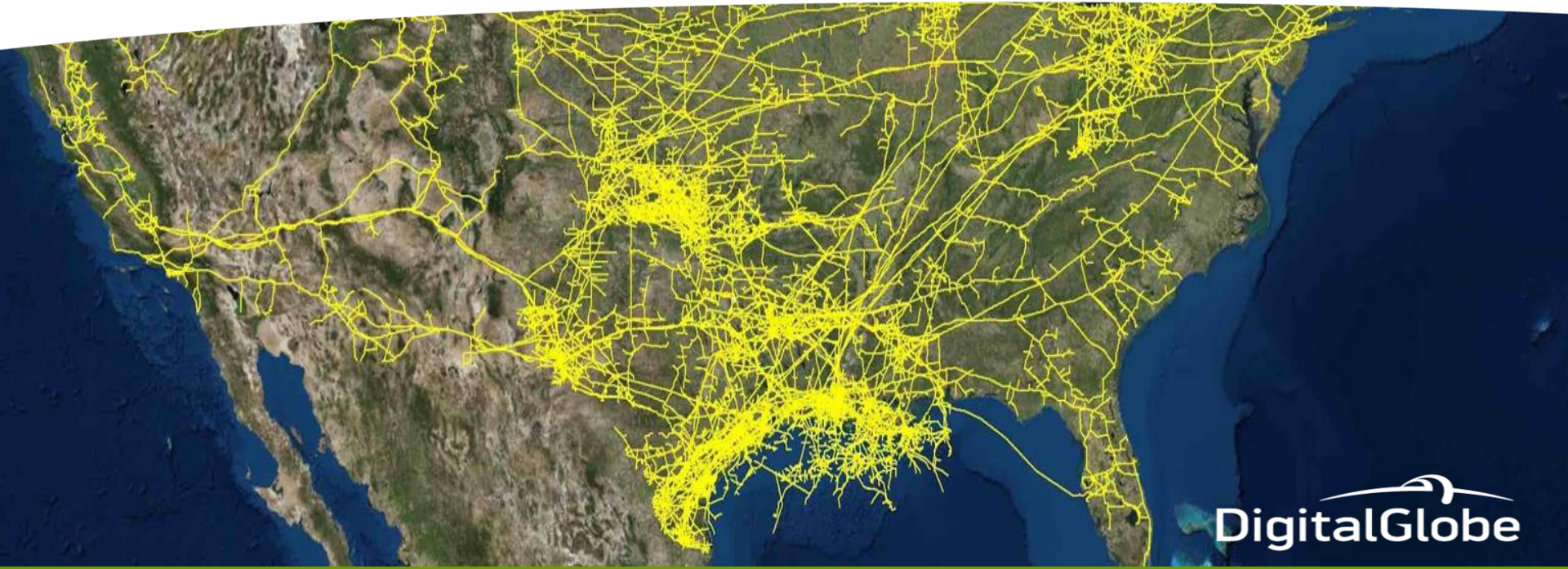
Pipeline Monitoring

Employing Geospatial Big Data in ArcGIS



DigitalGlobe

Pipeline Monitoring Employing Geospatial Big Data in ArcGIS

A treasure trove of new data offers the potential to identify leading indicators of human activity near critical energy assets. New breakthroughs in algorithmic feature extraction and machine learning can bring greater awareness of significant changes around expensive oil and gas infrastructure, enabling oil and gas companies to mitigate risks and reduce costs

Harsh Govind, Manager of Strategic Products
John-Isaac Clark, Director of Product Management

Overview

What problem are we trying to solve?

- Can we effectively leverage machine learning algorithms on raster data along with open social vector data to identify changes along pipeline routes better and more efficiently than typical methods?

What advantage did GIS provide us in solving it?

- Traditional basic spatial operators and functionality within ESRI tools, combined with cloud-based top-level processing at scale = best of both worlds!

What types of GIS Analysis did we use?

- Intersection queries, metadata filtering, area reduction, and aggregation

What were our findings/results?

- Integrating access to these capabilities within ArcMap around corporate GIS assets will enable very exciting new methods for Pipeline Monitoring (and similar) applications [site selection, R-o-W assessment,…]

What can we learn from this?

- Making advances in remote sensing, “big” vector data, and machine learning that are easily consumable within every-day tools can improve outcomes by increasing efficiency.

Problem Statement

- Monitoring dynamic changes along pipeline infrastructure is complex, costly, and time consuming
- Automated methods to narrow the focus of field/inspection staff on areas that warrant investigation = opportunity for efficiency
- Using on-demand raster analysis of any new satellite data collected over infrastructure has historically been impossible or too expensive
- Aggregating, collecting, and managing all the vector open data sources that could be used in this endeavor is a large undertaking for any GIS team
- But if you COULD do the above, GIS users and their stakeholders would greatly benefit

Vector Big Data Problem

OpenStreetMap

Report run at Apr, 27th 2016 1:03 am CET
Statistics of the free wiki world map (OpenStreetMap.org) created in Central European Time (CET)

Number of OSM Nodes in the database	3336646203
Number of members who are the last modifier of at least one node	433616
Max. OSM Node ID	4149979395
Yesterday's number of created nodes	1892397
Yesterday's number of modified nodes	270919
Yesterday's number of deleted nodes	341569

OpenStreetMap stats report run at 2016-04-27

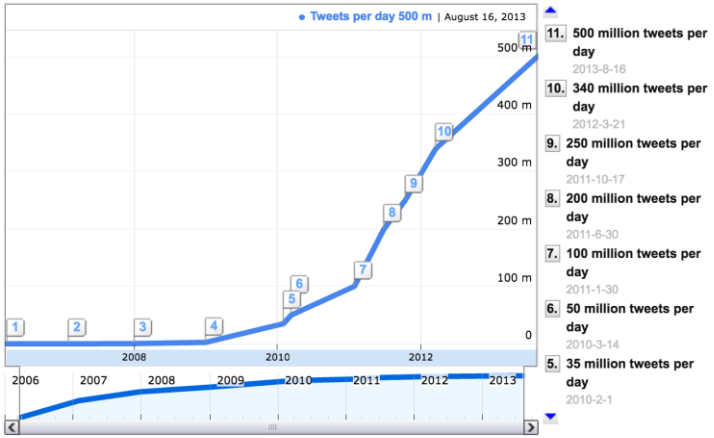
Number of users	2618722
Number of uploaded GPS points	5171741556
Number of nodes	3336836604
Number of ways	344702535
Number of relations	4178242

