Near Real-Time Disaster Monitoring of Agriculture using Remote Sensing and Geospatial Data

Disaster Analysis Website:

Claire G. Boryan, Zhengwei Yang, Avery Sandborn, and Patrick Willis
National Agricultural Statistics Service
Claire.Boryan@nass.usda.gov

Agriculture Outlook Forum | February 21 - 22, 2019
Outline

• **Background**
  – Why monitor and assess agriculture during disasters?
  – Recent disasters impacting agriculture

• **Geospatial Data**
  – Copernicus Sentinel-1 Synthetic Aperture Radar (SAR)
  – NASA MODIS optical imagery
  – Fire location data
  – NASS Cropland Data Layer (CDL)

• **Process Flow**

• **Deliverables**

• **Summary**
Disaster monitoring and assessment of agriculture are important for food security, disaster assistance, crop insurance, agricultural statistics and decision support.

NASS’s mission is to provide timely, accurate and useful statistics in service to U.S. agriculture.

Freely available satellite imagery and geospatial techniques are currently used to monitor and assess cropland and pasture in *near real-time* during disaster events.
Recent Disasters – Hurricanes

Hurricane Harvey
August 2017

Hurricane Irma
September 2017

Hurricane Michael
October 2018

Hurricane Florence
September 2018
Recent Disasters – Fires

Wine Country Fires
October 2017

Oregon Substation Fire
July 2018
Geospatial Data

Synthetic Aperture Radar, Optical Imagery, Fire Location Data and the Cropland Data Layer
Why Use Radar?
Radar Can Penetrate Through Clouds

MODIS Terra – Optical
August 29, 2017

Copernicus Sentinel-1 Synthetic Aperture Radar
August 29, 2017
Copernicus Sentinel-1 Synthetic Aperture Radar

Launch
• Sentinel-1A: April 3, 2014
• Sentinel-1B: April 25, 2016

Revisit time: Six days (at the equator) with two-satellite constellation

Flooding near Houston, Texas (Harris and Liberty Counties) August 29, 2017

Website: https://sentinels.copernicus.eu/web/sentinel/home
NASA MODIS Optical Data

Before Fire: July 17, 2018

After Fire: July 24, 2018

Geospatial Fire Data

Cal Fire Perimeter Polygons
http://www.fire.ca.gov/general/firemaps

USDA Forest Service Continental Active Fire Detection Points
https://fsapps.nwcg.gov/afm/gisdata.php
NASS Cropland Data Layer (CDL)

- Annually released, geo-referenced, 30 meter, crop-specific land cover data set
- Produced with optical imagery, from multiple satellites, acquired across the summer growing season
- Multiple versions produced during the growing season to obtain independent acreage estimates
- National scale since 2008
- The 2018 CDL was released to the public on February 15, 2019
# NASS Cropland Data Layer

