



Efficient distribution and use of soil moisture and ecosystem services



**Research
Program on
Water, Land and
Ecosystems**



Launch Workshop: Harnessing Floods for Enhanced Livelihoods and Ecosystem Services

ECOSYSTEM SERVICES MANAGEMENT

1 manage soil moisture and soil fertility



2 manage microclimate



3 manage sedimentation



Distribution of fine sediments

Distribution of micronutrients

Soil Moisture and Ecosystems Studies

Why?

- To better understand issues and ecosystem services of soil moisture
 - Moisture movement in space and time (incl capillary rise)
 - Link to water stress or root zone water logging > result of current mesqa system
 - Link to soil fertility
- To complement groundwater and crop (AquaCrop) modelling for the entire area
- To evaluate proposed pilot on soil moisture
 - Pilot mesqa (with field canal)
 - Control mesqa



Optimal condition for plants



Reduced stress



Nitrogen fixation



Secure microclimate



(Capillary) Water for plants



Nitrogen release



Environment for soil biota



Temperature of soil and atmosphere

SOIL MOISTURE

Degree (%) of soil moisture



Depth of soil moisture



Memory



Variation of soil moisture



Clay: slow but high capillary rise
(up to 2,5m²)
Silt: fast but medium capillary rise



CAPILLARY RISE EFFECTS



Stored moisture moves upwards in cold season providing sub-irrigation

Redistribution of infiltrated water

Recharge



Frost heave

- Freezing temperatures
- High water tables
- Frost susceptible soils
 - Salty soils
 - Non compacted clays
 - No gravels or non swelling clay layers

