Monitoring croplands using Remote sensing

Murali Krishna Gumma and team

ICRISAT

Geospatial World Forum:
Knowledge based agriculture: the linkages with sustainability, food security and climate change impacts
18th Jan, 2018, HICC, Hyderabad
Overview

1. Geospatial products for multi-disciplinary teams
2. Monitoring croplands using multi-temporal imagery
3. Improving crop water productivity
**Geospatial products for SAT**

- Crop type / intensity maps
- Land use changes
- Length of growing periods
- Abiotic stresses
- Water productivity
- Spatial modeling (Prioritization)
- Impact assessment
- Simulated yield estimations and impact
- Tracking adoption of NRM Technologies

**Research groups**

- Breeders
- System modelers
- Social scientists
- Hydrologists
- Planning departments

**Studies**

- Abiotic stresses
- Tracking adoption of NRM Technologies
- Spatial modeling (Prioritization)
- Impact assessment
- Simulated yield estimations and impact
- Land use changes
- Length of growing periods
- Water productivity
Methods & Approach: Flowchart

MODIS NDVI, EVI & LSWI/Landsat

Crop Extent/Mask

Crop Signatures

DT/SMT - Interpretation based on knowledge

VHRI

ACCA - Automated Decision Tree

Reference Bank

Baseline Map (2014 for now)

FAO statistics

Annual Dynamic Map (2003-2014)
ICRISAT mandate crops

Major crops (2014)

01. Rainfed-sc-sorghum
02. Rainfed-sc-millets/sorghum
03. Rainfed-sc-groundnut
04. Rainfed-sc-pigeonpea
05. Rainfed-SC-maize/sorghum/millet
06. Other crops

Land use / land cover Area (ha)
01. Rainfed-DC Maize/mixed crops 6372292
02. Rainfed-SC Maize/sorghum 1815141
03. Rainfed-SC tef, sorghum, Maize 2001659
04. Rainfee-SC-tef/wheat/barly 2479437
05. Rainfed mixed Crops (vegetables etc) 3245085
06. Irrigated-SC-sugarcane-VLS 742929
07. Irrigated_mixedcrops 3885358
08. Rainfed_Rice 425107
09. Rangeland/fallow 8707126
10. Range lands/Shrublands 31388136
11. Shrublands/Wasteland tress 33157504
12. Barenlands/Sanddunes 13747506
13. Forest 4671170
14. Waterbodies 697645
15. Builtup 40946

11,33,77,041
Spatial distribution of croplands

Croplands (2013-14)

01. Irrigated-DC-rice-wheat
02. Irrigated-DC-rice-rice
03. Irrigated-DC-rice-pulses
04. Irrigated-TC-pulses-rice-rice
05. Irrigated-DC-soyabean-wheat
06. Irrigated-DC-pulses-wheat
07. Irrigated-DC-Pulses/maize-wheat
08. Irrigated-millet-wheat
09. Irrigated-DC-maize/potato-wheat/pulses
10. Irrigated-DC-soyabean/maize-wheat/chickpea/fallow
11. Irrigated-GW-DC-sesamum/millet-wheat/mustard
12. Irrigated-DC-pulses/maize-maize
13. Rainfed-SC-sorghum
14. Rainfed-SC-rice-fallow
15. Rainfed_SC_pigeonpea
16. Rainfed-SC-cotton/groundnut
17. Rainfed-supplemental-SC-cotton
18. Rainfed-SC-millet
19. Rainfed-DC-sorghum-chickpea/fallow
20. Rainfed-SC-pulses
21. Rainfed-SC-fallow-chickpea
22. Irrigated-sugarcane
23. Groundnut
24. Irrigated-DC-Maize-Othercrop
25. Rainfed-SC-maize
26. Mixed crops
27. Other LULC
Spatial distribution of rice & wheat (2013-14)

- **Rice**
- **Wheat**
Spatial distribution of major dryland crops(2013-14)

- Kharif + Rabi sorghum (4.32 Mha)
- Groundnut (0.8 Mha)
- Millets (5.35 Mha)
- Groundnut (1.67 Mha)
- Pigeonpea
- Chickpea
Rice-fallows (rainfed agriculture)

<table>
<thead>
<tr>
<th>State</th>
<th>Rainfed: rice-fallows (Mha)</th>
<th>% of total rice-fallow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chhattisgarh</td>
<td>4.1</td>
<td>35.2%</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
<td>1.9</td>
<td>16.0%</td>
</tr>
<tr>
<td>Orissa</td>
<td>1.7</td>
<td>15.3%</td>
</tr>
<tr>
<td>Jharkhand</td>
<td>1.0</td>
<td>8.3%</td>
</tr>
</tbody>
</table>

Gumma et al., (2016)
Rice-fallows (temporal changes)
Tracking adoption of Chickpea: Andhra Pradesh

