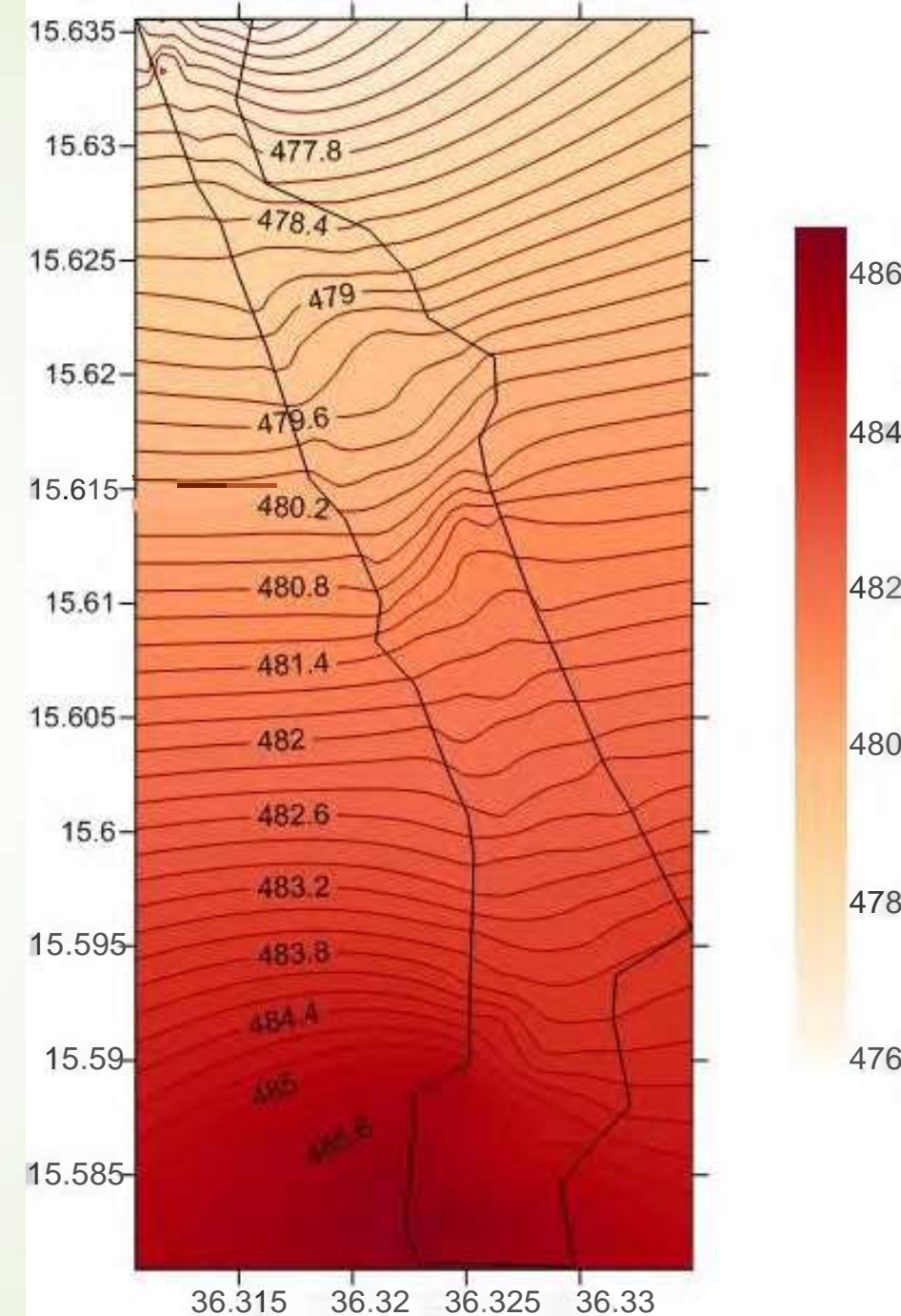


# Surveying Work

Elevation Table

| Distance (m) | Elevation (m) |
|--------------|---------------|
| 0            | 485.729       |
| 103.6688     | 485.698       |
| 635.9703     | 486.196       |
| 2710.441     | 482.819       |
| 2915.188     | 482.791       |
| 3946.767     | 481.620       |
| 4344.235     | 481.539       |
| 5342.112     | 480.159       |
| 5544.929     | 479.870       |
| 6110.561     | 479.372       |
| 6710.597     | 478.139       |
| 8400         | 474.130       |

➡ This table was input to WinSRFR





# Flow measurements

## I. WL measurements

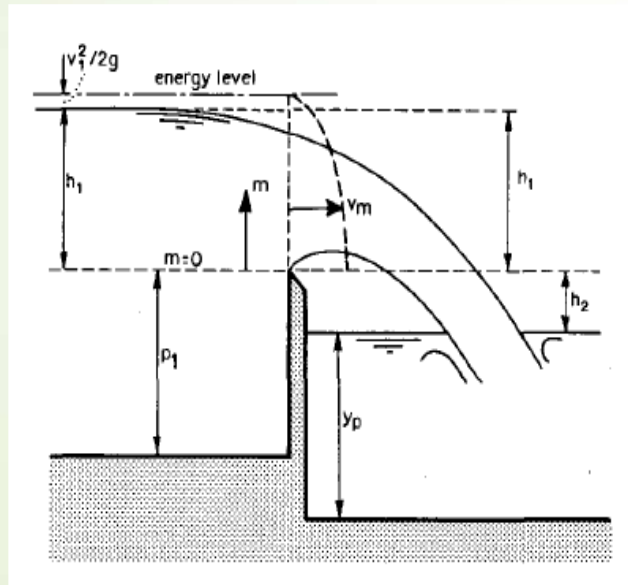


|          | Interval | Duration  | No. of days |
|----------|----------|-----------|-------------|
| Mesga 1  | 2-hour   | 26/7-10/8 | 16          |
|          |          | 25/7-15/8 | 22          |
| Mesga 16 | 2-hour   | 30/7-5/9  | 37          |

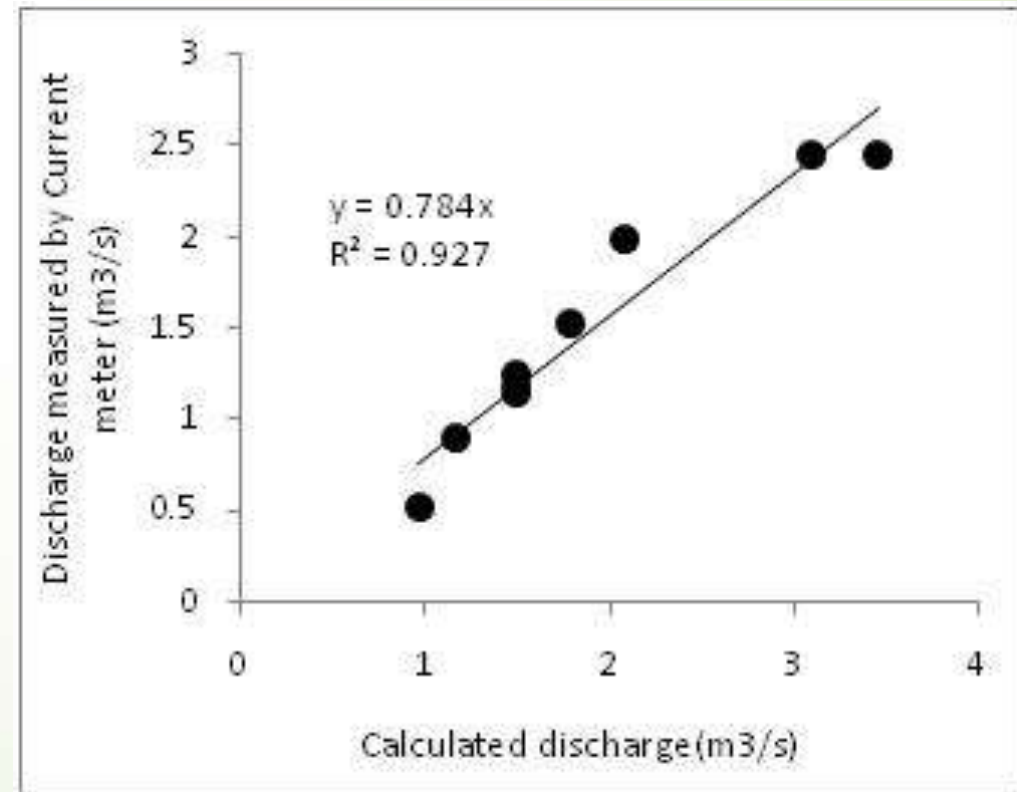


## II. Quantification of flows

Mesga 1 – Kassala Block



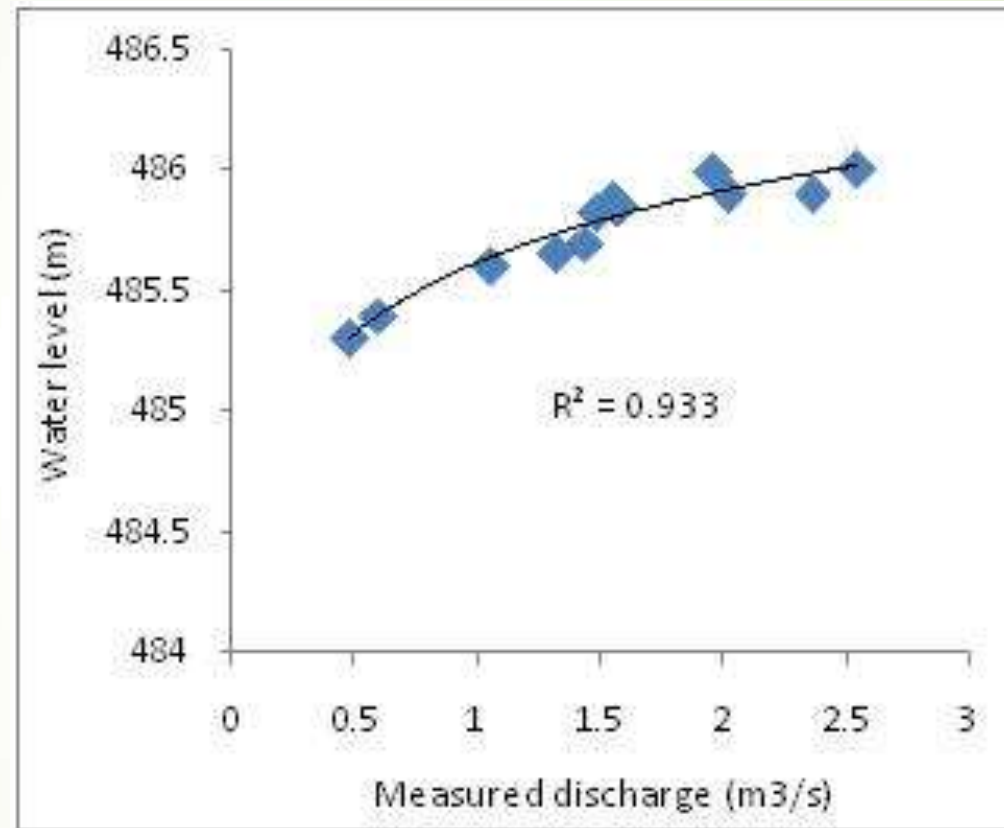
$$Q = C_e \frac{2}{3} (2g)^{0.50} b_c h_1^{1.50}$$





