Using Disruptive Technologies for Monitoring SDGs

Adel Bolbol Fernández PhD
abolbolfernandez@esri.com

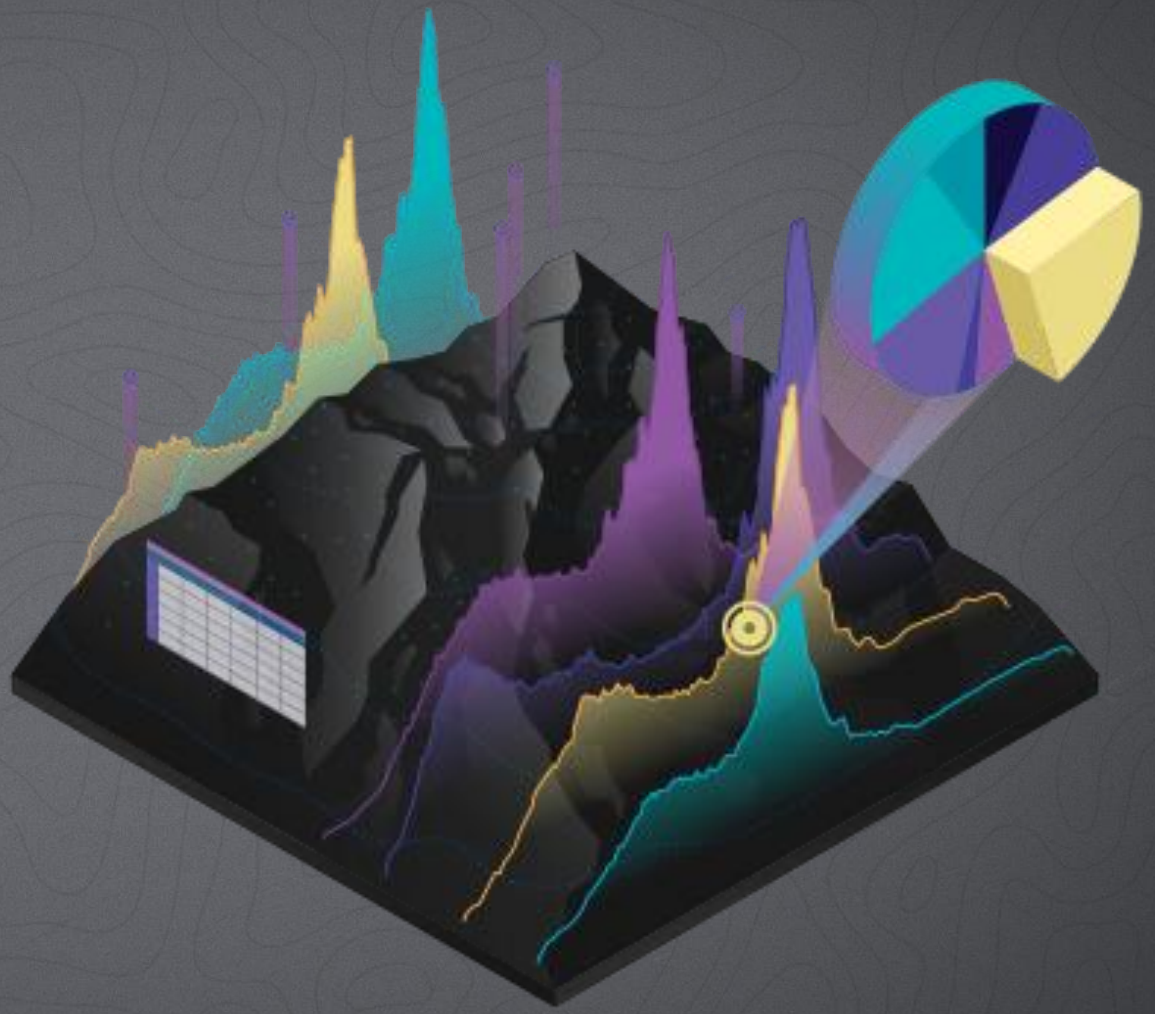
Regional Business Development Lead
Disruptive Technologies

