

Global

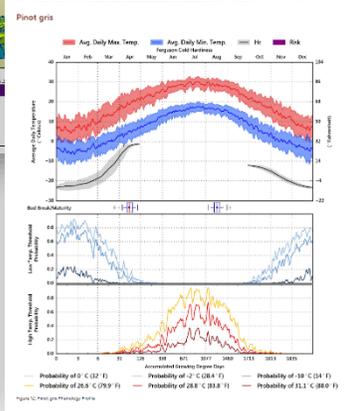
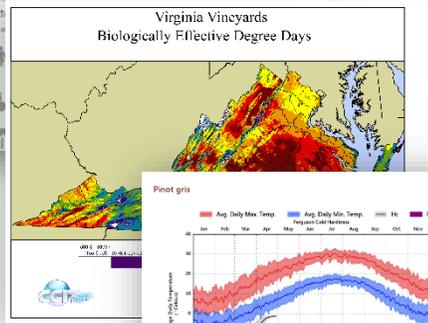
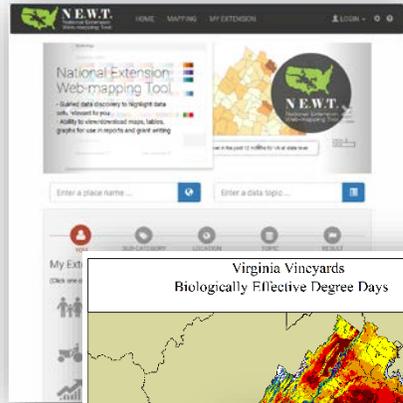
Research

Local

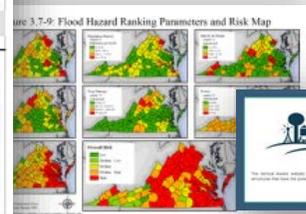
Operations

CGIT

Center for Geospatial Information Technology



Year	2015	2016	2017	2018
...



Peter Sforza
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Virginia Tech
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Global
Agroclimatology

Vineyard
Site
Suitability

DMV Crash
Geolocation

NRV 911

Local
Research
&
Outreach



Center for Geospatial Information Technology

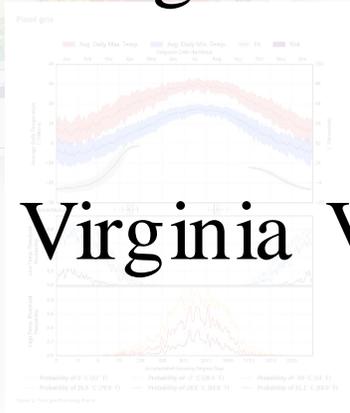


Hazard
Mitigation

Virginia Veterans

Broadband

Extension



Research

Global

Local

Operat

Geography

Computer
Science

Civil
Engineering

Urban
Affairs
&
Planning



CGIT
Center for Geospatial Information Technology



Electrical
Engineering

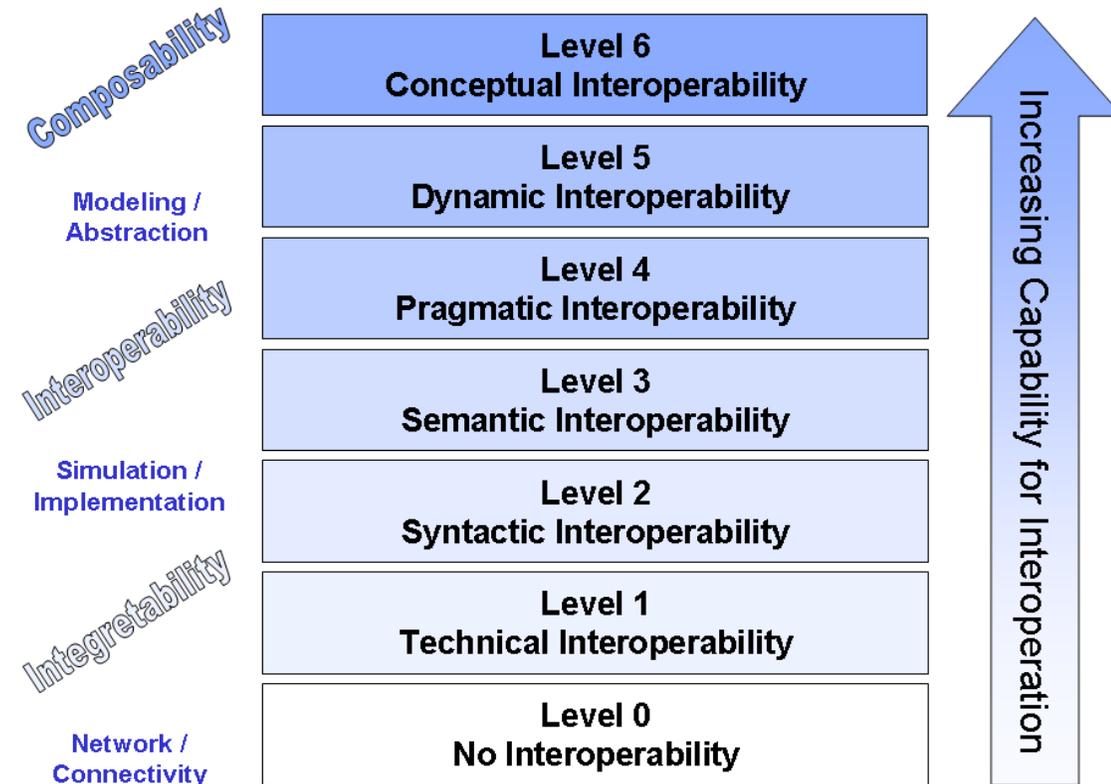
Extension

Plant
Pathology

Met e o r o l o g y

MOD-SIM Platform

- Meta-modeling
- Workflow management for CGIT-NECTAR
- Cloud
- Computing: HPC
- Data
- Integration points (python notebooks, MATLAB, SAS, etc)
- Code management



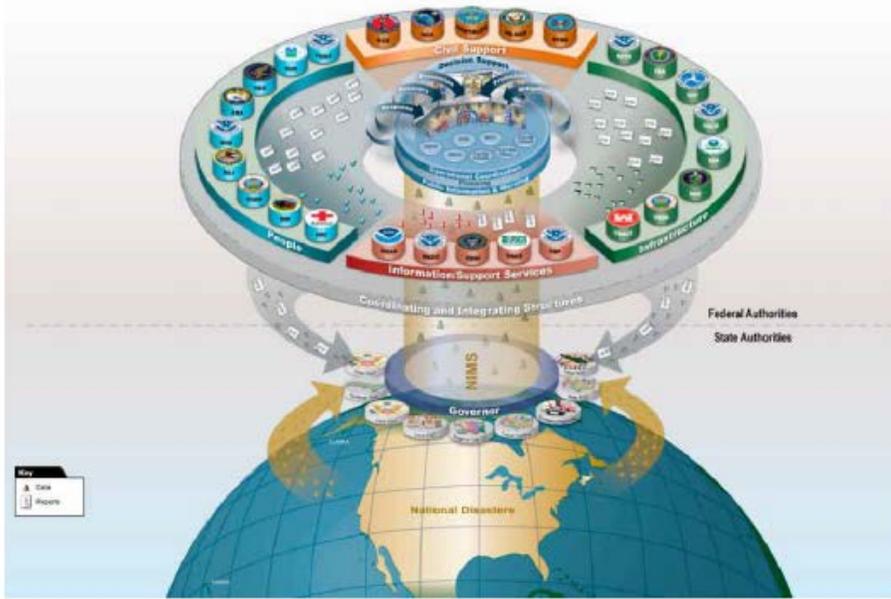


Figure 1.1: Disasters Geospatial Concept of Operations: Department of Homeland Security, USA

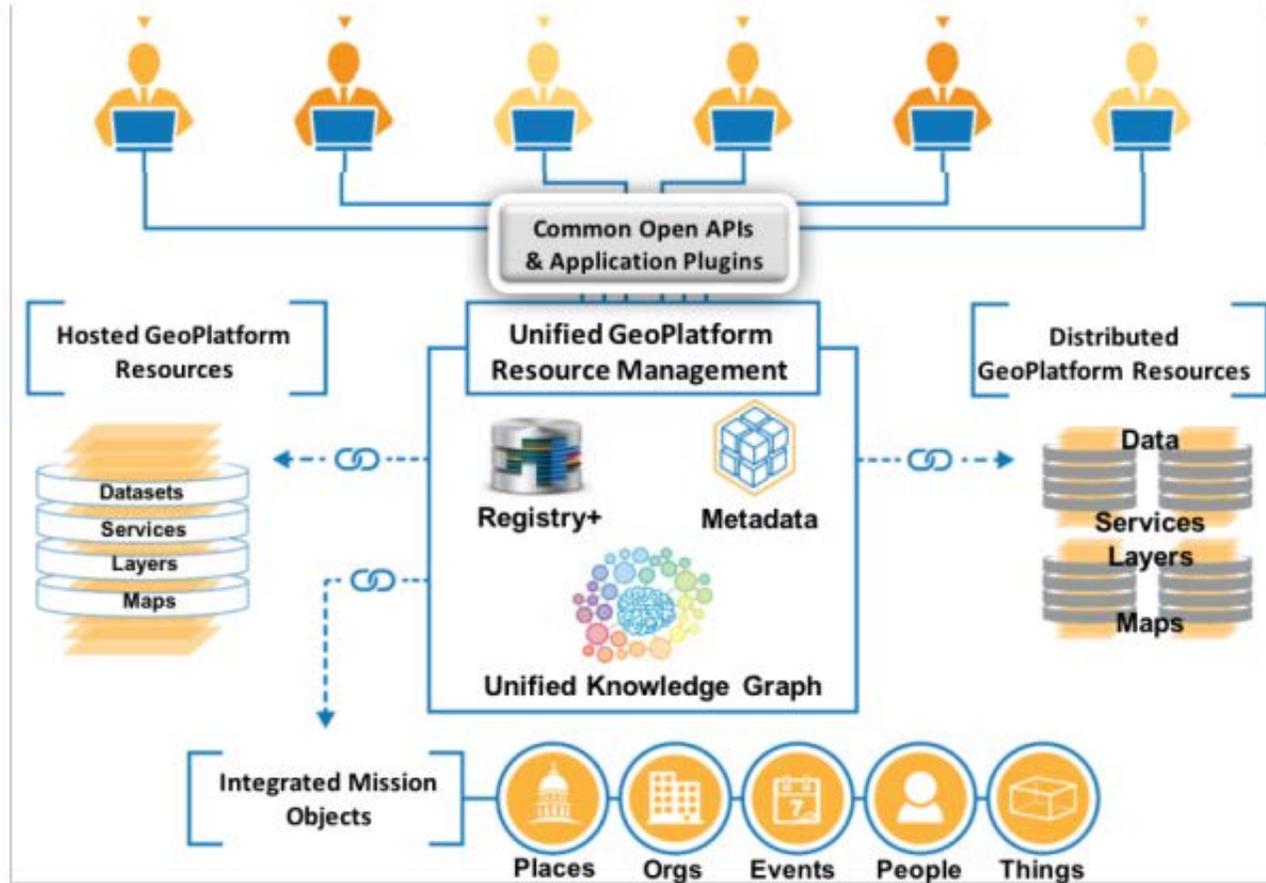


Figure 1.3: US National Spatial Data Infrastructure — GeoPlatform Architecture

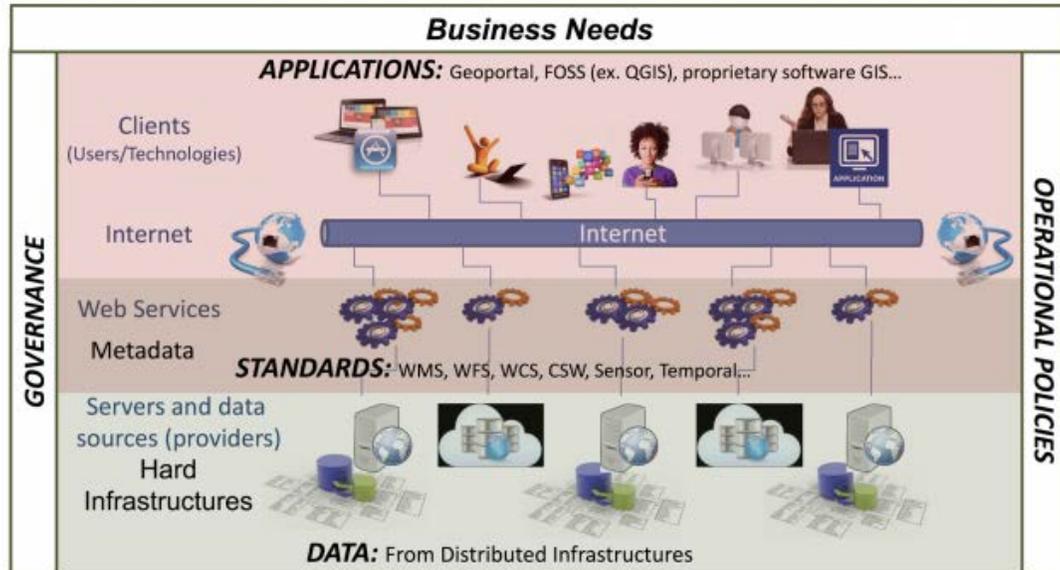
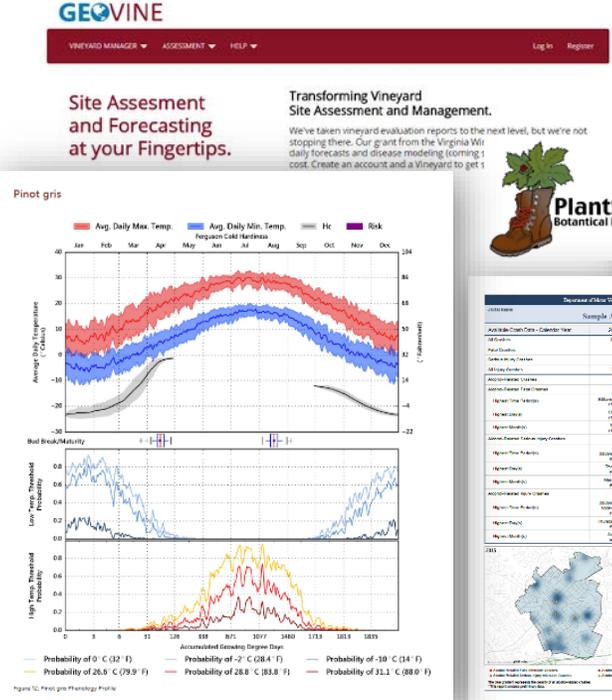
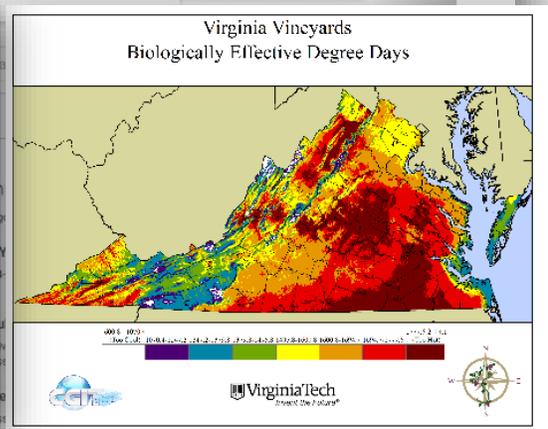


Figure 1.2: Aspects of an SDI (Source: Natural Resources Canada)



Location	2010	2011	2012	2013
Accumulated Frost Hours	100	120	150	180
High Temp. Exceeds Probability	0.8	0.6	0.4	0.2
Low Temp. Exceeds Probability	0.2	0.4	0.6	0.8



Applied geospatial research programs engaging broad communities of stakeholders with data, modeling and simulation, and translational interfaces to support decision making.

Challenges

- Complex variety of community needs and considerations for data, models and analytics, user interfaces.
- Urban-Rural / Digital Divides
- Too much data, yet never enough data
- Sustainable org/cyberinfrastructure
- Blackboxes

Practice

- Spatial Data Infrastructures
- MaaS/Cloud/HPC
- Research to Operations
- Automation
- Data fusion
- Mod-Sim-Viz
- Web/AR/VR
- Translation and Decision Making

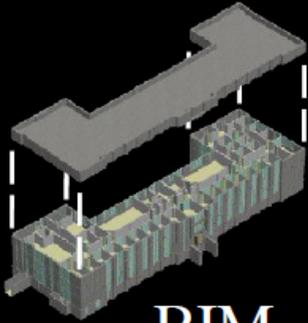
Future

- Interdisciplinary Methods
- Synthesis and Integration
- Network Analysis
- Economic Development
- Community Resilience
- Knowledge Management Systems

Current Projects: Geovine.org, Geohops, Virginia Broadband Mapping Initiative, National Extension Web Mapping Tool (NEWT), PlantShoe, VA Highway Safety Office, VA Veterans, Renewable Energy Siting, NRV911, Hazard Mitigation / Resilience, United Way SWVA, Bike Sensors for Air Quality, SmartFarm

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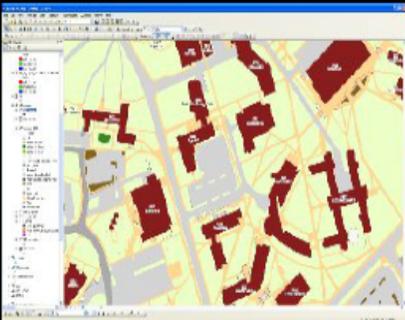
Technology convergence