<table>
<thead>
<tr>
<th></th>
<th>Crop</th>
<th>Code</th>
<th>Crop</th>
<th>Code</th>
<th>Crop</th>
<th>Code</th>
<th>Crop</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Corn</td>
<td>41</td>
<td>Sugarbeets</td>
<td>73</td>
<td>Other Tree Fruits</td>
<td>227</td>
<td>Lettuce</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Cotton</td>
<td>42</td>
<td>Dry Beans</td>
<td>74</td>
<td>Pecans</td>
<td>228</td>
<td>Cucumbers</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Rice</td>
<td>43</td>
<td>Potatoes</td>
<td>75</td>
<td>Almonds</td>
<td>229</td>
<td>Pumpkins</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Sorghum</td>
<td>44</td>
<td>Other Crops</td>
<td>76</td>
<td>Walnuts</td>
<td>230</td>
<td>Lettuce/Durum Wht</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Soybeans</td>
<td>45</td>
<td>Sugarcane</td>
<td>77</td>
<td>Pears</td>
<td>231</td>
<td>Lettuce/cantaloupe</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Sunflower</td>
<td>46</td>
<td>Sweet Potatoes</td>
<td>80</td>
<td>Other Non-Tree Fruit</td>
<td>232</td>
<td>Lettuce/Upland Cotton</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Peanuts</td>
<td>47</td>
<td>Misc. Vgs. &amp; Fruits</td>
<td>92</td>
<td>Aquaculture</td>
<td>233</td>
<td>Lettuce/Barley</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Tobacco</td>
<td>48</td>
<td>Watermelons</td>
<td>204</td>
<td>Pistachios</td>
<td>234</td>
<td>Durum Wht/Sorghum</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Sweet Corn</td>
<td>49</td>
<td>Onions</td>
<td>205</td>
<td>Triticale</td>
<td>235</td>
<td>Barley/Sorghum</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Pop. or Orn. Corn</td>
<td>50</td>
<td>Pickles</td>
<td>206</td>
<td>Carrots</td>
<td>236</td>
<td>WinWht/Sorghum</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Mint</td>
<td>51</td>
<td>Chick Peas</td>
<td>207</td>
<td>Asparagus</td>
<td>237</td>
<td>Barley/Corn</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Barley</td>
<td>52</td>
<td>Lentils</td>
<td>208</td>
<td>Garlic</td>
<td>238</td>
<td>WinWht/Cotton</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Durum Wheat</td>
<td>53</td>
<td>Peas</td>
<td>209</td>
<td>Cantaloupes</td>
<td>239</td>
<td>Soybeans/Cotton</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Spring Wheat</td>
<td>54</td>
<td>Tomatoes</td>
<td>210</td>
<td>Prunes</td>
<td>240</td>
<td>Soybeans/Oats</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Winter Wheat</td>
<td>55</td>
<td>Caneberrries</td>
<td>211</td>
<td>Olives</td>
<td>241</td>
<td>Corn/Soybeans</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Other Small Grains</td>
<td>56</td>
<td>Hops</td>
<td>212</td>
<td>Oranges</td>
<td>242</td>
<td>Blueberries</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Dol. Crop WinWht/Soy</td>
<td>57</td>
<td>Herbs</td>
<td>213</td>
<td>Honeydew Melons</td>
<td>243</td>
<td>Cabbage</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Rye</td>
<td>58</td>
<td>Clover/Wildflowers</td>
<td>214</td>
<td>Broccoli</td>
<td>244</td>
<td>Cauliflower</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Oats</td>
<td>59</td>
<td>Sod/Grass Seed</td>
<td>216</td>
<td>Peppers</td>
<td>245</td>
<td>Celery</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Millet</td>
<td>60</td>
<td>Switchgrass</td>
<td>217</td>
<td>Pomegranates</td>
<td>246</td>
<td>Radishes</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Speltz</td>
<td>61</td>
<td>Fallow/Idle Cropland</td>
<td>218</td>
<td>Nectarines</td>
<td>247</td>
<td>Turnips</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Canola</td>
<td>62</td>
<td>Pasture/Grass</td>
<td>219</td>
<td>Greens</td>
<td>248</td>
<td>Eggplants</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Flaxseed</td>
<td>66</td>
<td>Cherries</td>
<td>220</td>
<td>Plums</td>
<td>249</td>
<td>Gourds</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Safflower</td>
<td>67</td>
<td>Peaches</td>
<td>221</td>
<td>Strawberries</td>
<td>250</td>
<td>Cranberries</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>Rape Seed</td>
<td>68</td>
<td>Apples</td>
<td>222</td>
<td>Squash</td>
<td>251</td>
<td>Corn - Non-Irrigated</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Mustard</td>
<td>69</td>
<td>Grapes</td>
<td>223</td>
<td>Apricots</td>
<td>252</td>
<td>Soybean - Non-Irrigated</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Alfalfa</td>
<td>70</td>
<td>Christmas Trees</td>
<td>224</td>
<td>Vetch</td>
<td>253</td>
<td>WinWheat - Non-Irrigated</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>Other Hay</td>
<td>71</td>
<td>Other Tree Nuts</td>
<td>225</td>
<td>WinWht/Corn</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>Camellina</td>
<td>72</td>
<td>Citrus</td>
<td>226</td>
<td>Oats/Corn</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CropScape: [https://nassgeodata.gmu.edu/CropScape/](https://nassgeodata.gmu.edu/CropScape/)
Process Flow