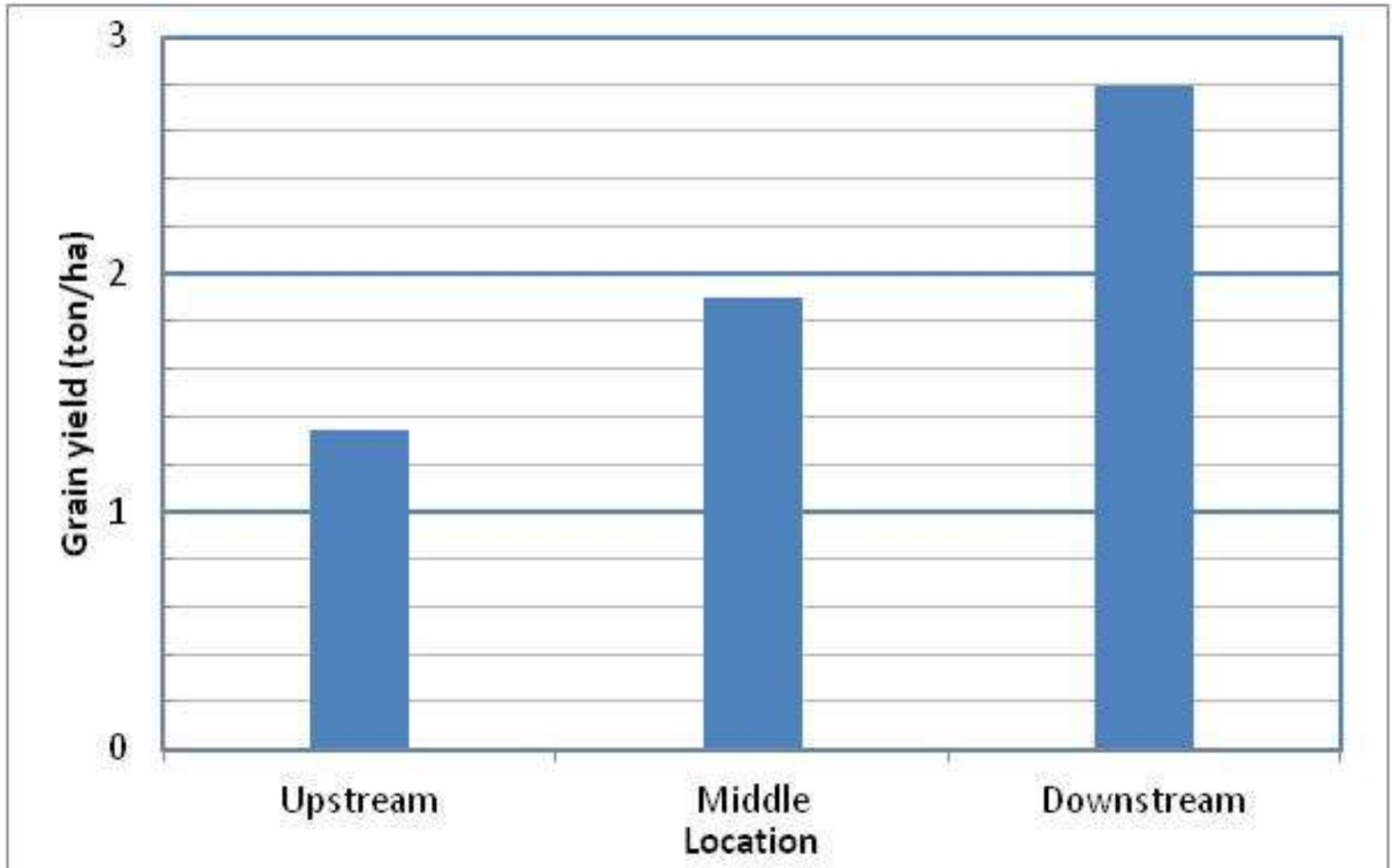
From: Ali M. Adeeb

Effect of Land Inundation Period on Spate Irrigated Sorghum Yield in Gash Delta, Sudan

- **Mesqa = 7600 meter long.**
- **Non-uniform coverage**
- **More than 27% of the misga area was not irrigated.**

- The mean wetting front (downward percolation) reached
- 2.7 m, upstream
- 2.07 m, middle
- 1.43 m, downstream

Grain Yield



Site	Yield (ton/ha)	Water (mm)	Productivity (kg/mm)
Upstream	1.34	663.60	2.02
Middle	1.90	542.01	3.51
Downstream	2.79	412.80	6.76

Water spreading through guide bunds

Water is spread through the command area using guide bunds



Field to field irrigation



Link to other studies

- Link to water allocation/ irrigation scheduling (different soils with different irrigation requirements and production potentials)
- Link to groundwater recharge (risk of surface sealing and effect on soil biota)

Two quick supplementary studies

1. Quality of sediment (Gash system transects)
 - Organic content (first flush)
 - Grain-size distribution
 - Micro-nutrient distribution (Fe, Se, Zn, I)
2. Link between soil moisture and micro-climate
 - Temperature in/outside system (Gash Dy)
including relation fluctuation-moisture

- Carried as part of sediment
- Distribution varies

MICRONUTRIENTS



Zn

1 Zinc

Se

2 Selene

I

3 Iodium

Fe

4 Iron

- Clay soils % availability is lower
- Acidity affects availability differently for different micro-nutrients

Total vs. available micronutrient for uptake by plants



Several factors



Uptake in human body

1 Soil characteristics (permeability)



2 Duration of run-off > high infiltration rates at beginning of event, followed by rapid decline to lower near-constant values



7 swelling, drying and cracking of some soils

INFILTRATION RATE IS INFLUENCED BY:



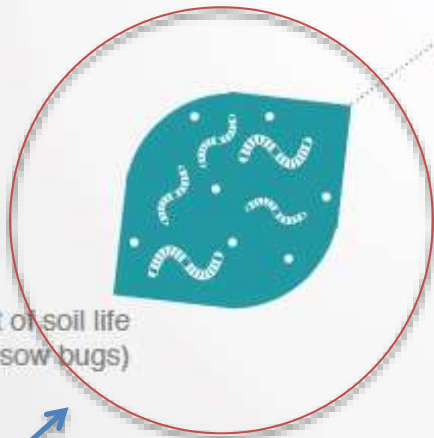
3 Degree of soils of surface compaction and sealing by fine particles