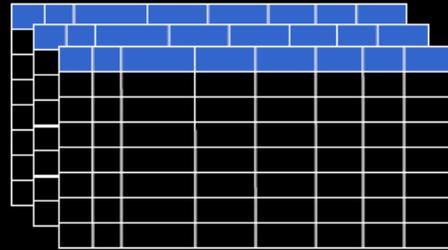
BIM



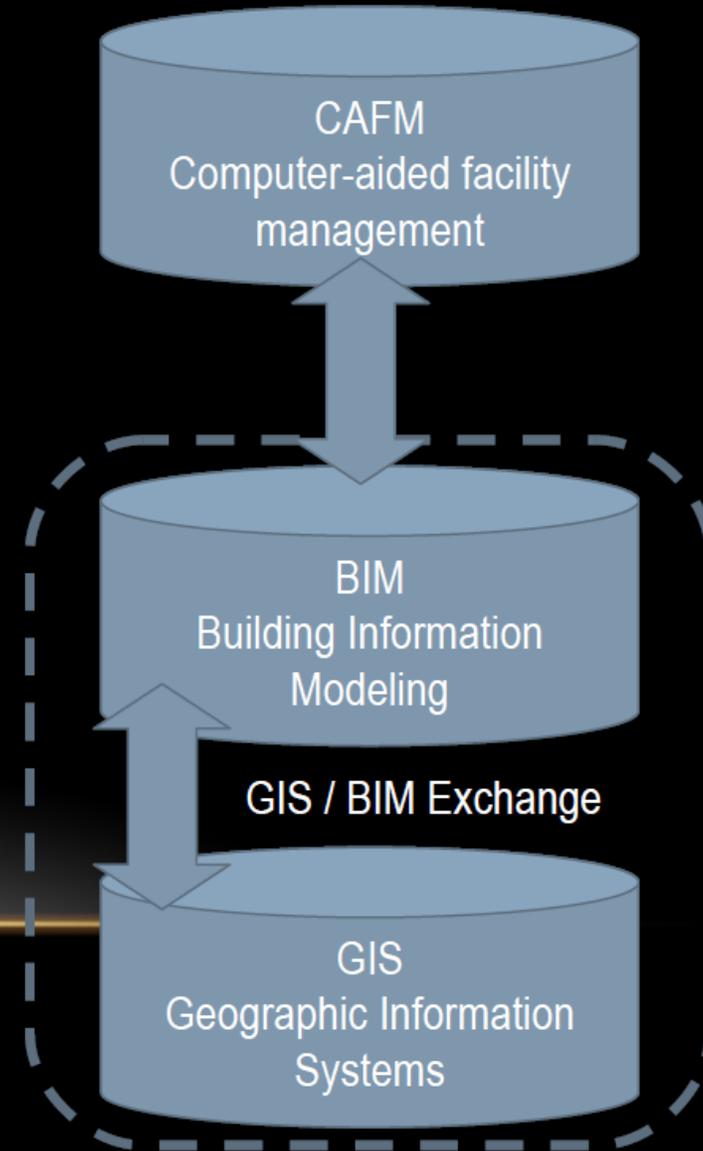
CAD

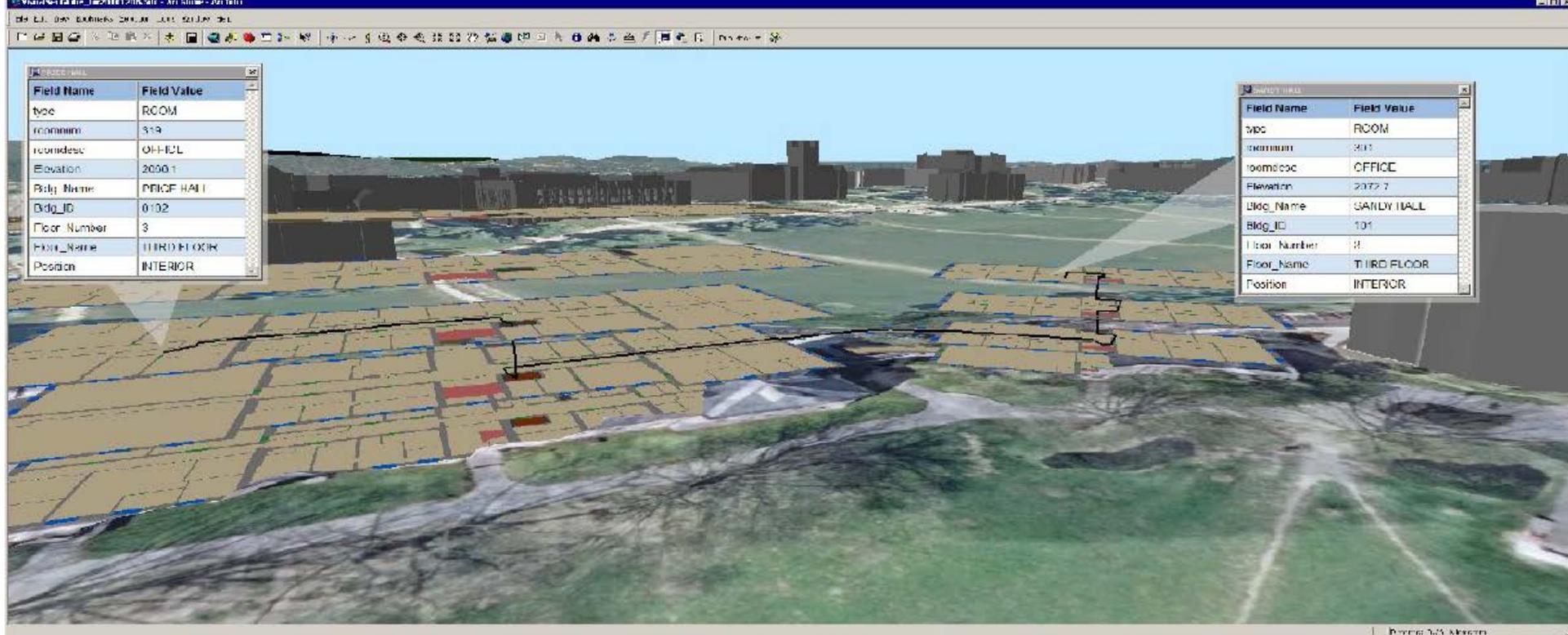


GIS



**Tabular
Data**





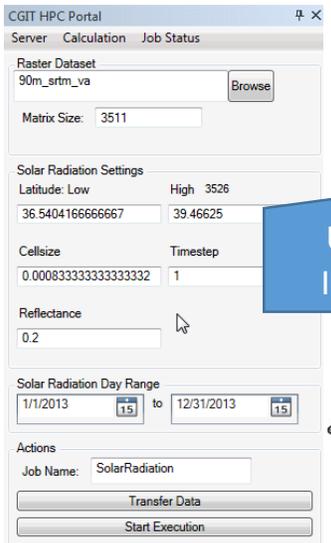
Sample Route Solution



Routing Network



Innovation Visualization



ICAT
Cube

Unity Scene

User
Input

CGIT HPC
Tools

HPC

Queue



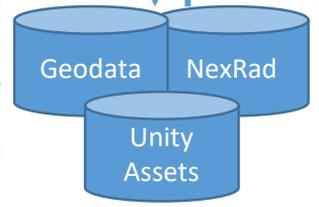
Completed
Data

Software Libraries

Python

In-place
compute

- NexRad processing
- Terrain, Imagery, GIS processing
- Unity Scenegraph construction



Data Repository



Virginia Department of Motor Vehicles

Standardizing crash location attributes according to spatial reference data for use across all jurisdictions and organizations.

VGIN Road Centerlines

VDOT Linear Referencing System

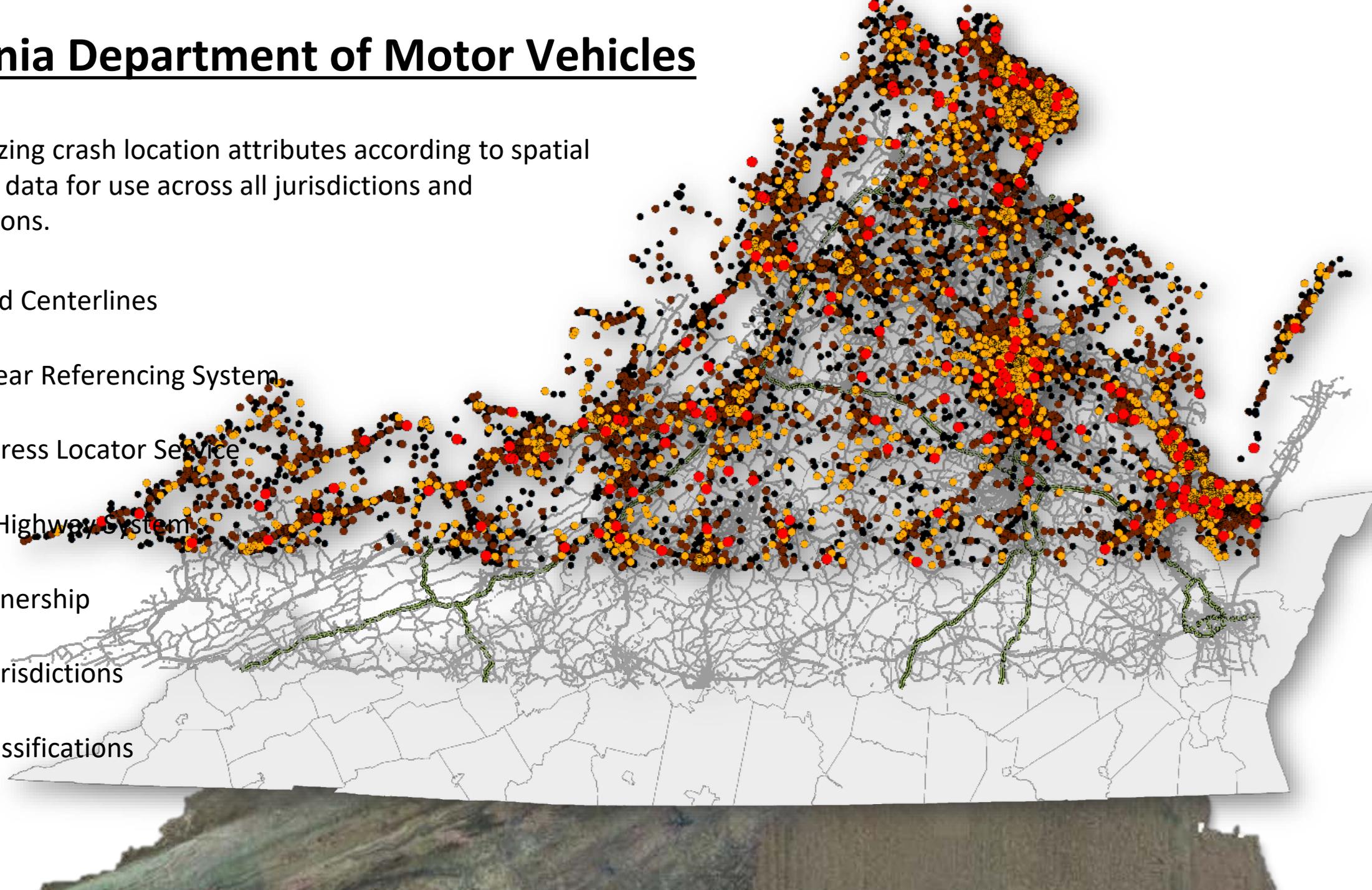
VGIN Address Locator Service

National Highway System

VDOT Ownership

Census Jurisdictions

Urban Classifications



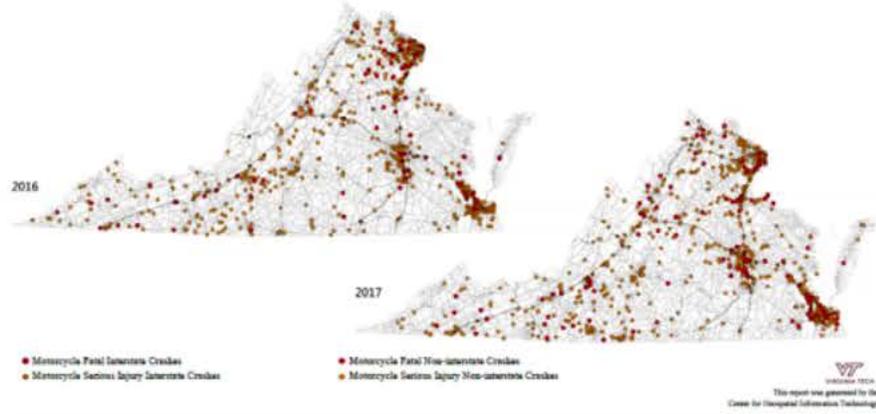
Crash Statistics Reports

Department of Motor Vehicles Virginia Highway Safety Office

Statewide Virginia Motorcycle Crash Statistics May, 2018

Available Crash Data - Calendar Year	2014	2015	2016	2017
All Crashes	120274	125792	128514	127362
Fatal Crashes	656	711	723	787
Serious Injury Crashes	6145	6528	6595	6332
All Injury Crashes	41592	42955	44155	42422

Motorcycle Crashes	2005	2001	1919	2119
Motorcycle Fatal Crashes	76	69	72	108
Highest Time Period(s)	6:00pm - 8:59pm (24%)	6:00pm - 8:59pm Noon - 2:59pm (38%)	3:00pm - 5:59pm (28%)	3:00pm - 5:59pm Noon - 2:59pm (44%)
Highest Day(s)	Sunday (36%)	Sunday (23%)	Saturday (25%)	Sunday (27%)
Highest Month(s)	July (24%)	May (22%)	August (18%)	June (18%)
Motorcycle Serious Injury Crashes	585	668	663	723
Highest Time Period(s)	3:00pm - 5:59pm (27%)	3:00pm - 5:59pm (26%)	3:00pm - 5:59pm (27%)	3:00pm - 5:59pm (27%)
Highest Day(s)	Saturday (28%)	Sunday (22%)	Saturday - Sunday (42%)	Saturday (25%)
Highest Month(s)	May (16%)	May (16%)	July - June (28%)	July - June (26%)
Motorcycle Injury Crashes **	1637	1644	1565	1670
Highest Time Period(s)	3:00pm - 5:59pm (28%)	3:00pm - 5:59pm (29%)	3:00pm - 5:59pm (28%)	3:00pm - 5:59pm (27%)
Highest Day(s)	Saturday (32%)	Sunday (21%)	Sunday (20%)	Saturday (21%)
Highest Month(s)	May (14%)	May (16%)	June (14%)	June (13%)



Department of Motor Vehicles Virginia Highway Safety Office

Report of Crashes for January 1st - December 31st, 2017

Report Generated April, 2018

Virginia Senate District 36 Distracted Driver Crash Statistics

Count	Highest Time Period(s)	Highest Day(s)	Highest Month(s)
4	6:00pm - 8:59pm 50% of distracted driver-related fatal crashes	Monday - Saturday 50% of distracted driver-related fatal crashes	March 50% of distracted driver-related fatal crashes
5	6:00pm - 8:59pm 64% of distracted driver-related serious injury crashes	Thursday 26% of distracted driver-related serious injury crashes	April 22% of distracted driver-related serious injury crashes
18			

Crash Data - Calendar Year (CY)	CY 2014	CY 2015	CY 2016	CY 2017
Distracted Driver-Related Crashes	3155	2750	2733	2653
Distracted Driver-Related Fatal Crashes	10	10	10	11
Distracted Driver-Related Serious Injury Crashes	1058	987	848	862
Distracted Driver-Related Fatal Crashes to Total	2%	3%	1%	4%
Distracted Driver-Related Serious Injury Crashes to Total	26%	30%	19%	26%
Distracted Driver-Related Injury Crashes	268	222	215	217
Distracted Driver-Related Injury Crashes to Total	25%	24%	25%	27%

Department of Motor Vehicles Virginia Highway Safety Office

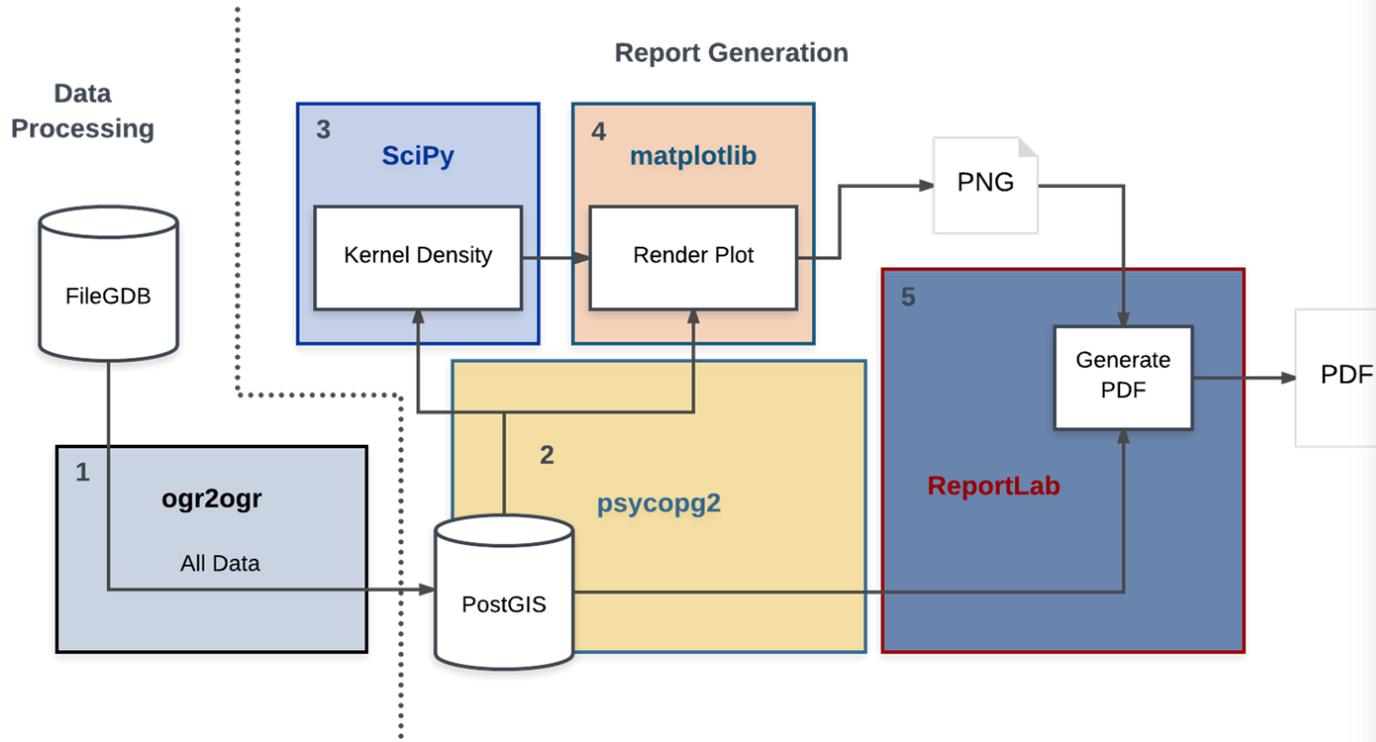
Virginia Beach City Alcohol Crash Statistics

Available Crash Data - Calendar Year	2014	2015	2016
All Crashes	858	887	718
Fatal Crashes	29	15	18
Serious Injury Crashes	104	105	107
All Injury Crashes	212	218	222
Alcohol Crashes	353	489	478
Alcohol Fatal Crashes	13	8	4
Alcohol Serious Injury Crashes	67	39	41
Alcohol Injury Crashes	184	173	200

Crash Data - Calendar Year (CY)	CY 2014	CY 2015	CY 2016	CY 2017
All Crashes	490	500	490	490
Fatal Crashes	10	10	10	10
Serious Injury Crashes	10	10	10	10
All Injury Crashes	20	20	20	20

Automated Method for Crash Statistics Reports

Open-source python workflow:

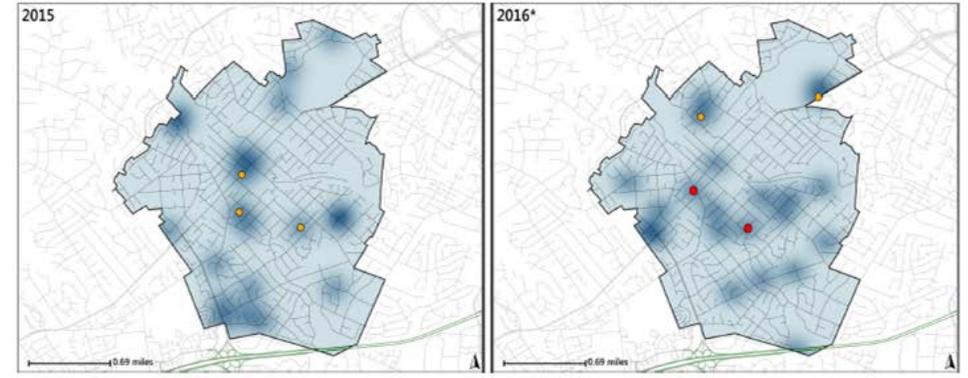


Department of Motor Vehicles Virginia Highway Safety Office

Fairfax Region This is a sample report containing randomly generated data.

Sample Alcohol Crash Statistics

Available Crash Data - Calendar Year	2013	2014	2015	2016*
All Crashes	280	249	370	212
Fatal Crashes	5	1	1	3
Serious Injury Crashes	7	14	10	9
All Injury Crashes	32	88	29	29
Alcohol-Related Crashes	16	9	21	22
Alcohol-Related Fatal Crashes	1	No Alcohol-Related Fatalities	No Alcohol-Related Fatalities	2
Highest Time Period(s)	9:00pm - 11:59pm (100%)			3:00pm - 5:59pm (100%)
Highest Day(s)	Friday (100%)			Sunday - Friday (100%)
Highest Month(s)	May (100%)			September (100%)
Alcohol-Related Serious Injury Crashes	3	2	3	2
Highest Time Period(s)	3:00pm - 5:59pm (67%)	6:00am - 8:59am (100%)	9:00am - 11:59am Noon - 2:59pm (66%)	9:00am - 11:59am Noon - 2:59pm (100%)
Highest Day(s)	Thursday (67%)	Friday - Saturday (100%)	Thursday (67%)	Sunday - Monday (100%)
Highest Month(s)	May - June (66%)	January (100%)	August (67%)	December - November (100%)
Alcohol-Related Injury Crashes	7	8	12	8
Highest Time Period(s)	3:00pm - 5:59pm Noon - 2:59pm (58%)	9:00am - 11:59am 6:00am - 8:59am (50%)	3:00pm - 5:59pm (50%)	3:00pm - 5:59pm (38%)
Highest Day(s)	Thursday - Friday (58%)	Tuesday - Friday (50%)	Sunday - Tuesday (34%)	Monday (38%)
Highest Month(s)	August (43%)	January - February (100%)	September (67%)	December (75%)



● Alcohol-Related Fatal Interstate Crashes
 ● Alcohol-Related Fatal Non-Interstate Crashes
 ● Alcohol-Related Serious Injury Interstate Crashes
 ● Alcohol-Related Serious Injury Non-Interstate Crashes

The blue gradient represents the density of all alcohol-related crashes.
 * This report contains preliminary data.