Tracking NRM technologies: Anantapur

Temporal changes: MODIS 250m

Legend
- Moderate drought
- Severe drought
- Crop lands (No drought)
- Other LULC
- River
Crop production and water use: Sakare, Dhule District

Baseline scenario

Improved scenario

40% water savings and 71% rice equivalent yield gain
Crop production and water use (A. Baseline scenario; B. Improved scenario)

<table>
<thead>
<tr>
<th>Crop type</th>
<th>Percent of total cropland area in season 1 (%)</th>
<th>Percent of total cropland area in season 2 (%)</th>
<th>Water used for producing 1 kg of grain (liters)</th>
<th>Yield per hectares in kg/ha</th>
<th>Total water used by all crops in 2 season (billion liters)</th>
<th>Total production ('000 tones)</th>
<th>Rice equivalent yields ('000 tones)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>51</td>
<td>27</td>
<td>1500</td>
<td>2284</td>
<td>49.8</td>
<td>33.2</td>
<td>33.2</td>
</tr>
<tr>
<td>Sorghum</td>
<td>21</td>
<td>0</td>
<td>650</td>
<td>1249</td>
<td>4.3</td>
<td>6.5</td>
<td>6.8</td>
</tr>
<tr>
<td>Maize</td>
<td>21</td>
<td>0</td>
<td>800</td>
<td>2476</td>
<td>10.4</td>
<td>22.5</td>
<td>19.5</td>
</tr>
<tr>
<td>pulses</td>
<td>6</td>
<td>0</td>
<td>600</td>
<td>694</td>
<td>0.6</td>
<td>1.8</td>
<td>5.7</td>
</tr>
<tr>
<td>Cropland fallow</td>
<td>0</td>
<td>73</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Area of croplands (ha)</td>
<td>24756</td>
<td>6684</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total area (croplands + non-croplands) (ha)</td>
<td>42919</td>
<td>42919</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**A. Baseline scenario**

<table>
<thead>
<tr>
<th>Crop type</th>
<th>Percent of total cropland area in season 1 (%)</th>
<th>Percent of total cropland area in season 2 (%)</th>
<th>Water used for producing 1 kg of grain (liters)</th>
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<th>Rice equivalent yields ('000 tones)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>38</td>
<td>19</td>
<td>700</td>
<td>2500</td>
<td>19.4</td>
<td>27.8</td>
<td>28</td>
</tr>
<tr>
<td>Sorghum</td>
<td>24</td>
<td>0</td>
<td>500</td>
<td>2000</td>
<td>6.0</td>
<td>12.0</td>
<td>12</td>
</tr>
<tr>
<td>Maize</td>
<td>19</td>
<td>0</td>
<td>600</td>
<td>3000</td>
<td>8.6</td>
<td>24.9</td>
<td>22</td>
</tr>
<tr>
<td>pulses</td>
<td>19</td>
<td>19</td>
<td>500</td>
<td>1500</td>
<td>4.8</td>
<td>16.2</td>
<td>50</td>
</tr>
<tr>
<td>Cropland fallow</td>
<td>0</td>
<td>62</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Area of croplands (ha)</td>
<td>24756</td>
<td>9407</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>39</td>
<td>112</td>
</tr>
</tbody>
</table>

**B. Improved scenario**

<table>
<thead>
<tr>
<th>Crop type</th>
<th>Percent of total cropland area in season 1 (%)</th>
<th>Percent of total cropland area in season 2 (%)</th>
<th>Water used for producing 1 kg of grain (liters)</th>
<th>Yield per hectares in kg/ha</th>
<th>Total water used by all crops in 2 season (billion liters)</th>
<th>Total production ('000 tones)</th>
<th>Rice equivalent yields ('000 tones)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>65</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reduced water use in new scenario**

<table>
<thead>
<tr>
<th>Water Savings</th>
<th>26 billion liters</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Increased rice equivalent yields</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Increased Production</strong></td>
<td>47 ('000 tones)</td>
</tr>
</tbody>
</table>

**Note**

- [Yield](https://data.gov.in/catalog/yield-hectare-major-crops)
- [Water use](http://www.fao.org/docrep/s2022e/s2022e02.htm)
- [Prices](http://www.narendramodi.in/minimum-support-prices-msp-for-kharif-crops-of-2016-17-season-483894)
Conclusions

- Availability of multi-resolution/temporal data
- Contributed several publications
- Developed web portals for public use

Further work

- Automated crop classification algorithms (GEE)
- Conducting ground surveys in major cropland areas in India using Mobile apps.,
- Conducting research on spectral characteristics of ICRISAT mandate crops using high resolution multispectral data and hyperspectral data
- Supporting multi-disciplinary teams
Mobile application for ground data collection

iCrops Mobile application

• Android mobile application

• Captured geo-tag photo’s

• Freely available software

• Data can be used for training and validation
Thank You

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