Developing Geoprocessing Service for Cropland Data Layer Thematic Map Creation

Weiguo Han[1], ZhengWei Yang[2], Liping Di[1]

[1]*Center for Spatial Information Science and Systems*

George Mason University

[2]*US Department of Agriculture*

National Agricultural Statistics Service

The First International Conference on Agro-Geoinformatics

Shanghai, April 2-4, 2012

Contents

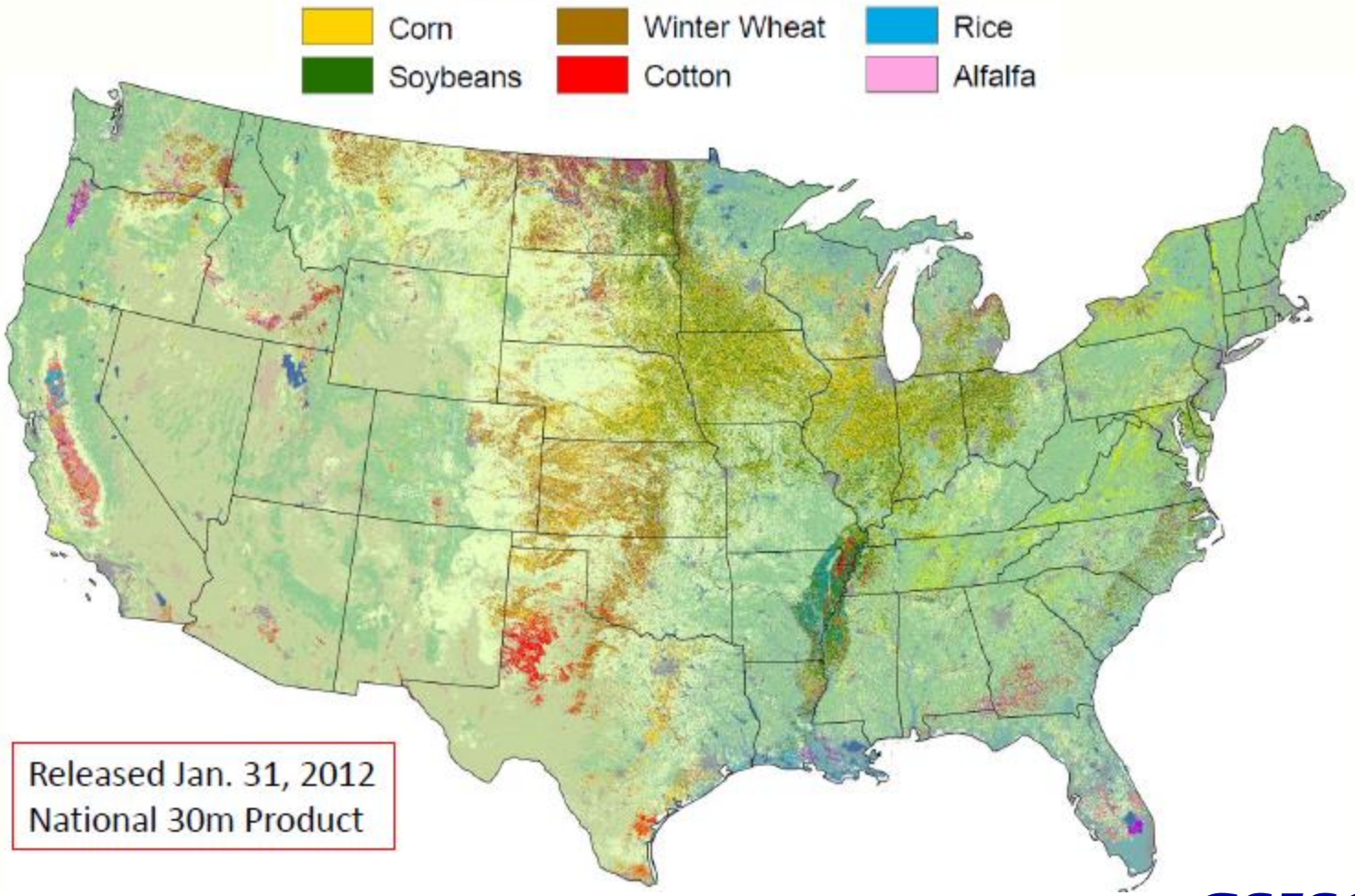
- Cropland Data Layer (CDL)
- CropScape
- Geoprocessing Services of CDL Thematic Map Creation
- Service Request Examples
- Discussions and Conclusions

Cropland Data Layer (CDL)

- The annual CDL products (1997-2011) are derived from mid-resolution satellite data and ground truth data
- Provides the specific crop and other land cover classifications covering all 48 conterminous states
- Previous distribution methods
  - Paper Thematic Map
  - CD/DVD Copy
  - HTTP/FTP Links (at the state level only)