Just Twitter (all time)
2,664,928,875,000,000
(2.6 Trillion)

Just OSM (all time)
3,336,646,203
(3.3 Billion)

Twitter

Every second, on average, around 6,000 tweets are tweeted on Twitter (visualize them here), which corresponds to over 350,000 tweets sent per minute, **500 million tweets per day** and around 200 billion tweets per year. The chart below shows the number of tweets per day throughout Twitter's history:



Raster Big Data Problem

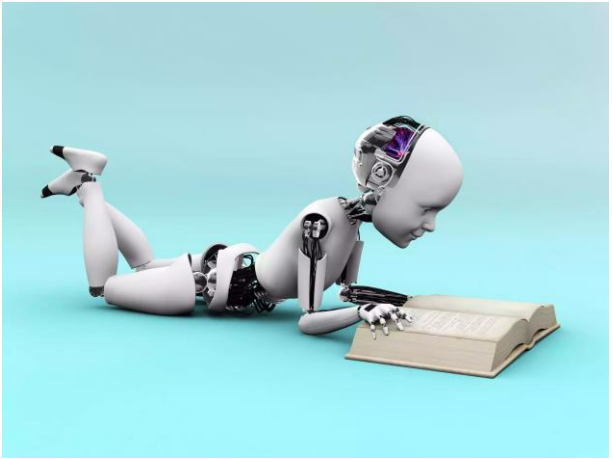
DigitalGlobe Satellite Data Alone…

But it CAN be processed

Crowd-sourced Analysis

http://blog.tomnod.com/crowd-and-machine-combo

Deep Learning (Machine Learning/AI)

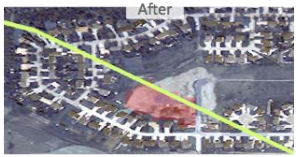


http://www.digitalglobeblog.com/2016/02/22/helping-facebook-connect-the-world-with-deep-learning/

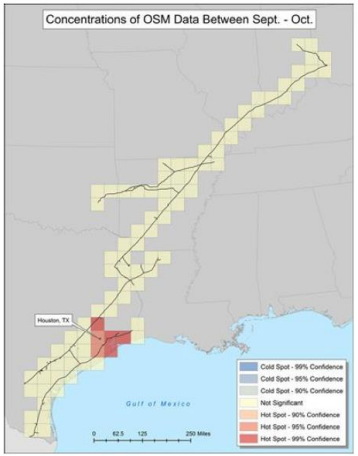
Around my pipeline, show me…

New Construction

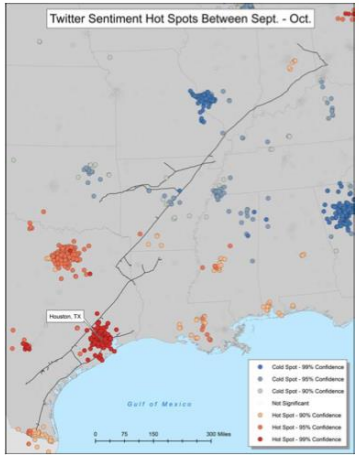
Changes in soil or land use



New roads



New Open Streetmap Features



New indicators of human activity (Twitter)

Potential Solution

DigitalGlobe recently released a capability which allows analysis of raster and vector data at scale, and on demand, on DigitalGlobe (and other's) content via cloud services and RESTful web service APIs.

We wanted to explore using existing customer data within ArcMap (pipelines/buffers/ROWs/etc) to leverage these cloud-based capabilities in addressing this use case. In order to do this, we identified the following requirements for an ArcMap add-in.

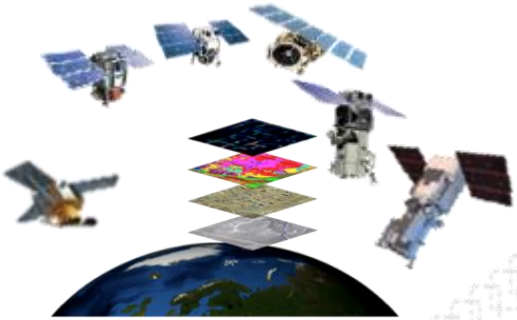
Given selected vectors or buffers that exist in ArcMap…

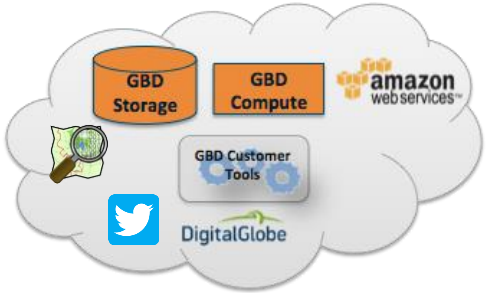
- Let me select the type of changes I want to detect within past or future Satellite imagery
  - Building footprints, new roads, human activity, change in land use, etc.
- Let me select the type of changes I want to detect within recent or future vector data sources
  - Increase in human activity (Tweets near assets), new OpenStreetMap features near my assets, etc.
- Run my selections every day/week/month/whenever new imagery or vector data is available!

When you get results I care about….

- Let me easily see "where" there is an increase in change and what the change is/may be directly in ArcMap.
- Give me an easy way to show/share that with my organization so I can take action/inform others.

But we needed a connection!