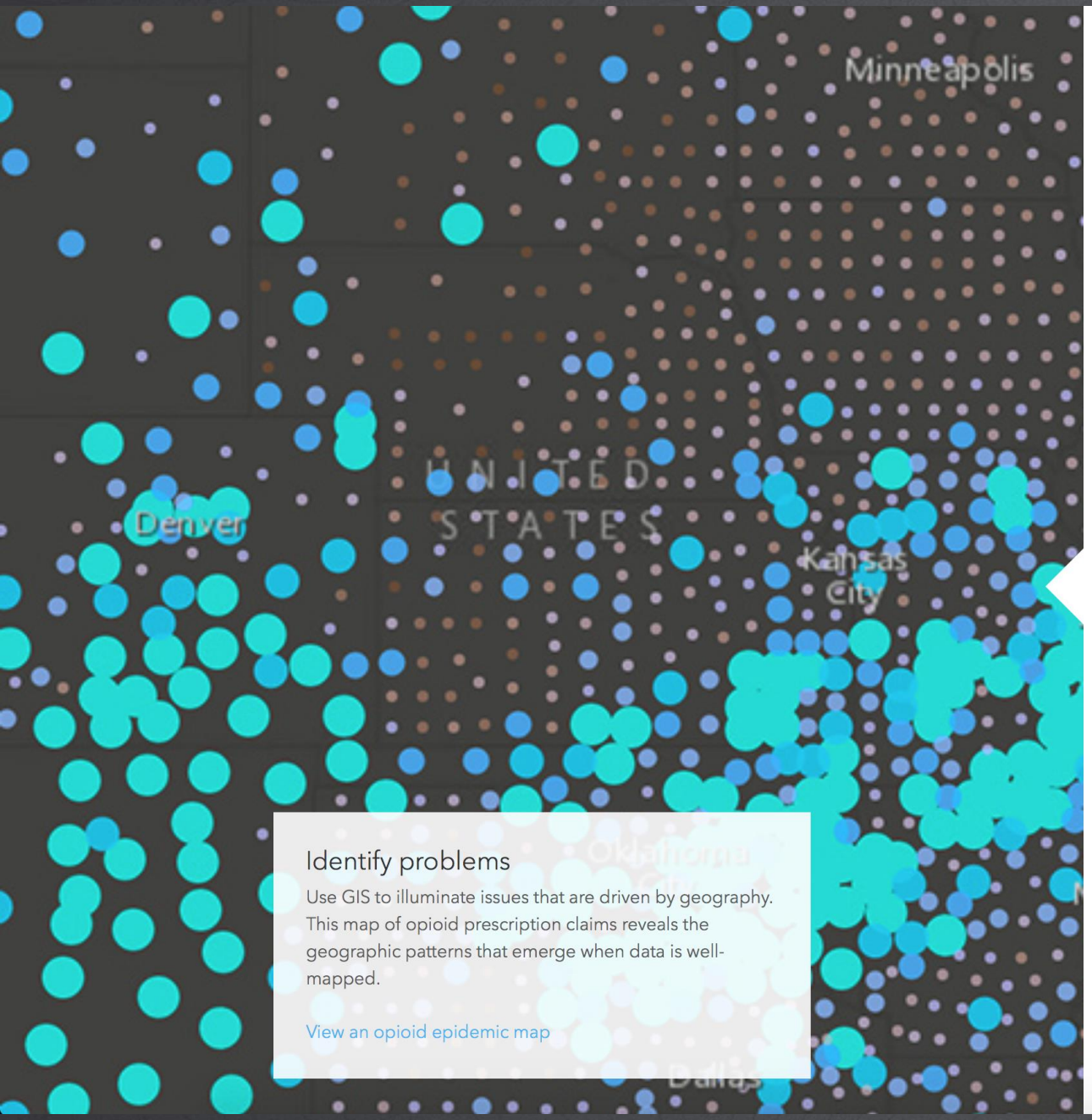
GIS

What is Location Intelligence?

What is GIS?

A framework to organize, communicate, and understand the science of our world





What is GIS

Hundreds of thousands of organizations in virtually every field are using GIS to make maps that communicate, perform analysis, share information, and solve complex problems around the world. This is changing the way the world works.

- Identify problems
- Monitor change
- Manage & respond to events
- Perform forecasting
- Set priorities
- Understand trends

Monitor change

If a picture tells a thousand words, a map tells a thousand pictures. This map starkly reveals the extent of glacier retreat in the Southern Hemisphere.

Look at the Patagon Journal Memories of Ice map

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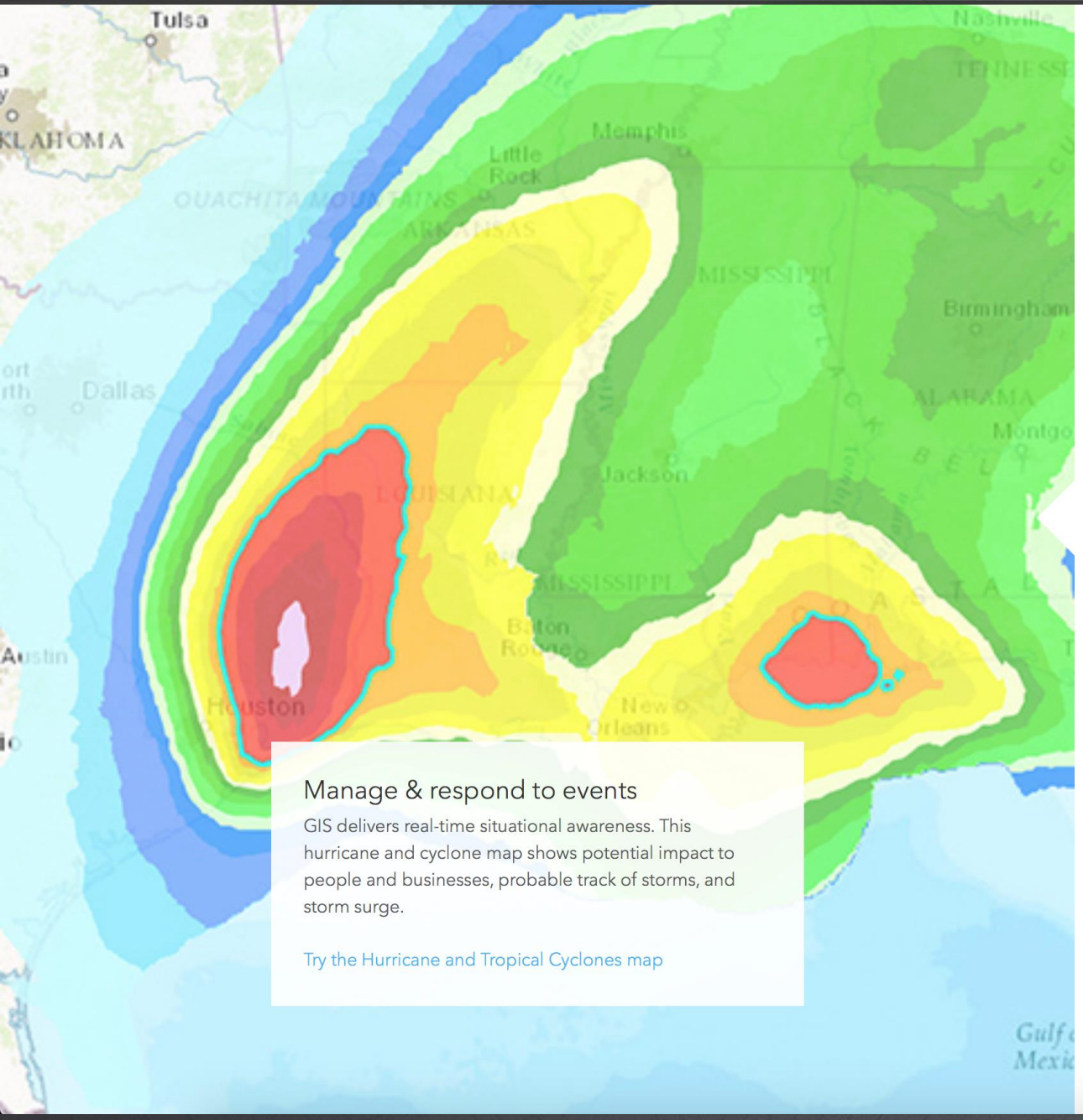

Manage & respond to events

GIS delivers real-time situational awareness. This hurricane and cyclone map shows potential impact to people and businesses, probable track of storms, and storm surge.