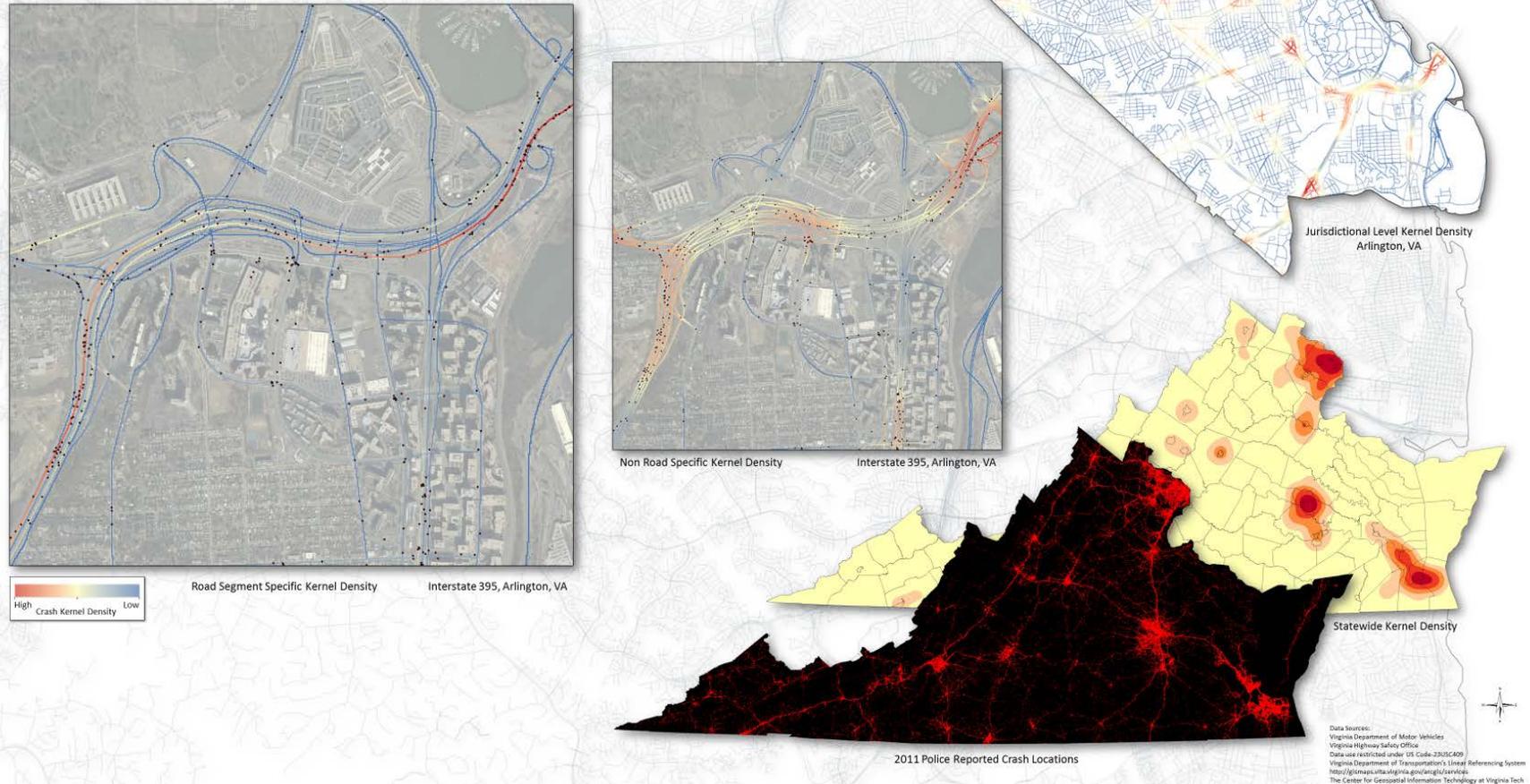
Virginia Tech
 Center for Geospatial Information Technology

Research and Analysis

Road Segment Oriented Crash Density Analysis

The Center for Geospatial Information Technology has been working with the Virginia Department of Motor Vehicles to process all police reported vehicle crashes within the Commonwealth of Virginia.

Road segment dependent kernel density modeling allows detailed visualizations of crash distributions based on road centerline segments.



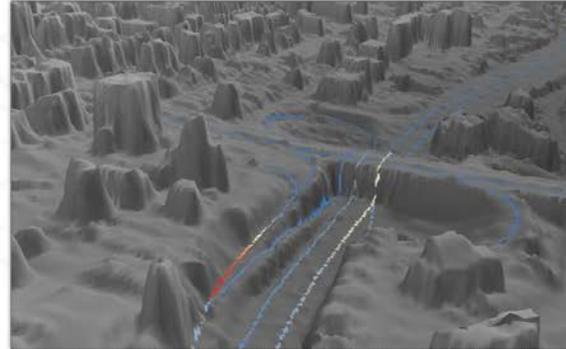
Crash Location and Surrounding Environment

New Approaches to Analyzing Vehicle Crash Trends in Virginia

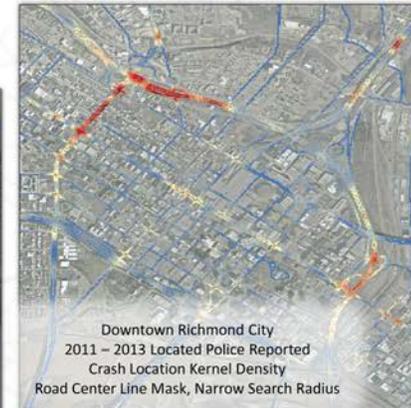
Newman, Joseph; Sforza, Peter; Virginia Department of Motor Vehicles

The Center for Geospatial Information Technology at Virginia Tech has developed a spatial database of all police reported crash locations within the Commonwealth of Virginia, spanning from 2011 to 2013. This extensive database allows researchers to identify roadways with increased crash densities and investigate potential factors through explanatory modeling.

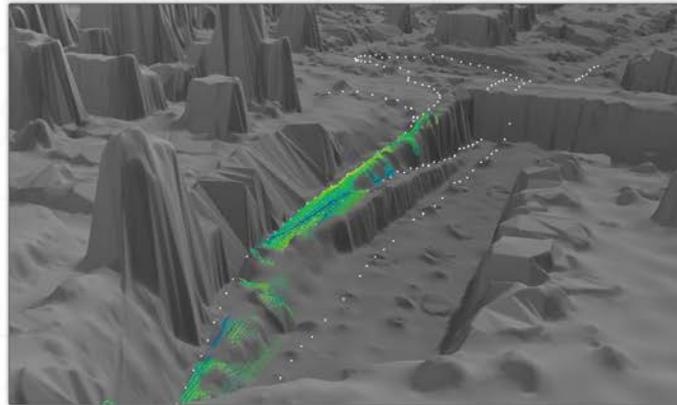
Leveraging historical crash locations and a high resolution digital surface model allows geospatial researchers to develop virtual study areas that can model driver visibility. This method bridges the gap between traditional crash analysis that focuses on the distributions of specific instances and a naturalistic approach that focuses on the environmental factors that impact driver safety.



Ramp from N. Belvidere St. to Eastbound I-64/Southbound I-95, Richmond City
2011 – 2013 Located Police Reported Crash Location
Segment-Oriented Kernel Density

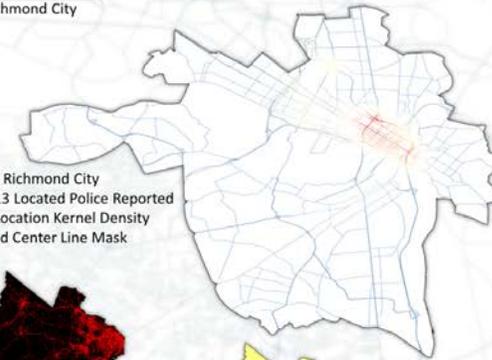


Downtown Richmond City
2011 – 2013 Located Police Reported
Crash Location Kernel Density
Road Center Line Mask, Narrow Search Radius

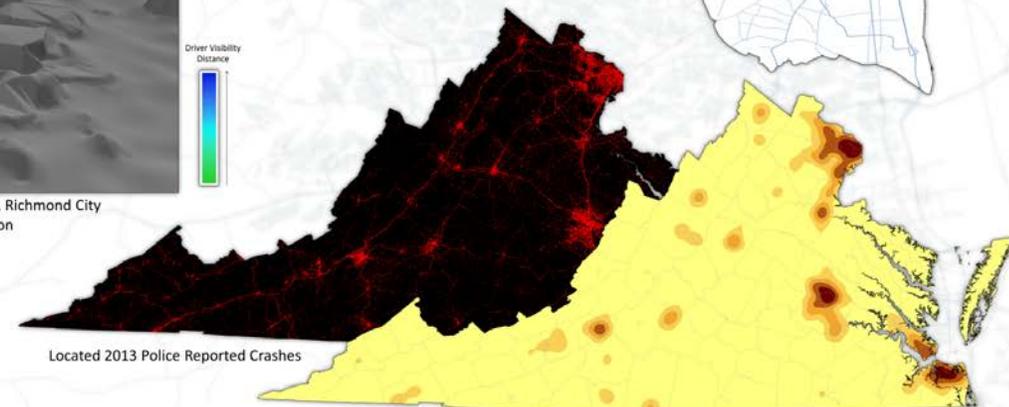


Ramp from N. Belvidere St. to Eastbound I-64/Southbound I-95, Richmond City
2011 – 2013 Located Police Reported Crash Location
Driver Visibility Analysis

This analysis allows researchers to visualize the relationship between increased crash densities and driver reaction time according to driver visibility in merge/diverge intersections.



Richmond City
2011 – 2013 Located Police Reported
Crash Location Kernel Density
Road Center Line Mask



Located 2013 Police Reported Crashes

2011 – 2013 Located Police Reported Crash Kernel Density



Data Sources:
Virginia Department of Motor Vehicles
Virginia Highway Safety Office (Data use restricted under US Code 2305C400)
Virginia Department of Transportation Linear Referencing System
Virginia Geographic Information Network Road Center Line Data
The Center for Geospatial Information Technology at Virginia Tech

3D Analysis Capabilities



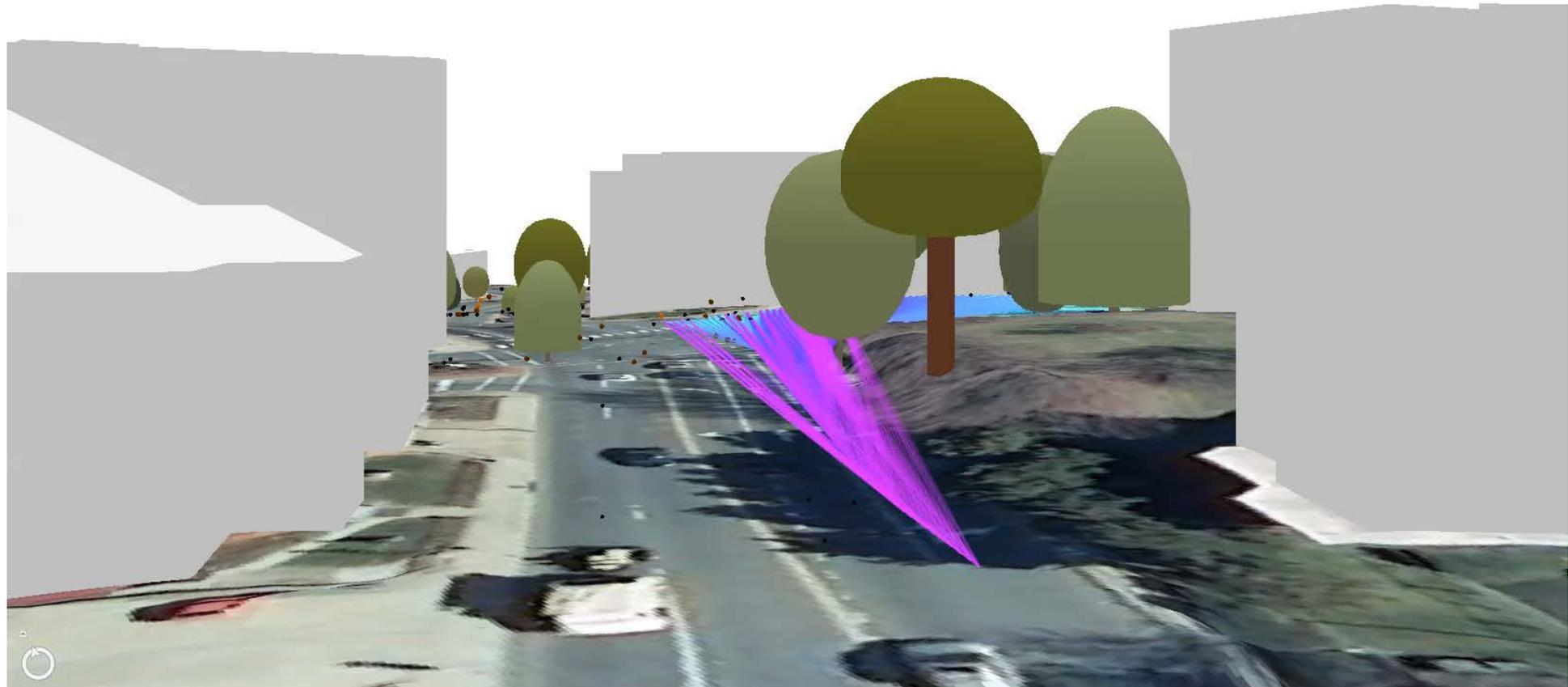
Crash Density Analysis

Automated LiDAR Processing

Building & Tree Form Extraction

Driver Visibility Analysis

3D Analysis Capabilities



Crash Density Analysis

Automated LiDAR Processing

Building & Tree Form Extraction

Driver Visibility Analysis

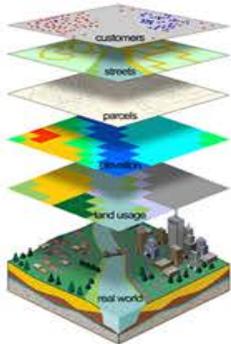
Hazard is an act of phenomenon that has potential to produce harm or other undesirable consequences to a person or thing



Hazards in Virginia

Risk Mitigation Planning

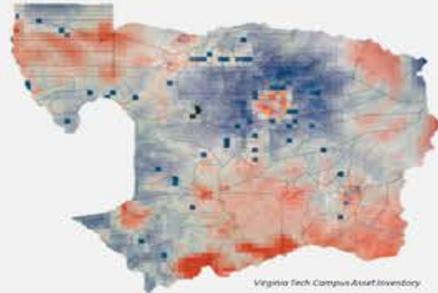
is the process of developing options and actions to enhance opportunities and reduce threats to project objectives



Geospatial Information System

is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data

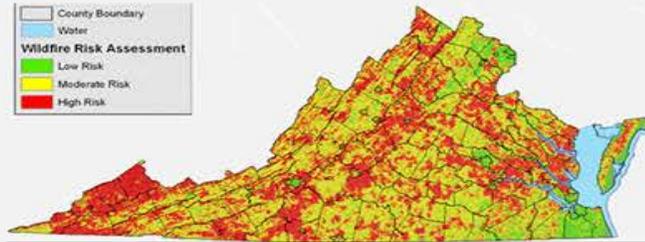
Social Vulnerability



Virginia Tech Campus Asset Inventory

Social vulnerability refers to the socioeconomic factors that affect the resilience of communities. Mapping the vulnerability helps with mitigation planning

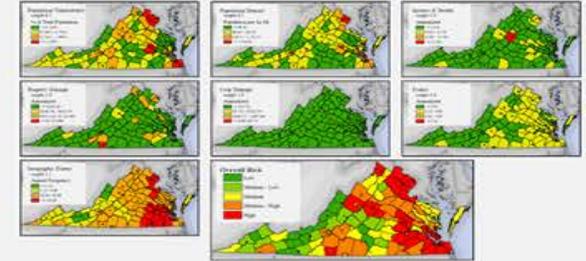
Risk Assessment (HIRA)



State of Virginia: Wildfire Risk Assessment

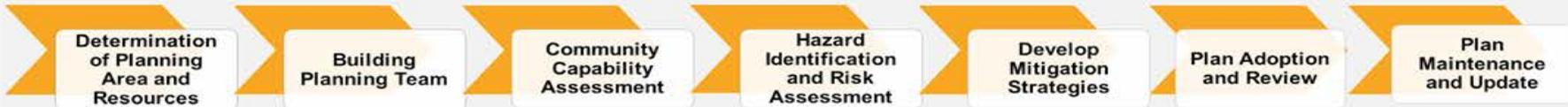
Risk Assessment is the process of measuring potential loss of life, personal injury, economic injury, and property damage resulting from hazards

Ranking



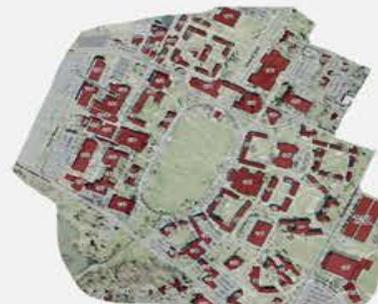
State of Virginia: Tornado Hazard Ranking Parameters and Risk Map

Risk Assessment is the process of measuring potential loss of life, personal injury, economic injury, and property damage resulting from hazards



Asset Inventory

Assets are the people, property, and activities in a community. Assets mapping enables hazard mitigation planning teams to understand what can be affected by different hazard events



Virginia Tech Campus Asset Inventory

Hazard Index

Assets are the people, property, and activities in a community. Assets mapping enables hazard mitigation planning teams to understand what can be affected by different hazard events



Virginia Tech Flood Hazard Index

Community Engagement

Sharing the plan updates and assessments through a web platform. Giving a narrative form to geographic information impresses it with realistic character that just doesn't come across in charts or graphs



ET Hirus: Mapping Disaster Risk

Broadband Planning and Analysis Toolkit

<http://www.cgis.vt.edu/broadband>

Broadband Policy Database: Generates a report based on user-selected location. The report highlights policies at multiple jurisdictional levels that may affect broadband deployment at that location.

ADVANCED PLANNING AND ANALYSIS BROADBAND TOOLBOX FOR VIRGINIA'S STATE BROADBAND INITIATIVE

CIT **CGIT** **VGIN** **CORPUS CROSS**

Broadband Coverage Data
The Virginia Broadband Initiative map was developed to provide the location that users to highlight the availability of broadband services. Map mapping the regions per broadband.

Verification & Analysis
The ability to verify whether coverage is available in a specific geographic area is a key component of the broadband planning process. The ability to verify whether coverage is available in a specific geographic area is a key component of the broadband planning process.

Map Books
The Map Book provides a comprehensive overview of the broadband planning process. It includes a list of map books, a list of map books, and a list of map books.

Policy Database
The Policy Database provides a comprehensive overview of the broadband planning process. It includes a list of policy areas, a list of policy areas, and a list of policy areas.