User

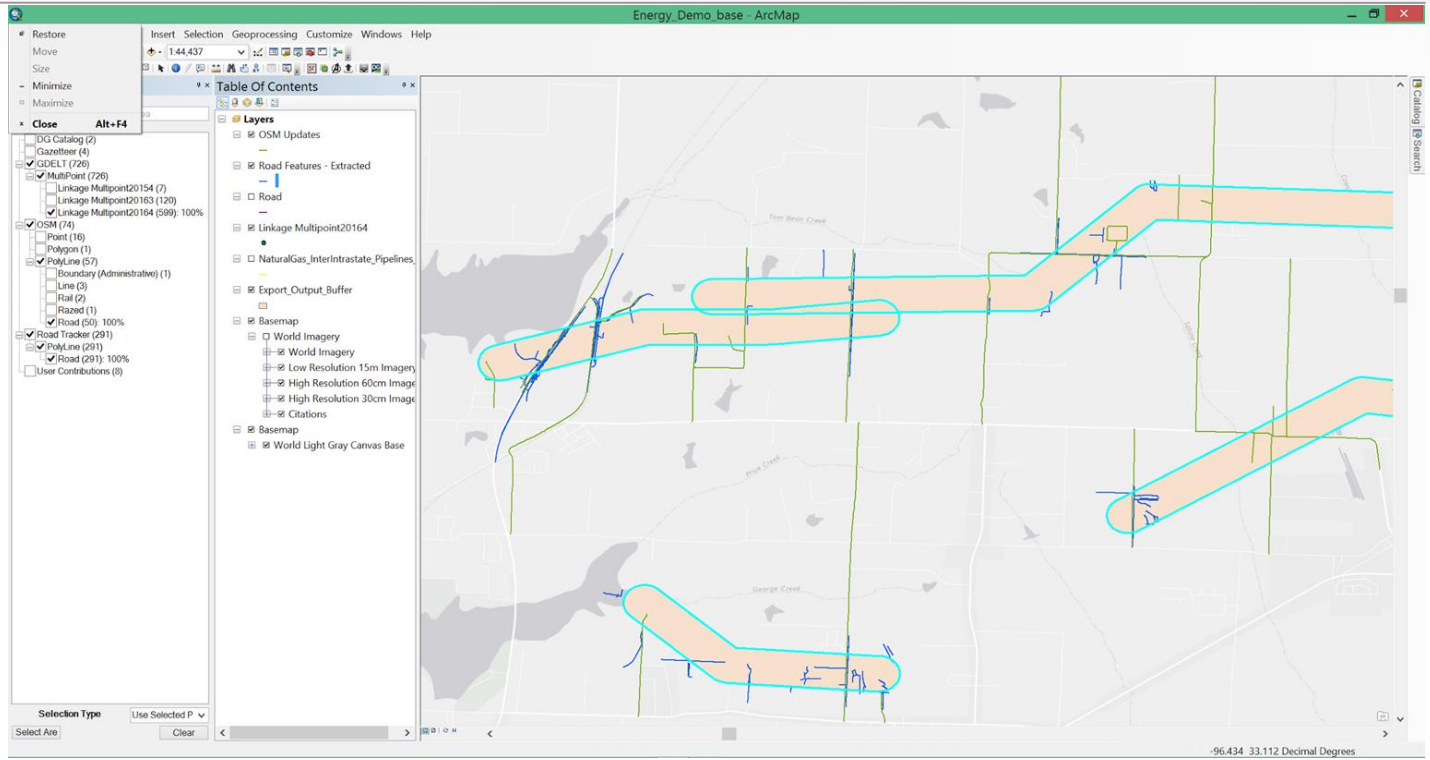
Data

esri

Tools

Solution - connect ArcMap to Cloud Geobigdata!

Comparing Open Street Map Vector updates (RED) to road feature extraction (BLUE) from most recent satellite imagery (ground truthing).



Demonstration – Inspect & Compare

- Identify changes, events, and activities manually across assets
- Past activity history
- New updates on activity
- Back-correlate to prior events
- Other types of analysis

Demonstration - Share

- How do we share with other organizational stakeholders?
- How can organizational users request information that we can use within GIS team?
- Can other organizational elements benefit from this capability?

Findings

- We were able to identify multiple types of potential benefits for this use case
- We are exploring making this an automated process versus manually performed
- Better to deliver“results” or “insights” without the noise (WHERE is there change? WHAT is the change?)
- Allow analyst to view/see pixels and output vectors used in the analysis for high-probability interest areas (man-in-loop validation) as WMS.
- What if we add aerial/UAS data that customers may already have?
- Can we integrate classification determination as well?

Our Vision

- At DigitalGlobe, we see a future in which operators of pipelines and other infrastructure can be kept dynamically aware of physical changes to and nearby their assets
- Adopters of these new technologies will enjoy siginficant cost savings in monitoring, analysis and compliance reporting relative to those using traditional methods
- The marriage of machine learning and human verification can be an incredibly cost effective way to monitor change at scale on an ongoing basis
- We’re engaged in robust dialogue with our clients and industry partners about these technologies and their numerous use cases in real-world applications, and welcome all feedback and suggestions

Q&A

- Open Q&A Session

Thank you!