4 Depth of soils (Thin soils need high impact rainfall to penetrate to deeper layers)



5 Degree of saturation of soils

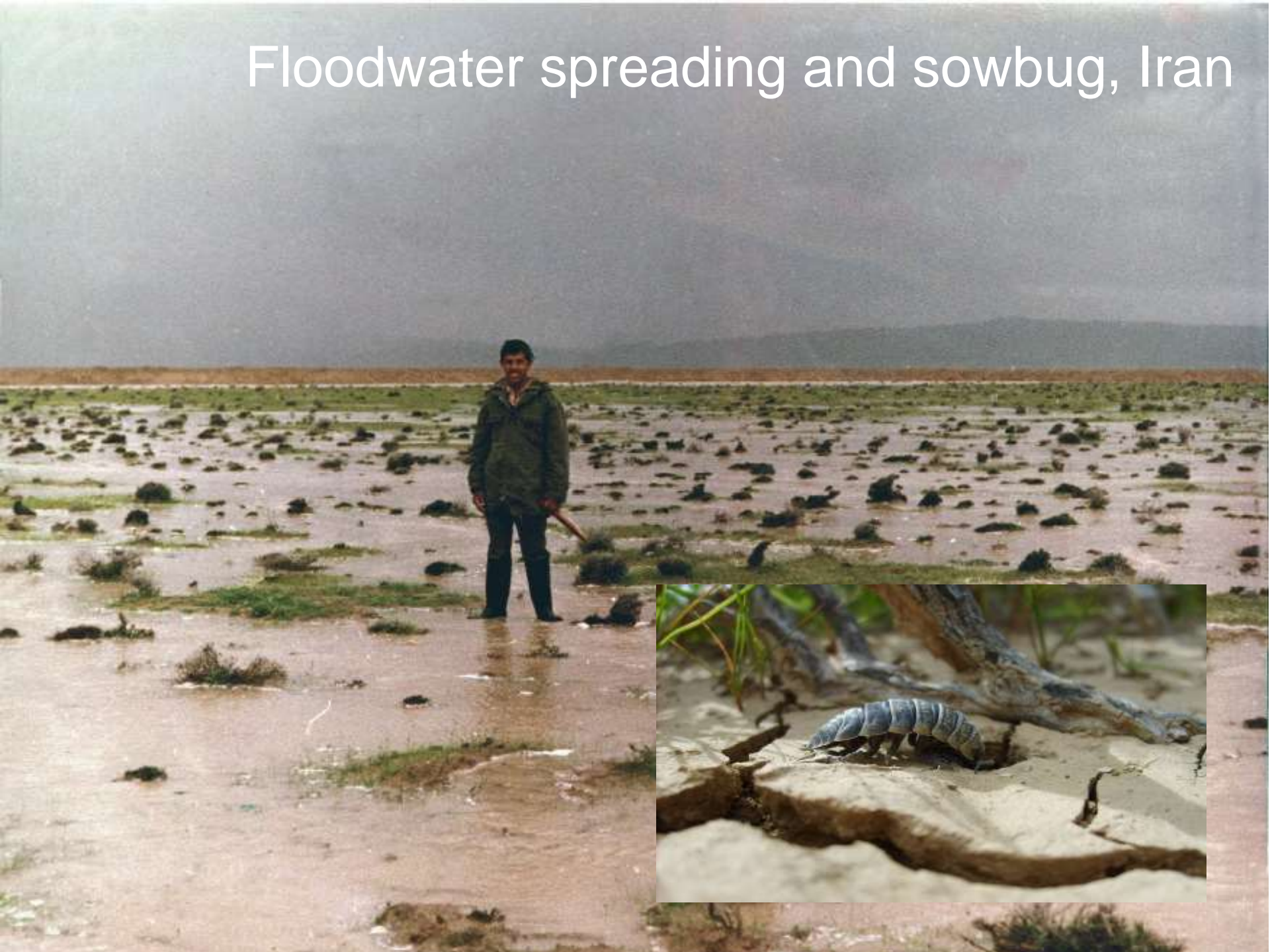


6 burrowing effect of soil life (rain worms, sow bugs)



Rapid assessment

Floodwater spreading and sowbug, Iran



SOIL MOISTURE TO SOIL TEMPERATURE

- ALBEDO (COLOUR)

- Wet sand albedo > dry sand

- Hence absorb more solar energy



- HEAT PER VOLUME

- increase with water content

- heating/cooling off is less in wet than in dry soils



Very wet and very dry soils do not heat up easily

- HEAT CONDUCTIVITY

- Increase with water content

- Heat used in evaporation > temperature down



- Heat used in dew formation > temperature down



Activity	
Transect of farmers/ focus group discussions	Soil classification Understanding of soil processes: <ul style="list-style-type: none"> - Presence of soil biota in different soils - Nitrogen fixation - First flushes - Soil temperature - Capillary rise - Overirrigation - Link with microclimate
Overall soil mapping (incl micro nutrient)	Check existing studies
Pilot area and control area and detailed soil moisture and nitrogen	Depth and spread over time of soil moisture, soil temperature
Special studies	Quick micro climate comparison Sediment quality transect Soil life