Try the Hurricane and Tropical Cyclones map

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Perform forecasting

Use GIS to forecast traffic. This map highlights challenges at an intersection in Fort Mitchell, Kentucky, where forecasting shows traffic is expected to worsen based on land use changes.

Open the NKYmapLAB interactive map

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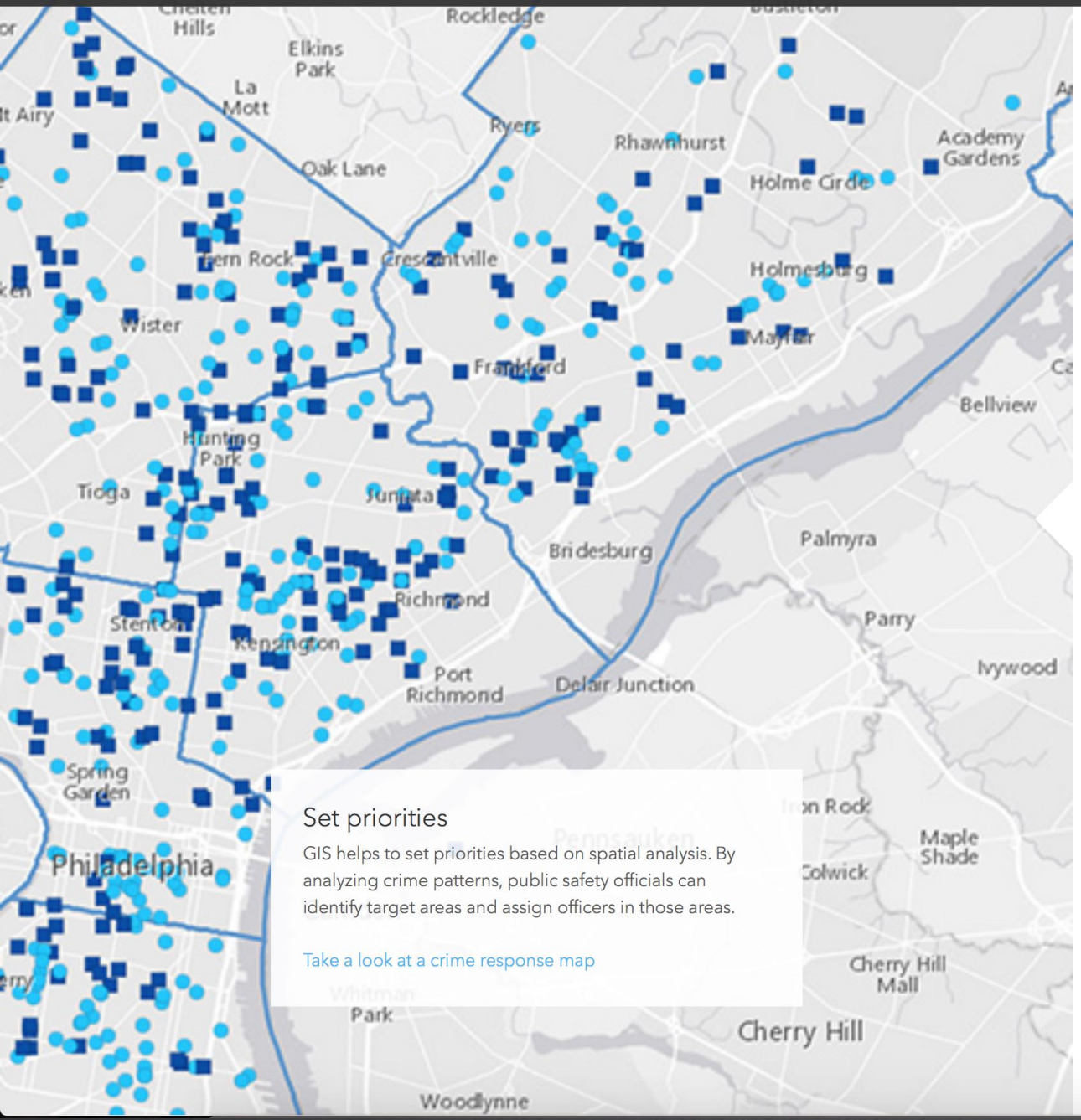

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Understand trends

GIS helps you gain insight into data that might be missed in a spreadsheet. This map measures job growth or losses in different industries and quantifies local competitive advantage.