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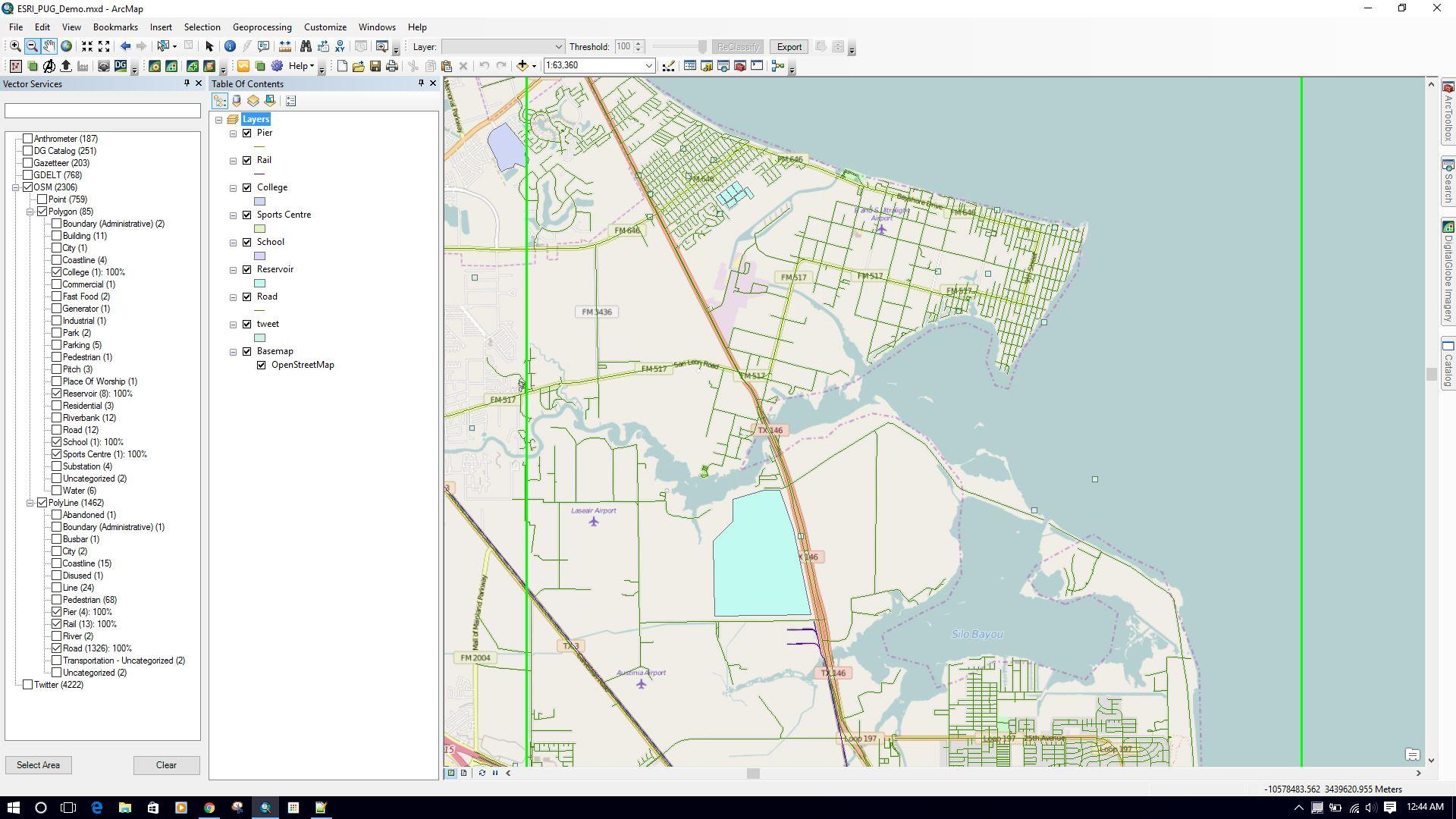
Backup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Anthrometer (187)
DG Catalog (251)
Gazetteer (203)
GDELT (768)
OSM (2306)
Point (759)
Polygon (85)
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Building (11)
City (1)
Coastline (4)
College (1): 100%
Commercial (1)
Fast Food (2)
Generator (1)
Industrial (1)
Park (2)
Parking (5)
Pedestrian (1)
Pitch (3)
Place Of Worship (1)
Reservoir (8): 100%
Residential (3)
Riverbank (12)
Road (12)
School (1): 100%
Sports Centre (1): 100%
Substation (4)
Uncategorized (2)
Water (6)
PolyLine (1462)
Abandoned (1)
Boundary (Administrative) (1)
Busbar (1)
City (2)
Coastline (15)
Disused (1)