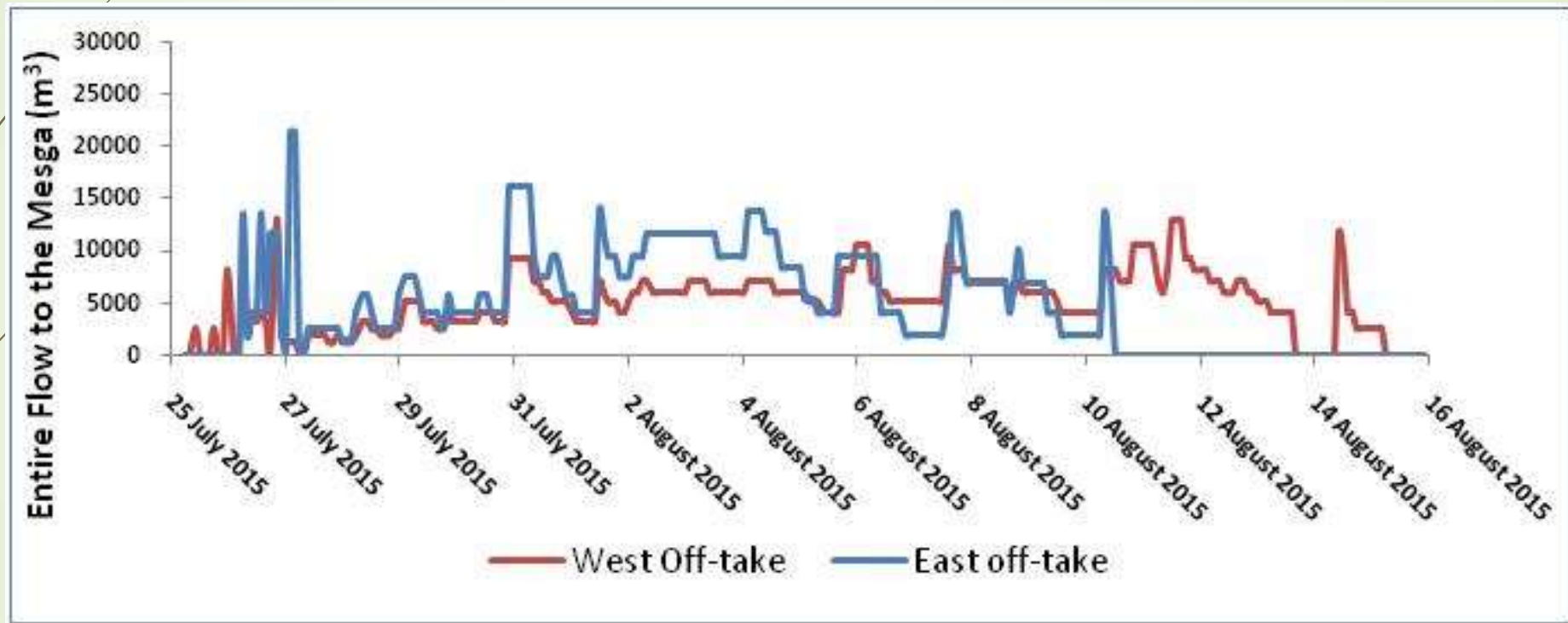
## Mesga 16 – Haddaliya Block

$$Q = a (H - H_0)^b$$





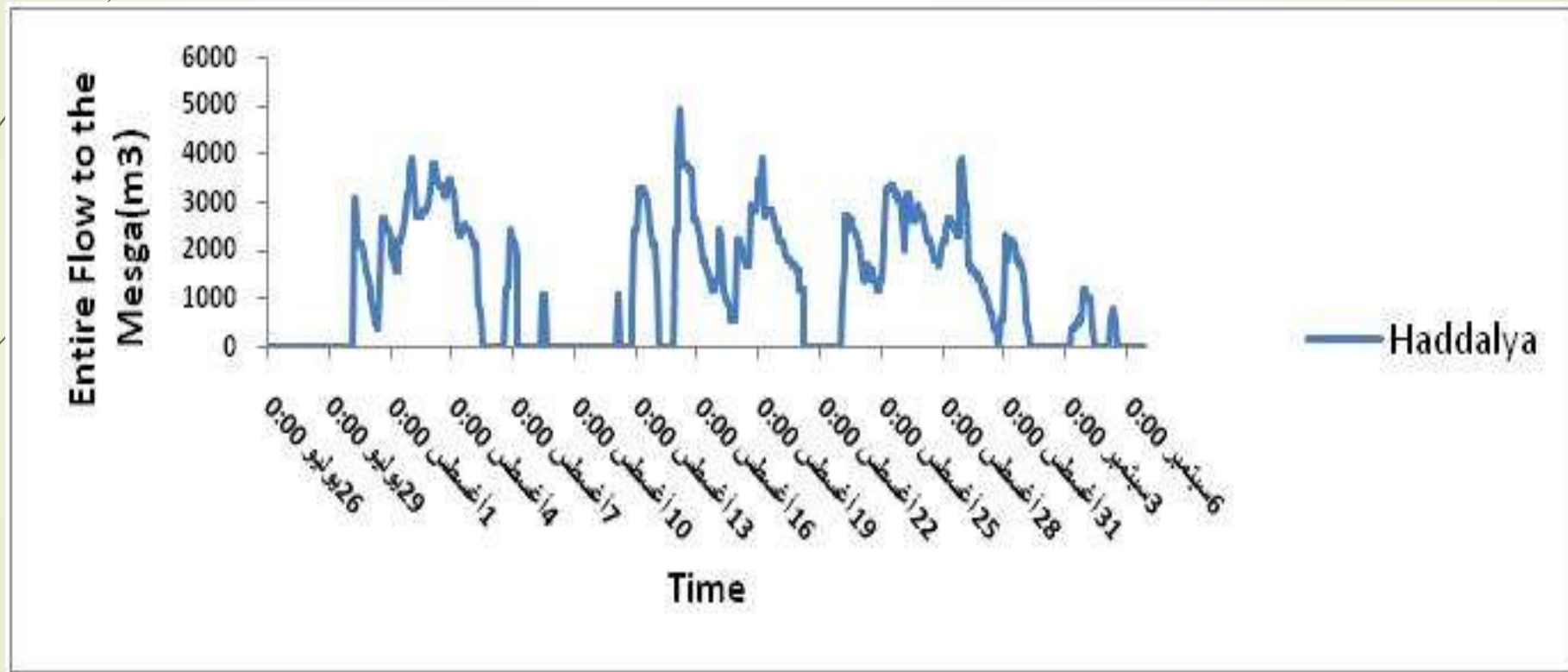
## Inflow measurement ( Mesga 1 – Kassala Block)