Try the shift-share analysis map

What is GIS

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Identify problems

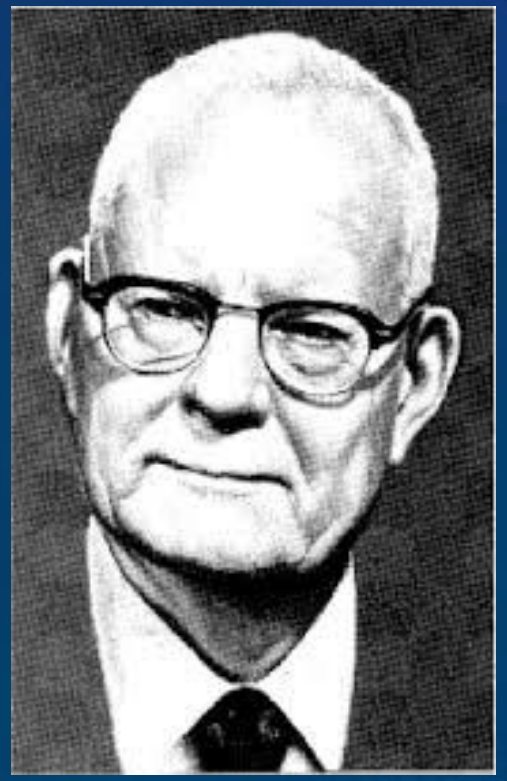

Perform forecasting


Monitor change


Set priorities


Manage & respond to events


Understand trends

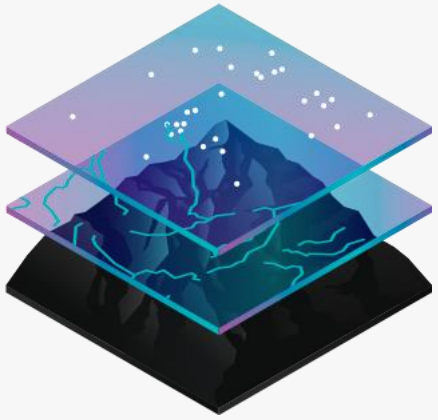


W. Edwards Deming

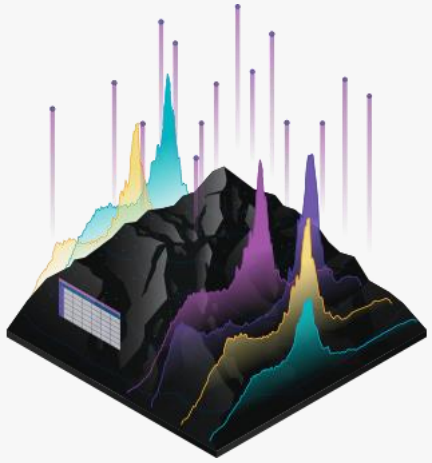
In God we
T R U S T;
All others,
MUST bring
D A T A.

How GIS Works

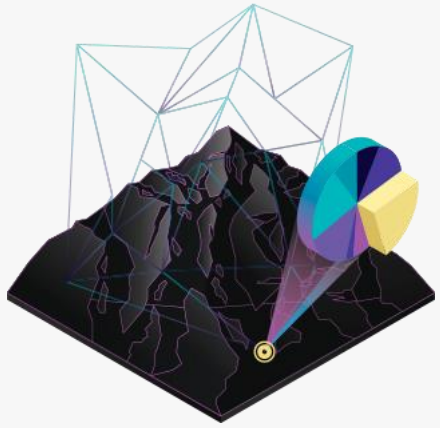
GIS technology applies geographic science with tools for understanding and collaboration. It helps people reach a common goal: to gain actionable intelligence from all types of data.



Maps



Data



Analysis

Apps

Web GIS Is the Modern GIS Architecture

Helping Everyone Do Their Work Better

Distributed

. . . and

Interconnected

End Users
and Developers

Communities

Organizations

Departments

Teams

Individuals

Engaging
Everyone

Leveraging
Web Services

Sharing and
Collaboration

Web GIS Provides the Means . .

. . For Creating Federated Systems

A Network of Collaboration Is Emerging

Connecting Organizations and Individuals

A Global Network of Collaboration Is Emerging

A Network of Collaboration Is Emerging

Connecting Organizations and Individuals

http://data-irelandsdg.opendata.arcgis.com

Ireland

UAE

http://sdgsuae-fcsa.opendata.arcgis.com

Palestine

http://sdg-pcbs.opendata.arcgis.com

UNSD

http://www.sdg.org

Senegal

https://senegals-ansdsdg.opendata.arcgis.com

Tanzania

https://mapstat-psa.opendata.arcgis.com

Philippines

Mexico

Colombia

http://odsprueba-ambiente-esri-co.hub.arcgis.com

A Global Network of Collaboration Is Emerging

Open SDG Data Hubs

Are enabling in-country collaboration and action

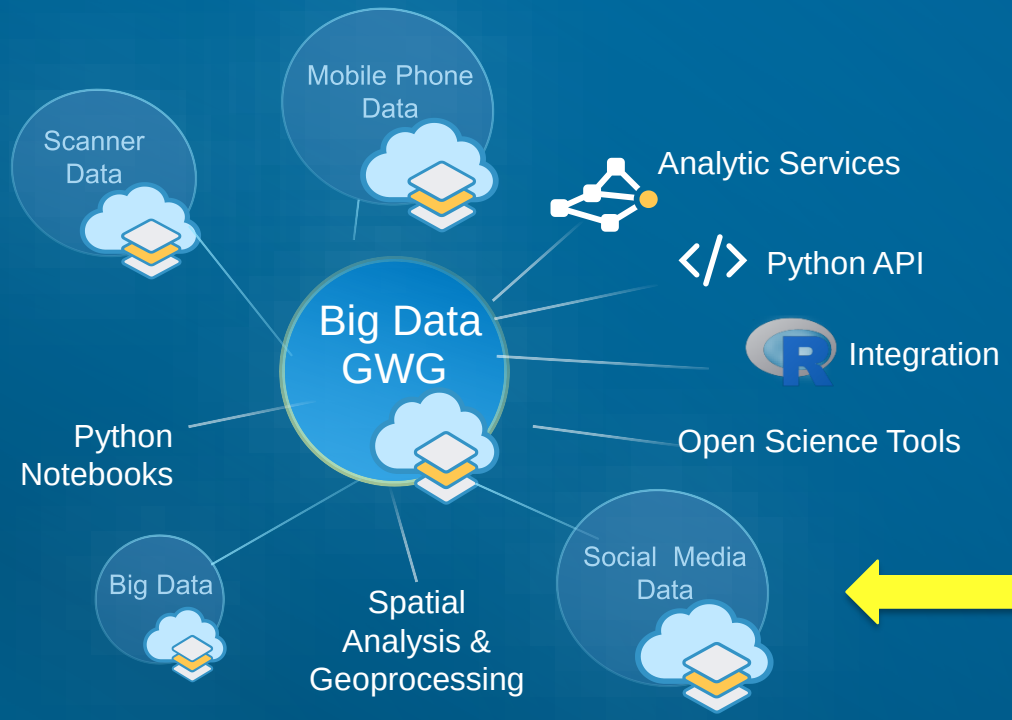
Sub-national
Data
Reporting
OPEN
SDGs
National
Standards Based
Implementation
Enabling
Country Led
Collaboration
Aggregation
Geospatial
Country Owned
Interoperability
Statistical
Integration
Dis-aggregation
GIS
Monitoring
Global