Line (24)
Pedestrian (68)
Pier (4): 100%
Rail (13): 100%
River (2)
Road (1326): 100%
Transportation - Uncategorized (2)
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Reservoir
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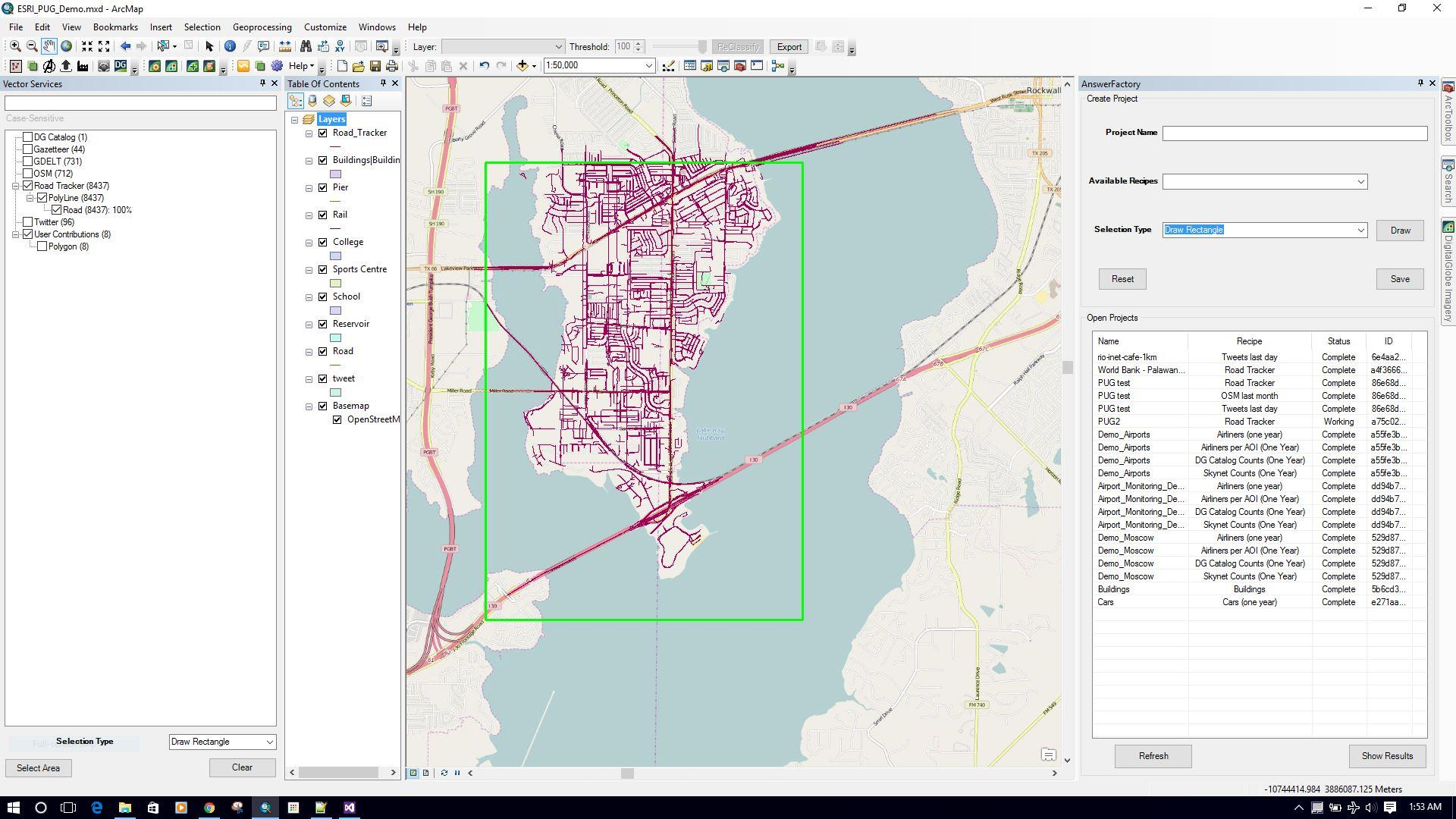
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OSM (712)
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Twitter (96)
User Contributions (8)
Polygon (8)
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Layers
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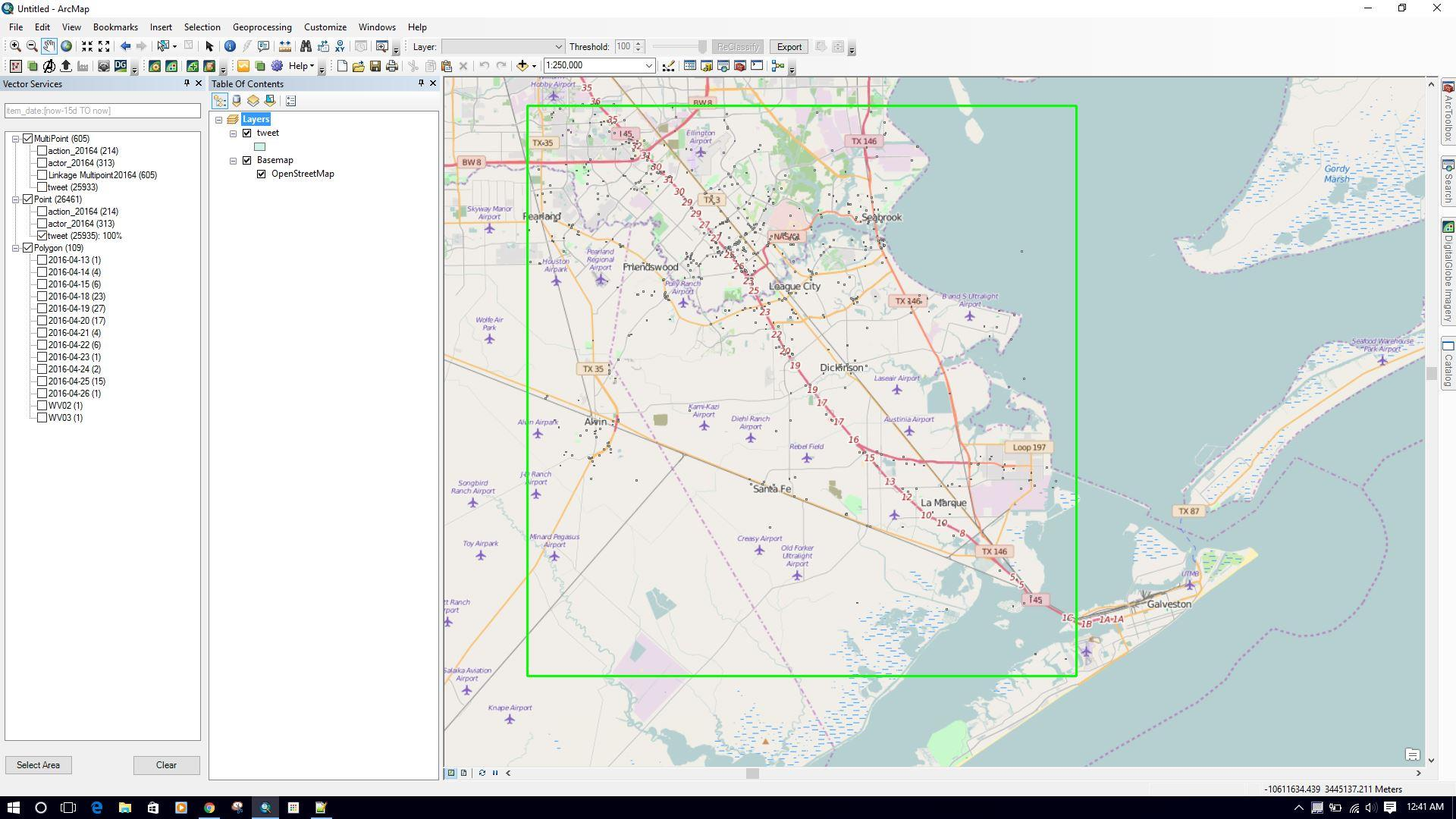
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DigitalGlobe | john-isaac.clark | DG-Platf | Answer Factory | Answer Factory