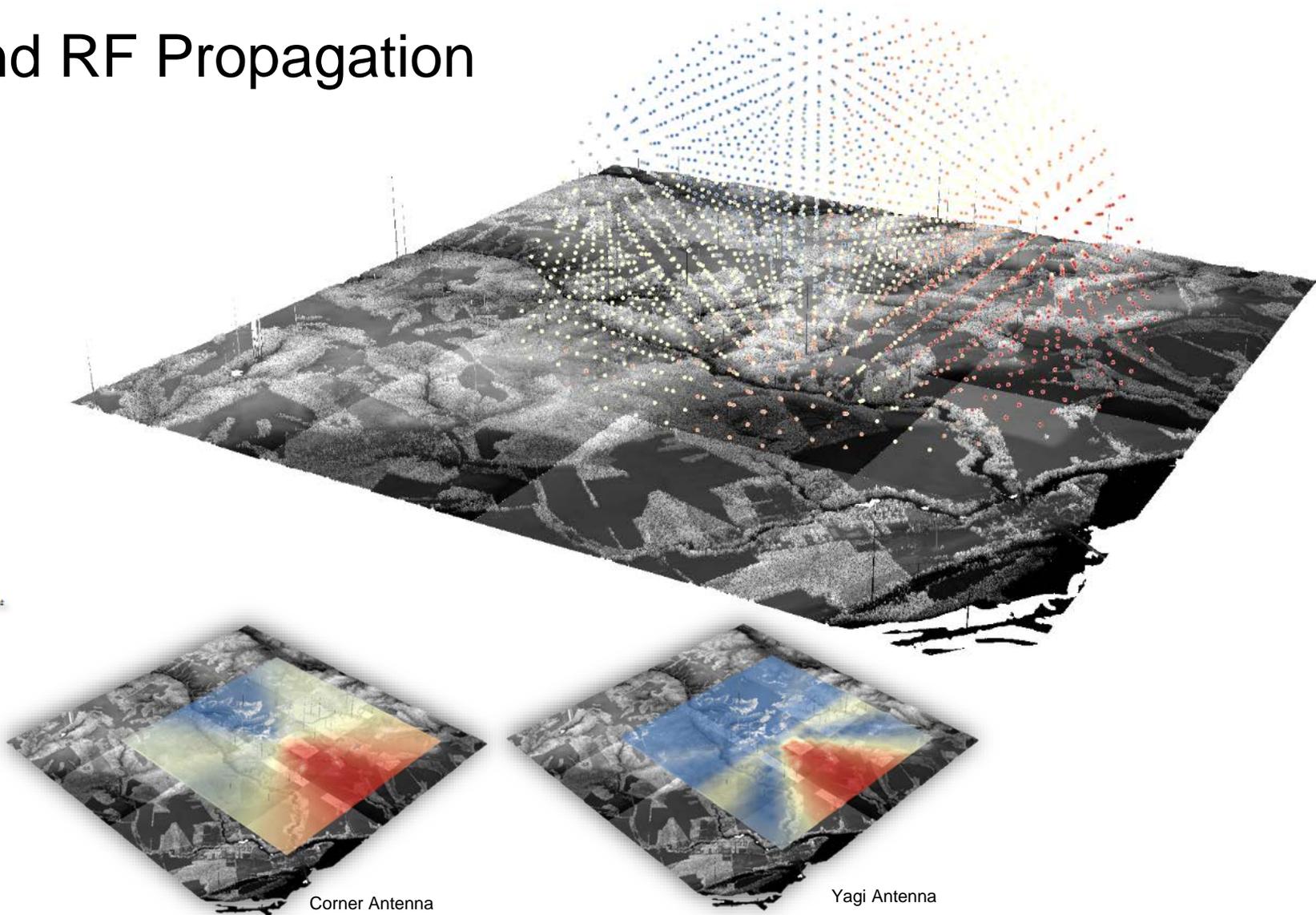
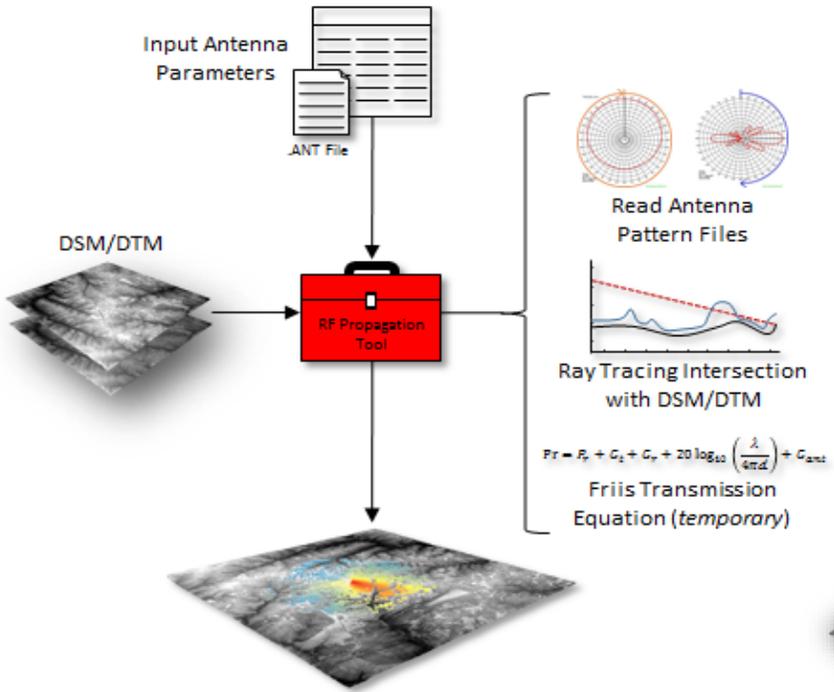
Vertical Assets
The Vertical Assets Inventory provides a comprehensive overview of the broadband planning process. It includes a list of vertical assets, a list of vertical assets, and a list of vertical assets.

DTM & DSM 3-D Viewer
The DTM & DSM 3-D Viewer provides a comprehensive overview of the broadband planning process. It includes a list of DTM & DSM 3-D Viewer, a list of DTM & DSM 3-D Viewer, and a list of DTM & DSM 3-D Viewer.

RF Modeling
The RF Modeling provides a comprehensive overview of the broadband planning process. It includes a list of RF Modeling, a list of RF Modeling, and a list of RF Modeling.

Virginia Tech
Invent the Future

3D Virginia: Statewide Broadband and RF Propagation



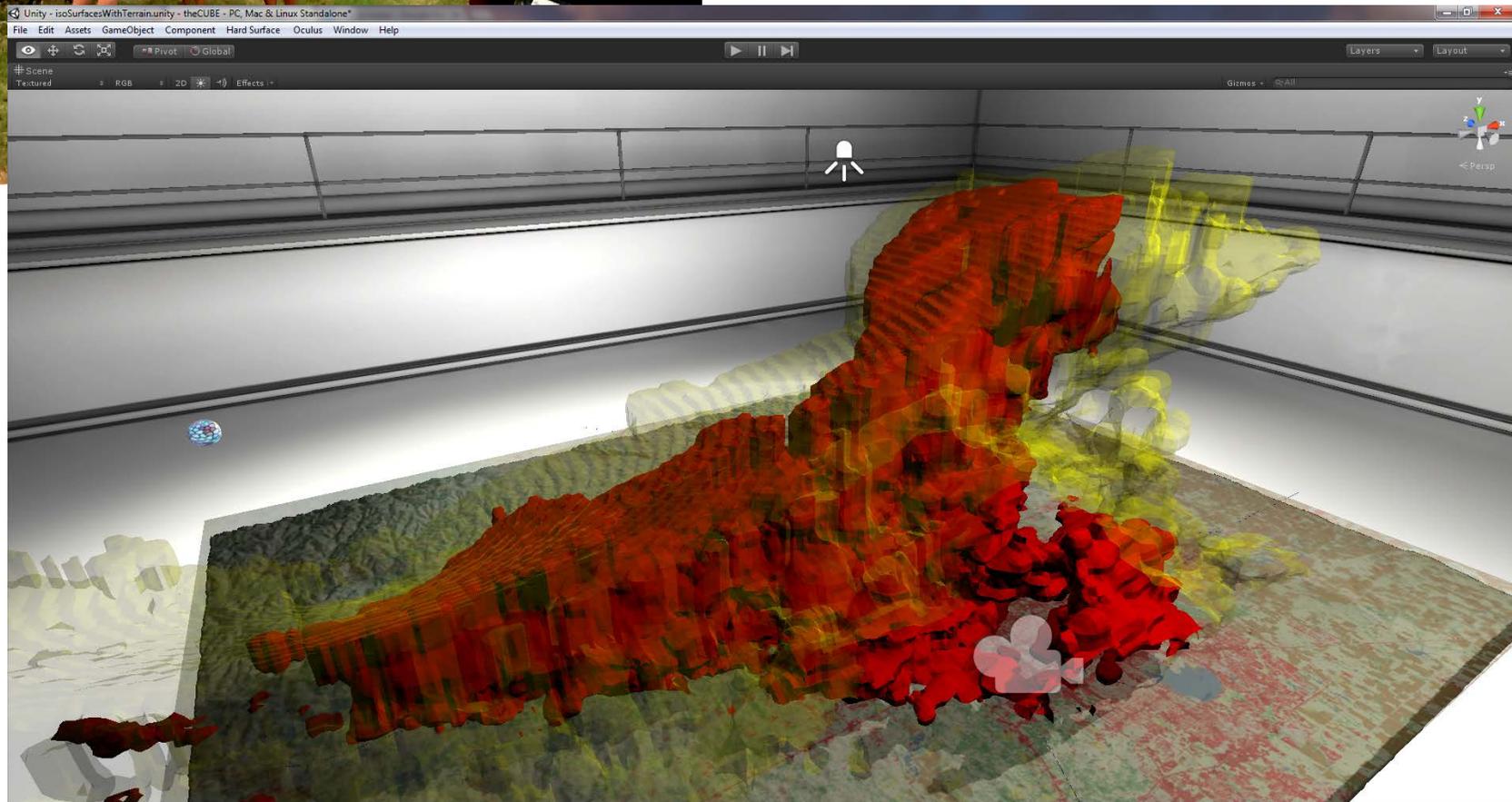
Human-Computer Interaction





Virginia Tech ICAT Scientific Visualization Moore, OK Tornado

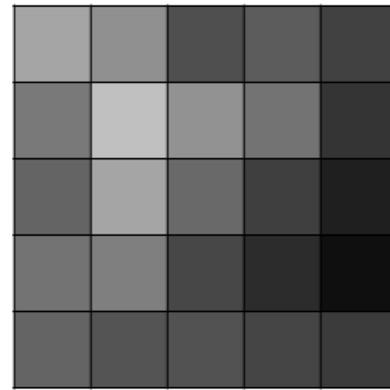
- Dave Carroll – Instructor of Meteorology
- Bill Carstensen – Professor of GIS
- Drew Ellis – Professor of Meteorology
- Kenyon Gladu – undergraduate student in Meteorology
- Peter Sforza – Director of the Center for Geospatial Information Technology
- Trevor White – Graduate student in Business Information Technology (but presently transferring to Geography)
- Run Yu – PhD. student in Computer Science



2/9/2015

GUI Window tries to begin rendering while something else has not finished rendering! Either you have a recursive OnGUI rendering, or previous OnGUI did not clean up properly.

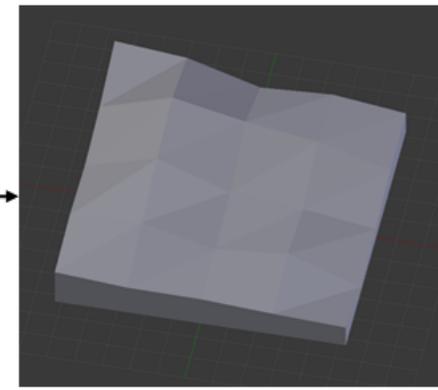
3D Printing



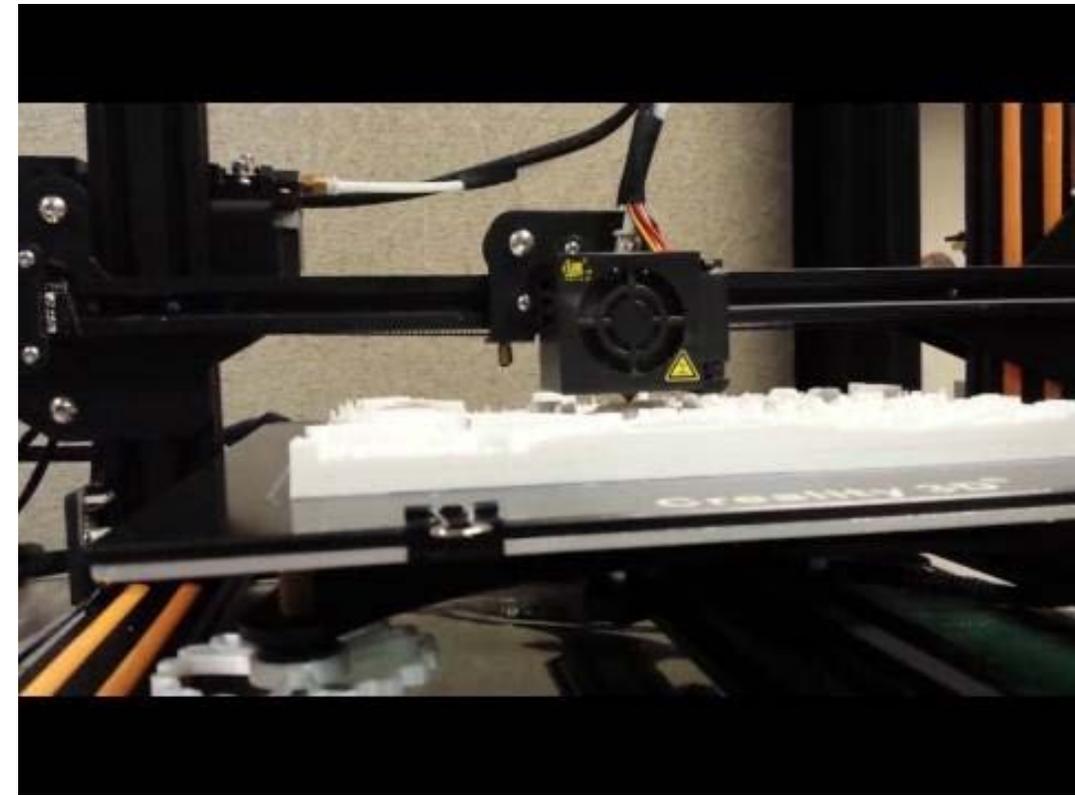
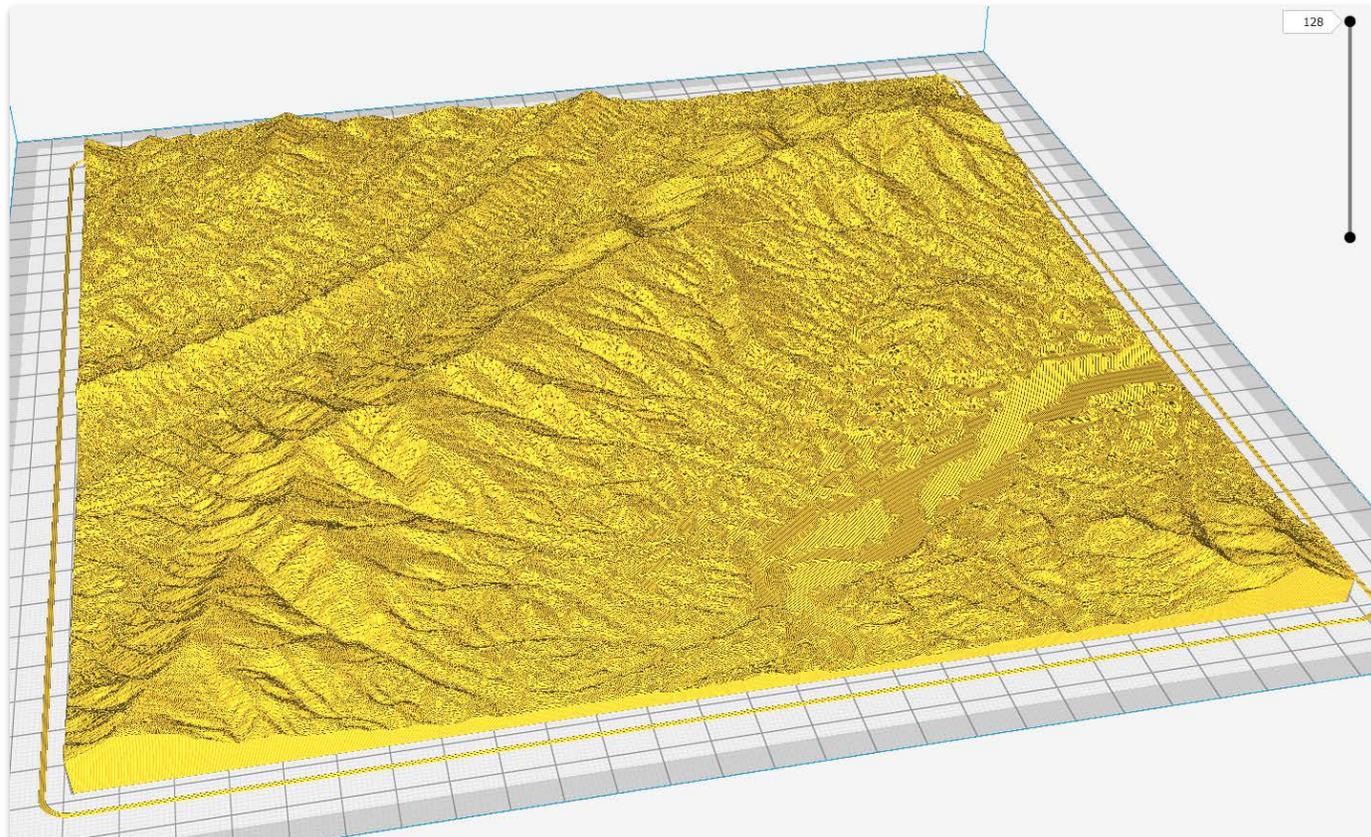
Load the Data (geotif file)

8.47	7.29	3.62	4.35	2.82
5.99	10.0	7.40	5.65	2.09
4.80	8.47	3.90	2.71	0.90
5.65	6.33	3.16	4.46	0.00
4.80	3.90	3.79	3.05	2.49

Scale the Raster



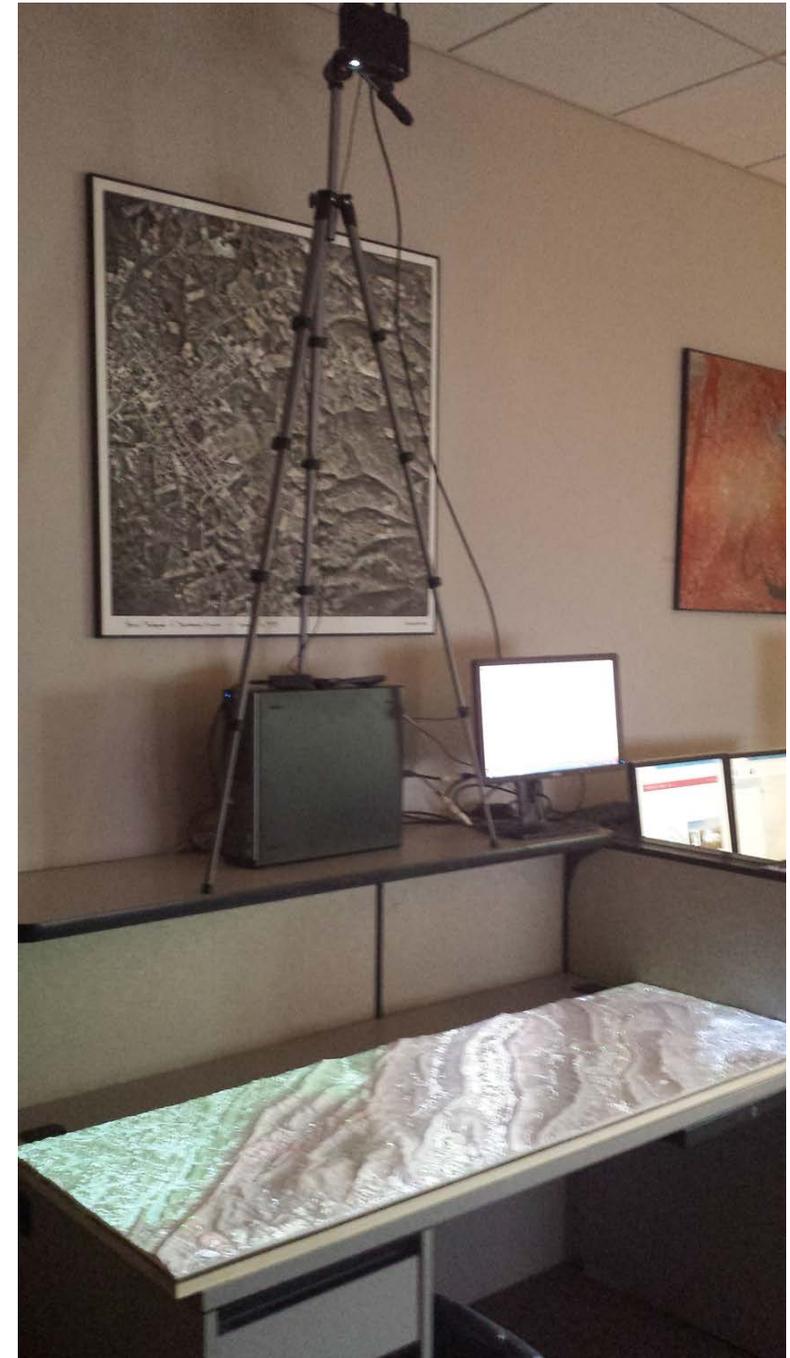
Generate STL
(stereolithography file)



AR

3D print of the AT, from Daleville to Narrows

Overlay projection displaying data from web services



3D Blacksburg



Using Geographic Information Systems for Enhanced Network Security Visualization

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ABSTRACT

The sheer volume of information that floods a network makes it difficult for network analysts to identify and isolate network security threats. This difficulty is compounded by the fact that the tools available to accomplish this task lack usability and are primarily text-based. Our goal is to design a network security visualization tool that leverages global information system (GIS) technology. This tool will provide enhanced usability and meet the needs of the network security community. In this paper, we present the results of a

to design a security visualization prototype tool that takes advantage of global information systems (GIS) to help with the rapid identification of security shortcomings in a network and allows for better protection of critical network assets. We base our design off of feedback from a broad group of network and security professionals. We collect this feedback through a survey to gather information regarding the current security analysis methods in use and to identify any gaps in analysis methods.