2011 CDL

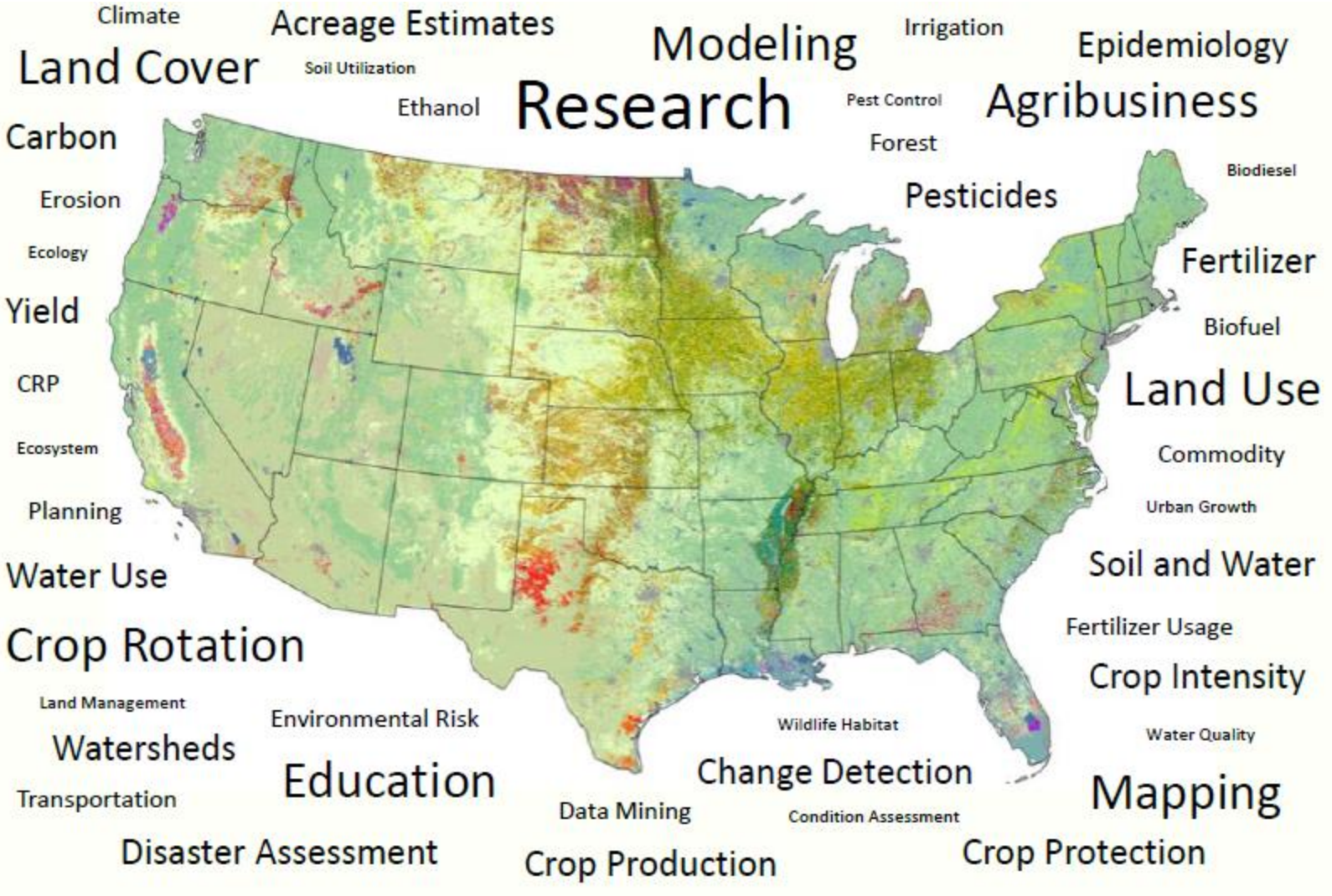
The Cropland Data Layer product is a raster-formatted, geo-referenced, crop specific, land cover map.



CSISS

Center for Spatial Information Science and Systems

CDL Applications



CropScape

- Web portal

  http://nassgeodata.gmu.edu/CropScape

- Support the common browsers 

- Offer online CDL visualization, query, customization, analysis, and dissemination functions

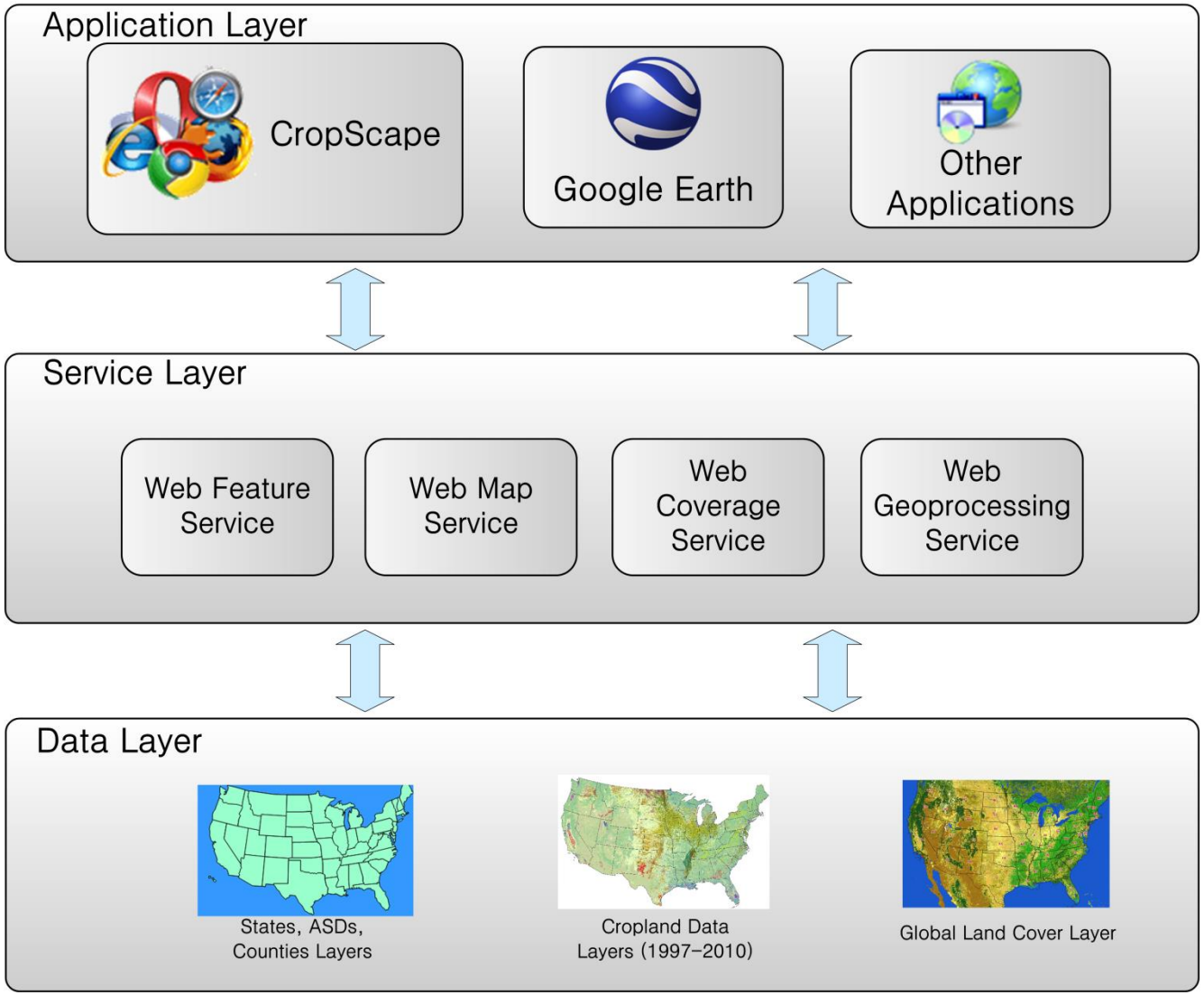
- Provide OGC standard Web data services (WCS, WFS and WMS)