Esri Commitment

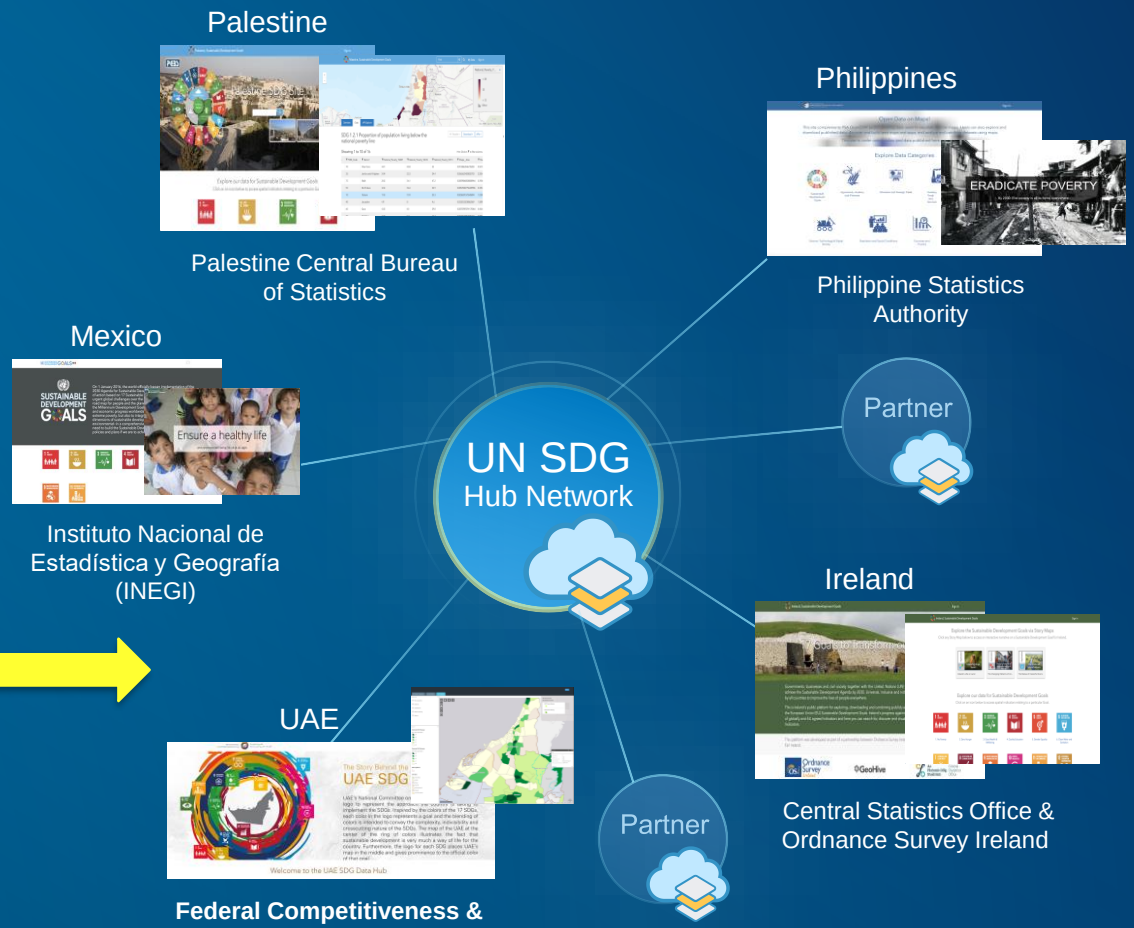
- To support the sustainable scale-up of this work:
  - Donation of software bundle for the first 3 years to developing countries and those in need
  - After 3 years until 2030, Esri will provide a discount of 85% of ongoing annual cost
  - Ongoing Support
    - Learn lessons and other online training resources
    - Story Map templates
    - Data – Living Atlas, Imagery, OSM
    - Africa Geoportal
    - Multi-lingual capabilities
    - Git-hub repo

Supporting Statistical Capacity Building

UN Big Data Global Working Group



UNSD Federated Information System for the SDGs



Create … Publish … Share

GIS Now Provides the Means . . .

SDGs

. . . For Creating Federated Systems

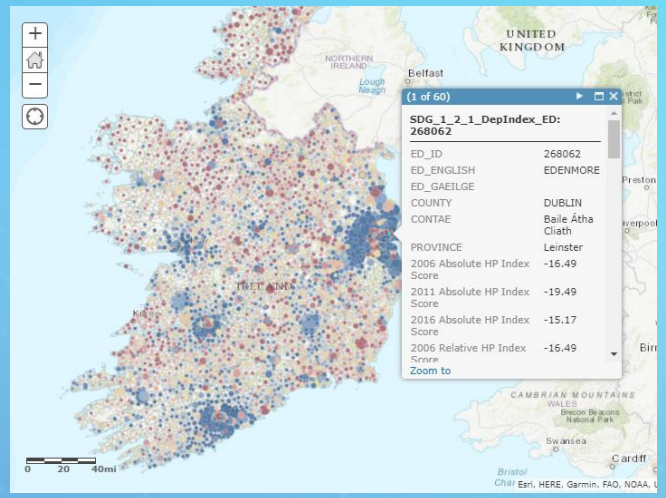

THE GLOBAL GOALS
For Sustainable Development
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE AND JUSTICE STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS