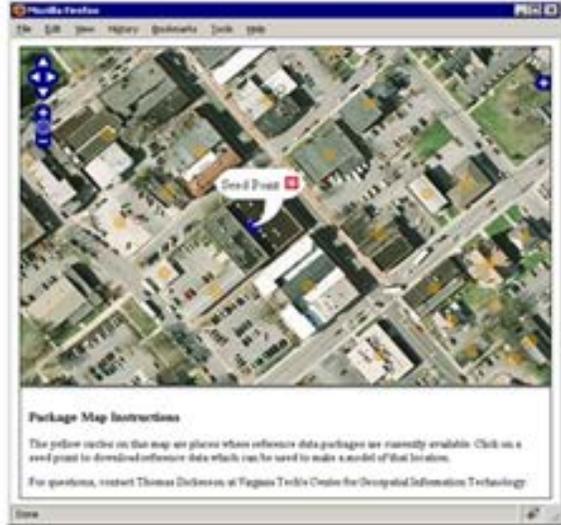
Our paper is organized in the following manner. Section 2 describes related work with regard to visualization and GIS



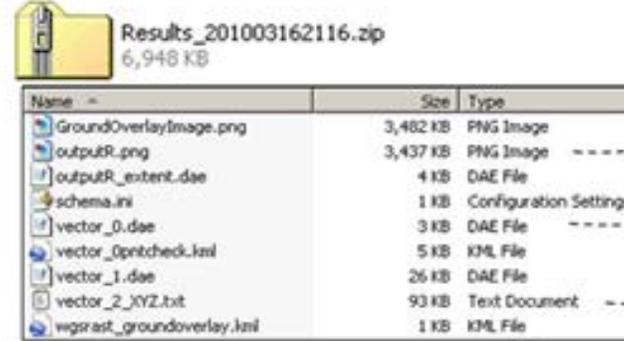
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215	3.945516	192.168.1.100	192.168.1.1	ARP	who has *
216	4.022255	192.168.1.100	192.168.1.1	SSDP	NOTIFY *
217	4.022346	192.168.1.100	192.168.1.1	SSDP	NOTIFY *
218	4.023418	192.168.1.100	192.168.1.1	SSDP	NOTIFY *
219	4.023463	192.168.1.100	192.168.1.1	SSDP	NOTIFY *
220	4.040815	192.168.1.100	192.168.1.1	SSDP	NOTIFY *
221	4.040906	192.168.1.100	192.168.1.1	SSDP	NOTIFY *
222	4.061507	192.168.1.100	192.168.1.1	ARP	who has *
223	4.085255	192.168.1.100	192.168.1.1	SSDP	NOTIFY *
224	4.085340	192.168.1.100	192.168.1.1	SSDP	NOTIFY *
225	4.086747	192.168.1.100	192.168.1.1	SSDP	NOTIFY *
226	4.087722	192.168.1.100	192.168.1.1	SSDP	NOTIFY *
227	4.115166	192.168.1.100	192.168.1.1	SSDP	NOTIFY *

Collaborative 3D City Modeling

Data Download Website



Individuals Receive Reference Data Zip File



Aerial photo

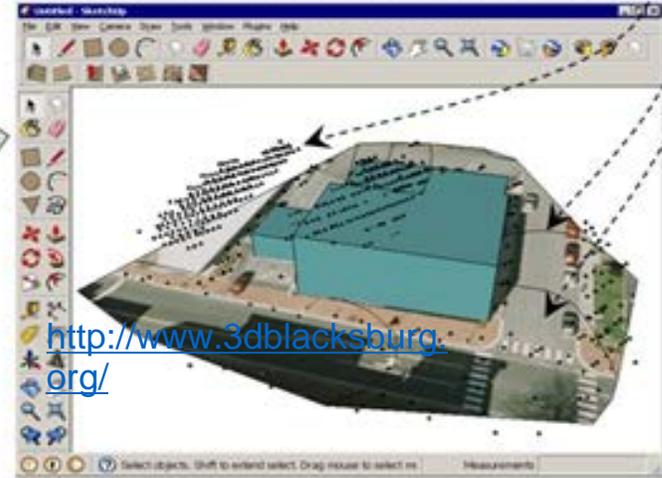
Contours

LiDAR*

*LiDAR not yet eligible for public release

CGIT / VTGIS data storage:
•Reference Data
•Building Models
•Organization

3D Modeling Based on Data



Virtual 3D City Model



Other Creative Uses:

- GIS analysis and modeling
- Artistic visualization

Peter Sforza - VT Geographic Society

Historical 3D Blacksburg



Situational Awareness via Video Analytics: incorporating video metadata into 3D models

Integrating video footage with geospatial data can enhance the interpretation of information contained in the video.

By calibrating video camera footage, a mapping between video frame coordinates and real-world geospatial coordinates is established. Features tagged in the video footage can be viewed on a map, and vice-versa.



VT CGIT, VT ARC and IBM Watson Exploratory Video Analytics Research Group

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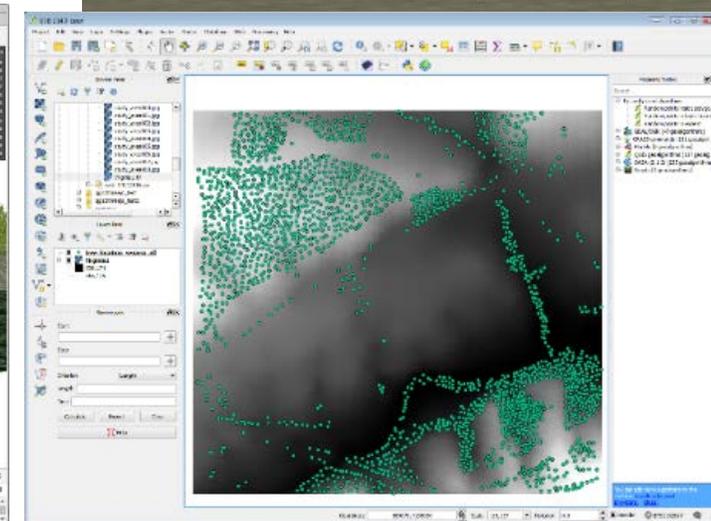
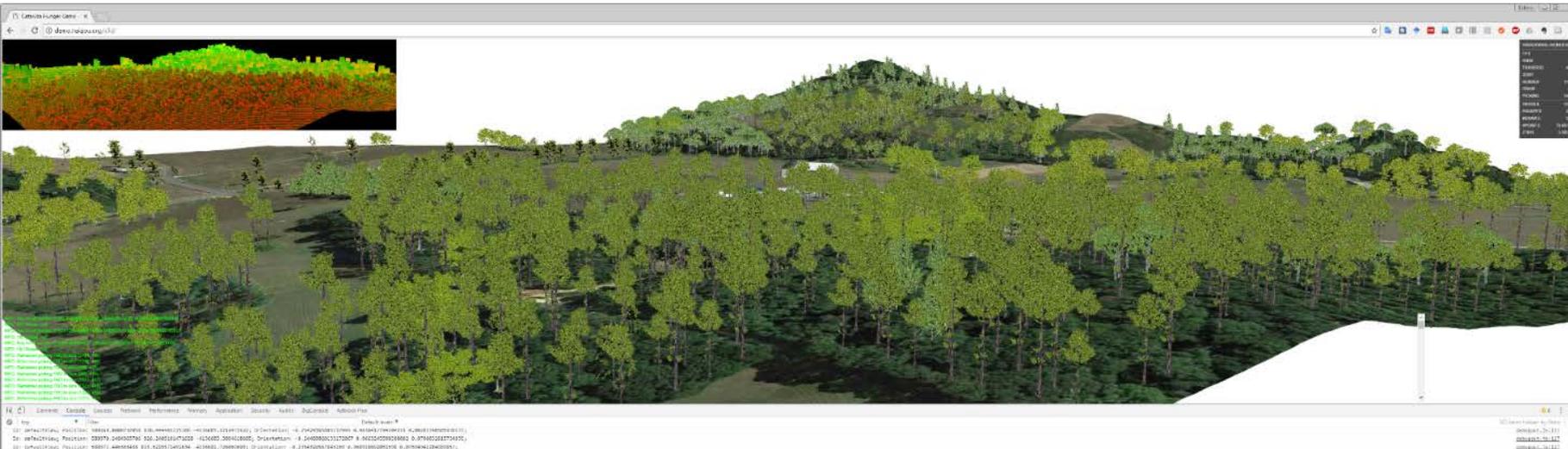
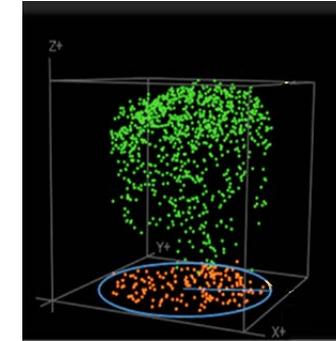
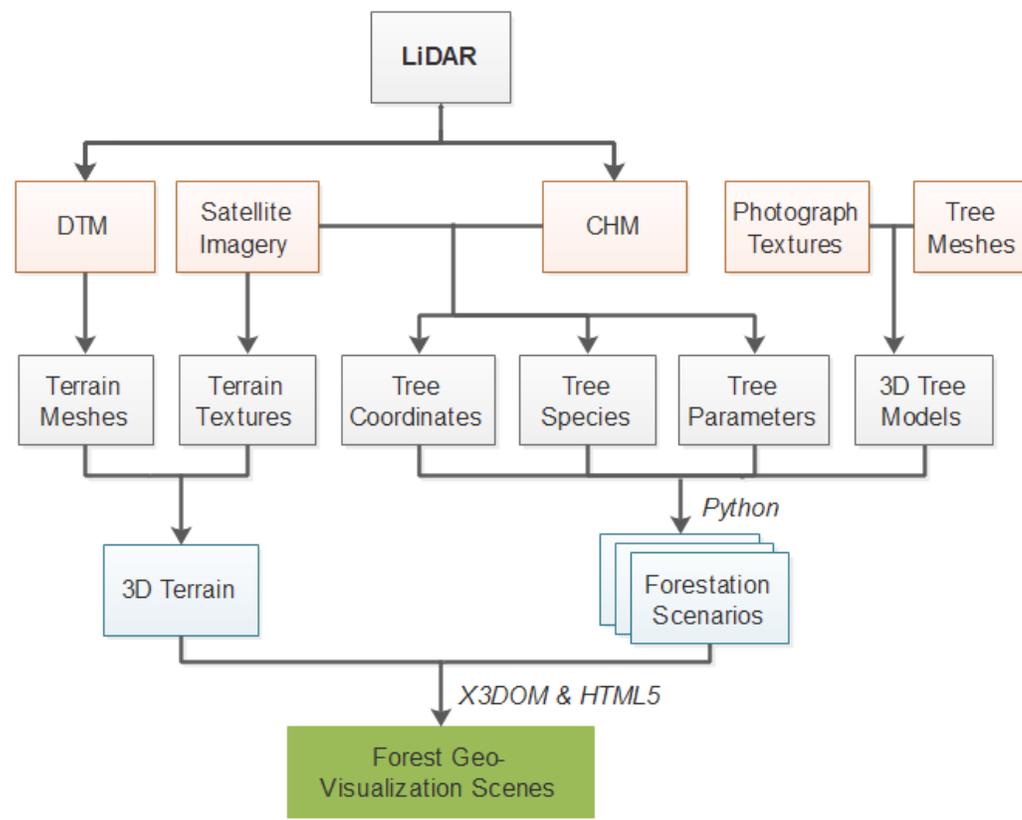
[Connect with twitter](#)

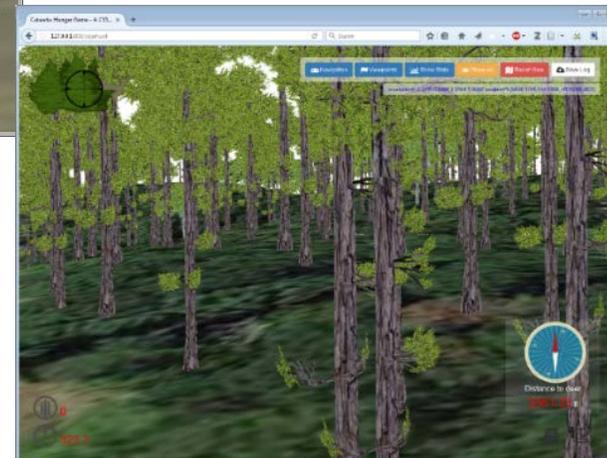
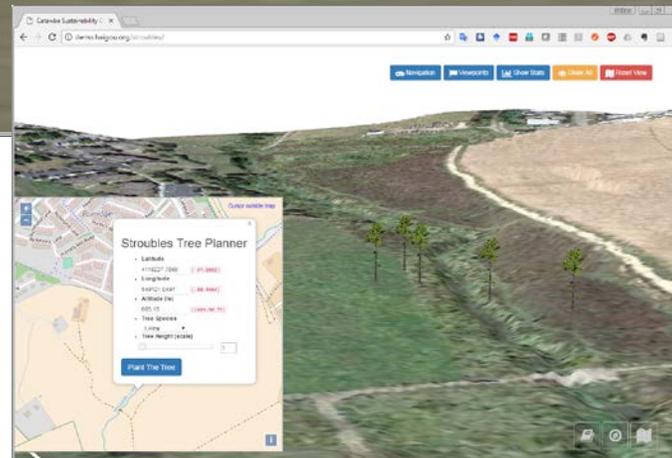
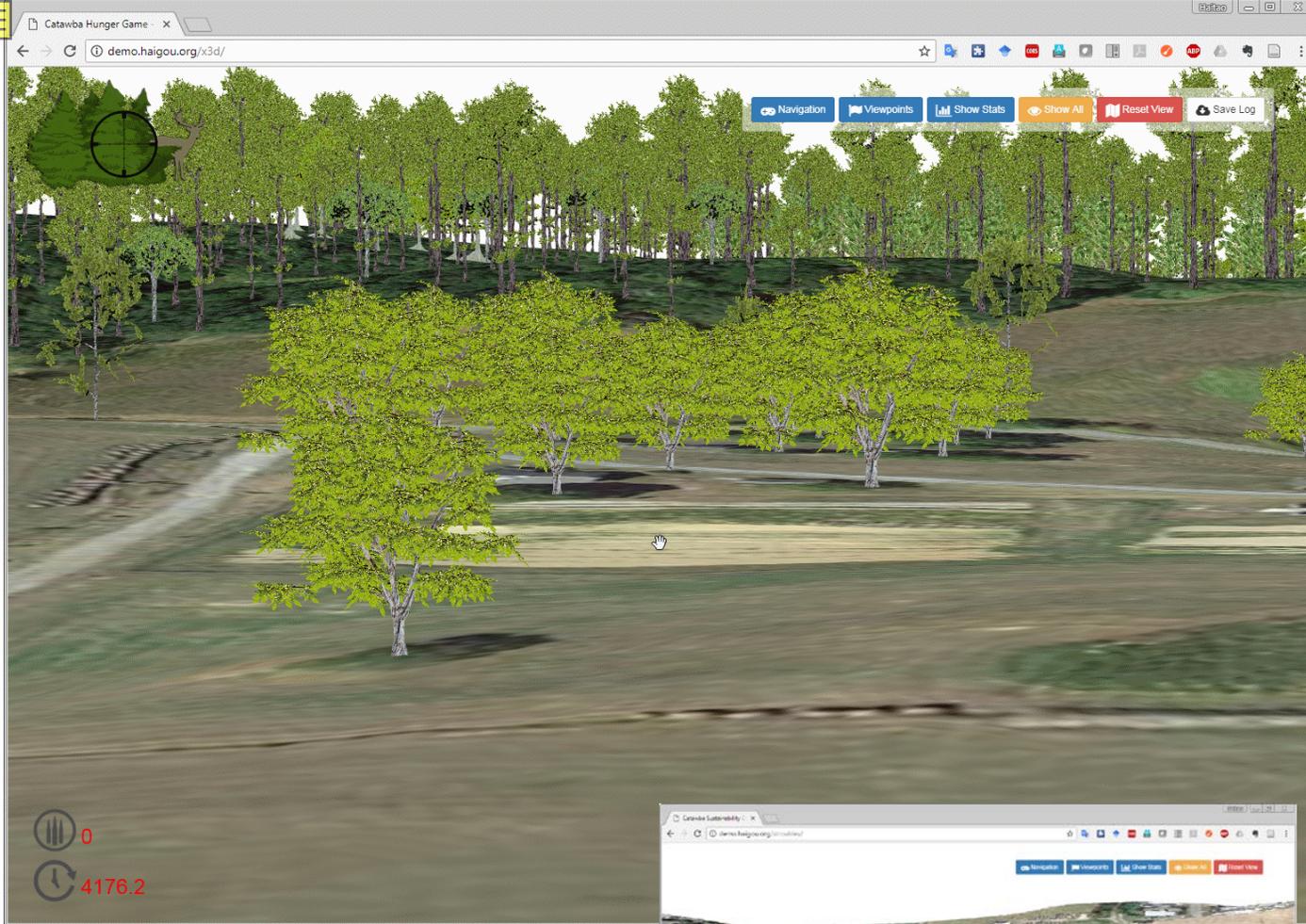
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@Dpesin	Link	11:20am on Monday 10th September 2012
@RLBASDEN	Link	9:33am on Monday 10th September 2012
@Ashley_Boland	Link	8:23am on Monday 10th September 2012
@PeterSforza	Link	7:41am on Monday 10th September 2012
@MegAnn6591	Link	12:37am on Monday 10th September 2012
@wickham_myles	Link	6:07pm on Sunday 9th September 2012
@Em_Barb09	Link	4:57pm on Sunday 9th September 2012
@devdavis	Link	4:22pm on Sunday 9th September 2012
@Javian_x3	Link	4:04pm on Sunday 9th September 2012
@Steve_Chandler	Link	1:46pm on Sunday 9th September 2012
@HolaBrody	Link	11:57am on Sunday 9th September 2012
@VT_Lauren	Link	10:36am on Sunday 9th September 2012
@AddieOldham	Link	9:38am on Sunday 9th September 2012
@TheMammovan	Link	8:14am on Sunday 9th September 2012
@TriCenter	Link	5:36am on Sunday 9th September 2012
@typicalsquirrel	Link	5:07am on Sunday 9th September 2012
@CompetitorDC	Link	4:40am on Sunday 9th September 2012
@CGIprguy	Link	4:38am on Sunday 9th September 2012
@heartcallah	Link	6:32pm on Saturday 8th September 2012
@CLAUDIALOPEZTV	Link	6:17pm on Saturday 8th September 2012
@Eduography	Link	5:10pm on Saturday 8th September 2012
@jshake	Link	4:21pm on Saturday 8th September 2012
@nathanielcline	Link	4:07pm on Saturday 8th September 2012
@kaydee_64	Link	7:17am on Saturday 8th September 2012