➡ 4.7 Mm<sup>3</sup> in 25 days = 2.2 m<sup>3</sup>/s



## Inflow measurement ( Mesga 16 – Haddaliya Block)



➡ 1.29 Mm<sup>3</sup> in 41 days = 0.36 m<sup>3</sup>/s



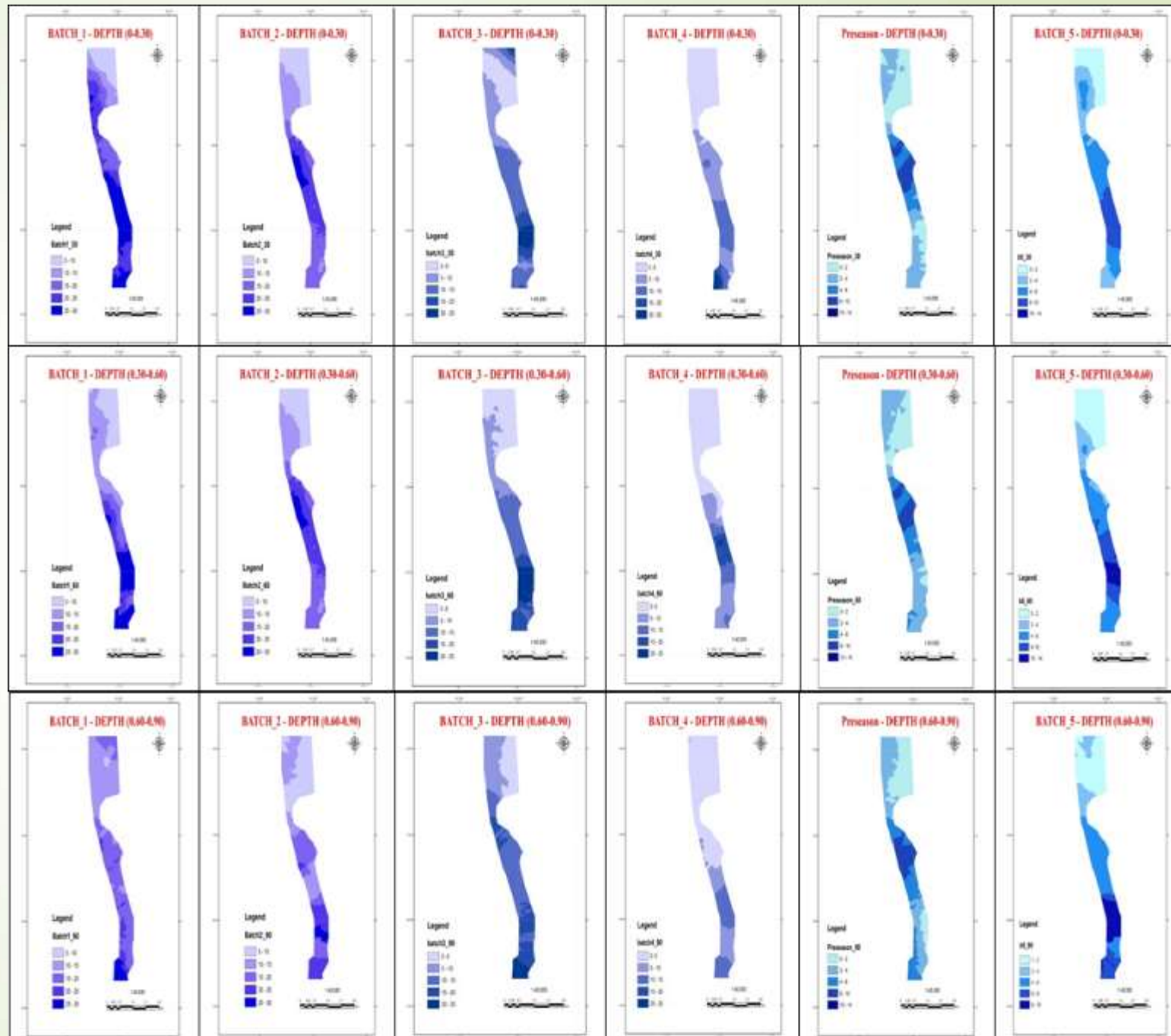
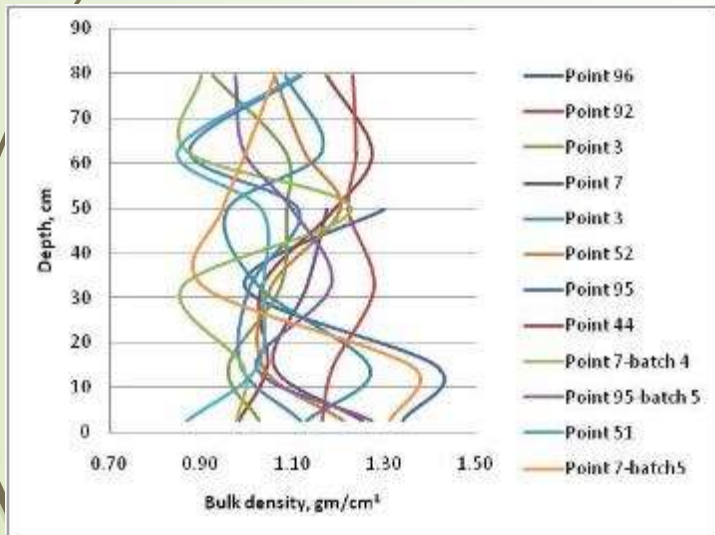
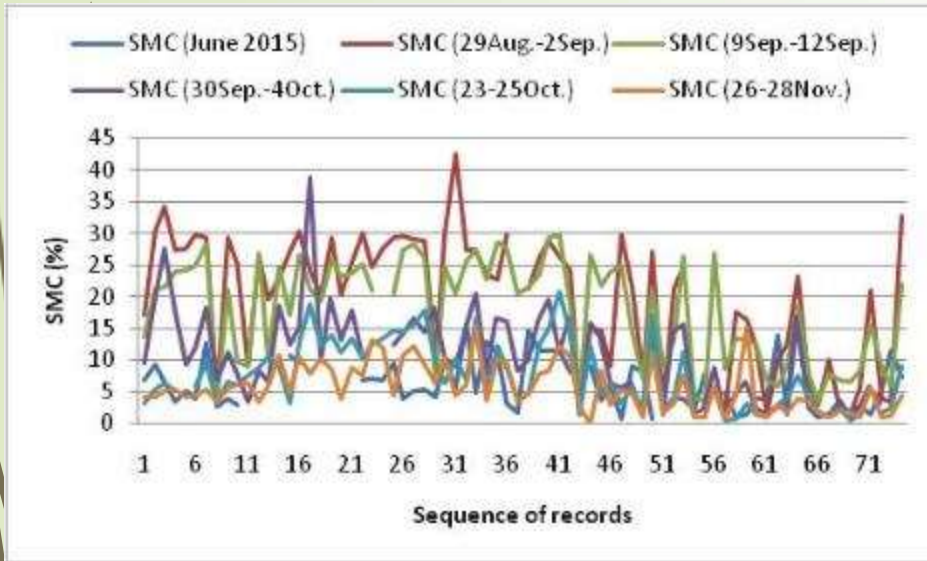
# SMC sampling

| <b>Sampling<br/>Mesga</b> | <b>Pre-<br/>season</b> | <b>Batch 1</b> | <b>Batch 2</b> | <b>Batch 3</b> | <b>Batch 4</b> | <b>Batch 5</b> | <b>Batch 6</b> |
|---------------------------|------------------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Mesga 1                   | 31/5-6/6               | 29/8-2/9       | 9/9-12/9       | 30/9-4/10      | 23-25/10       | 26-28/11       | -              |
| Mesga 16                  | 6/6/201<br>5           | -              | 10/9           | 3/10           | 26/10          | 26/11          | 2/1/2016       |

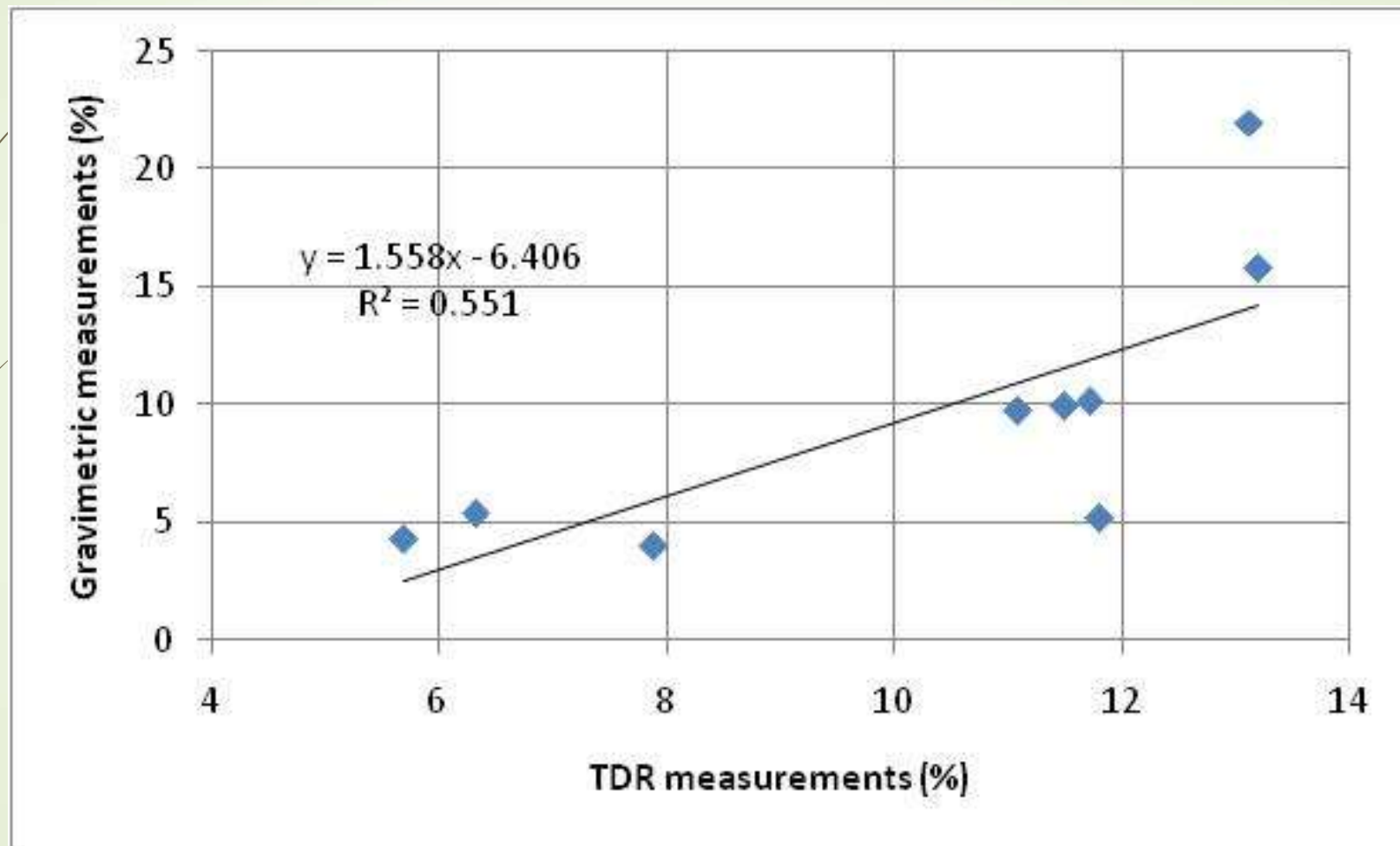




# DETERMINATION SMC





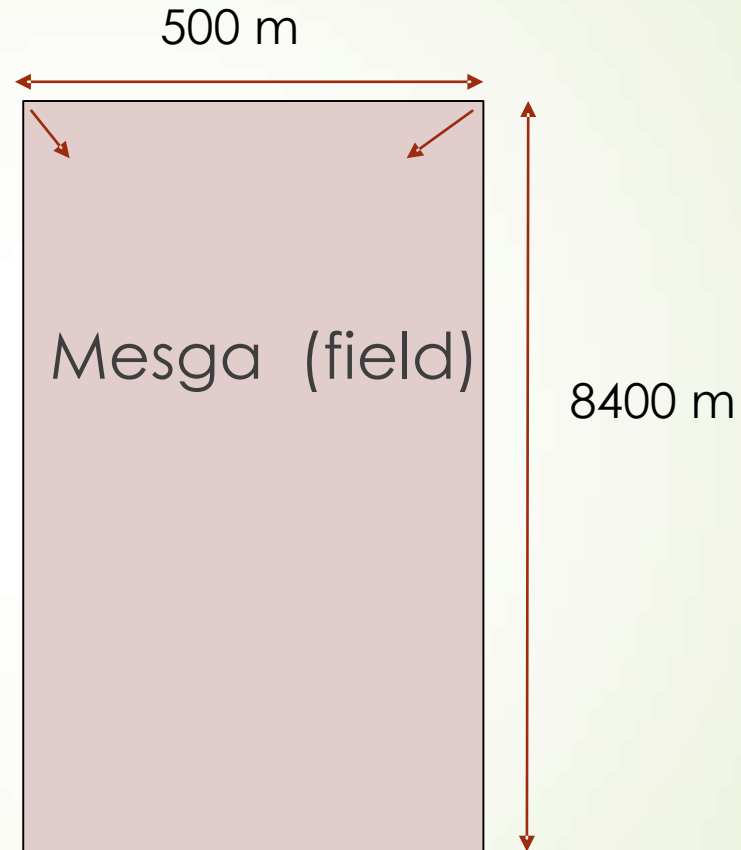




# Scenario formulation

## 1. Current situation

- Area 1000 fd (field/plot) as one field unit
- Irrigation duration: 25 days
- Inflow =  $2.2 \text{ m}^3/\text{s}$
- Soil type: Silt/clay

