

FGDC CAP Category 2 - Framework Client Development Project:
Integrated Mapping and Analysis Tool (IMAT) Client
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Project Narrative

In collaboration with the Western Regional Air Partnership (WRAP) and the Cooperative Institute for Research in the Atmosphere (CIRA), Image Matters has built the Integrated Mapping and Analysis Tool (IMAT) as a data exploration, visualization, and analysis capability for the WRAP Technical Support System (TSS). The WRAP consists of local, state, federal, tribal governmental participants as well as representation from industry, the scientific community, and various public interest groups. The focus of the TSS is to provide States and Tribes the technical information required for constructing their Implementation Plans for meeting Regional Haze Rule requirements of the Clean Air Act.

The IMAT provides users access to geospatial data from multiple sources in varying projections and formats. IMAT supports interactive display of maps using Web Mapping Services (WMS) standards, query and display of geospatial feature information using Web Feature Service (WFS) standards, data registry support using Catalog Service for the Web (CSW), and Federal Geospatial Data Committee (FGDC) metadata standards, and custom feature analysis and reporting. This project involves multi-agency participants and several distributed data sources that must be integrated into coherent, actionable information views and reports. Please refer to the *draft* Specification Sheet for a brief description of the IMAT product, attached as the last page of this report.

The software is running in its target operational environment for the TSS, and can be accessed as a stand-alone page at <http://victor.cira.colostate.edu/imat/>. That software was subject to quality assurance through rigorous test protocols involving every known use case. All known bugs have been fixed. A demonstration version of that same configuration is located in its testing environment at <http://www.usersmarts.com/imat/>.

We have published a website (<http://imat.usersmarts.com/>) to make this software freely-available and to support the IMAT user community that we hope will grow and flourish. This website provides:

- Full suite of documentation about the IMAT software including detailed descriptions of its functionality and installation and configuration instructions, as well as downloadable guide for Configuration and Usage.
- Video showcasing IMAT functionality and how it can be applied (the WRAP example).
- Download access to the software and licensing agreement.
- A “User Forum” and a Support Forum” for the user community.

Strengths, Weaknesses, and Future Challenges

The project was successful in that it exceeded its stated goals. The software was delivered as designed, and met all of its functional objectives. The strength of the IMAT is its capability to

integrate a number of geospatial data sources and its powerful core function: to query and summarize the features in one database on the basis of the features of another database. Another strength of the product is its capability to harvest and integrate layers from external WMSs through the GUI. One weakness of the product is that the WFS configuration does not take place at the GUI level, and requires changes at the file level.

In terms of our collaboration with our partners, there was one overall impediment, and three initiatives that we were unable to see to fruition. Resources were not available to train users on the IMAT, and for this reason the product to this point in time has received less use than initially anticipated. The first unfulfilled initiative was to integrate IMAT components more ubiquitously throughout the TSS with programmatic control. The basic communication language was established, but the timing of staff co-availability (Image Matters and CIRA) to complete the development was not in synch, and the staff resources of our CIRA partners were dedicated elsewhere (due to loss of key staff). Integration of these same components (e.g., one view and one list) into other web pages has been successful in other environments (e.g., NDEP/NDOP Project Tracking System). The second uncompleted initiative was to fully migrate IMAT's supporting infrastructure and all services to the CIRA environment. A quasi-WMS developed by another consultant outside of the IMAT team was not compatible in the new (64-bit) CIRA environment, and remains hosted from the consultant's office. Third, authoritative sources for features (via WFS) were not available during the project duration (see below section).

Our hope is that Image Matters and others will collaborate, through the <http://imat.usersmarts.com/> and other forums, and build out more functionality to the IMAT. There are several areas for future development of the IMAT could include:

- User-friendly API and Administrative Tools
- User tools for discovering and accessing feature-level information through published WFS sources (and/or Admin tools for easier pre-configuration).