THE HOOK, DOWNTOWN, 2012/09/09 19:00:02



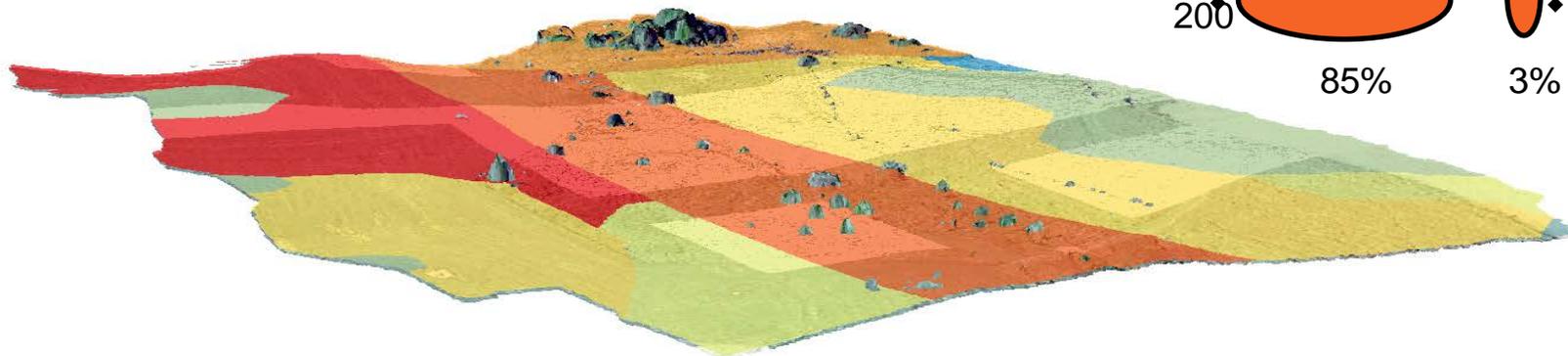
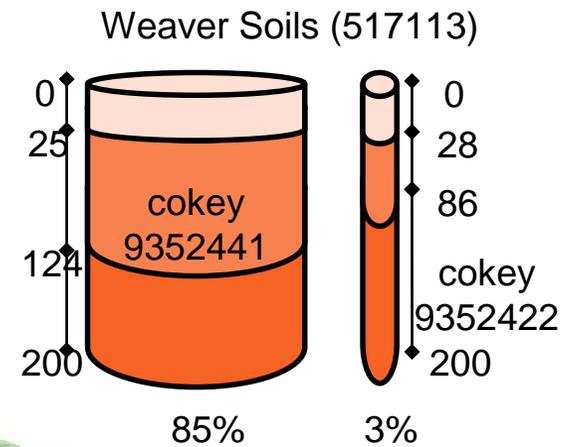
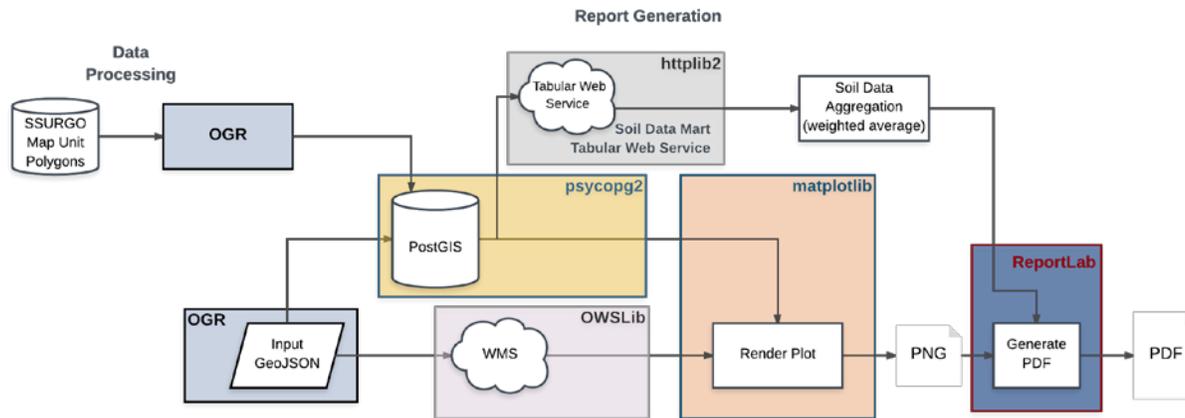
Reconstruction Web3D Geo-Visualization





Haitao Wang, Xiaoyu Chen, Nicholas Polys, and Peter Sforza. A Web3D forest geo-visualization and user interface evaluation. Web3D '17, 2017.

3-D Soils



mukey	muname	cokey	compct_r	corcon	chkey	hzdept_r	hzdepb_r	ksat_l	ksat_r	ksat_h	awc_l	awc_r	awc_h	dbthirdbar_r	ph1to1h2o_r	om_r	cec7_r	cec7_l	cec7_h	resdept_r
517113	Weaver soils	9352422	3	High	26255060	0	28	1.4	2.7	4	0.18	0.21	0.24	1.4	4.6	1	9	7	18	
517113	Weaver soils	9352422	3	High	26255061	28	86	0.42	0.9	1.4	0.12	0.15	0.18	1.45	4.6	1	17	12	20	
517113	Weaver soils	9352422	3	High	26255062	86	200	0.42	0.9	1.4	0.1	0.13	0.16	1.45	4.6	0.25	14	11	19	
517113	Weaver soils	9352441	85	Low	26255122	0	25	4	9	14	0.15	0.18	0.2	1.43	7.5	3	16	9	19	127
517113	Weaver soils	9352441	85	Low	26255123	25	124	4	9	14	0.15	0.18	0.2	1.43	7.5	1.5	16	9	17	127
517113	Weaver soils	9352441	85	Low	26255124	124	200	4	9	14	0.15	0.18	0.2	1.43	7.9	0.75	12	8	15	127

3D Site Model

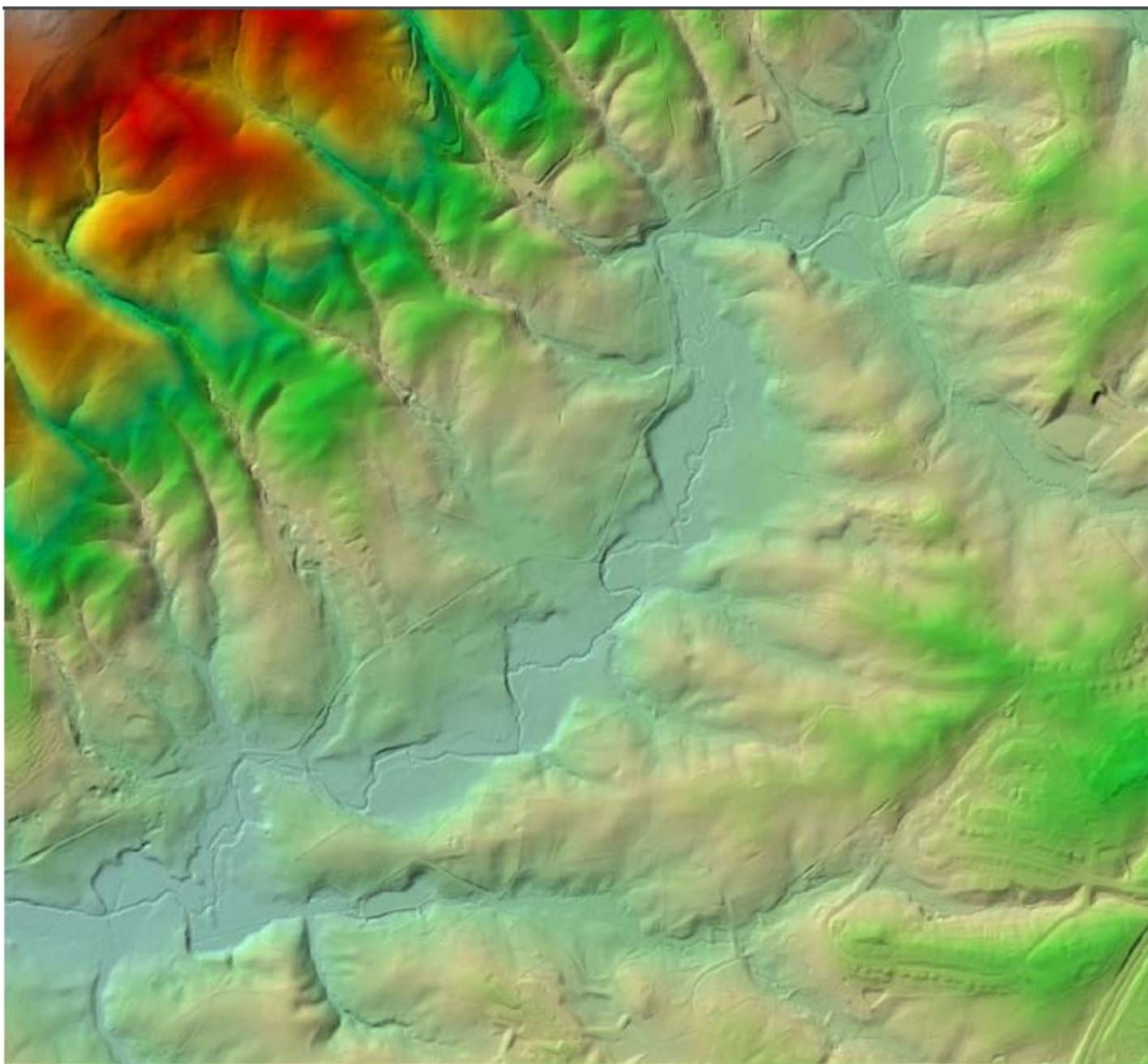


CGIT SmartFarm project <https://cgit04.cc.vt.edu:2003/map/>

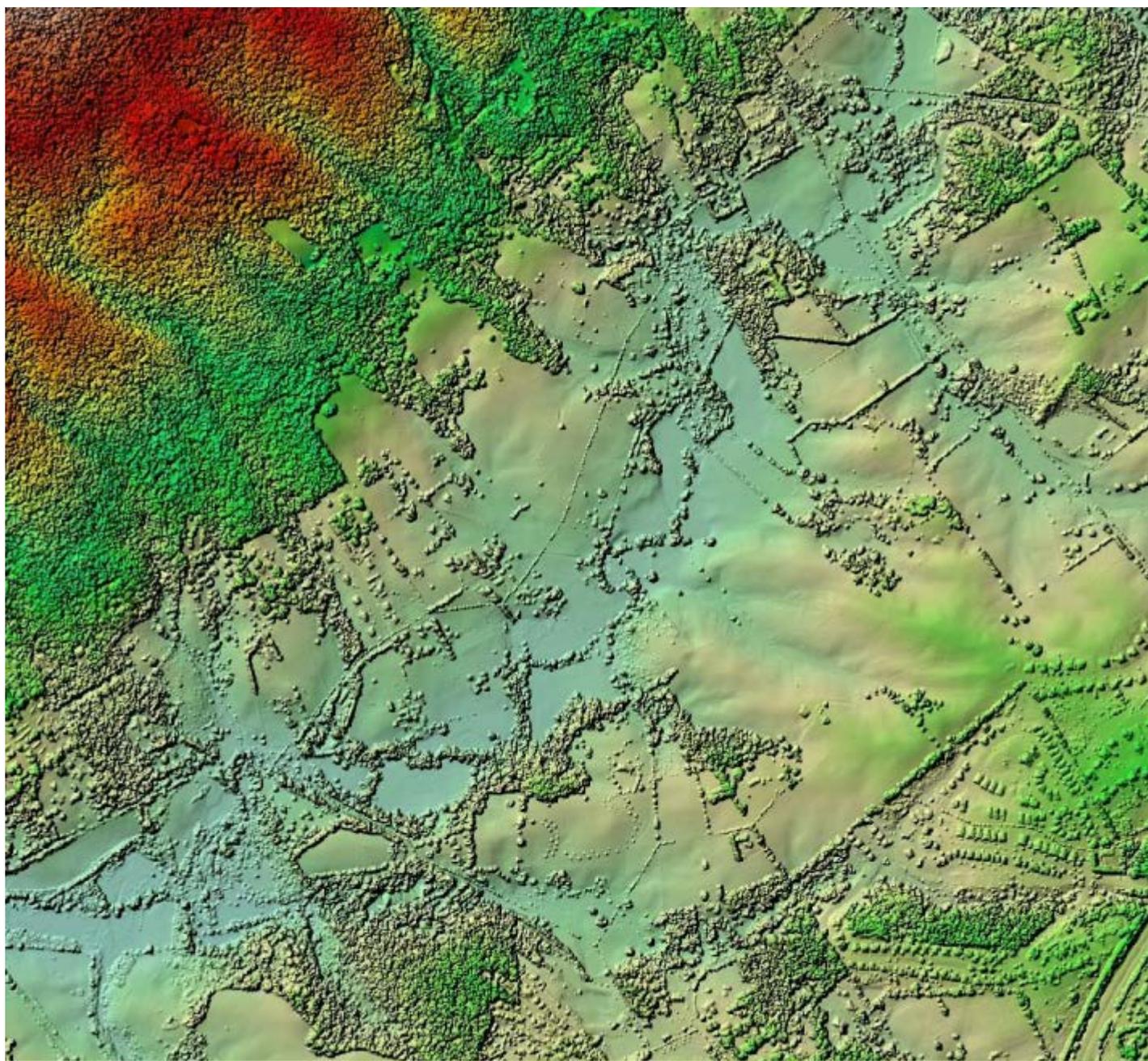
The screenshot displays the CGIT SmartFarm project web application. The main view is a 3D aerial site model of the ALSON H. SMITH farm, outlined in yellow. The site includes several buildings, a road, and numerous trees represented by green and purple spheres. The interface includes a top navigation bar with 'SmartFarm' and '3D site models', a search bar, and a 'Map'/'Scene' toggle. A 'Growing Degree Day Calculator' overlay is visible on the right, with the following settings:

- Site: ALSON H. SMITH
- Units: F
- Minimum Threshold F: 10.0
- Maximum Threshold F: 100.0
- Start Date: Apr 1
- End Date: Nov 1
- Run Calculation button

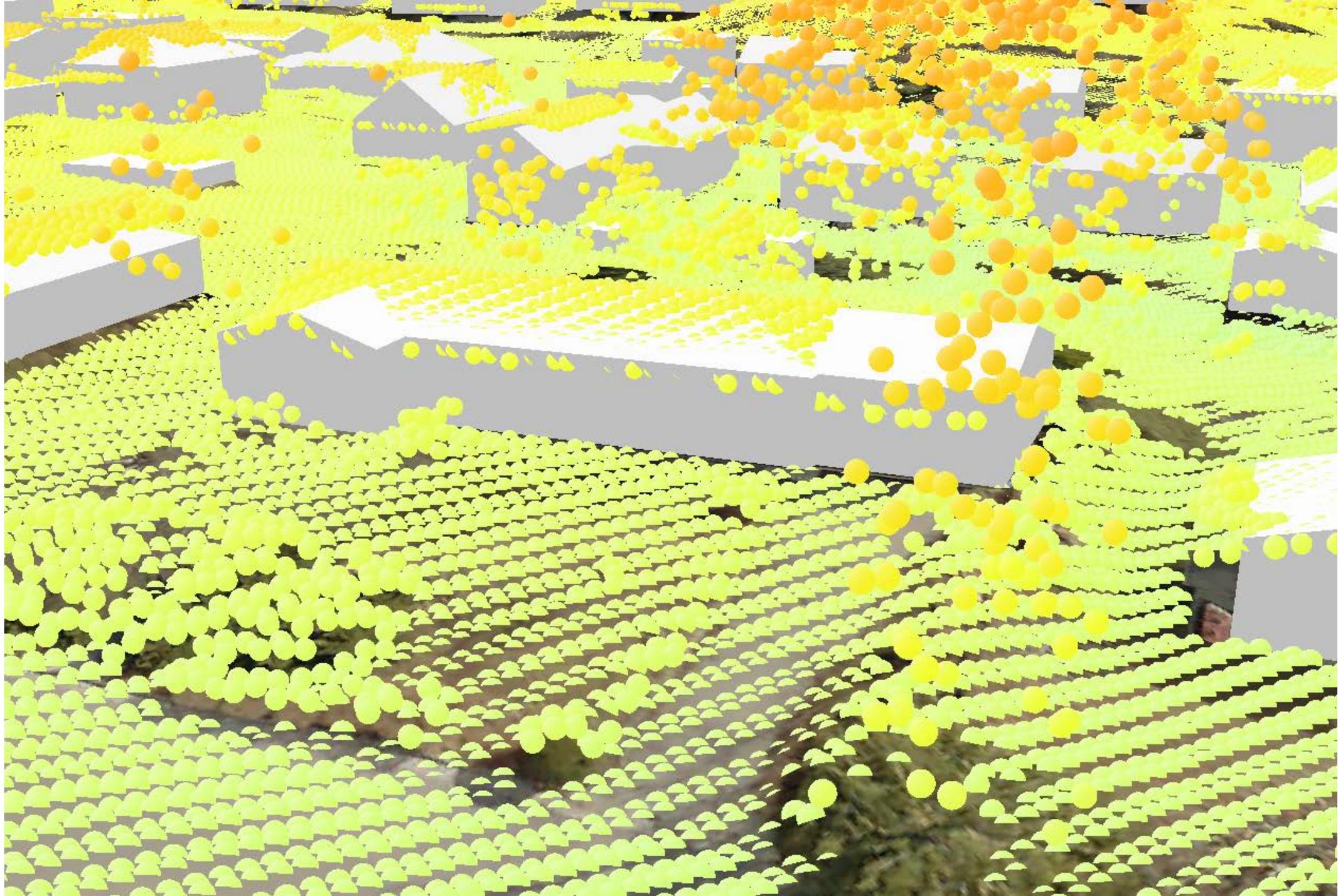
At the bottom, a 'SmartFarm Sites' gallery shows thumbnails for various locations: MOORE FARM, KENTLAND, CATAWBA CTR, ALSON H. SMITH (selected), EASTERN SHORE, EASTERN VA, HAMPTON ROADS, MIDDLEBURG, REYNOLDS HOMESTEAD, S. PIEDMONT, SHENANDOAH VA, and SOUTHWEST VA. A 'TIC' label is visible at the far right of the gallery.