  http://nassgeodata.gmu.edu/CropScape/devhelp/help.html

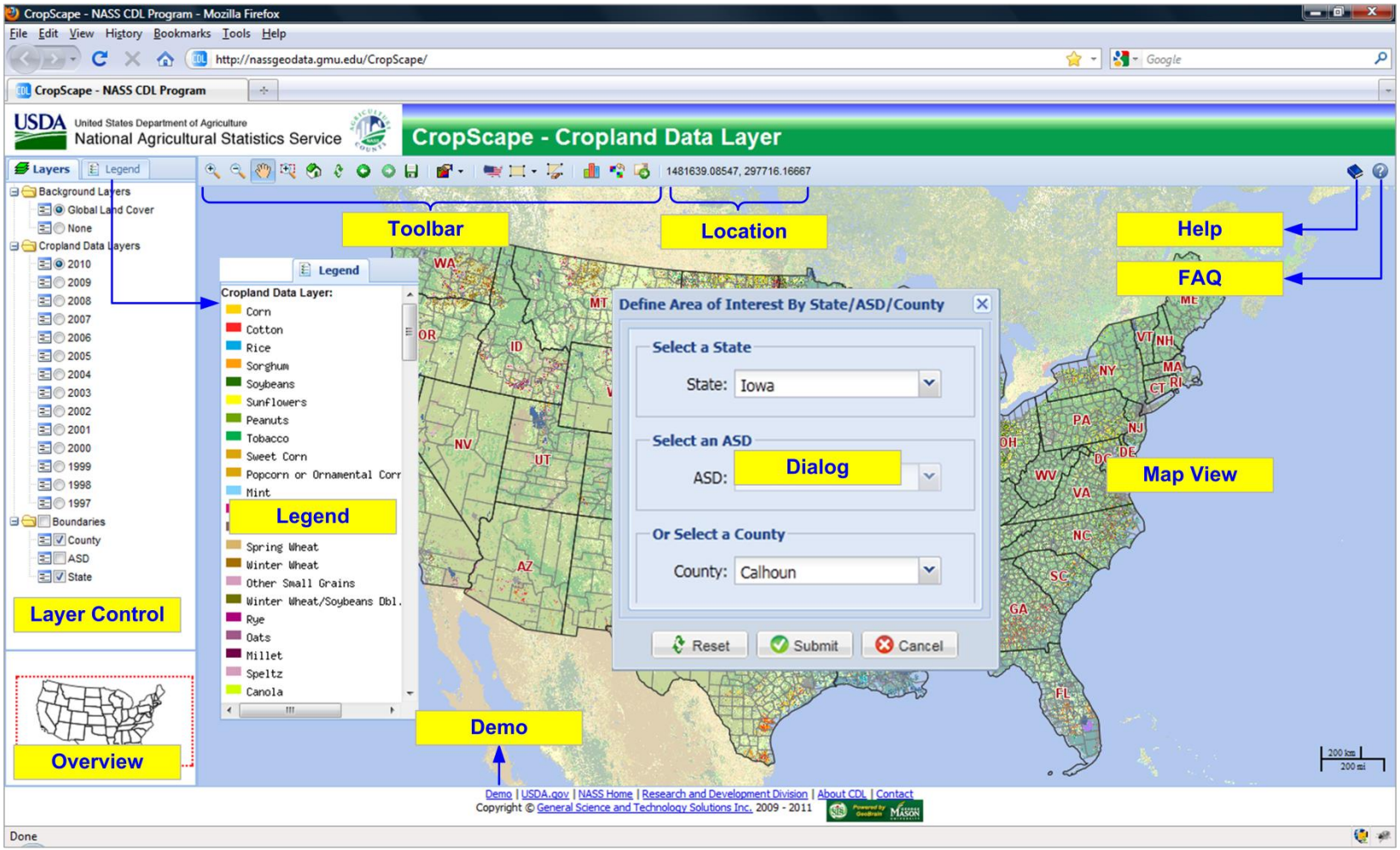
- Publication

Han, W., Yang, Z., Di, L., Mueller, R., 2012. CropScape: A Web service based application for exploring and disseminating US conterminous geospatial cropland data products for decision support. Computers and Electronics in Agriculture, 84, 111–123.