https://devvector.geobigdata.io/answer-factory/#/view-project/553cfc3c-d902-43ea-ae9b-bbe5de912516

Apps | Alarm | left | digitalglobe | bubz | red | right | Disrupt. Reimagine. | Bookmarks | Innovation at 50X - | Because Location Mat | StarCIO Agile Guide

DigitalGlobe

Open Project | Create Project

AnswerFactory powered by GBDX

log out

<< airports_mtrotter

Owner: mtrotter

Created:

Updated:

Configured recipes:

- Airliners per AOI (One Year) [X]
- Aircraft Detection [X]
- Skynet Counts (One Year) [X]
- DG Catalog Counts (One Year) [X]
- Fighters (one year) [X]

Available recipes:

-- Select a recipe --

Add Recipe

Answers

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Fighters (one year)-51803f70-6c69-491e-b871-cbe2290301d5
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By Type and Time Aggregation

Table Data

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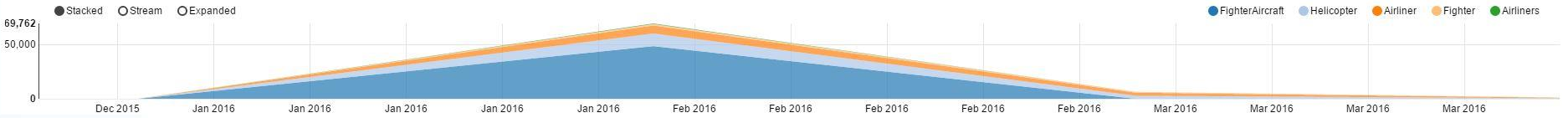

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50 km

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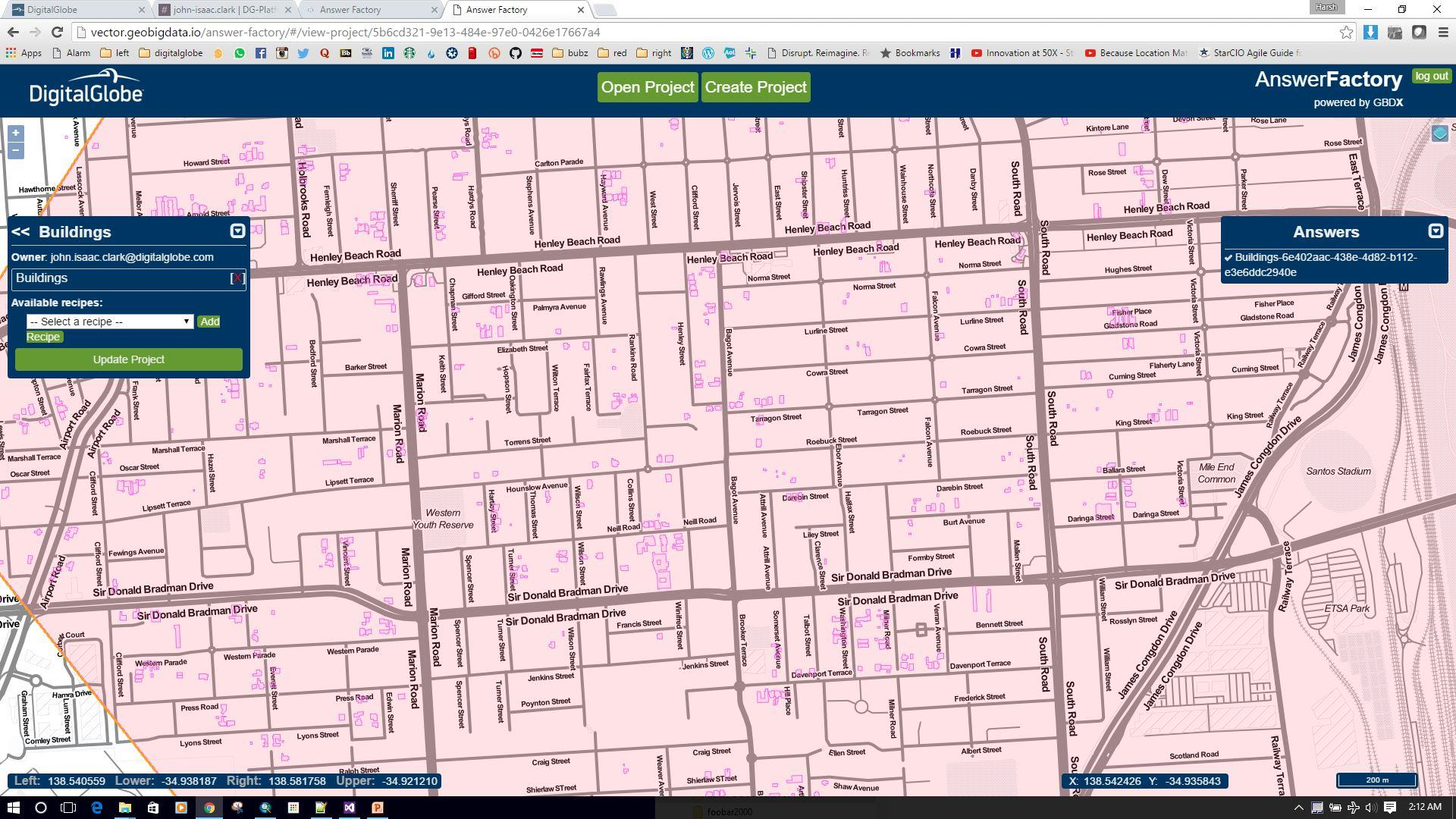
DigitalGlobe
Open Project
Create Project
AnswerFactory
powered by GBDX
log out
<< Buildings
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Buildings [X]
Available recipes:
-- Select a recipe --
Add Recipe
Update Project
Answers
Buildings-6e402aac-438e-4d82-b112-e3e6ddc2940e
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South Road
Marion Road
Airport Road
Sir Donald Bradman Drive
James Congdon Drive
Railway Terrace
Western Youth Reserve
Mile End Common
Santos Stadium
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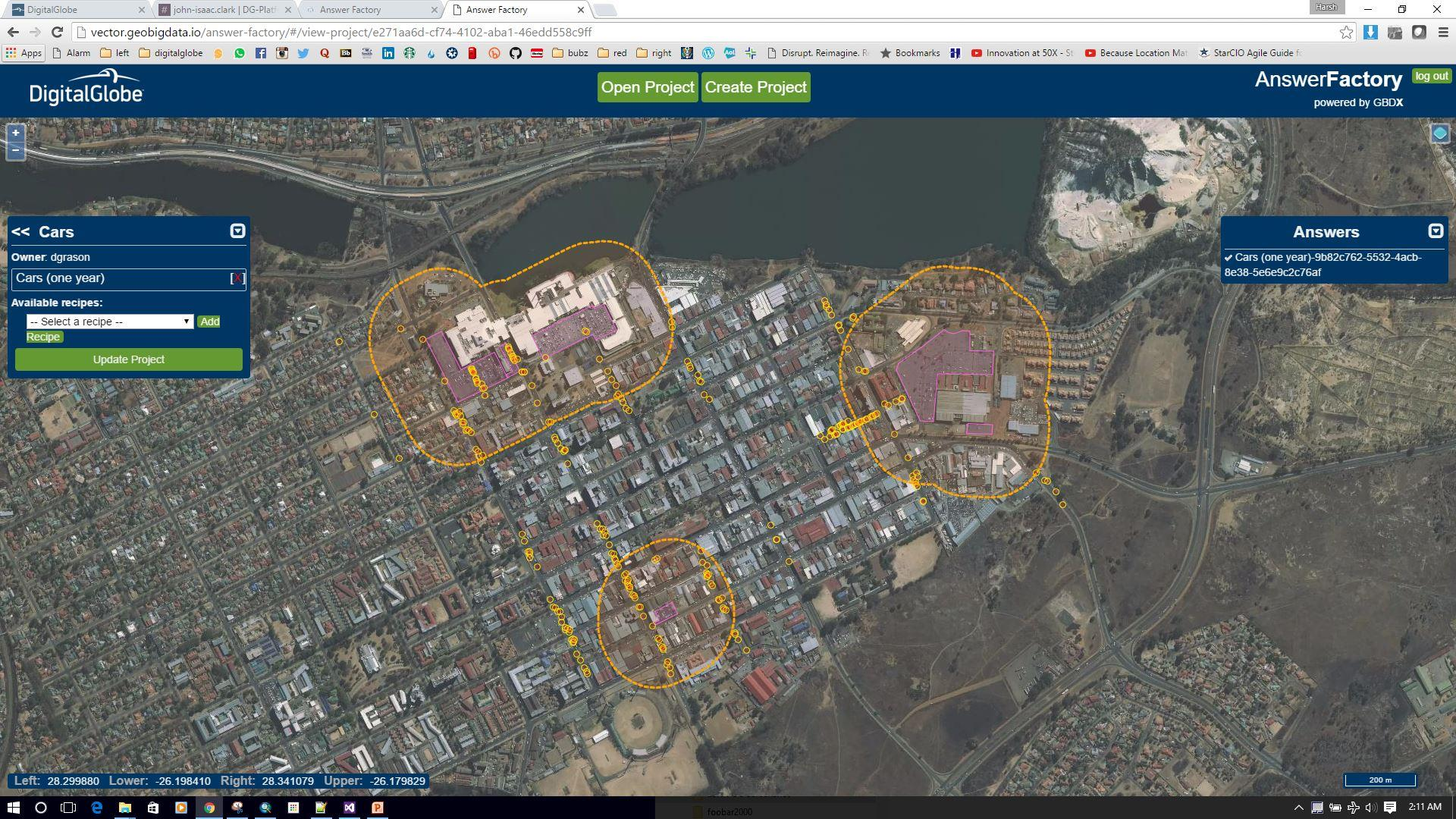
200 m