Disaster:
- Hurricanes
- Floods
- Fires

Data:
- Satellite Imagery (Radar, Optical)
- Fire Location Data
- Cropland Data Layer

Analysis:
- Process Data
- Tabulate Land Cover Affected

Deliverables:
- Maps
- Tables
- Reports
- Geospatial Data

Review:
- Quality Review
- Statistics Division (Crops Branch, Livestock Branch)
- Methodology Division

Release:
- NASS
- USDA
- Emergency Operations Division
- Website
Deliverables

Maps, Tables, Reports, Geospatial Data and Disaster Analysis Website
Hurricane Wind Swath Maps

NOAA Hurricane GIS Data: https://www.nhc.noaa.gov/gis/
Crop Inundation Raster Layers

08/22/2017 (Pre-flood)

Hurricane Harvey
Calhoun County, Texas

Copernicus
Sentinel-1A
Synthetic Aperture Radar (SAR)

09/03/2017 (Post-flood)

Inundation Layer

- Water
- Cropland
- Pasture Hay
- Other
- Inundated Cropland
- Inundated Pasture/Hay
Inundation Analysis and Maps

Crop Type | Percent Inundated
---|---
Corn | 14.54%
Cotton | 14.53%
Fallow/Idle Cropland | 9.47%
Oats | 10.39%
Rice | 7.43%
Sorghum | 25.72%
Winter Wheat | 11.45%
Total Cropland | 10.16%
Pasture/Hay | 3.68%

Total Area Analyzed
Total: 62,517,290 acres
Cropland: 7,061,403 acres
Pasture/Hay: 9,448,350 acres
Fire Analysis and Results

Northern California Wildfires - Oct 13 - 19, 2017

- Mendocino
- Sonoma
- Napa

<table>
<thead>
<tr>
<th>County</th>
<th>Grapes Acres, NASS Official Estimate 2016</th>
<th>Percent of Grapes within Fire Perimeter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mendocino</td>
<td>17,252</td>
<td>8.90%</td>
</tr>
<tr>
<td>Sonoma</td>
<td>18,320</td>
<td>1.14%</td>
</tr>
<tr>
<td>Napa</td>
<td>45,343</td>
<td>2.77%</td>
</tr>
</tbody>
</table>

Oregon Substation Fire - Jul 17 - 25, 2018

- Klickitat County, WA
- Sherman County, OR

Accurate fire perimeter data (July 17 - 25, 2018) provided by the USDA Forest Service Fire Program Applications. Engine data was collected by the Oregon Department of Forestry and integrated into a fire perimeter map. Map service created on October 19, 2017 (http://www.fore.state.or.us/FireApp).
Disaster Analysis Website


Files Available for Download

- Maps
- Assessment reports
- Geospatial data
- Metadata
- Methodology paper
Summary

• NASS monitors agricultural disasters in *near real-time* and provides quantitative assessments using satellite data and geospatial analysis to support crop estimation and emergency response.

• This capacity is possible due to *free* satellite imagery and geospatial data, which are posted with short latency, and geospatial analysis.

• Disaster maps, reports, and geospatial data are delivered to stakeholders within NASS, at the department level, and to the USDA Emergency Operations Division.

• Data are made available to the general public on the NASS Disaster Analysis website.
Thank You

Claire G. Boryan, PhD
USDA National Agricultural Statistics Service
Claire.Boryan@nass.usda.gov

Disaster Analysis Website:

Photo Courtesy: Dorothy Edwards, Naples (Fla.) Daily News