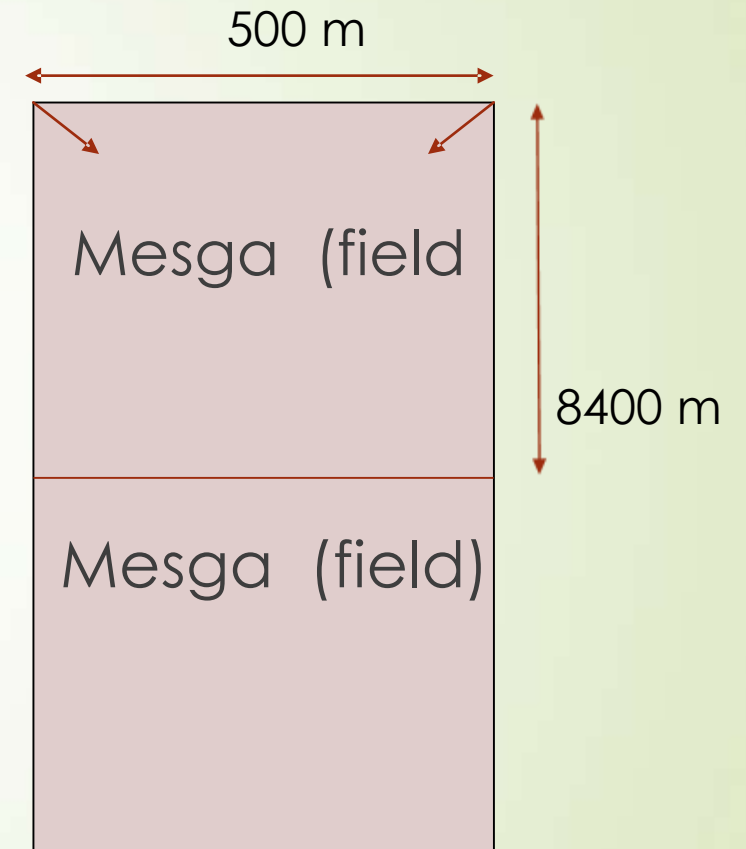
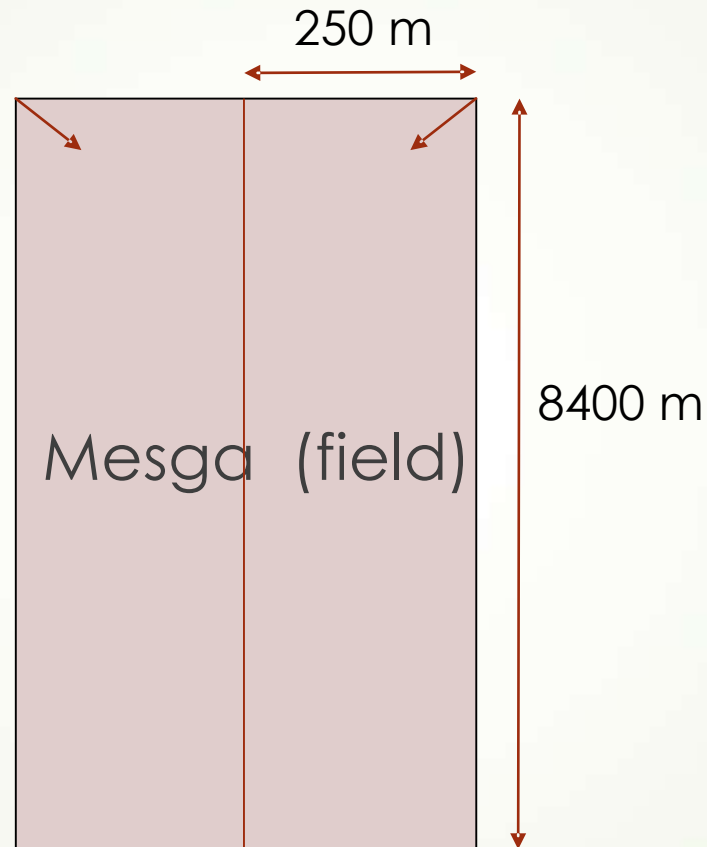




# Scenario Formulation

## 2. Scenario 1

- Mesga divided into two parts vertically/horizontally - 500 feddan each
- Irrigation duration: 10 days for each part
- Inflow =  $2.2 \text{ m}^3/\text{s}$

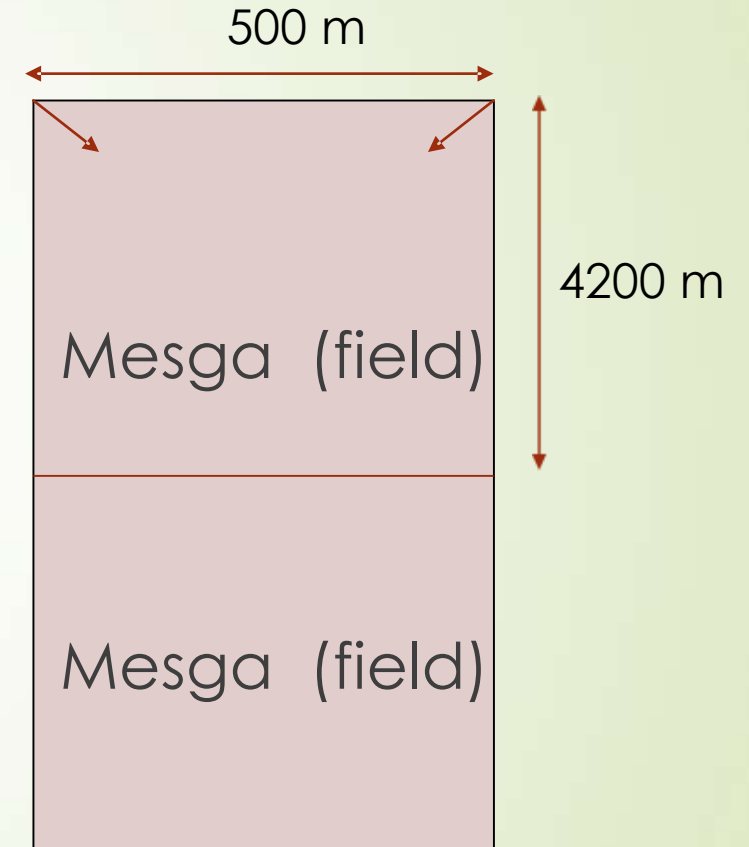
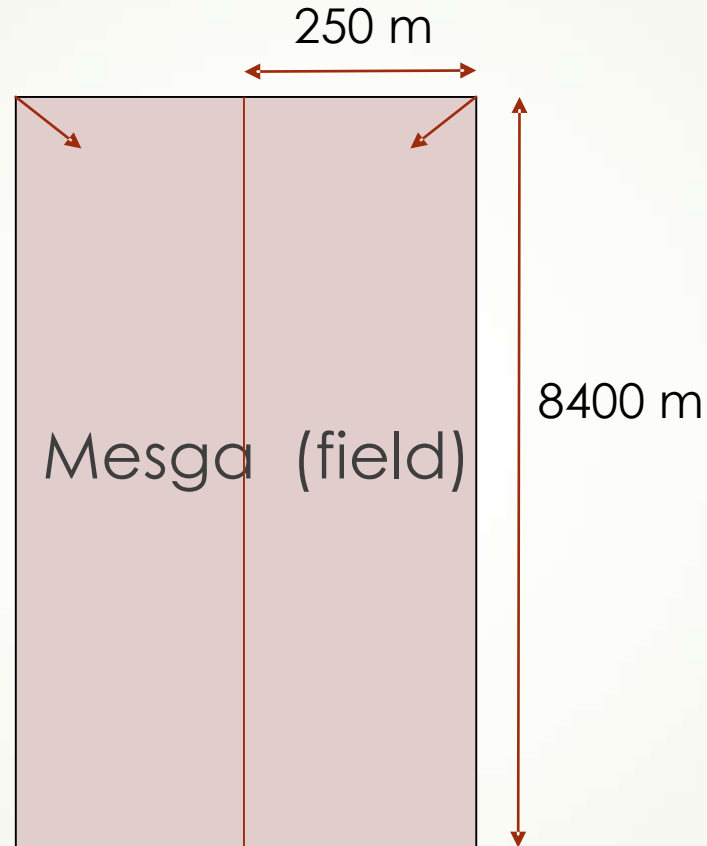




# Scenario Formulation

## 2. Scenario 1

- ➡ Mesga divided into two parts vertically/horizontally - 500 feddan each
- ➡ Irrigation duration: 12.5 days for each part
- ➡ Inform =  $2.2 \text{ m}^3 / \text{s}$

