STARS-ISIS

Irrigation Scheduling and Information Services for the Delta region in Bangladesh

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Team

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- Bruno Gérad, Director Global Conservation Agriculture
Partners

- **CEGIS**: Center for Geographic information
  - Mohammad Shahidul, Director of RS Division
- **IWM**: Institute for Water Modeling
  - Mr. Zahirul Haque Khan, Director, Coast, Port & Estuary Division
- **BIID**: Bangladesh Institute of ICT in Development
  - Shahid Uddin Akbar, Director
- **BWDB**: Bangladesh Water Development Board
- **BADC**: Bangladesh Agricultural Development Corporation
- **DAE**: Department of Agricultural Extension
- **iDE**: International Development Enterprises
Abundant water, but little irrigation in the South

- Irrigation facilities least developed in the South.
- Shallow aquifers are usually saline.
- Surface water alternative?

Deep and shallow tube wells:
- 0 - 954
- 954 - 7059
- 7059 - 19311
- 19311 - 29030
- 29030 - 38825
- 38825 - 51644
- 51644 - 88158
Surface water irrigation to hedge risk

The Axial Flow Pump: Up to 50% more fuel efficient for low-lift pumping
Krigged surface water salinity: 90th percentile Weeks 1-2
Krigged surface water salinity: 90th percentile Weeks 5-6
Krigged surface water salinity: 90th percentile Weeks 9-10
Krigged surface water salinity: 90th percentile Weeks 13-14
Surface water irrigation to hedge risk

- 10 year bi-weekly median water salinity
- Interpolation by kriging
Objectives

• Use Case 1: Analysis at the macro- (regional watershed) and meso- (sub-regional watershed) scales to determine safe operation space and best bet areas for technology targeting.
Processing steps to determine Safe operating space

1. Satellite data monthly December-April → Classification → Crop land data layer
2. Waterways (FINNMAP) → Classification → River water availability → Intersect
3. DEM
4. Estimate crop water use
   - 20 years of weather data
   - Maximum potential crop water use
5. For various scenarios, simulate effects of crop water use on surface water dynamics (quantity and salinity)
6. Safe operating space for irrigable area

Addressable cropland
Use Case 2

- Development of an irrigation scheduling service for 4 major crops:
  - Maize
  - Wheat
  - Rice
  - Mungbean
CWU Estimation Using Remote Sensing

Daily CWU can be estimated using the “spectral crop coefficient” approach:

\[ \text{CWU} = K_{sp} \times \text{PET} \times F_{\text{stress}} \]

- \( K_{sp} \) is the spectral crop coefficient (value 0-1)
- \( \text{PET} \) is the potential ET (Penman-Monteith Eqn.)
- \( F_{\text{stress}} \) is a stress factor (value 0-1)

\( K_{sp} \) is numerically equal to the crop ground cover (GC).

Details of the procedure can be found in:

Crop Water Use (CWU) estimation with remote sensing

Daily CWU can be estimated using the “spectral crop coefficient” approach\(^1\):

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\text{CWU} = K_{sp} \times \text{PET} \times F_{\text{stress}}
\]

- \(K_{sp}\) is the spectral crop coefficient (value 0-1)
- \(\text{PET}\) is the potential ET
- \(F_{\text{stress}}\) is a water stress factor (value 0-1)
- \(K_{sp}\) is numerically equal to the ground cover (GC)

Challenges in Bangladesh:
- Contribution from ground water table (capillary rise of water)
- Water salinity

# Measurement plan

<table>
<thead>
<tr>
<th>Product</th>
<th>Parameter measured</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground cover (to estimate CWU)</td>
<td>% green pixels</td>
<td>RGB camera</td>
</tr>
<tr>
<td></td>
<td>Shear line</td>
<td>CropScan Radiometer</td>
</tr>
<tr>
<td></td>
<td>Reflectance</td>
<td>Multispectral on UAV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High resolution satellite images</td>
</tr>
<tr>
<td>Spectral characteristics of crops</td>
<td>Reflectance</td>
<td>CropScan Radiometer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Multispectral on UAV</td>
</tr>
<tr>
<td>Water stress</td>
<td>Soil moisture</td>
<td>TDR</td>
</tr>
<tr>
<td></td>
<td>Canopy temperature</td>
<td>Thermal camera on UAV</td>
</tr>
<tr>
<td>Depth of water table</td>
<td>Distance</td>
<td>Piezometer</td>
</tr>
<tr>
<td>Soil salinity</td>
<td>Electrical conductivity</td>
<td>EC meter / EM-38</td>
</tr>
<tr>
<td>Water salinity</td>
<td>Electrical conductivity</td>
<td>EC meter</td>
</tr>
<tr>
<td>Yield and biomass</td>
<td>Dry matter</td>
<td>Scale &amp; oven</td>
</tr>
<tr>
<td>Potential evapotranspiration</td>
<td>Weather data</td>
<td>Weather station</td>
</tr>
</tbody>
</table>
Expected outcomes

• Safe operating space well quantified
• Irrigation scheduling
  – Algorithm validated
  – Crop specific ground cover development curves defined
  – Prototype of software tested in the field
• Identification of
  – Crop land
  – Crop types (major)
• Semi-automatic detection of field boundaries
Future

• PhD student sponsored by ANEI (Asociación Nacional de Especialistas en Irrigación) to sponsor PhD student to conduct field studies at CIMMYT station in Ciudad Obregon, MX

• G4AW call for proposals (Geodata for Agriculture and Water) by Netherlands Space Office
Groundwater footprints of aquifers that are important to agriculture

Discussion points

• Atmospheric correction
  – Measurements on the ground?
• Field boundary detection
  – Segmentation algorithms
• Processing chains?
• Data storage
Dank youi!
Dhanabad!