Status of data access activities

WRAP's emissions and modeling data constitute the bulk of the data for display, query, and analysis using the IMAT. Currently the IMAT makes accessible 375 layers of these air quality themes. The framework data theme accessed for this project, for use in providing context and spatial constraints for analytical tools, is Government Unit Boundaries (GUBS). Our intention was to use the authoritative sources of GUBS data wherever possible, and to obtain that information through WFS. Unfortunately, the Bureau of Census did not make available such a service during the course of the project, not did the USGS project (that included CAP Framework community participants) reach production status in time for integration. The IMAT, as applied to the WRAP TSS, presently utilizes four GUBS layers that are a part of the US Bureau of Census's Cartographic Boundary File (CBF) data set. Characteristics of these data sets are presented in the following table:

Name	Number Features	Spatial Extent	File Size
US States	273	US States + Puerto Rico (Bbox: -179.15 W, 179.78 E, 71.35 N, 17.88 S)	1.3 MB
US Counties	3489	US States + Puerto Rico (Same Bbox as above)	12.5 MB
Core-Based Statistical Areas	947	US States + Puerto Rico (Bbox: -178.34 W, -65.56 E, 65.45 N, 17.88 S)	5.8 MB
American Indian Areas (and Alaska Native Areas / Hawaiian Home Lands)	4929	US States (Bbox: -174.32 W, -67.04 E, 71.34 N, 18.92 S)	3.1 MB

These datasets were stood up behind a GeoTools (<http://geotools.codehaus.org/>) WFS with streaming feature data (GML) that is formatted according to the GUBS Framework data standard.

Status of Framework Client Development

The software development phase of project is complete. The client software was evaluated and tested at 3 levels: extensive testing by Image Matters staff for all known use cases, by the TSS project team (including WRAP and CIRA POC's listed above), and a subset of the intended users.

Client Software Packaging and Distribution

The software package being distributed for this project is a mix of open source software (e.g., GeoTools), new code and configurable files to be made freely-available (funded through WRAP and CAP), and proprietary Image Matters code used in the IMAT. The proprietary Image Matters code will be made available as an executable. All new code developed through the project will be made available as source code and javascript files. The third-party open source software will be distributed as it was accessed.

Client Software Promotion

Promotion of the software and its availability through the IMAT website (<http://imat.usersmarts.com/>) will be accomplished through a set of newsbriefs to be issued through *Directions*, *GIS Café*, and *geocommunity's SpatialNews*. The newsbriefs will contain a brief functional and architectural description of the software and its required environment, and point to our website and its documentation, video, and forums. We feel this method will reach a much larger audience than a single presentation at a conference.

Project management

At the present time we have no resources to direct towards continued development of the IMAT software. We do plan to use it for other projects, as software requirements dictate. We are committed to supporting the IMAT website for a period of one year, and after that as our business interests dictate.

Feedback on Cooperative Agreements Program

Without the CAP grant funds for the development of the IMAT, WRAP would not have been able to produce the mapping functionality made available through the TSS. Image Matters was able to make effective use of the funds as a supplement to the funds available through WRAP. The monthly CAP teleconferences were useful in gaining insight regarding standards status, adoption/support by various internet mapping software packages, and CAP participants' experience in developing compliant systems. Although it was not essential for moving forward, one aspect of the collaborative CAP process should be pointed out. In the early phases of our development effort, when attempting to use the services of other CAP participants for developing or testing our service or client component, we found that in several cases that either the GUBS standard was not being followed exactly or adherence to some other specification critical to our effort (e.g., logical operations for WFS through the OGC Filter) was lacking. This precluded us from being able to fully leverage and build upon work of other CAP participants.

Integrated Mapping and Analysis Tool (IMAT) Specification Sheet

Overview

- ❖ IMAT is an application suite providing GIS functionality using open standards and cutting edge technologies
- ❖ Tools for discovering, viewing, analyzing and reporting on multi-source geospatial data
- ❖ Powered by userSmarts® GX (see below)

GIS Integration

- ❖ Client-side manipulation and control of geospatial data and views enables fast response and dynamic user interactions for a positive user experience
- ❖ Connects to multiple types and instances of OGC Web Services as facades to "back office" GIS systems and data: Web Mapping Services, Web Feature Services, Catalog Service for the Web, Web Processing Services
- ❖ Compatible with ESRI ArcIMS/ArcSDE WMS and WFS connectors, GeoServer WMS and WFS, and others.

Map Support

- ❖ Easy-to-use map controls
- ❖ Support for multiple layers from multiple servers
- ❖ Interactive zooming and panning capabilities
- ❖ Dynamic layer controls for controlling visibility, opacity, and configurable layer-specific properties
- ❖ Support for multiple coordinate reference systems and projections
- ❖ Real-time cursor coordinates display
- ❖ Smart scale bar with configurable units

The screenshot shows the IMAT web application interface. At the top, there are navigation and search controls. The main area displays a map with a red grid overlay. Below the map, there is a table with the following columns: FeatureType, Id, AREA, PERIMETER, FAL_B02, FAL_B02_ID, X_COORD, Y_COORD, I_CELL, J_CELL, I_CELL, J_CELL, FIPS, UNITS, CM, CO, EC. The table contains several rows of data. At the bottom, there is a search bar and a results display showing 'Displaying 1 - 10 of 76 results'.