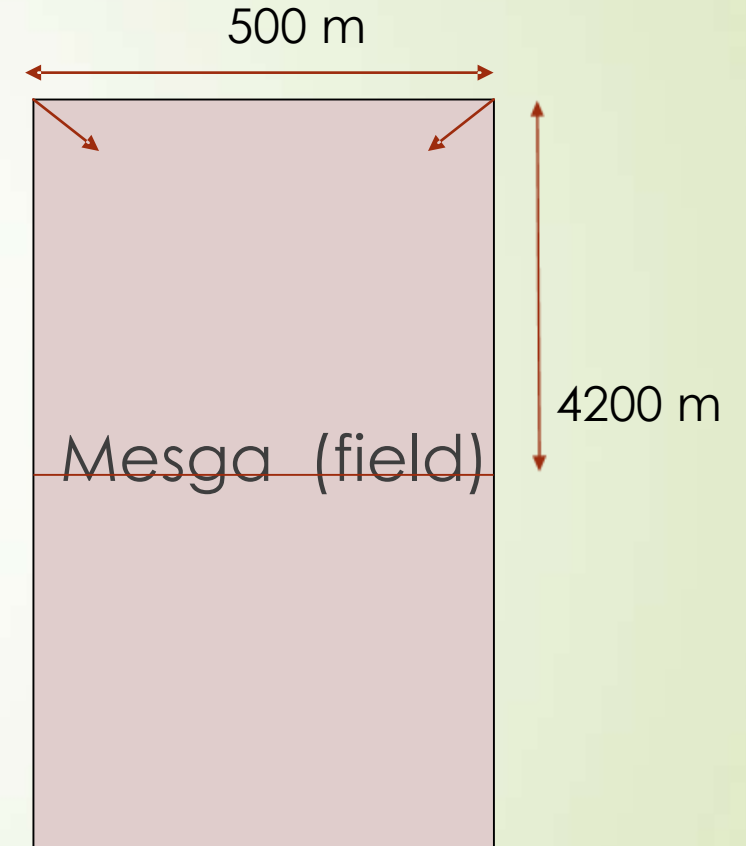
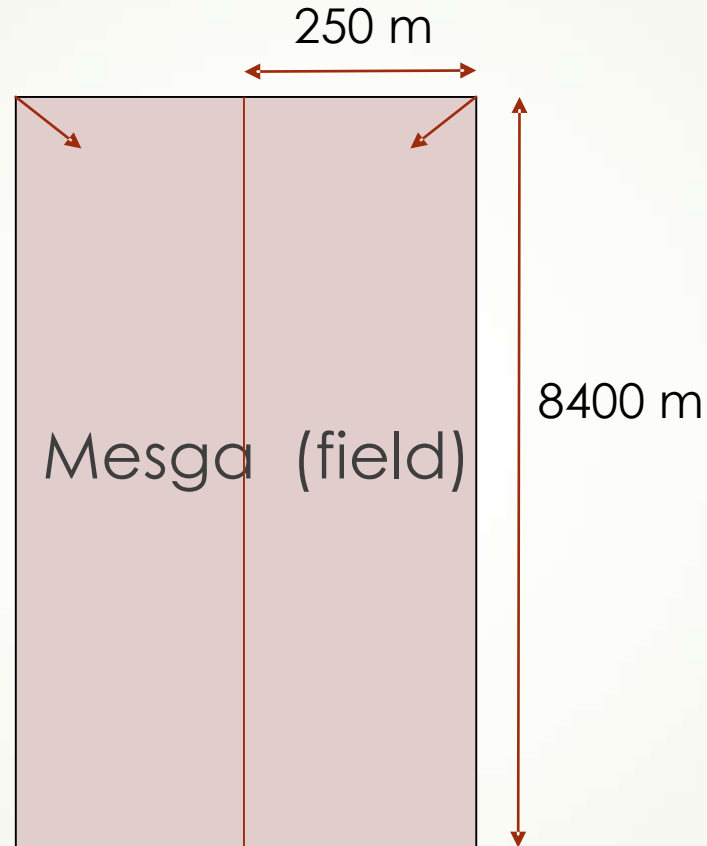




# Scenario Formulation

## 2. Scenario 1

- Mesga divided into two parts vertically/horizontally - 500 feddan each
- Irrigation duration: 15 days for each part
- Inform =  $2.2 \text{ m}^3/\text{s}$



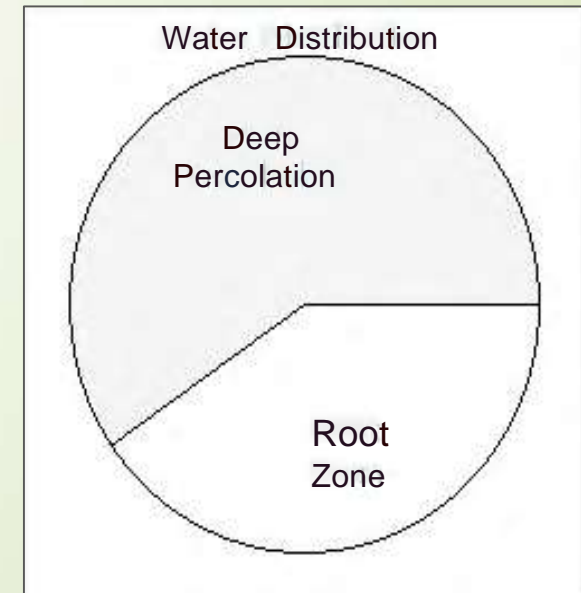
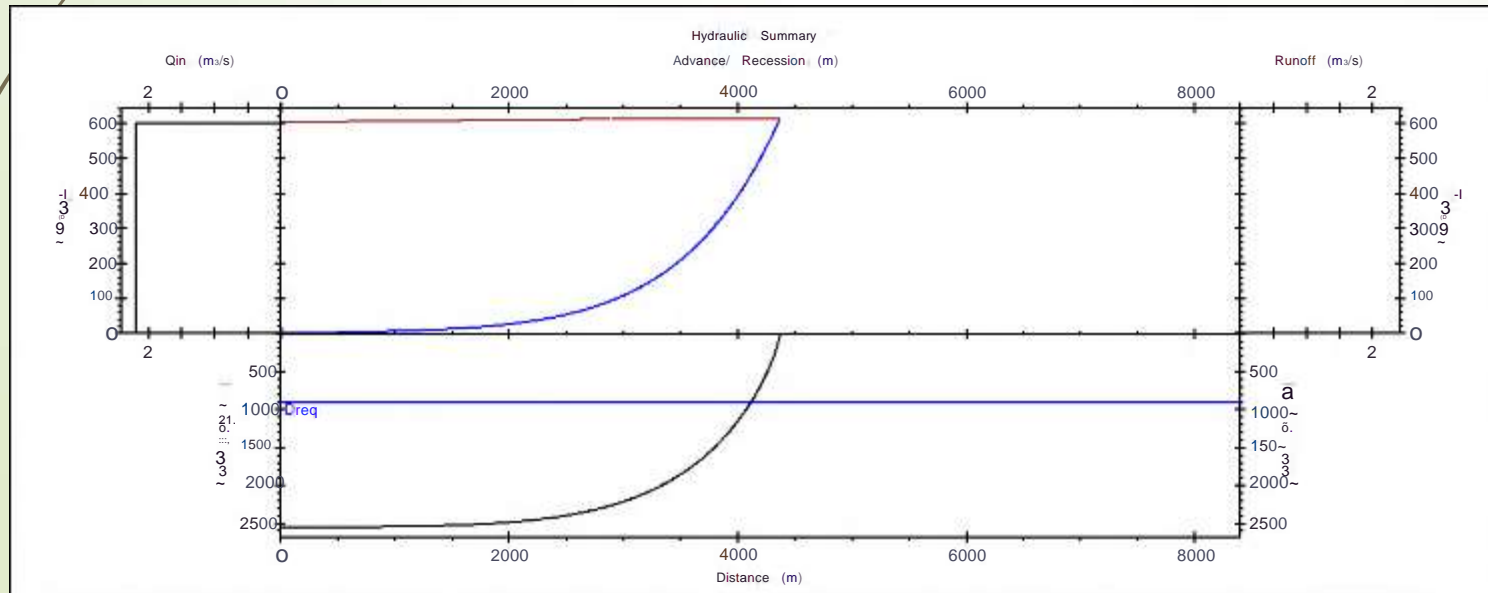


## Current situation

- Irrigation application:  
25 Days
- Mesga (field/plot) size:  
1000 Feddan (420 ha)
- Field layout: 0.00138 m/m  
uniform slope

## Results

- 50% of mesga is dry
- 40% efficiency: 60% deep percolation: Some will recharge the groundwater
  - Some will be available for crops by capillary rise
- In best soils (silt loam), vertical soil moisture movement will recover some of the dry area



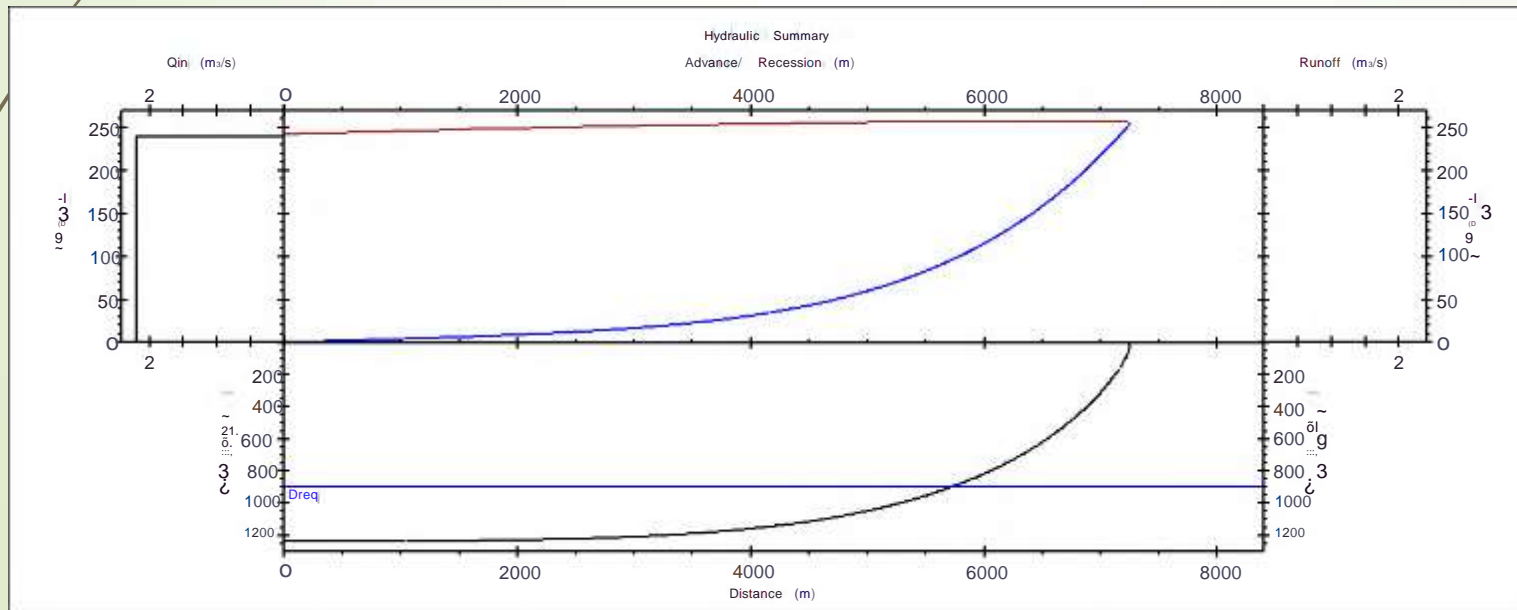


## Scenario 1:

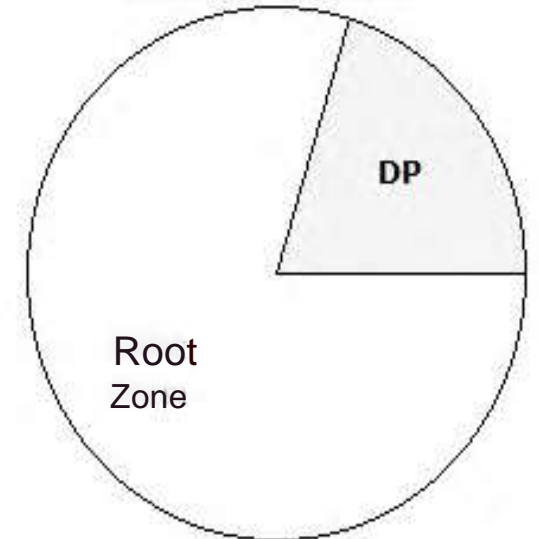
- Irrigation application: 10 Days
- *Mesga vertically/horizontally divided into two (420 ha)*
- Assumption: 0.00138 m/m uniform slope