Target Contribute to progress on the Target, not necessarily the Indicator									Goal	Indicator Direct measure or indirect support to the Indicator					
							1.4	1.5	1 No poverty	1.4.2					
						2.3	2.4	2.c	2 Zero hunger	2.4.1					
					3.3	3.4	3.9	3.d	3 Good health and well-being	3.9.1					
									4 Quality education						
								5.a	5 Gender equality	5.a.1					
		6.1	6.3	6.4	6.5	6.6	6.a	6.b	6 Clean water and sanitation	6.3.1	6.3.2	6.4.2	6.5.1	6.6.1	
					7.2	7.3	7.a	7.b	7 Affordable and clean energy	7.1.1					
								8.4	8 Decent work and economic growth						
					9.1	9.4	9.5	9.a	9 Industry, innovation and infrastructure	9.1.1	9.4.1				
						10.6	10.7	10.a	10 Reduced inequalities						
	11.1	11.3	11.4	11.5	11.6	11.7	11.b	11.c	11 Sustainable cities and communities	11.1.1	11.2.1	11.3.1	11.6.2	11.7.1	
				12.2	12.4	12.8	12.a	12.b	12 Responsible consumption and production	12.a.1					
					13.1	13.2	13.3	13.b	13 Climate action	13.1.1					
		14.1	14.2	14.3	14.4	14.6	14.7	14.a	14 Life below water	14.3.1	14.4.1	14.5.1			
	15.1	15.2	15.3	15.4	15.5	15.7	15.8	15.9	15 Life on land	15.1.1	15.2.1	15.3.1	15.4.1	15.4.2	
								16.8	16 Peace, justice and strong institutions						
17.2	17.3	17.6	17.7	17.8	17.9	17.16	17.17	17.18	17 Partnerships for the goals	17.6.1	17.18.1				

EARTH OBSERVATION AND GEOSPATIAL INFORMATION
LINKAGES TO SDG GOALS, TARGETS AND INDICATORS

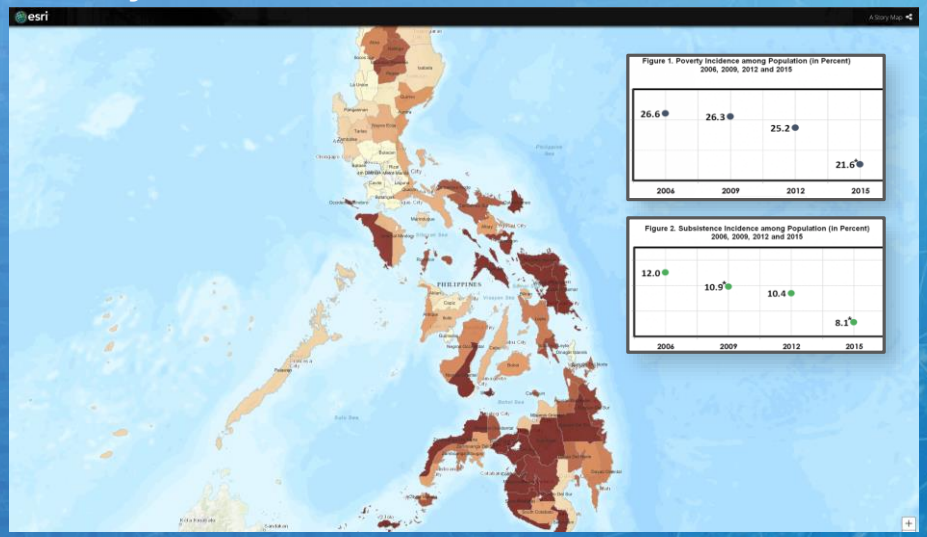
1 NO POVERTY

Population Below Poverty Line



Ireland

Poverty Incidence



Philippines

2 ZERO HUNGER

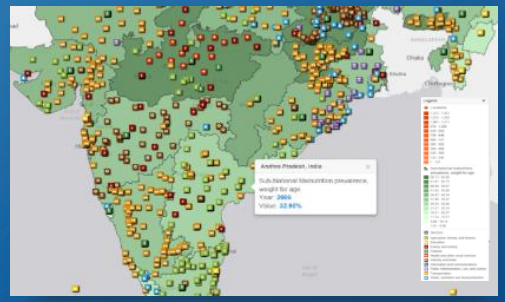
Food Supply

UN-Yemen

Crop Rotation

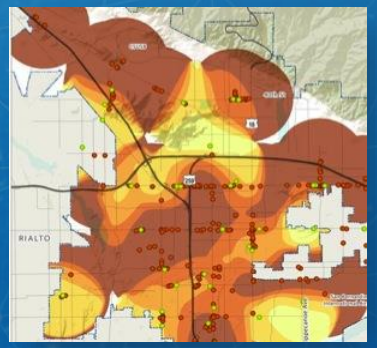
USA

Malnutrition



World

Healthy Food Access



California

Precision Agriculture

New Zealand

2 ZERO HUNGER

Machine Learning using Drone Data

- **Captured images for two study areas**
  - Animal Farms
  - Crop Farms
- **Use Esri Artificial Intelligence tools**
  - Multi-spectral image analysis
  - Auto-detect features
- **Focus on-site inspections to farms that have regulatory issues**

Animal Farms

3 cm resolution

Edit ×

Animal and Crop Farms Imagery Analysis

No issues detected ×

Animal and Crop Farms Receiving Monetary Subsidies

The farms colored green are receiving monetary subsidies.

The farms colored red are not receiving monetary subsidies.

Animal Farms
Crop Farms

Click on the links below to see the farms receiving monetary subsidies but the drone imagery shows there are no animals or crops present. Inspectors can be dispatched to these farms for review.