CropScape Architecture



CropScape User Interface



CropScape Visit Statistics

Location Jan 10, 2011 - Jul 25, 2012

% of visits: 100.00%

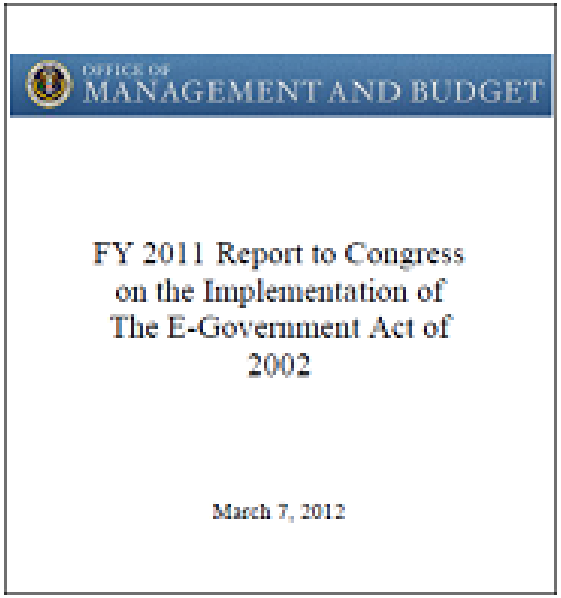
	Country / Territory	Visits	Pages / Visit	Avg. Visit Duration	% New Visits	Bounce Rate
1.	United States	46,934	1.18	00:01:16	59.84%	87.05%
2.	Canada	815	1.15	00:01:00	74.23%	88.59%
3.	Germany	345	1.06	00:00:27	57.39%	95.07%
4.	China	320	1.14	00:00:41	75.62%	88.44%
5.	Argentina	316	1.13	00:01:07	42.41%	91.14%
6.	Spain	301	1.12	00:00:43	74.42%	91.03%
7.	United Kingdom	294	1.17	00:01:13	60.54%	88.10%
8.	France	258	1.22	00:01:13	64.34%	86.43%
9.	Brazil	206	1.10	00:00:44	66.50%	91.75%
10.	Russia	195	1.14	00:00:58	49.23%	88.21%

Visits	Pages / Visit	Avg. Visit Duration	% New Visits	Bounce Rate
52,273	**1.18**	**00:01:15**	**60.61%**	**87.29%**
% of Total: 100.00% (52,273)	Site Avg: 1.18 (0.00%)	Site Avg: 00:01:15 (0.00%)	Site Avg: 60.61% (0.00%)	Site Avg: 87.29% (0.00%)

CSISS
Center for Spatial Information Science and Systems

CropScape

- ***"Highlights of Agency Open Government IT Accomplishments that improve citizen engagement"*** **in the FY 2011 Report to Congress on the Implementation of The E-Government Act of 2002**