## Results

- 15% of the mesga remains dry
- 79% efficiency: 20% deep percolation



Water Distribution



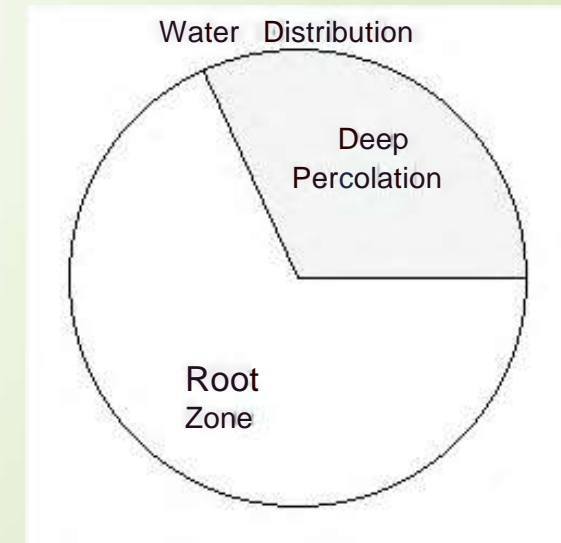
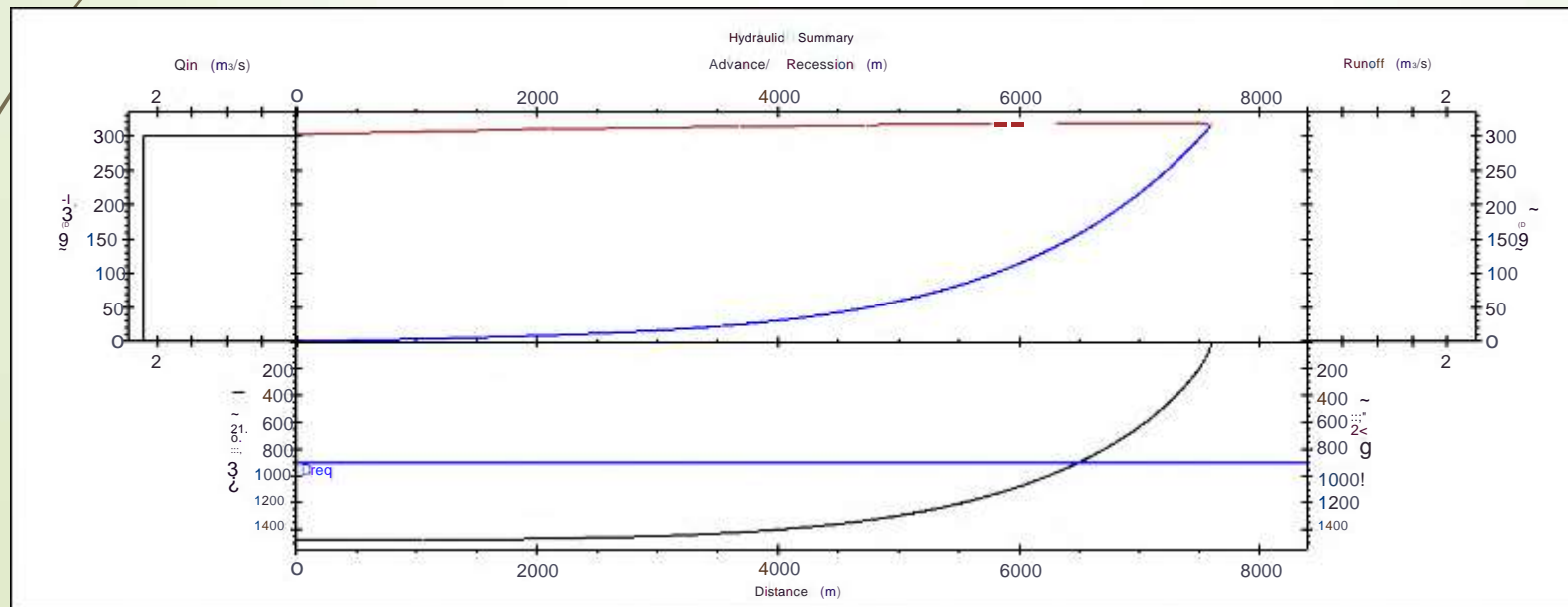


## Scenario 2:

- Irrigation application: 12.5 days
- *Mesga vertically/horizontally divided into three (240 ha)*
- Assumption: 0.00138 m/m uniform slope

## Results

- 10% of the mesga remains dry
- 64% efficiency: 32% deep percolation



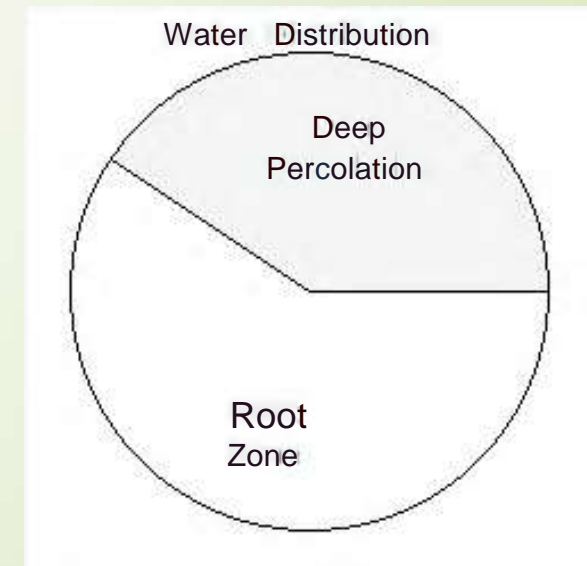
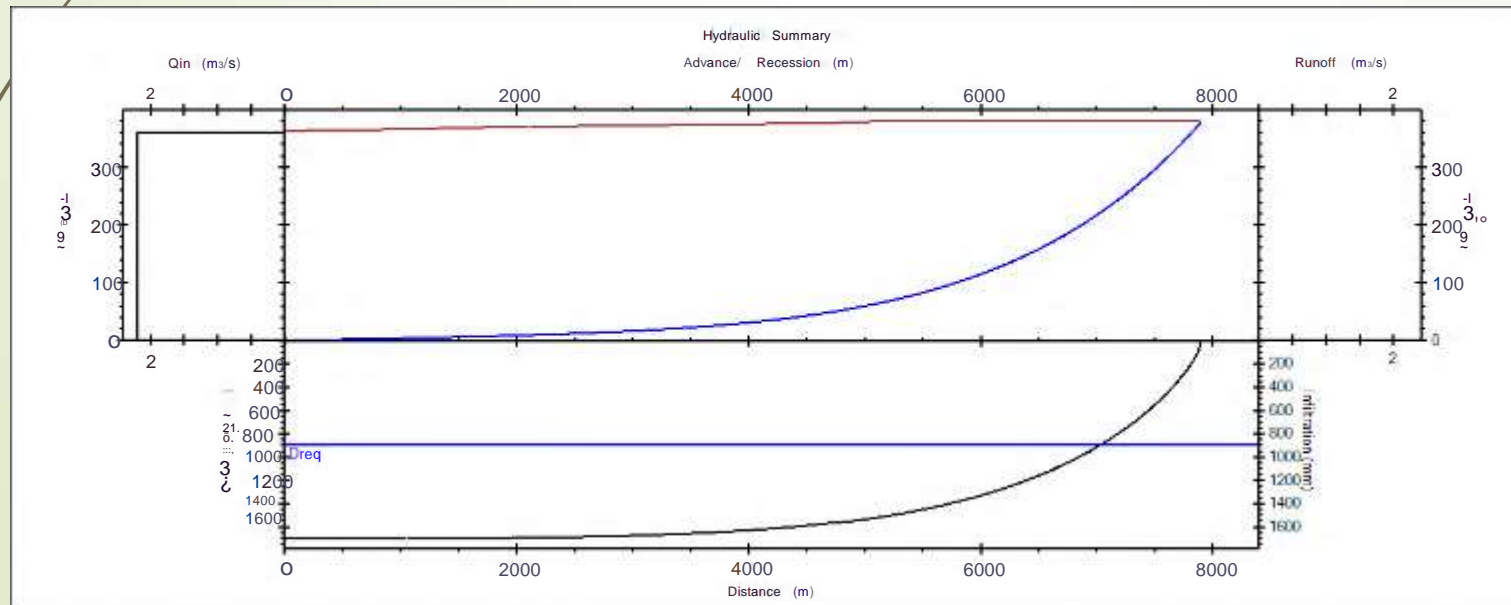


### Scenario 3:

- Irrigation application: 15 days
- *Mesga vertically/horizontally divided into three (240 ha)*
- Assumption: 0.00138 m/m uniform slope