DigitalGlobe
Open Project
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powered by GBDX
log out
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Cars (one year)
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Add Recipe
Update Project
Answers
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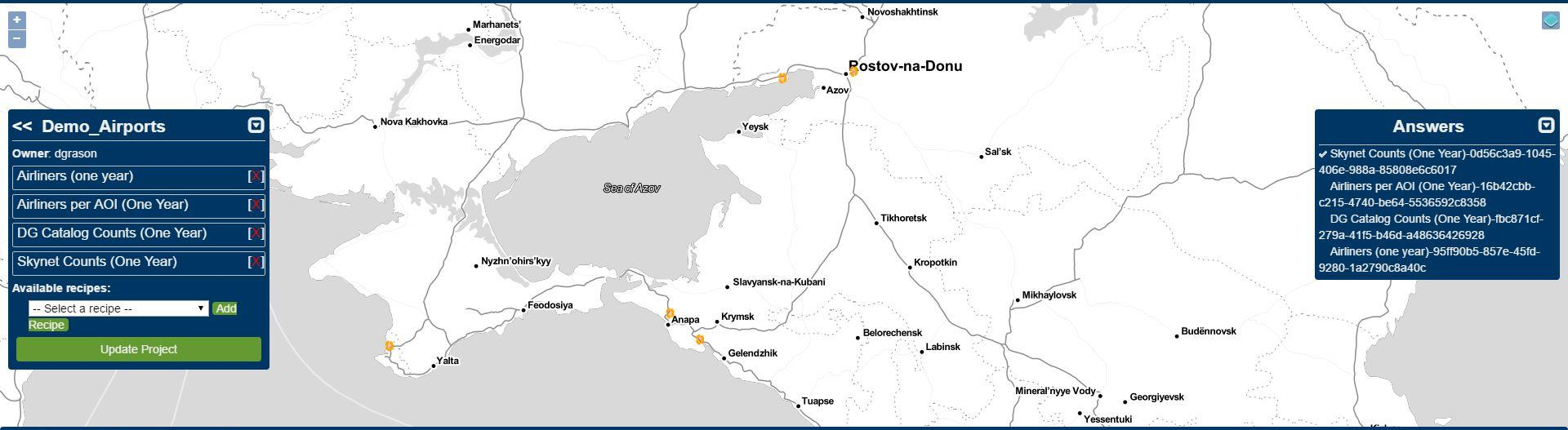
Open Project | Create Project

AnswerFactory powered by GBDX | log out



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- Airliners per AOI (One Year) [X]
- DG Catalog Counts (One Year) [X]
- Skynet Counts (One Year) [X]

Available recipes:

-- Select a recipe -- | Add Recipe

Update Project

Answers

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- Airliners per AOI (One Year)-16b42cbb-c215-4740-be64-5536592c8358
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By Type and Time Aggregation