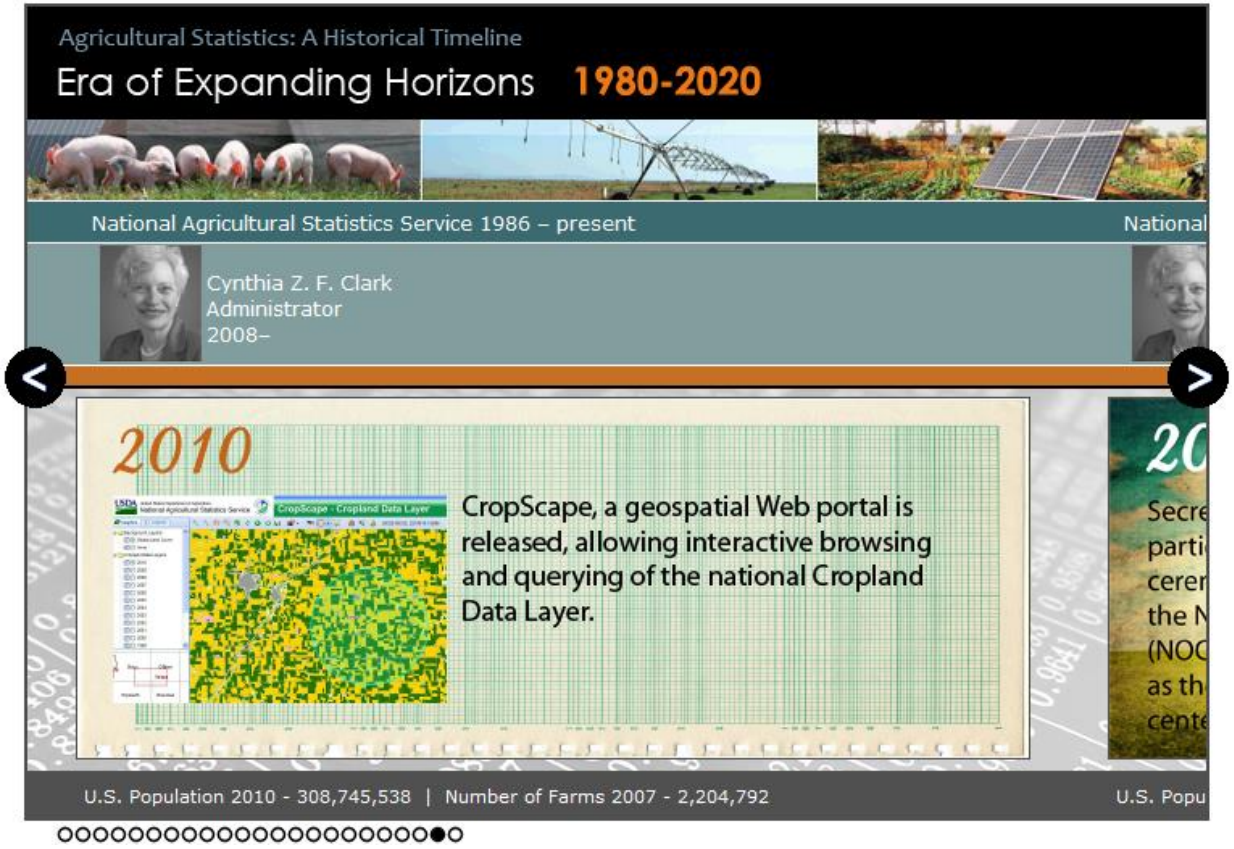


CropScape

- *The 63rd Annual Secretary's Honor Awards of U. S. Department of Agriculture in 2011*

CropScape

- Agricultural Statistics: A Historical Timeline (2010)



What Is Next?

- Online cropland data layer thematic map creation!
  - Reduce the hardship for creating a map
  - Automate the process - efficiency
  - Reduce map creation cost

Requirements of Geoprocessing Services

- Break the limitations of OGC WMS and WCS (within bounding box only)

- Provide open Web geoprocessing services of on-demand CDL visualization, dissemination, and analysis

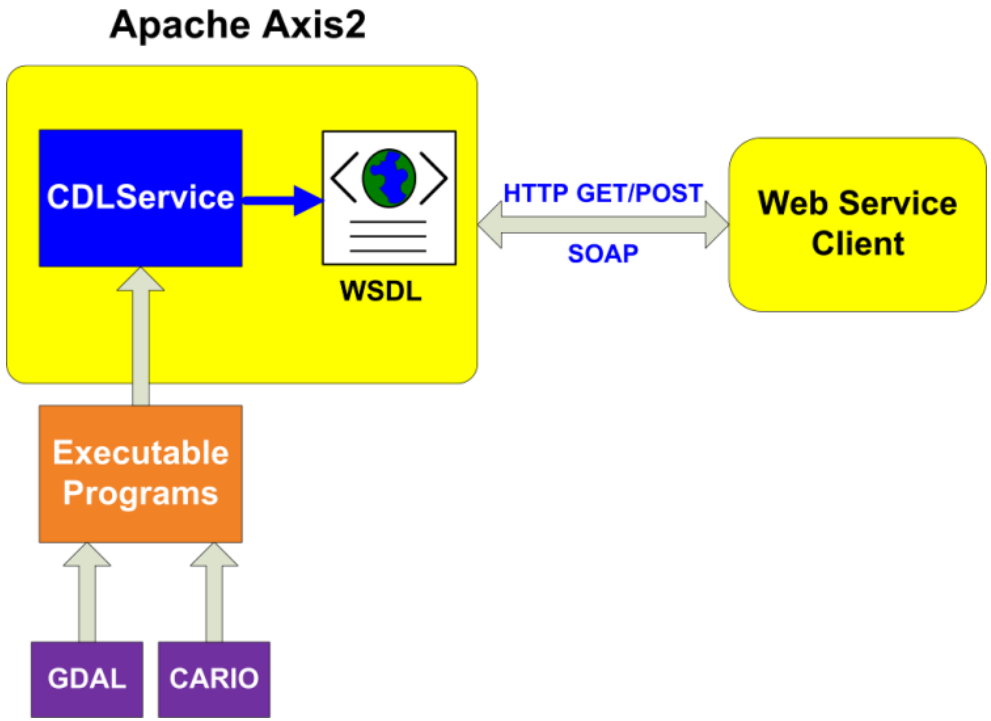
- Be invoked in other geospatial applications directly

- Be integrated in scientific workflows

CDLService Architecture

WSDL: http://nassgeodata.gmu.edu:8080/axis2/services/CDLService?wsdl

Guide: http://nassgeodata.gmu.edu/CropScape/devhelp/help.html



CDLService Architecture

- Axis2 (http://axis.apache.org/axis2/java/core/)

  - Axis2 plugins and Web Services Tools (WST) of Eclipse

  - Top Down method (WSDL -> Java-> Web Service)

- GDAL (http://www.gdal.org)

  - Open source geospatial library

  - Support to read and write common geospatial data formats

  - Create images and get the statistical information of area of interest (AOI)

- Cairo (http://www.cairographics.org)

  - Open source 2D vector graphic library

  - Offer powerful drawing APIs to draw geometries, images, and texts with various styles

  - Support multiple output formats (e.g. PNG, PDF, SVG, Win32 GDI, etc)