Animal farms receiving monetary subsidies with no animals

Crop farms receiving monetary subsidies with no crops

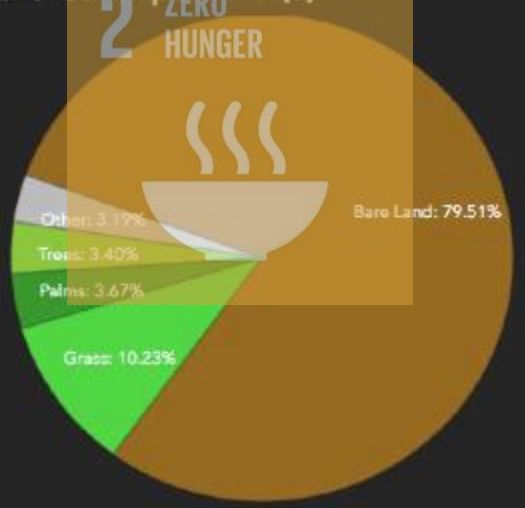
Animal Farms Receiving Fodder Subsidies

The animal farms colored green are receiving

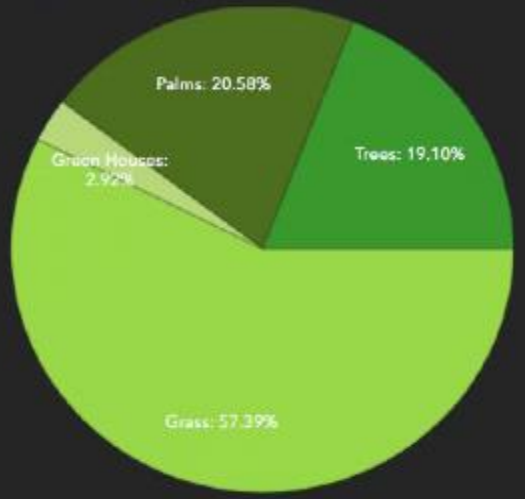
Land Cover Distribution

Animals in Farm(s) "Turn on Animals in Plots Layer" | Camels | Cattle | Goats | None | Sheep

Land Cover per Farm(s)



Green Cover per Farm(s)



Farms Count: 35	Open Water Storage: 2.3k Cubic meters	Goats Count: 258	Cattle Count: 0
Area: 61.2 Hecatres			
Grass: 6.3 Hecatres	Impervious Structures: 11.9k Square meters	Camels Count: 0	Sheep Count: 165
Grass: 9.8%	Impervious Structures: 3%	Palms Count: 2,456	Oxygen Production: 634.8 Cubic meters

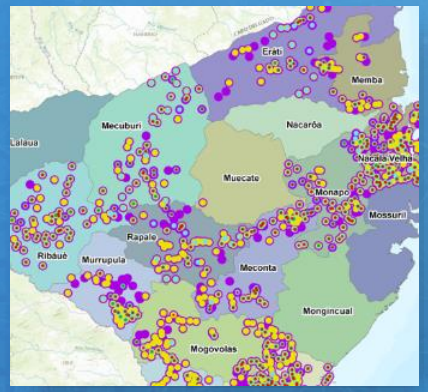
Total Oxyge...

The information shown in the dashboard describes all the farms in the current map extent. To show information of specific farm(s), use the select tool

http://ps-dubai.maps.arcgis.com/apps/opsdashboard/index.html#/0d5c77d3878448bbb2bbef6c70f87c41