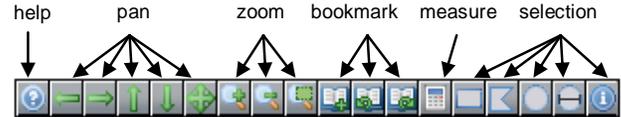
FeatureType	Id	AREA	PERIMETER	FAL_B02	FAL_B02_ID	X_COORD	Y_COORD	I_CELL	J_CELL	I_CELL	J_CELL	FIPS	UNITS	CM	CO	EC
fas_fm_002	fm_002_7145	1296000000	144000	7145	0	-1278000	200222.22222222	41	04	410004	49045	ppm	1.987502	0.171737	0.302	
fas_fm_002	fm_002_7146	1296000000	144000	7146	0	-1242000	200222.22222222	42	04	420004	49011	ppm	1.988237	0.382202	1.058	
fas_fm_002	fm_002_7147	1296000000	144000	7147	0	-1206000	200222.22222222	43	04	430004	49043	ppm	0.72537	0.109332	0.293	
fas_fm_002	fm_002_7281	1296000000	144000	7281	0	-1014000	184222.22222222	40	03	400003	49045	ppm	0.871502	0.110596	0.319	
fas_fm_002	fm_002_7283	1296000000	144000	7283	0	-1278000	184222.22222222	41	03	410003	49045	ppm	1.088109	0.142317	0.181	
fas_fm_002	fm_002_7284	1296000000	144000	7284	0	-1242000	184222.22222222	42	03	420003	49036	ppm	2.273537	0.387288	1.417	
fas_fm_002	fm_002_7286	1296000000	144000	7286	0	-1206000	184222.22222222	44	03	430003	49031	ppm	0.687478	0.14081	0.176	
fas_fm_002	fm_002_7288	1296000000	144000	7288	0	-1170000	184222.22222222	44	03	440003	49043	ppm	0.458748	0.11889	0.088	
fas_fm_002	fm_002_7297	1296000000	144000	7297	0	-1134000	184222.22222222	45	03	450003	49013	ppm	0.407186	0.109994	0.542	
fas_fm_002	fm_002_7439	1296000000	144000	7440	0	-1380000	128222.22222222	39	02	390002	49045	ppm	1.008819	0.112248	0.070	

Map, Layer Control, and Feature Control Components

- ❖ Smart layer management for high performance access to multiple remote Web Map Servers and other data sources
- ❖ Bookmarks allow multiple map states to be saved and instantaneously restored
- ❖ Provides tools for drawing geometric primitives useful in selecting regions of the map to drive data queries
- ❖ Distance measuring capabilities supporting multiple user-drawn segments with per-segment and cumulative

calculations, configurable units, and multiple projection systems

- ❖ Support for browser rendering technologies such as Vector Markup Language (VML) and Scalable Vector Graphics (SVG)
- ❖ Customizable and configurable tools: create your own tool and dynamically (at runtime) add it to the map



IMAT Map Toolbar Controls

Feature Support

- ❖ Provides query capabilities to discover geospatial features using Web Feature Service standards
- ❖ Offers components for displaying feature information in tabular form and on the map
- ❖ Supports querying and accessing features from a variety of sources and in different projections

Analysis and Reporting

- ❖ Provides summary reports about feature properties: minimum and maximum values, sums, area-weighted sums, area-weighted means, and number of sources
- ❖ Offers dynamic, feature-specific user controls for configuring analysis functionality

Data Management

- ❖ Uses Federal Geospatial Data Consortium (FGDC) digital geospatial metadata standards for describing data
- ❖ Provides discovery and examination of metadata within the system using Catalog Service for the Web (CSW) services

userSmarts® GX

- ❖ An open framework for constructing and deploying dynamic Web-based decision support and portal systems
- ❖ Provides a multi-layered framework to simplify AJAX application development
- ❖ Plug-in model simplifies application development, promotes customizable functionality, and supports code reuse.
- ❖ Easy to embed into existing Web pages and browser-based applications

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