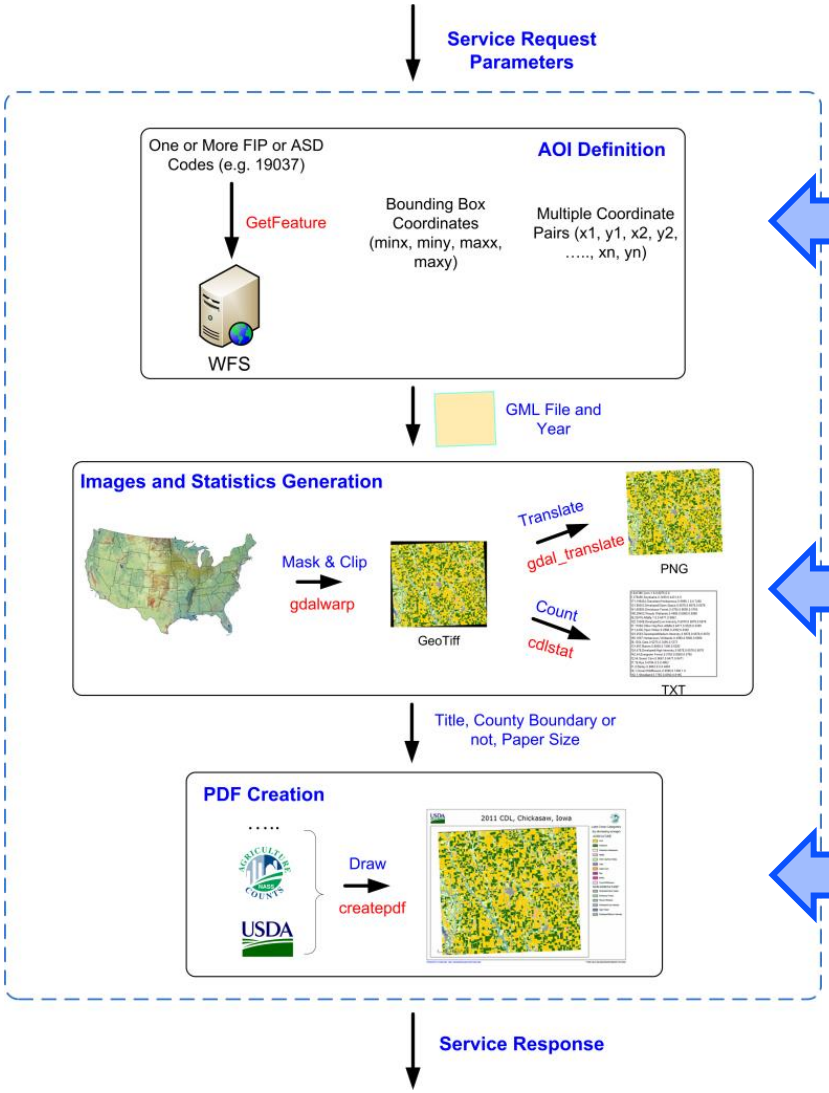
WSDL of GetCDLPDF Operation

```
<xsd:element name="GetCDLPDF">
  <xsd:complexType>
    <xsd:sequence>
      <xsd:element maxOccurs="1" minOccurs="1" name="year" type="xsd:string">
      <xsd:element maxOccurs="1" minOccurs="0" name="fips" type="xsd:string">
      <xsd:element maxOccurs="1" minOccurs="0" name="bbox" type="xsd:string">
      <xsd:element maxOccurs="1" minOccurs="0" name="points" type="xsd:string">
      <xsd:element default="Letter" maxOccurs="1" minOccurs="1" name="papersize" typ
      <xsd:element maxOccurs="1" minOccurs="1" name="title" type="xsd:string">
      <xsd:element default="false" maxOccurs="1" minOccurs="0" name="boundaryflag" type="xsd:boolean">
    </xsd:sequence>
  </xsd:complexType>
</xsd:element>
<xsd:element name="GetCDLPDFResponse">
  <xsd:complexType>
    <xsd:sequence>
      <xsd:element maxOccurs="1" minOccurs="1" name="returnURL" type="xsd:anyURI"
    </xsd:sequence>
  </xsd:complexType>
</xsd:element>
```

Input Parameters of GetCDLPDF Operation

Output of GetCDLPDF Operation

Data Processing in GetCDLPDF Operation



Three types of AOI definition:

(1) by FIPS code(s) or ASD code(s)