### Results

- 5% of the mesga remains dry
- 60% efficiency: 40% deep percolation





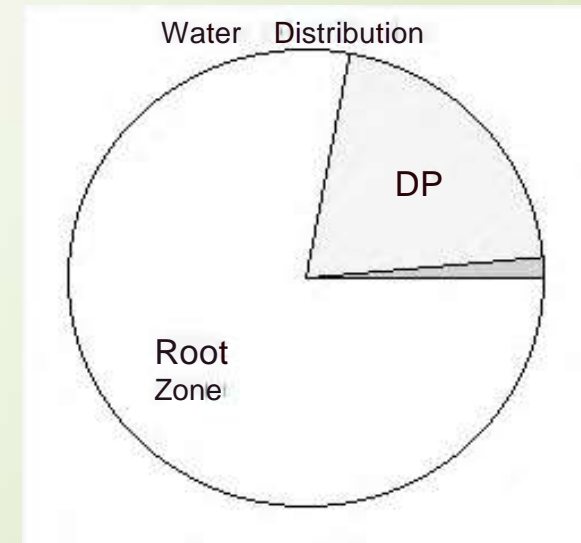
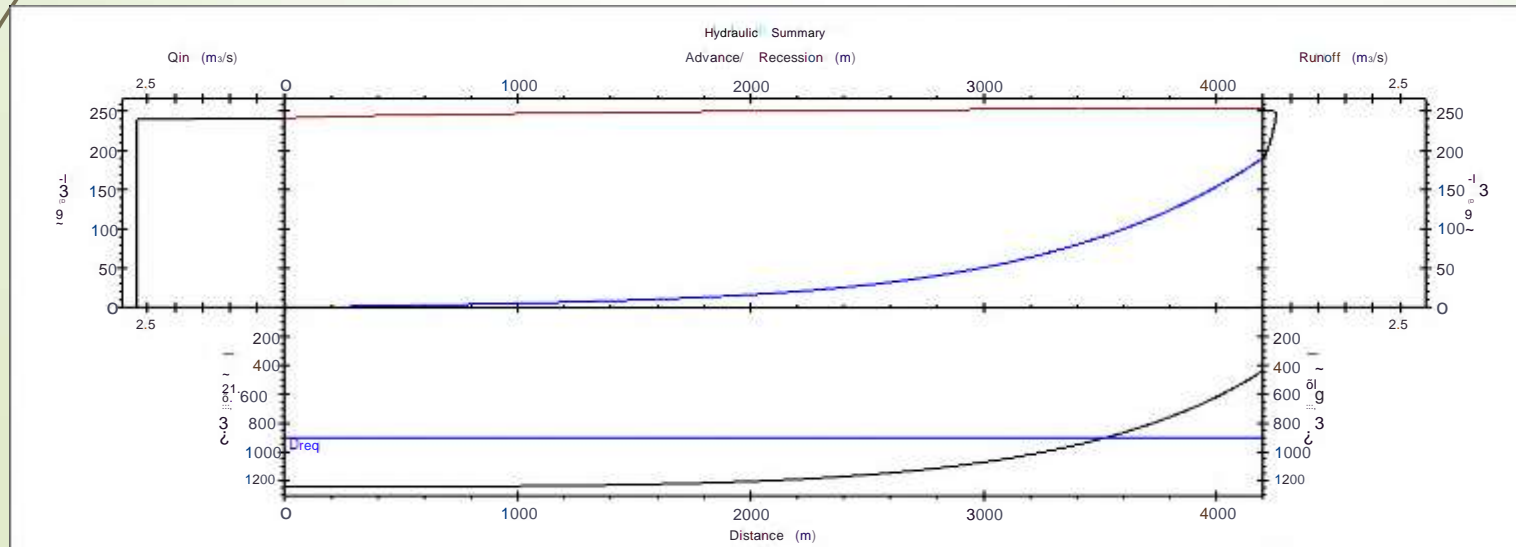
# Special Case (Mesga 1)

## Scenario 3:

- Irrigation application: 10 days
- *Mesga vertically/horizontally divided into three (240 ha)*
- Assumption: 0.00138 m/m uniform slope
- Inflow = 2.7 m<sup>3</sup>/s

## Results

- All the Mesga is irrigated
- 78% efficiency: 21% deep percolation





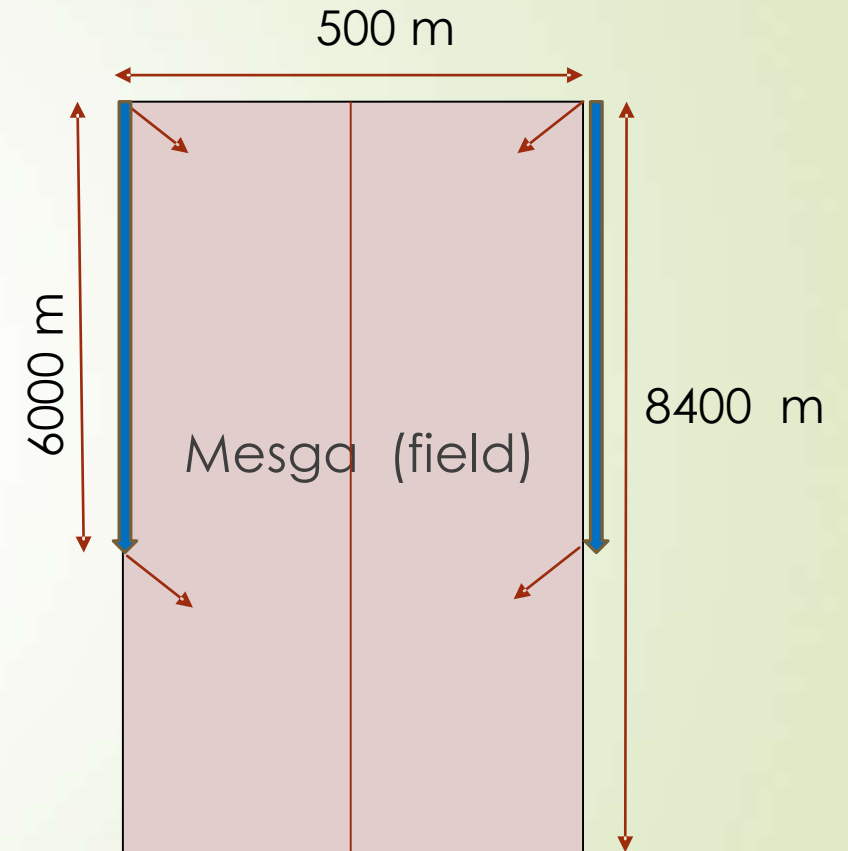
# Constraints/obstacles





# Recommendations

1. Divide the Mesga vertically into two parts of 500 feddan each
2. Introduce field channels covering at least 2/3 of the total length on both sides of the field(see blue line)
  - This will compensate for land levelling – the simulation assumes the fields are levelled throughout, which is not the case in reality





# Implementation Approach and estimated costs

- Approach: Pilot test the proposed intervention in 2 mesgas
- Cost of pilot test as estimated below

| Cost items   | Units          | Unit cost in SDG | Total units | Total cost in SDG |
|--|----------------|------------------|-------------|-------------------|
| <i>Investment cost</i>   |                |                  |             |                   |
| Dividing a mesgha (field)  | Hrs            | 350              | 8           | 2800              |
| feld canals  | M <sup>3</sup> | 4                | 12000       | 48000             |
| <i>Sub-total</i>   |                |                  |             | <i>50800</i>      |
| <i>Implementation cost</i>   |                |                  |             |                   |
| Researchers (flow measurement, soil moisture sampling, data analyses, reporting)         | Month          | 6000             | 6           | 72000             |
| Support staff - technicians (assist in data collection)                                  | Month          | 4000             | 6           | 48000             |
| Support staff – drivers  | Month          | 3000             | 6           | 36000             |
| Support staff daily labourers  | Month          | 500              | 6           | 6000              |
| Supervision staff  | Month          | 8000             | 1           | 16000             |
| Fuel cost  | litres         | 750              | 3           | 4500              |
| Guards   | Month          | 500              | 6           | 6000              |
| Other logistics such as batteries for GPS, torch, simple repair and spare parts for car) | Month          | 2500             | 3           | 15000             |
| <i>Subtotal</i>  |                |                  |             | <i>203500</i>     |
| <i>Grand total for 1000 feddan field</i>   |                |                  |             | <i>254300</i>     |
| <i>Grand total per feddan</i>  |                |                  |             | <i>254.3</i>      |





## PHASE II

- According to the results that was shown in the workshop where was hold in Kassala state in December 2016,the Administration and leader farmers in GAS were being discussed to applied the proposed solution in cropping season in 2017
- based on what is addressed in the workshop and meetings the field preparation is being gone so far to ensure succeed the experiment.