Table Data

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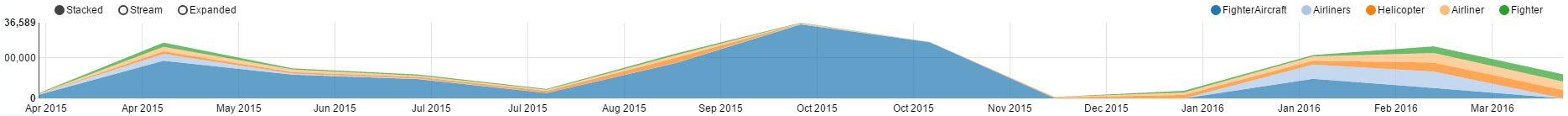

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100 km

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foobar2000

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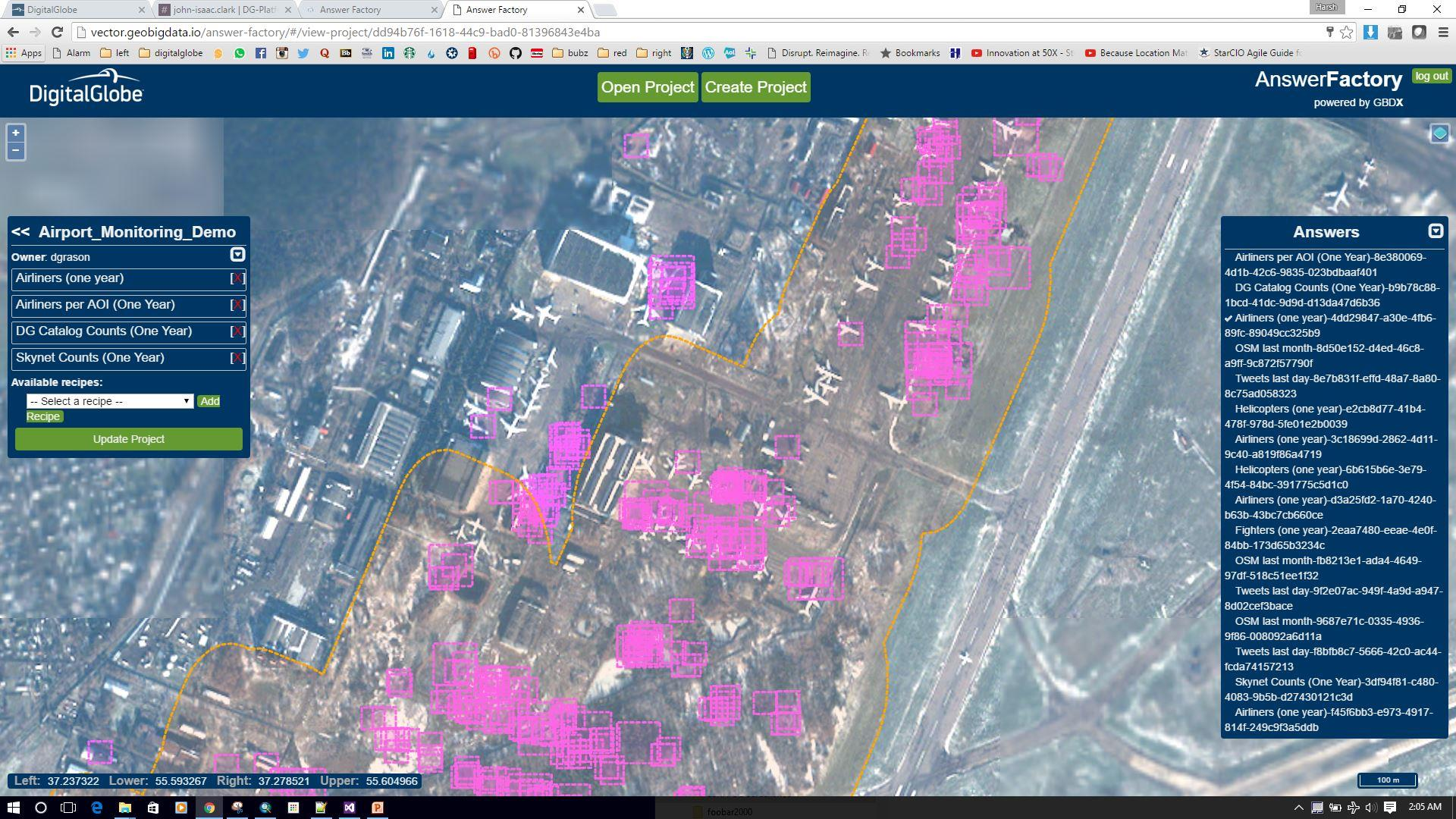
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Airliners per AOI (One Year) [X]
DG Catalog Counts (One Year) [X]
Skynet Counts (One Year) [X]
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OSM last month-9687e71c-0335-4936-9f86-008092a6d11a
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100 m


DigitalGlobe
Open Project
Create Project
AnswerFactory
log out
powered by GBDX
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Airliners (one year) [X]
Airliners per AOI (One Year) [X]
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Tweets last day-8e7b831f-effd-48a7-8a80-8c75ad058323
Helicopters (one year)-e2cb8d77-41b4-478f-978d-5fe01e2b0039
✔ Airliners (one year)-3c18699d-2862-4d11-9c40-a819f86a4719
Helicopters (one year)-6b615b6e-3e79-4f54-84bc-391775c5d1c0
Airliners (one year)-d3a25fd2-1a70-4240-b63b-43bc7cb660ce
Fighters (one year)-2eaa7480-eeae-4e0f-84bb-173d65b3234c
OSM last month-fb8213e1-ada4-4649-97df-518c51ee1f32
Tweets last day-9f2e07ac-949f-4a9d-a947-8d02cef3bace
OSM last month-9687e71c-0335-4936-9f86-008092a6d11a
Tweets last day-f8bfb8c7-5666-42c0-ac44-fcda74157213
Skynet Counts (One Year)-3df94f81-c480-4083-9b5b-d27430121c3d
Airliners (one year)-f45f6bb3-e973-4917-814f-249c9f3a5ddb
Left: 37.489085 Lower: 55.510269 Right: 37.530284 Upper: 55.521993
100 m