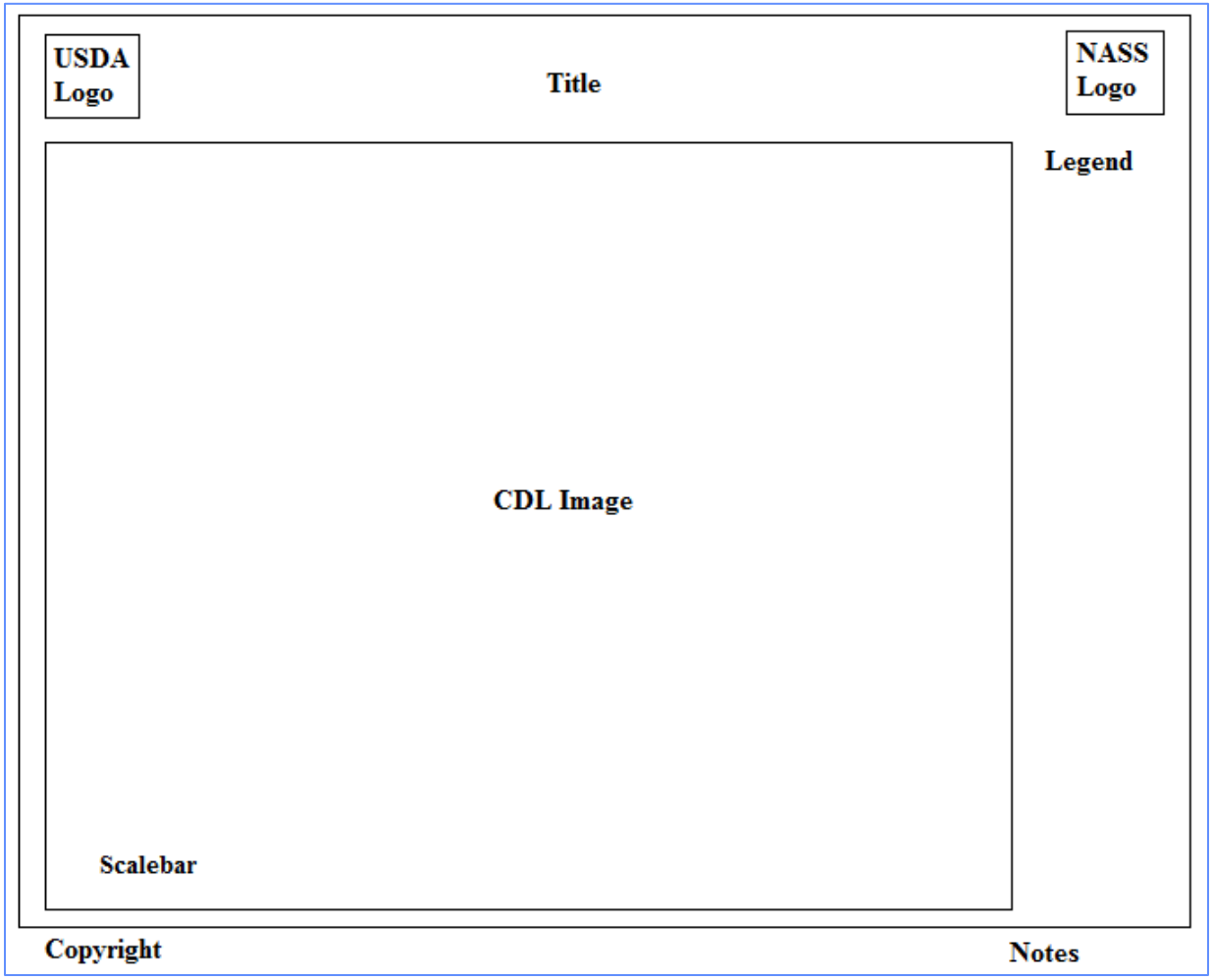
(2) by bounding box

(3) by polygon

GDAL utilities and programs from GDAL APIs

Program from Cairo APIs

Map Template



Rendering Process Using Cairo APIs

Step 1: Create PDF surface

```
surface = cairo_pdf_surface_create(pdffilename, sizex, sizey);
cr = cairo_create(surface);
cairo_set_source_rgb(cr, 0, 0, 0);
```

Step 2: Render the drawing area

```
cairo_set_line_width(cr, 0.5);
cairo_rectangle(cr, 0.7*marginx, 2.1*marginy, sizex-5*marginx, sizey-2.9*marginy);
cairo_stroke(cr);
```

Step 3: Draw all images in the predefined positions of map template

```
usdasurface = cairo_image_surface_create_from_png(usdafilename);
usdaw = cairo_image_surface_get_width(usdasurface);
usdah = cairo_image_surface_get_height(usdasurface);
cairo_save(cr);
ratio = usdaw/printareaw<usdah/printareah?usdaw/printareaw:usdah/printareah;
cairo_scale(cr, ratio, ratio);
cairo_set_source_surface(cr, usdasurface, 0.7*marginx/ratio, 0.5*marginy/ratio);
cairo_paint(cr);
cairo_restore(cr);
```

Rendering Process Using Cairo APIs

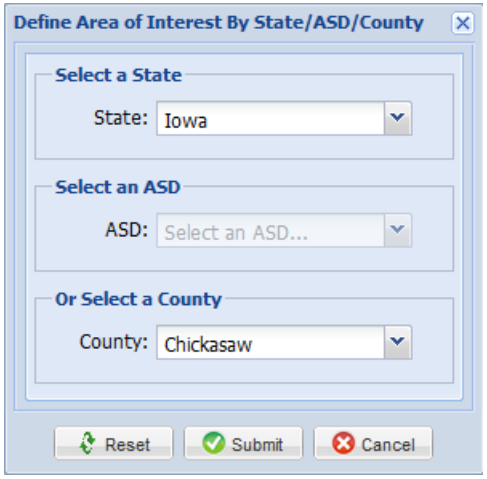
Step 4: Draw all texts and geometries in the predefined positions of map template

```
cairo_select_font_face(cr, "Sans", CAIRO_FONT_SLANT_NORMAL, CAIRO_FONT_WEIGHT_NORMAL);
cairo_set_font_size(cr, 25.0);
cairo_text_extents(cr, title, &extents);
titlex = sizex/2.0 - (extents.width/2.0 + extents.x_bearing);
titley = 1.3*marginy - (extents.height/2.0 + extents.y_bearing);
cairo_move_to(cr, titlex, titley);
cairo_show_text(cr, title);
```

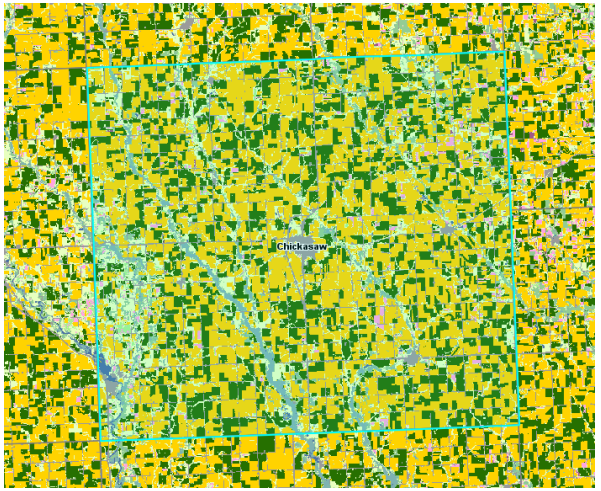
Step 5: Save the drawing context and destroy the created surfaces

```
cairo_show_page(cr);
cairo_surface_destroy(surface);
cairo_surface_destroy(imagesurface);
```