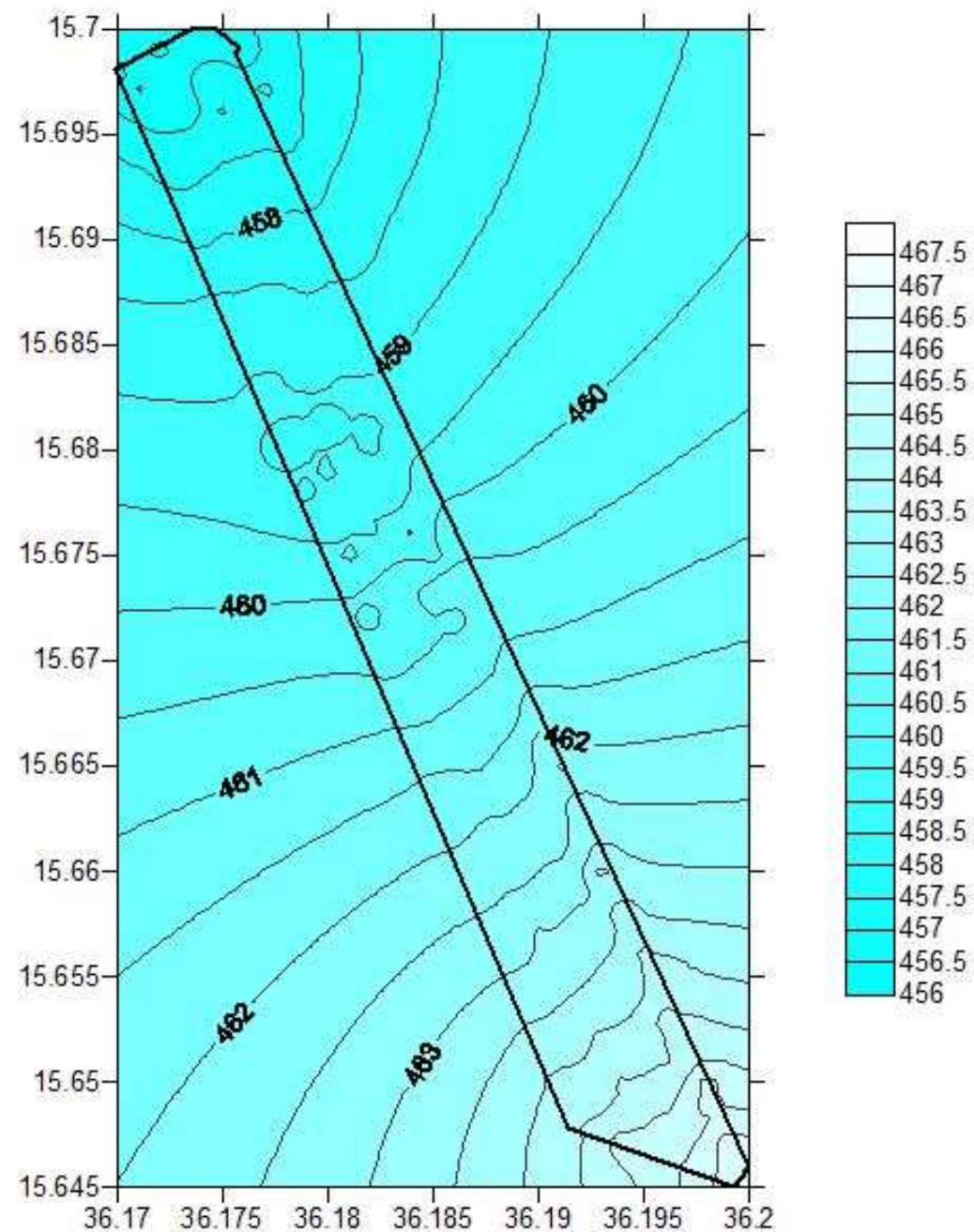


## SIDE VIEW OF MEETINGS AND FIELD VISIT

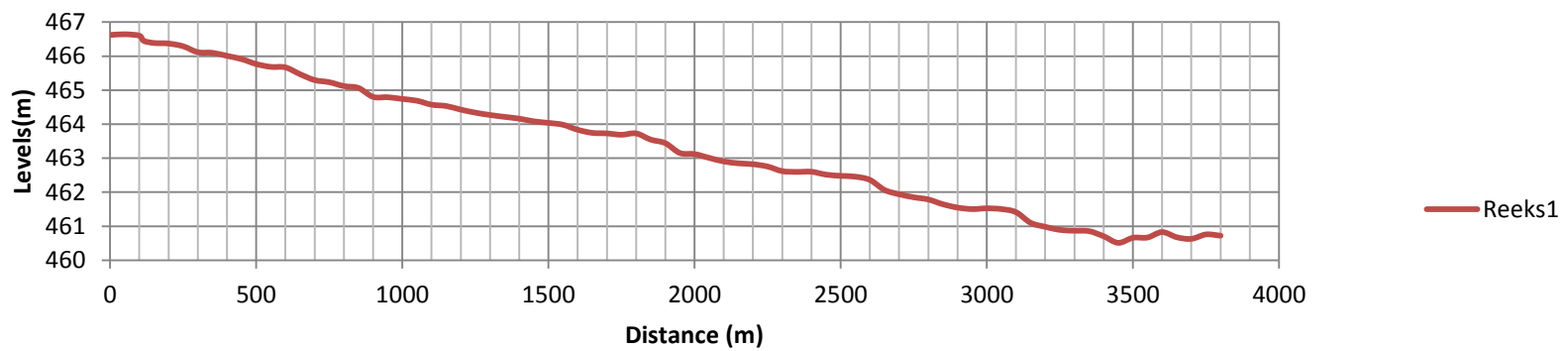




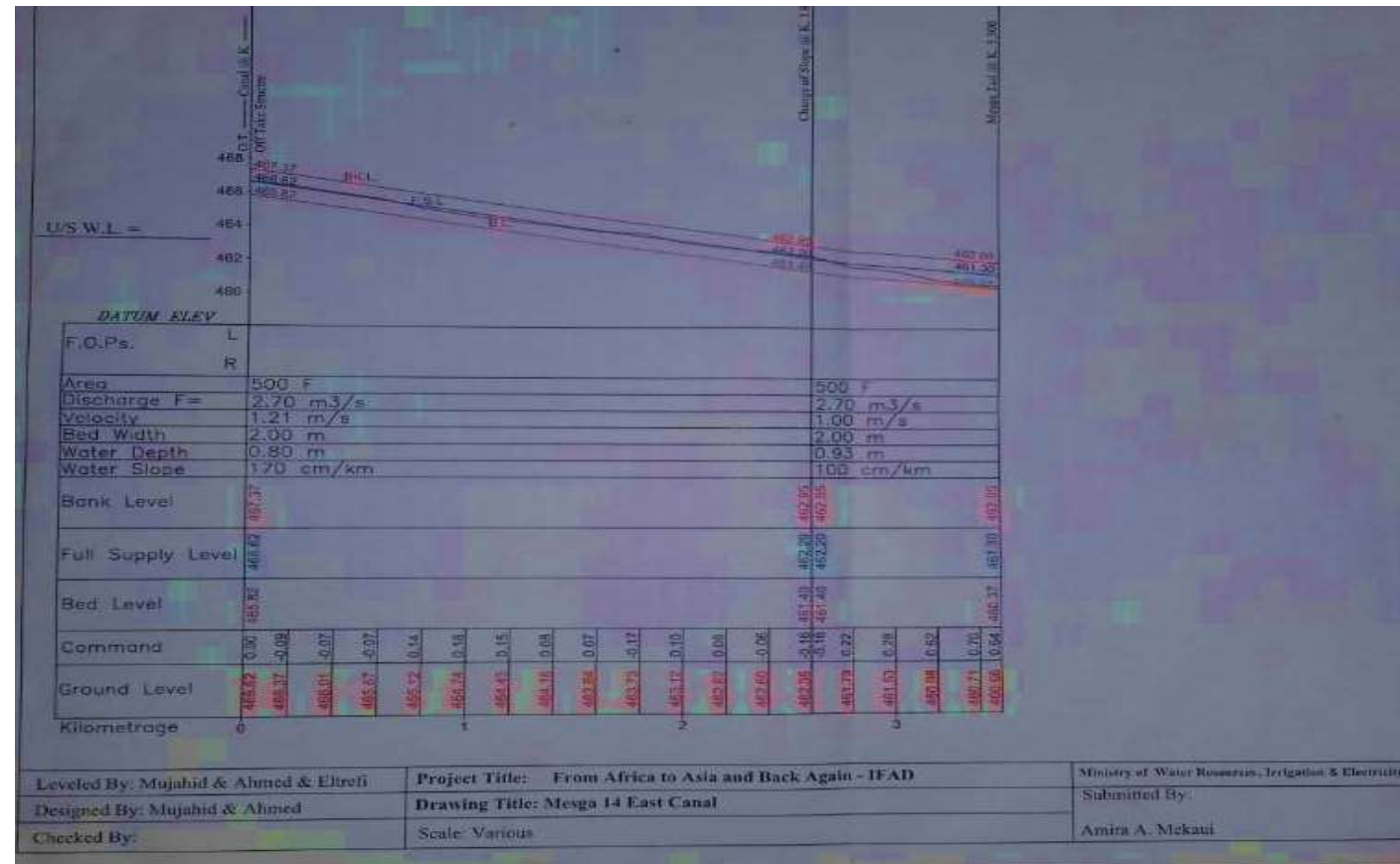
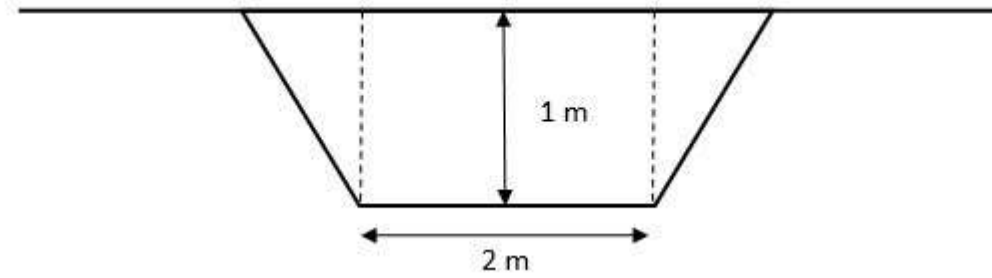
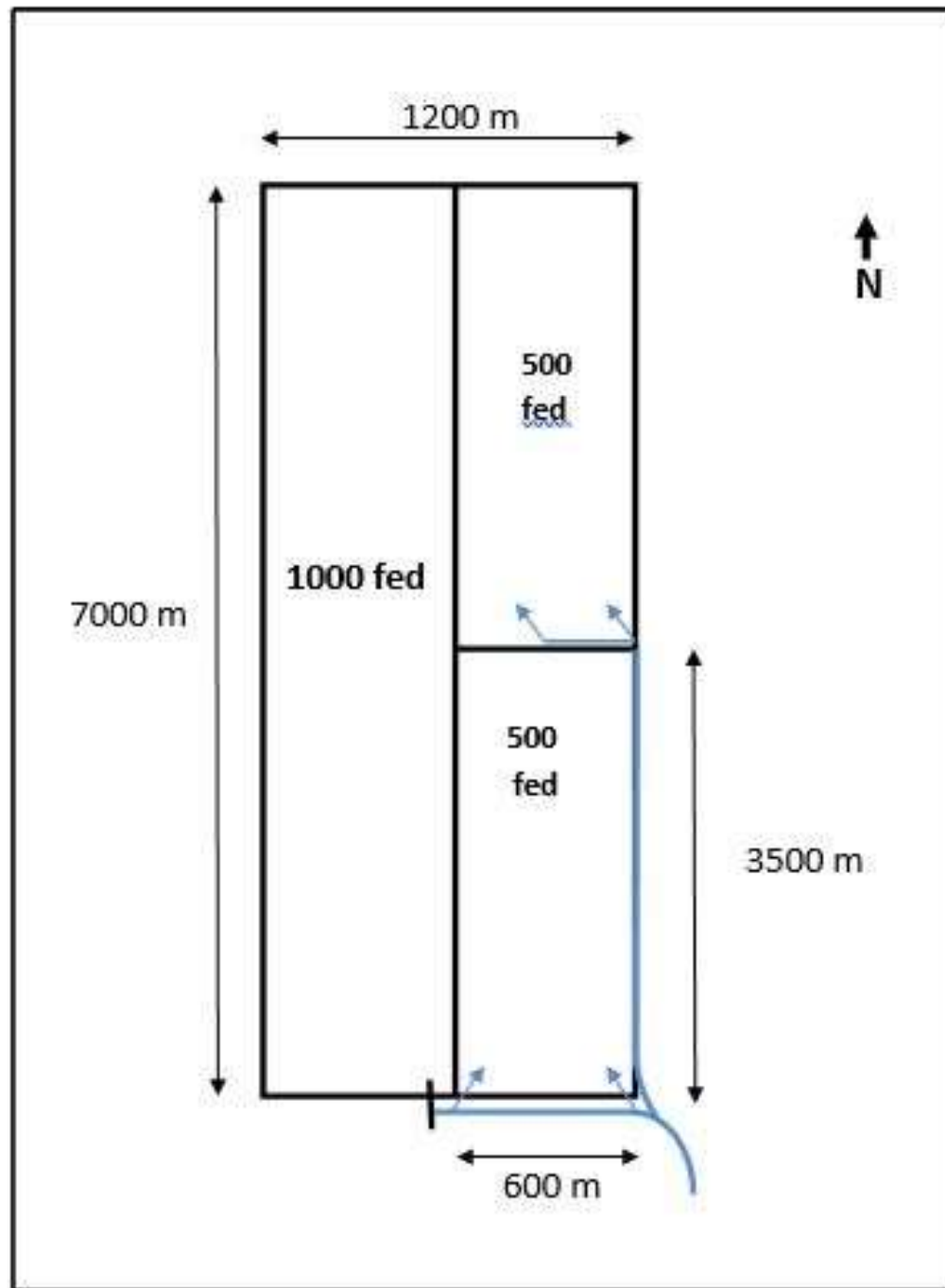
## Mesga 14 East













***THANK YOU***