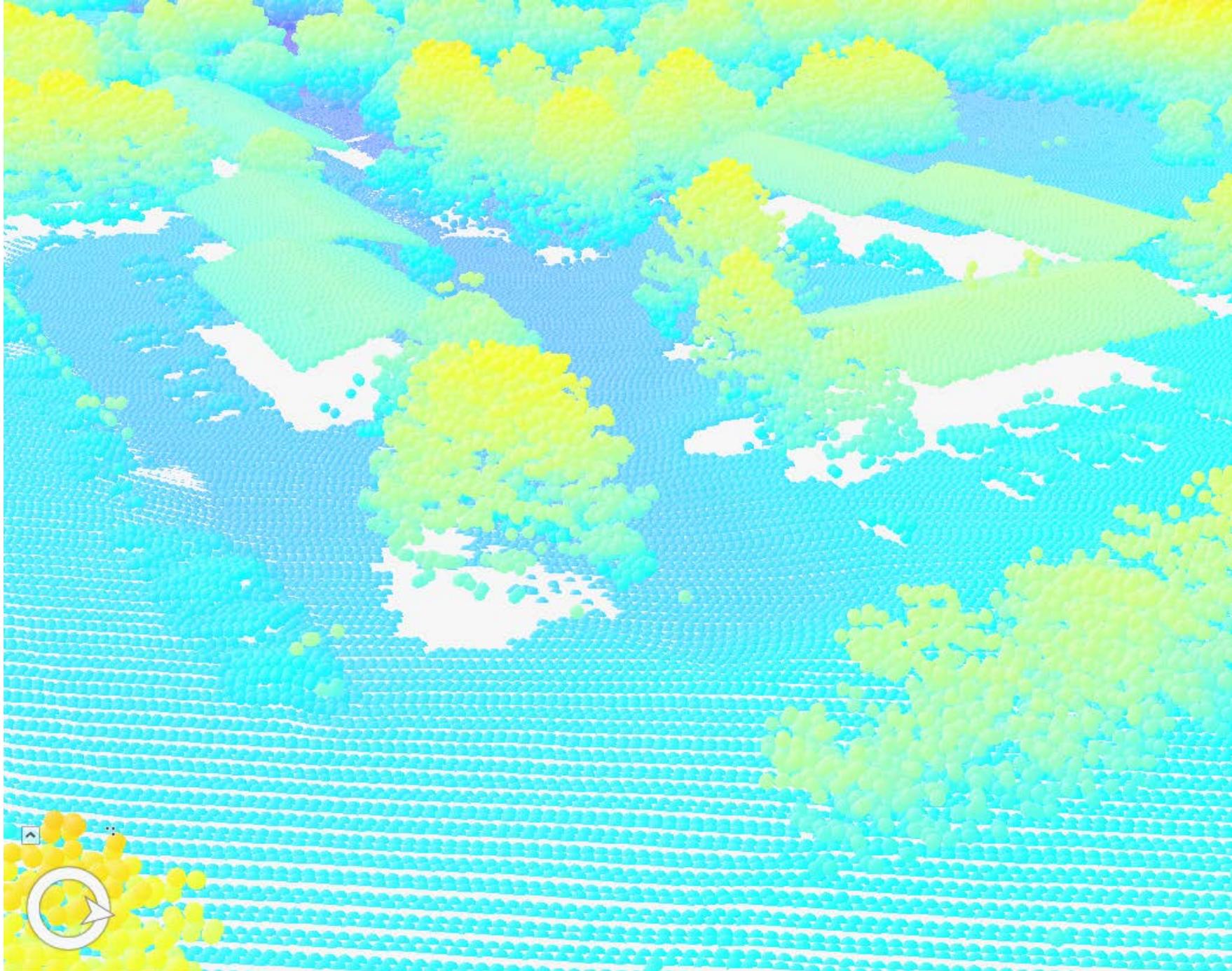


Digital Terrain Model (DTM)



Digital Surface Model (DSM)



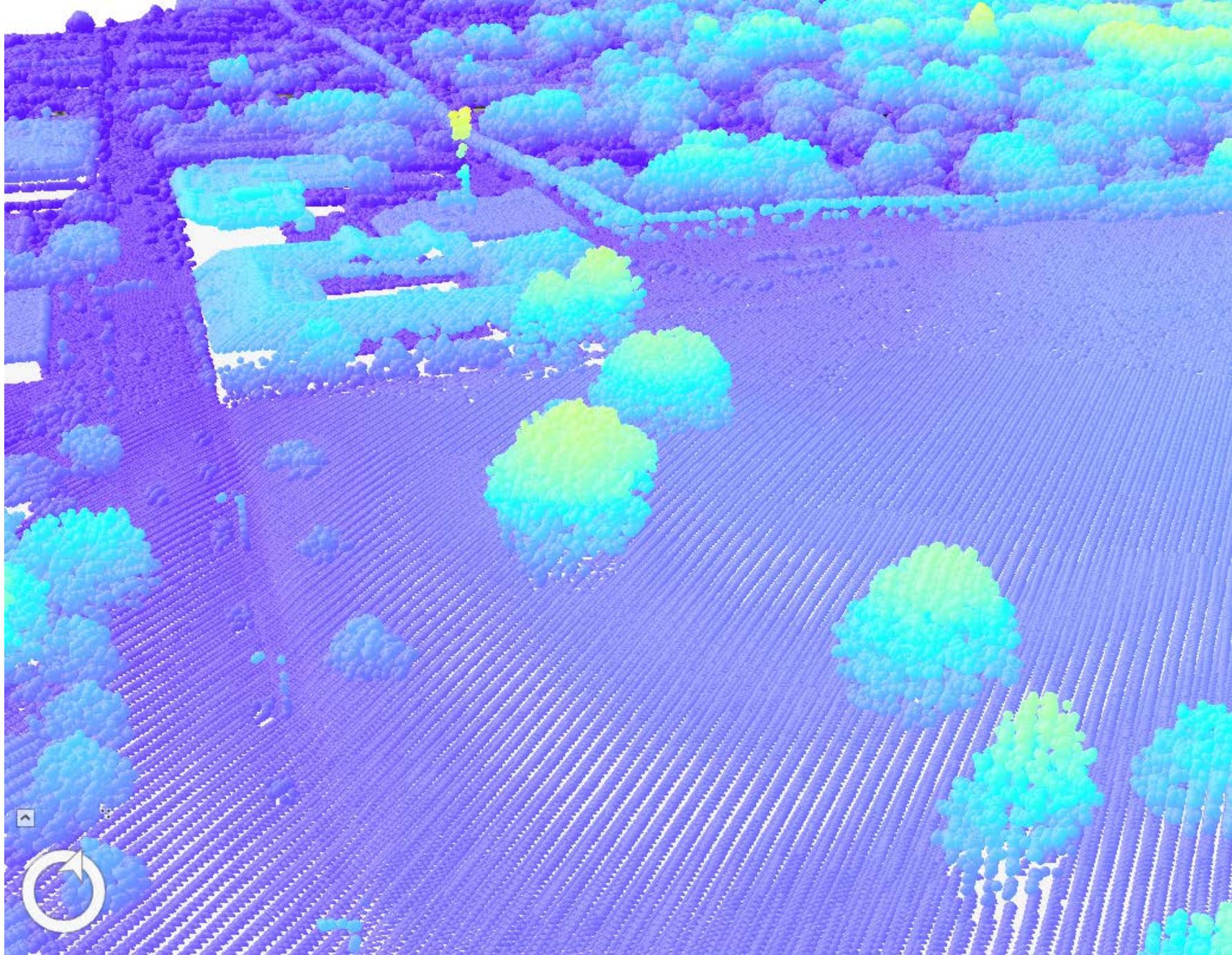


165 ft



80.4069812°W 37.2308943°N 2,163.865 ft

Selected Features: 0



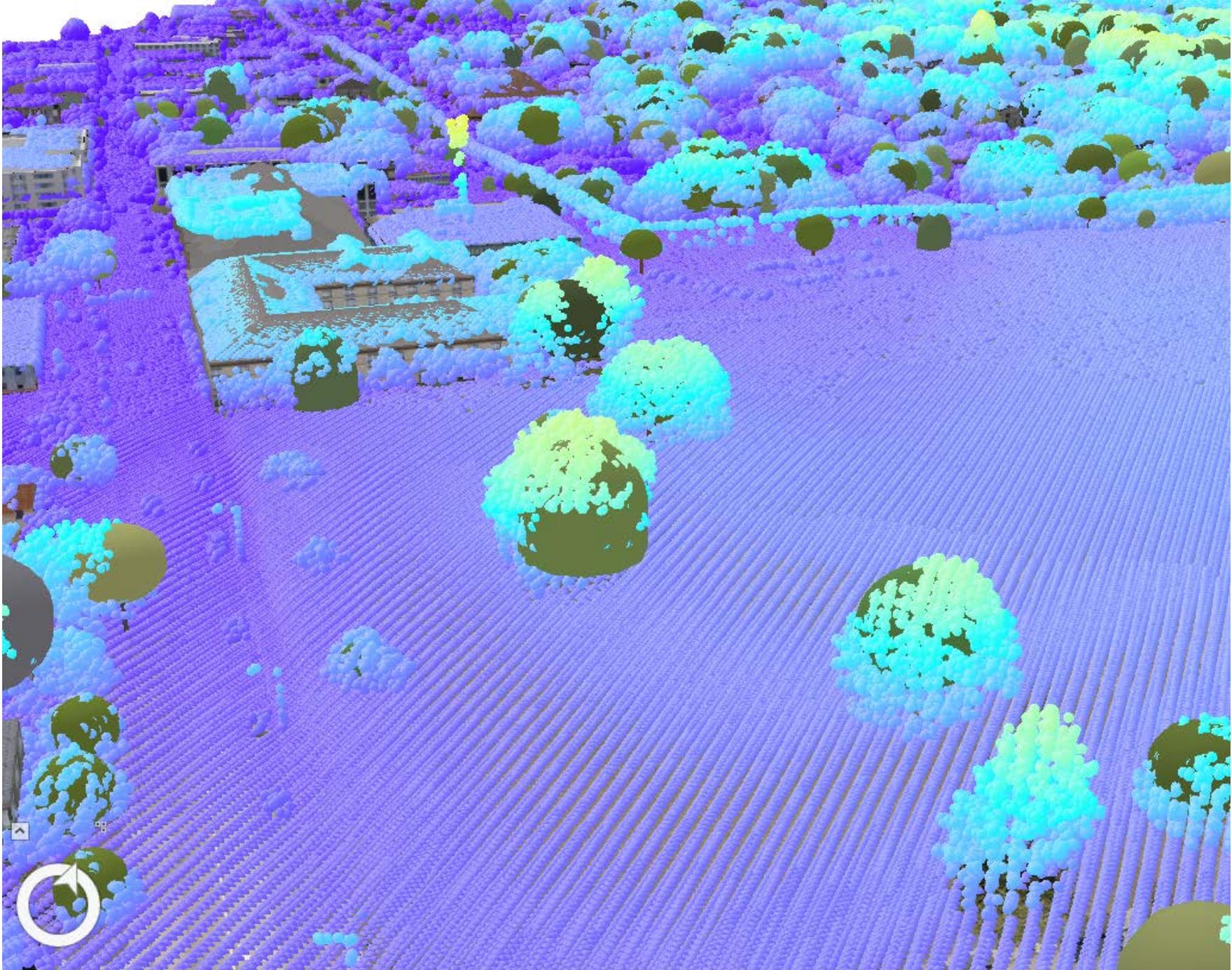
2,414 ft



80.4154880°W 37.2302073°N 2,089,914 ft

Selected Features: 0

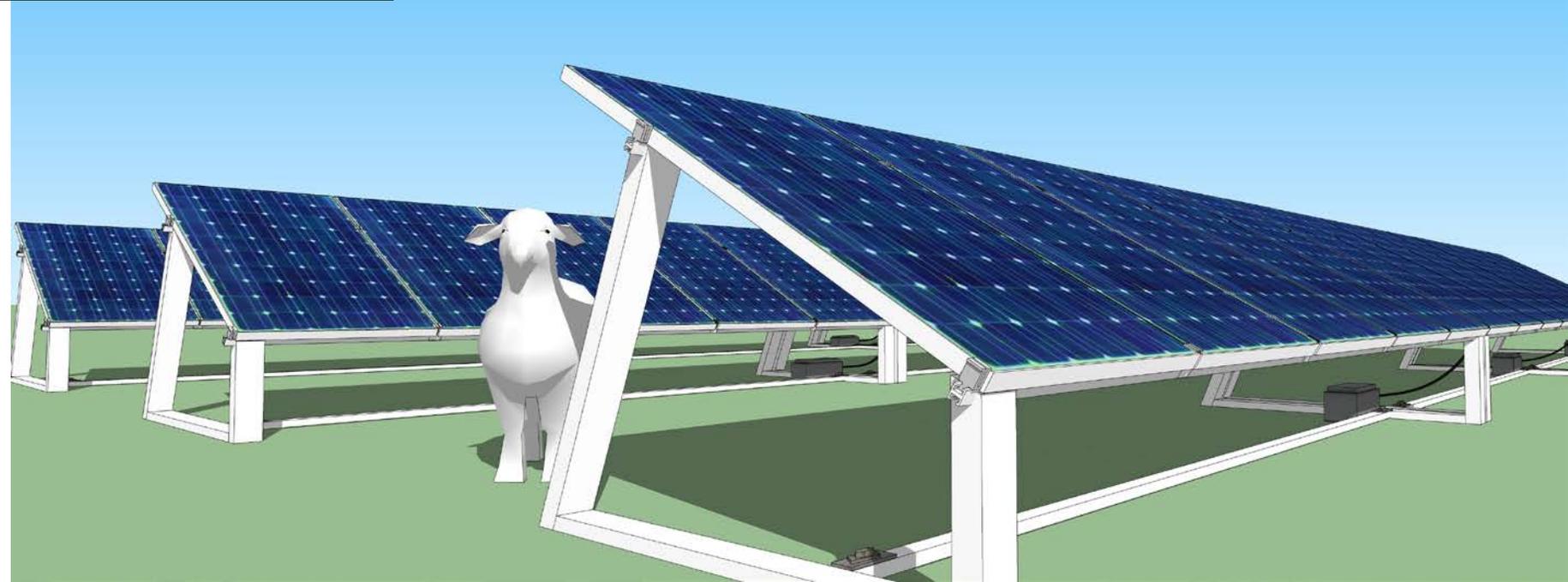






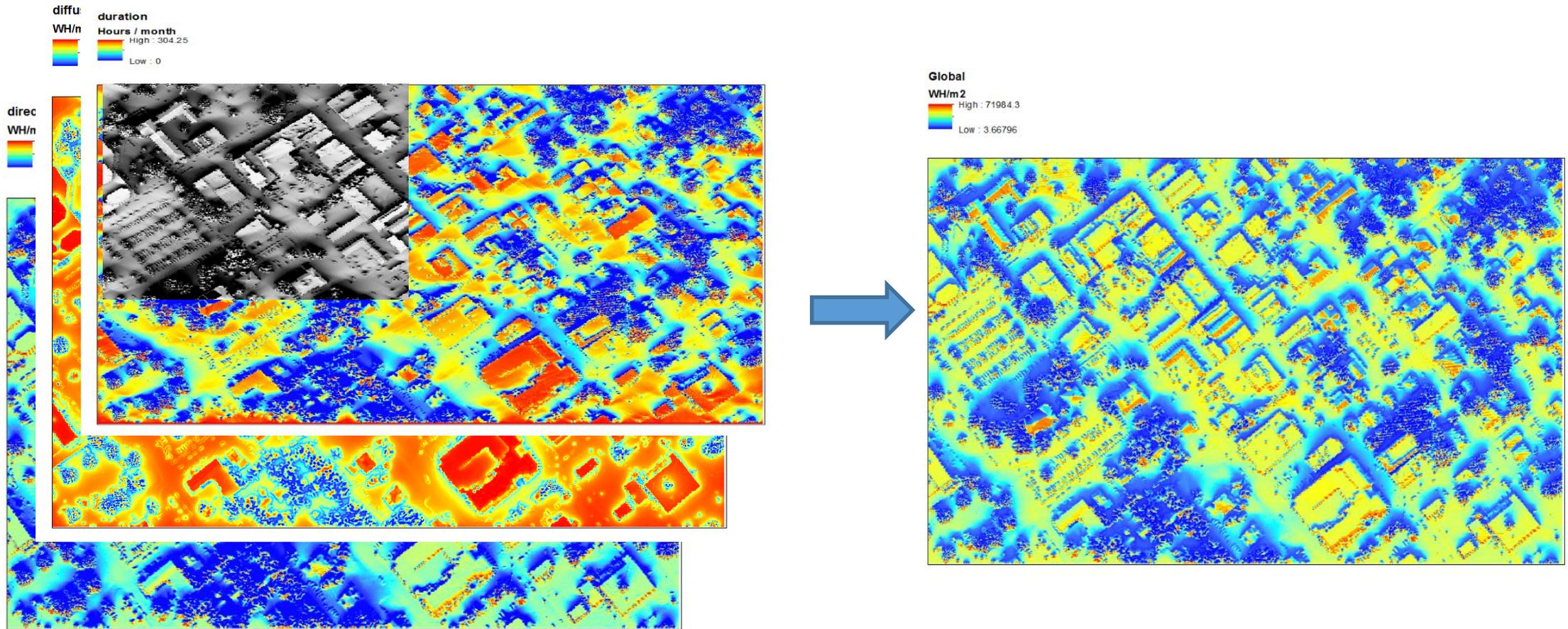


Turbine and solar panel models

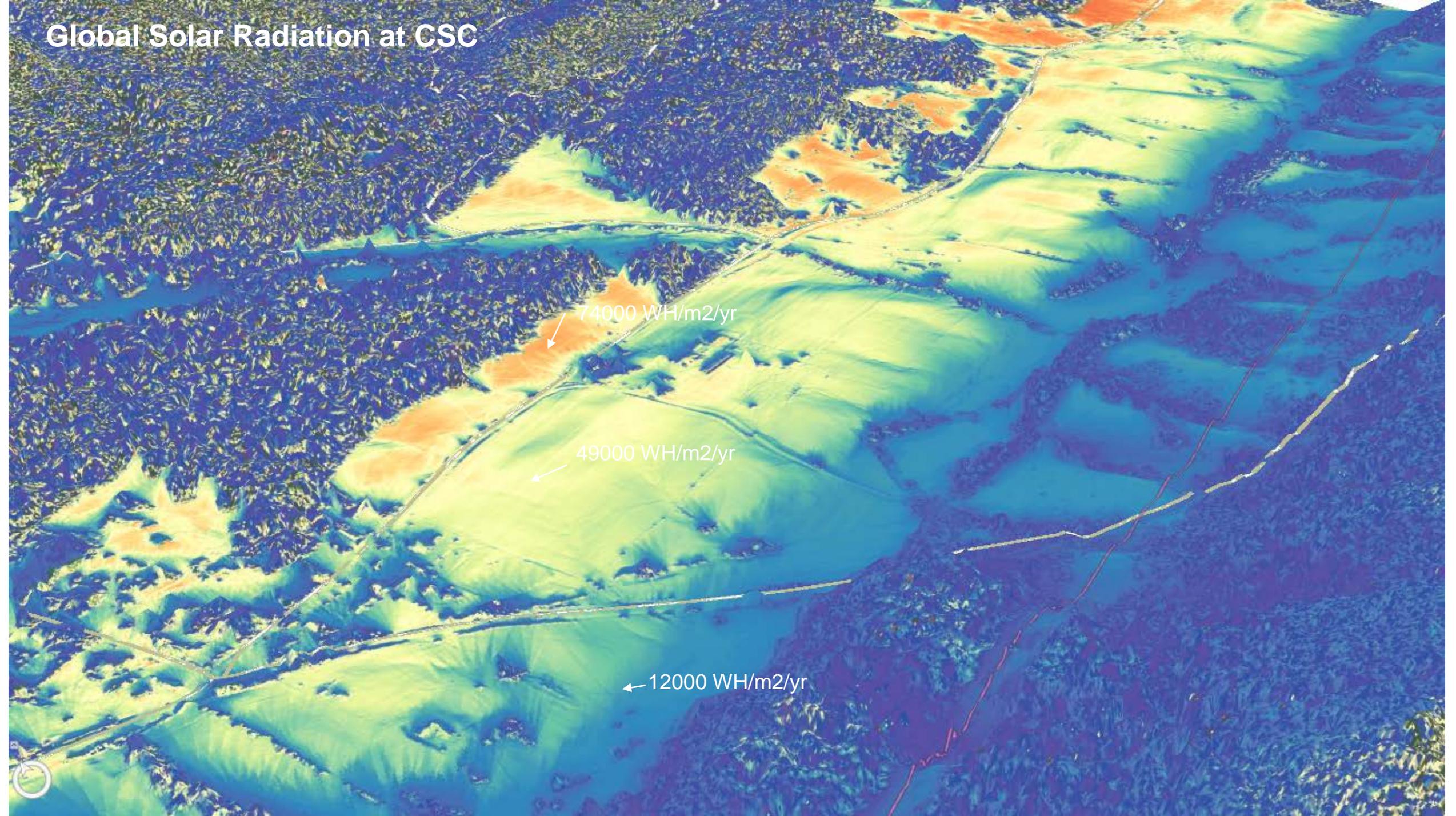


Solar

Solar radiation models calculate global radiation (WH/m²) from direct, diffuse and duration components.