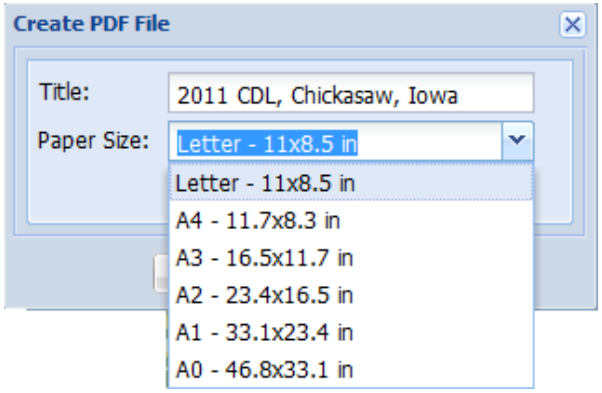
Demonstration in CropScape



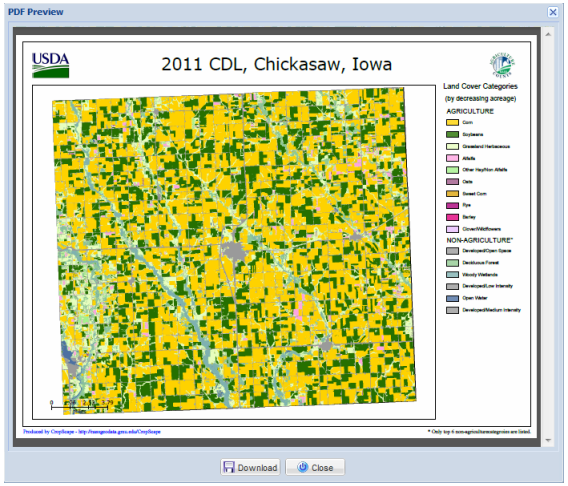
Define AOI by Administrative District



Highlight AOI in Map View



Specify Title and Paper Size



Display and Download PDF File

CSISS

Center for Spatial Information Science and Systems

HTTP/GET Example

- One FIPS or ASD code
  http://nassgeodata.gmu.edu:8080/axis2/services/CDLService/GetCDLPDF?year=2011&fips=19&papersize=Letter&title=2011%20Iowa%20CDL&boundaryflag=true
-
- Two or more FIPS or ASD codes (separated by ",")
  http://nassgeodata.gmu.edu:8080/axis2/services/CDLService/GetCDLPDF?year=2011&fips=19003,19029&papersize=A4&title=2011%20CDL

HTTP/POST Example

Service URL: http://nassgeodata.gmu.edu:8080/axis2/services/CDLService/GetCDLPDF
Year: 2011
Paper Size: A1
Title: 2011 CDL Map
Points: 175207,2219600,175207,2235525,213693,2235525,213693,221960
Submit

HTML Form

- **Host:**
  http://nassgeodata.gmu.edu:8080/axis2/services/CDLService/GetCDLPDF
- **Content:**
  year=2011&points=175207,2219600,175207,2235525,213693,2235525,213693,2219600&papersize=Letter&title=2011%20CDL
- **Content Type:**
  application/x-www-form-urlencoded

SOAP Request/Response Example

```
<?xml version='1.0' encoding='utf-8'?>
<soapenv:Envelope xmlns:soapenv="http://schemas.xmlsoap.org/soap/envelope/">
  <soapenv:Body>
    <ns1:GetCDLPDF xmlns:ns1="http://cropscape.csiss.gmu.edu/CDLService/">
      <year>2011</year>
      <fips>19037</fips>
      <papersize>Letter</papersize>
      <title>2011 Chickasaw County, Iowa</title>
      <boundaryflag>true</boundaryflag>
    </ns1:GetCDLPDF>
  </soapenv:Body>
</soapenv:Envelope>
```

Request (Chichasaw County, Iowa)

Response

```
<?xml version='1.0' encoding='utf-8'?>
<soapenv:Envelope xmlns:soapenv="http://schemas.xmlsoap.org/soap/envelope/">
  <soapenv:Body>
    <ns1:GetCDLPDFResponse xmlns:ns1="http://cropscape.csiss.gmu.edu/CDLService/">
      <returnURL>
        http://nassgeodata.gmu.edu/nass_data_cache/CDL_2011_19037_1936045126.pdf
      </returnURL>
    </ns1:GetCDLPDFResponse>
  </soapenv:Body>
</soapenv:Envelope>
```

Discussions and Conclusions

- Extend the reach of CDL data
- Promote sharing and utilization of geospatial cropland information in the agricultural related decision making
- Be very useful in NASS operation and utilized by many users
- Reduce operational resource and cost
- Improve efficiency and CDL data presentation

Discussions and Conclusions

- Support higher resolution (greater than 300 dpi) image in the graphic context
- Read and render the vector file (i.e. ESRI Shapefile) directly in the graphic context
- Develop a WYSIWYG (What-You-See-Is-What-You-Get) user interface in CropScape to create a high-quality map with user's preferences

Questions or comments?

Thanks!