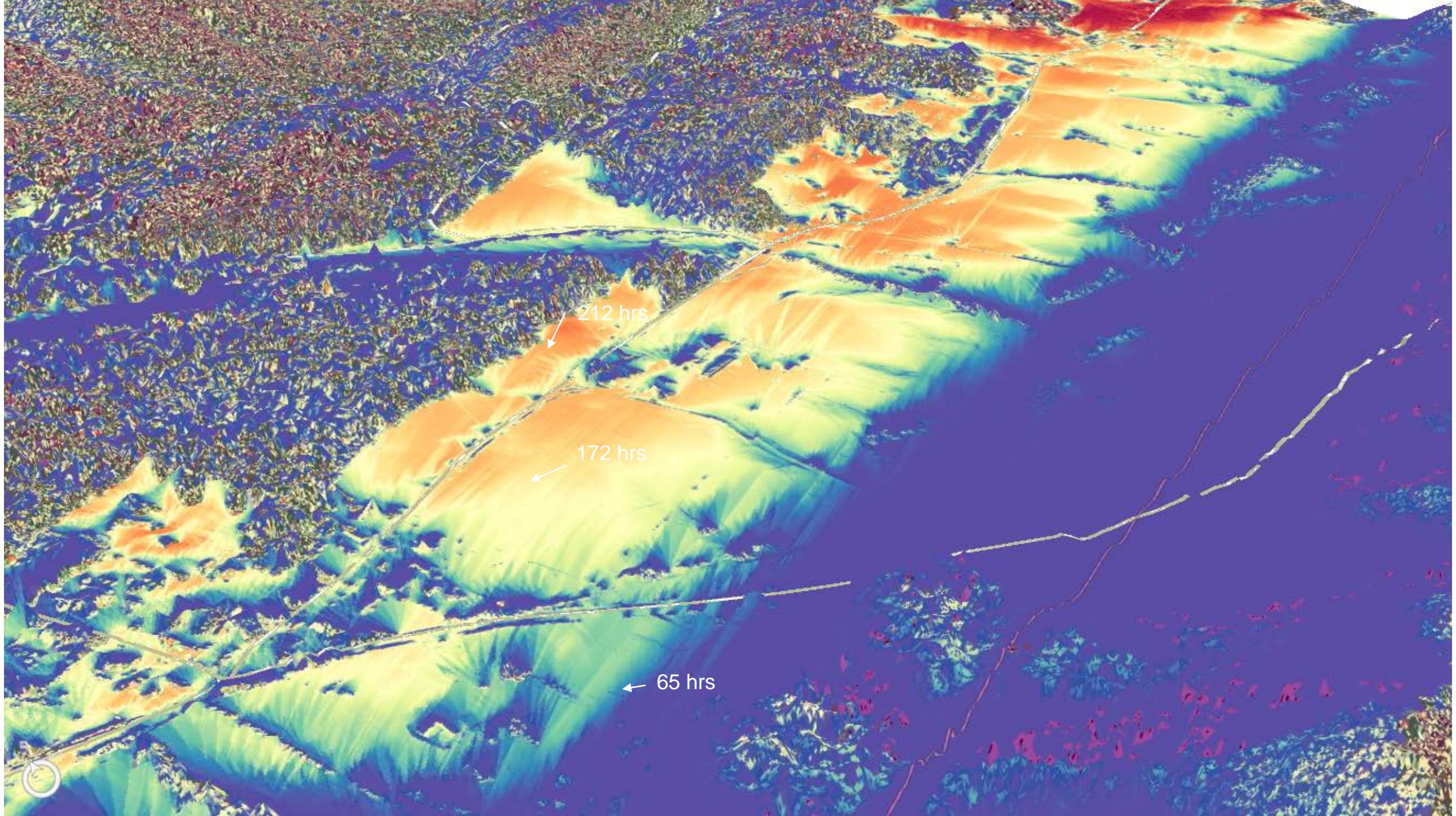
Global Solar Radiation at CSC



74000 WH/m²/yr

49000 WH/m²/yr

12000 WH/m²/yr



212 hrs

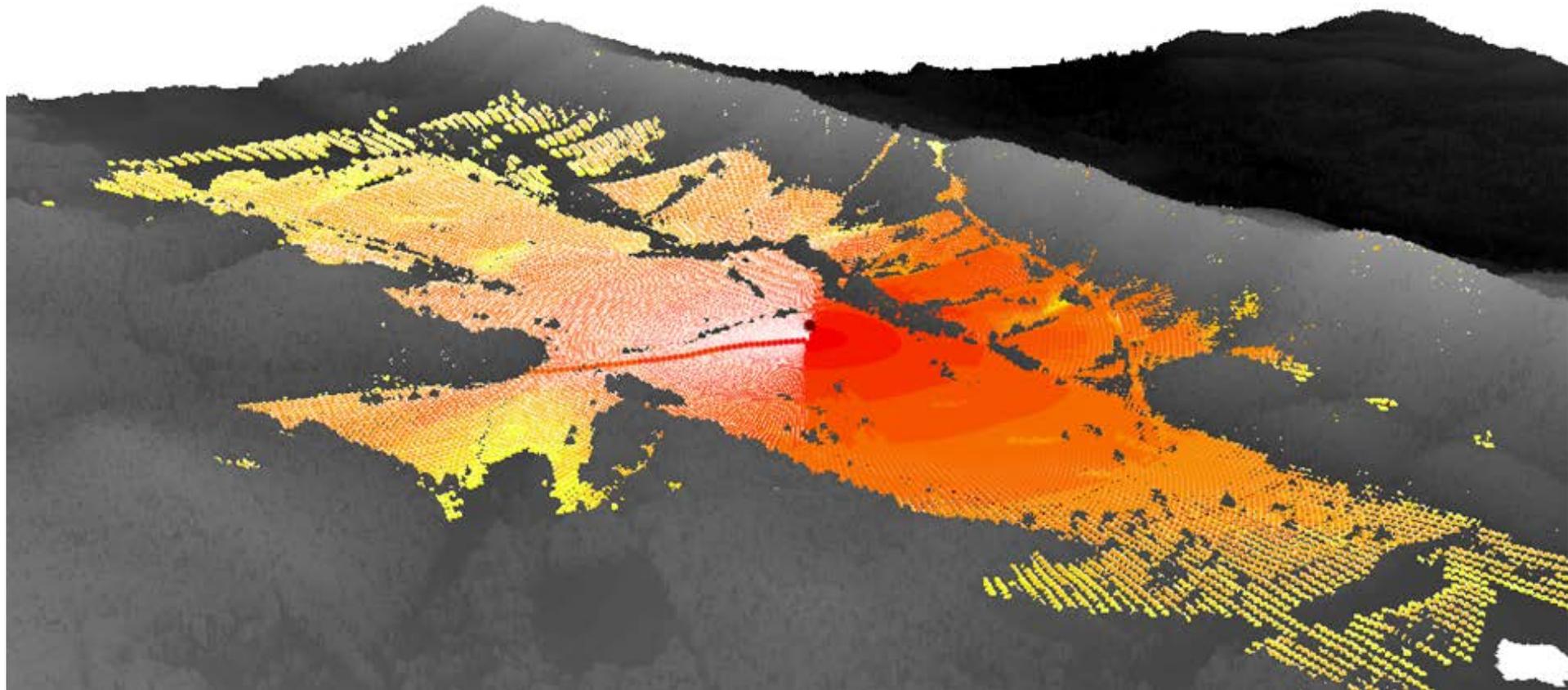
172 hrs

65 hrs

Renewable Energy Facility Siting

http://arcgis-research.gis.vt.edu/cgit/ref_demo/

Sound propagation estimation for farm scale turbine



VT CGIT model: Low-level calculation of shadow casting

Shadows are calculated using trig and vector geometry to determine which mesh triangles intersect the rays between the sun and each raster cell.

Calculations done in Python using the numpy library to handle arrays.

```
class Triangle(object):
    def __init__(self, origin, p0, p1, p2):
        """Takes in three points (x,y,z) with w/r/z coordinates and calculates the relevant information"""
        self.p0 = np.array(p0) * origin
        self.p1 = np.array(p1) * origin
        self.p2 = np.array(p2) * origin
        self.u = self.p1 - self.p0
        self.v = self.p2 - self.p0

        self.normal = np.cross(self.u, self.v)
        self.w = np.sum(self.u * self.v)
        self.wv = np.sum(self.v * self.v)
        self.wu = np.sum(self.u * self.u)
        self.denom = self.wv * self.wu - self.w * self.wv

class Shadowcast(object):
    def __init__(self, angle):
        """Read in data and calculate the physical characteristics of a terrain to calculate shadows"""
        self.angle = angle
        source_data = json.load(open('shadow\\shadow_cast_data_1.json').format(self.angle, '*'))

        self.x = np.array(source_data['x'])
        self.y = np.array(source_data['y'])
        self.elevation = np.array(source_data['elevation'])
        self.h0 = np.array(source_data['h0'])
        self.h1 = np.array(source_data['h1'])

        coords = [(100,80), (100,100), (80,100)]
        origin = [self.x[coords[0]], self.y[coords[0]], self.elevation[coords[0]]]
        origin1 = [self.x[coords[1]], self.y[coords[1]], self.elevation[coords[1]]]
        origin2 = [self.x[coords[2]], self.y[coords[2]], self.elevation[coords[2]]]

        self.meshes = [Mesh(origin), Mesh(origin1), Mesh(origin2)]

        theta = np.mod((math.pi*3/2 - 0) * np.where(self.angle > 0, math.pi*2 - self.h0, self.h0), math.pi*2)
        phi = math.pi/2 - self.h0

        self.u_component = np.sin(phi) * np.cos(theta)
        self.y_component = np.sin(phi) * np.sin(theta)
        self.x_component = np.cos(phi)

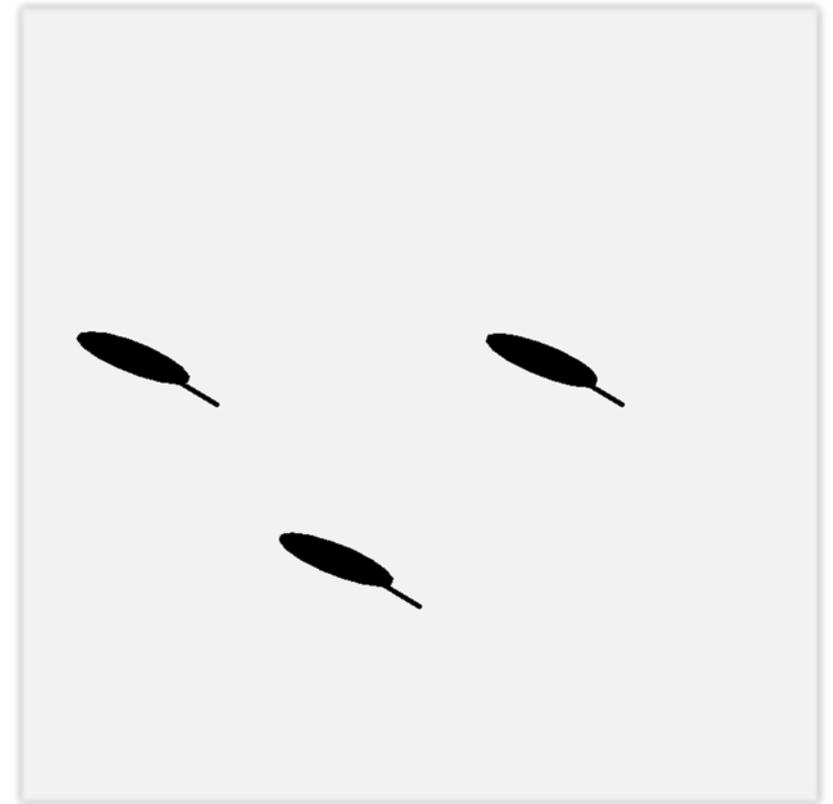
    def generate_shades(self):
        point = np.array([self.x, self.y, self.elevation])
        dir = np.array([-self.u_component, -self.y_component, self.x_component])

        results = np.zeros_like(self.x)
        for mesh in self.meshes:
            for tri in mesh.triangles:
                w0 = point - tri.p0[:, np.newaxis, np.newaxis] # Array of (3,y,w)
                a = -np.sum(tri.normal[:, np.newaxis, np.newaxis] * w0, 0) # Array of (y,w)
                b = np.sum(tri.normal[:, np.newaxis, np.newaxis] * dir, 0) # Array of (y,w)
                c = np.divide(a, b, out=np.zeros_like(a), where=b!=0)

                intersect = point + c * dir
                w = intersect - tri.p0[:, np.newaxis, np.newaxis]
                w = np.sum(w * tri.u[:, np.newaxis, np.newaxis], 0)
                wv = np.sum(w * tri.v[:, np.newaxis, np.newaxis], 0)
                a = (tri.uv * wv - tri.uv * w) / tri.denom
                t = (tri.uv * w - tri.uv * wv) / tri.denom

                shaded = np.logical_or(np.logical_or(a < 0, b > 0), np.logical_or(t < 0, (a+t) > 1))
                shadow = np.where(np.logical_or(a < 0, shaded), 0, 1 - mesh.transmissivity)

        results = np.where(shadow > 0, shadow, results)
```



37.27N, 79.98W, Mar 18
Solar noon ± 3 hours, 20-min steps

Cells	Triangles	Time
200x200	92	1.31 s
200x200	276	3.21 s
800x800	92	23.88 s
800x800	276	65.92 s



Researchers use virtual reality, GIS data to enhance trail management

By Robby Korth robbkorth@roanoke.com 381-1679 Apr 26, 2019



Connor McBane (center), a natural resource specialist with the Appalachian Trail Conservancy, and fellow trail managers "fly" above the trail route near Pearisburg by way of imagery of the AT made with aerial laser scanning data and elevation models.
MATT GENTRY | The Roanoke Times

BLACKSBURG — A team of Virginia Tech researchers has transformed Torgersen Hal on campus into the Appalachian Trail.

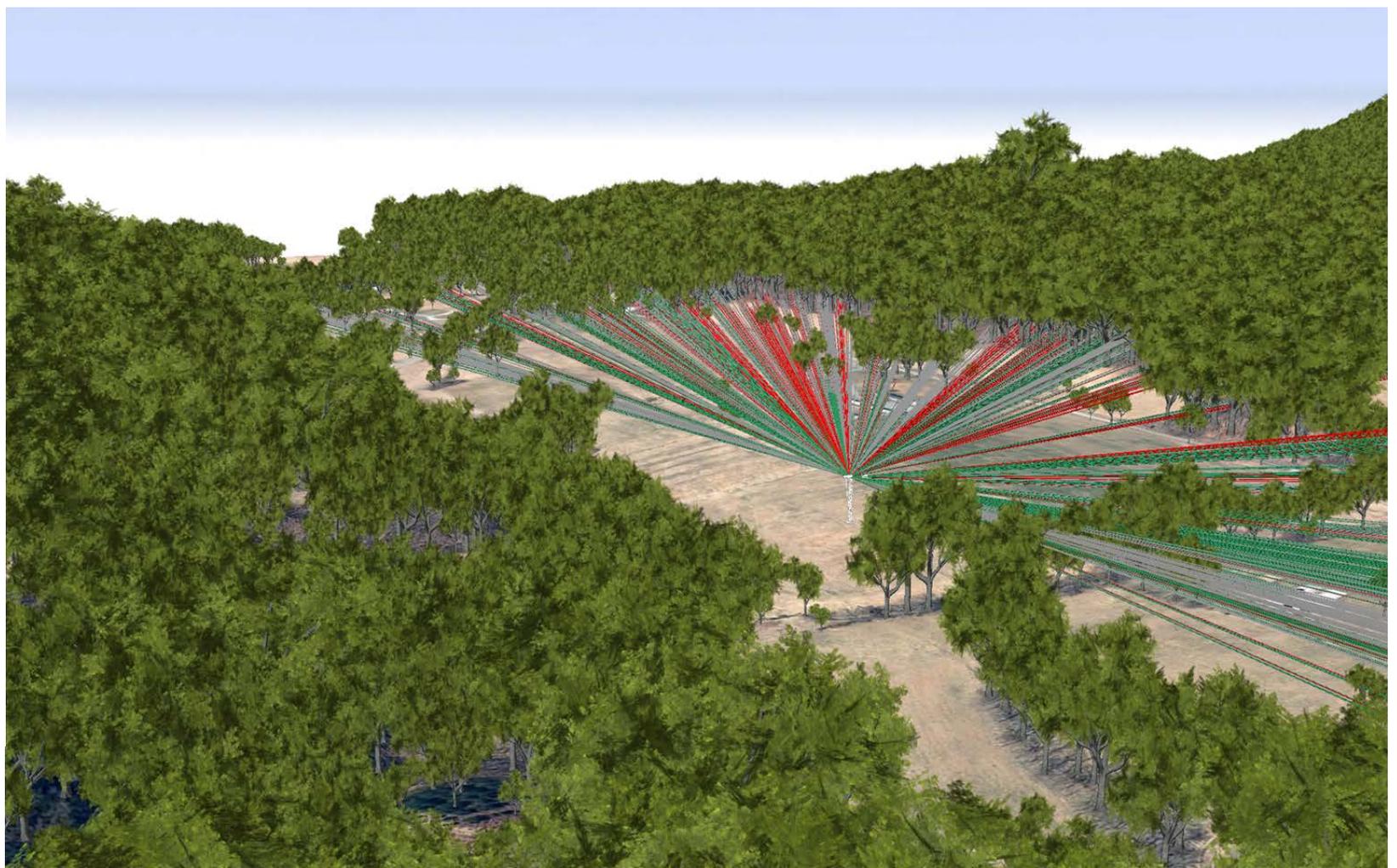
Using augmented reality, GIS data and 3D printing, people who manage the internationally known footpath can utilize technology to improve its management, researchers and stakeholders said during a workshop meeting at Tech this week. The researchers and trail managers are especially interested in protecting its majestic views.

Earlier this week, the Tech researchers from the Center for Geospatial Information

https://www.roanoke.com/news/education/researchers-use-virtual-reality-gis-data-to-enhance-trail-management/article_ac186080-f099-5bf9-b010-db77daef89e8.html

Renewable Energy Facility Siting

Line of sight from building footprints

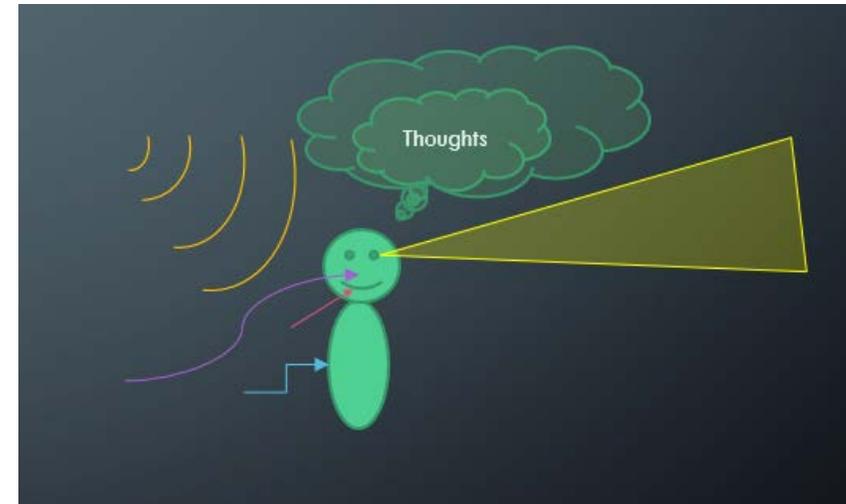
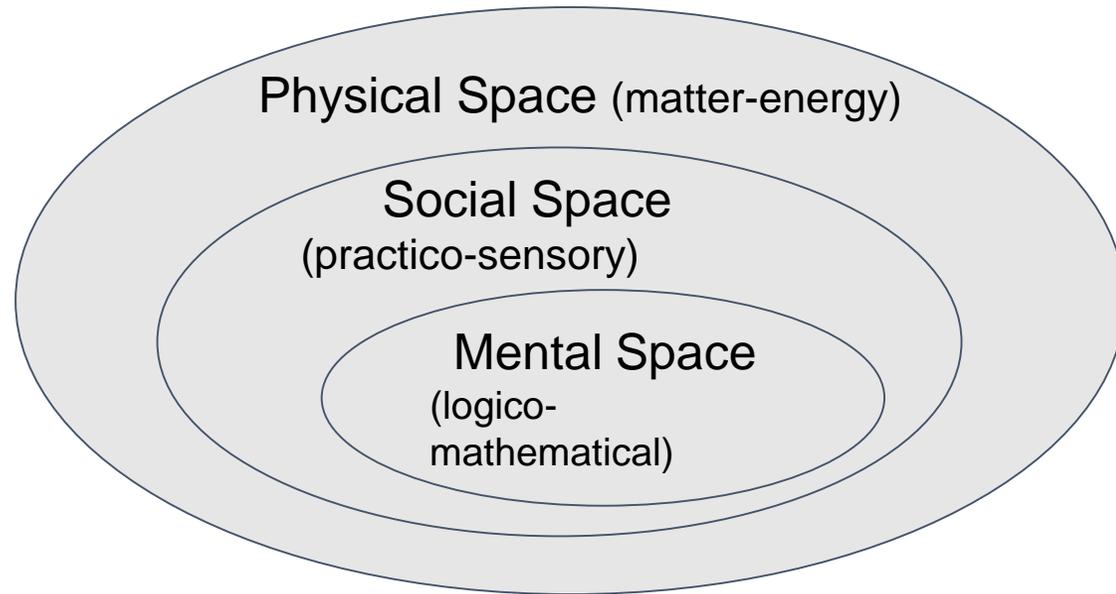


Theory

+ Practice

A **psycho-geographic** framework represents human-natural environment as external space (senses the physical world) and internal space (psychological and cognitive factors).

More recently, **unified theories** developed by philosophers describing the production of space (i.e. Lefebvre) further distinguishes *mental space* (logico-mathematical), *social space* (practico-sensory), and *physical space* (matter-energy).



Lefebvre (1974) discusses a 'unitary theory' with the aim to discover or construct a theoretical unity between 'fields' which are apprehended separately.

Current efforts at VT CGIT to discover and develop methods for bridging between theory and practice through a unified theoretical framework.