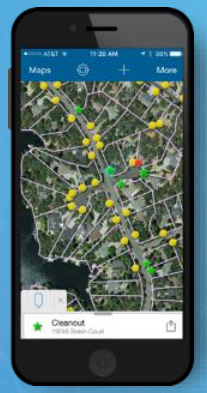
6 CLEAN WATER AND SANITATION

Water and Sanitation Projects



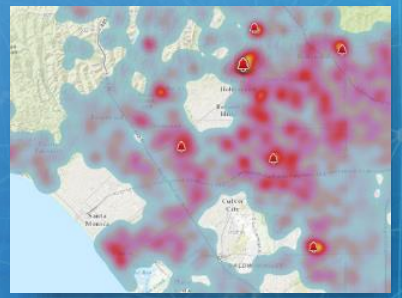
Mozambique

Sanitation Cleanout Locations



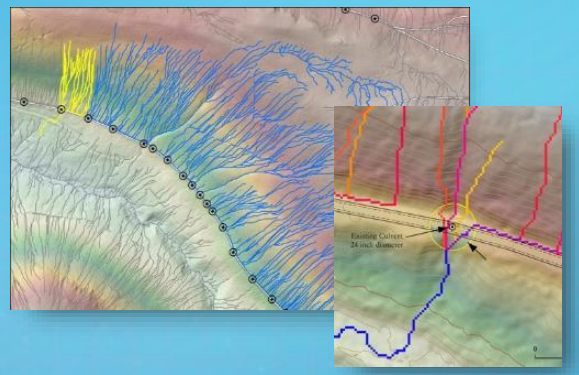
California

Water Monitoring



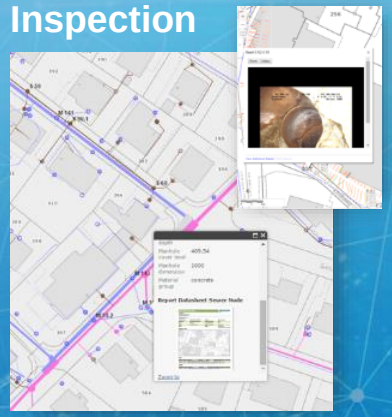
Los Angeles

Drainage Network Modeling



Washington

Sewer Inspection



Switzerland

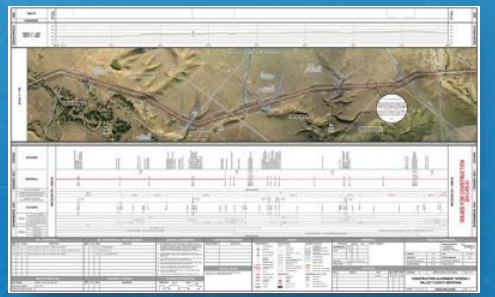
Work Order Management

New Jersey

Water Quality Monitoring

China

Pipeline Alignment



Montana

7 AFFORDABLE AND CLEAN ENERGY

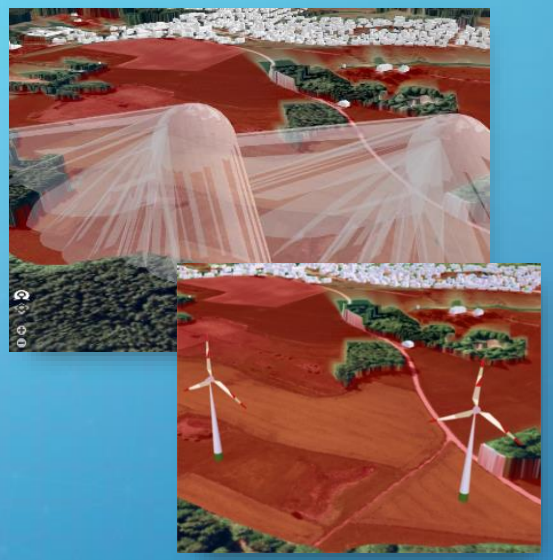
Rooftop Solar Potential

Massachusetts

Solar Potential

Singapore

Wind Farm Design



Bavaria, Germany

Renewable Energy Monitoring

China

Solar and Wind Energy

Philippines

Renewable Energy Connection Network

Southern California

Wind Resources

England

7 AFFORDABLE AND CLEAN ENERGY

Electricity Consumption per Capita:

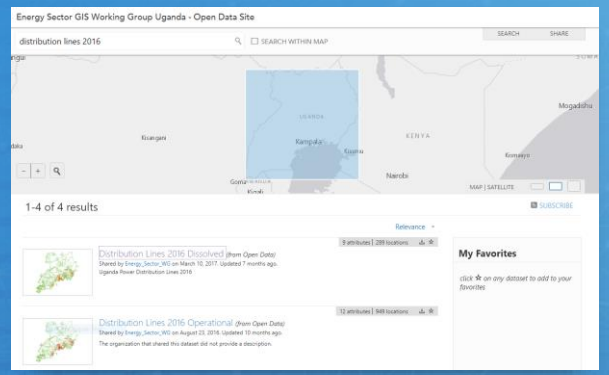
- Uganda (2016): 71 kWh/Capita
- Germany (2014): 7,035 kWh/Capita
- EU (2014): 5,909 kWh/Capita
- World (2014): 3,128 kWh/Capita

Solar Containers for rural communities

Goal:

Developing a GIS based decision support Model to decide whether it is more economical to electrify a village using Solar Home Systems, Mini-Grid or On-Grid Solutions

Data:



Energy Sector GIS Working Group Uganda Open Data Site

Facebook Population Data

https://ciesin.columbia.edu/data/hrsl/

Building Extraction from Satellite Images

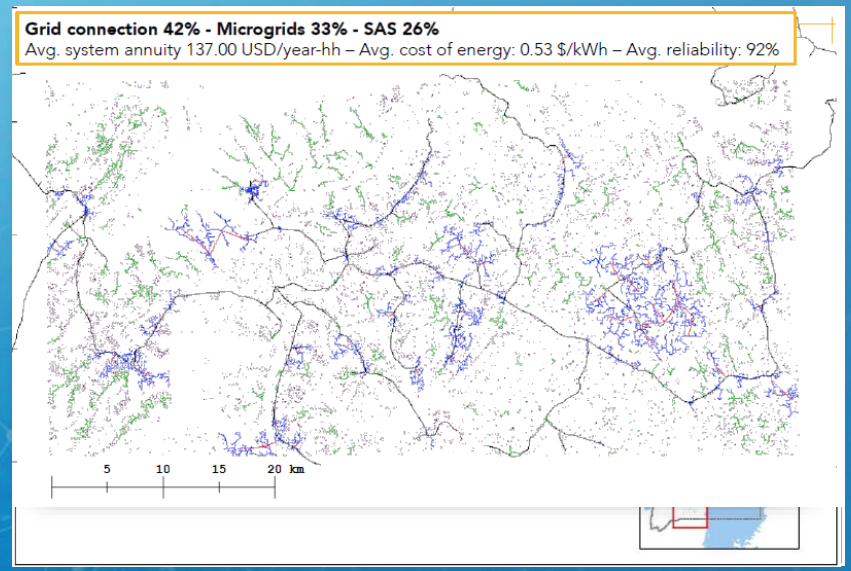
Cluster Buildings to Settlements

Load Transformer and Distribution Line Data as well as Electrification Status Estimates

Creating buffer around distribution lines and transformers according to economic data

Create a Ranking of Villages/Trading Centres to be electrified first

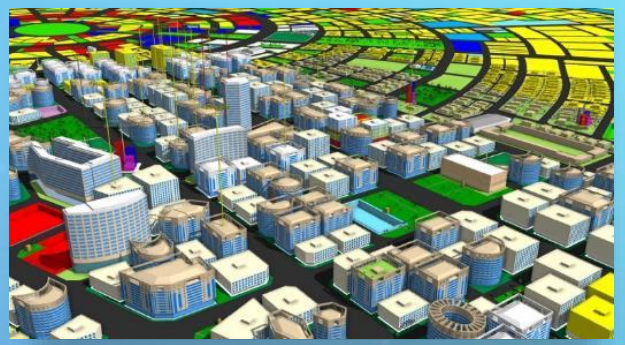
Sharing this information with investors



Electrification Planning in Uganda using Satellite Data

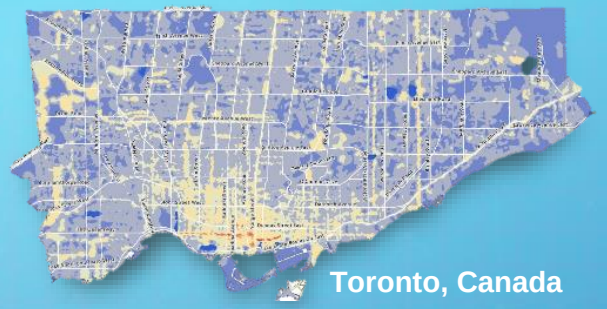
11 SUSTAINABLE CITIES AND COMMUNITIES

Urban Planning



Abu Dhabi, UAE

Vertical Intensification

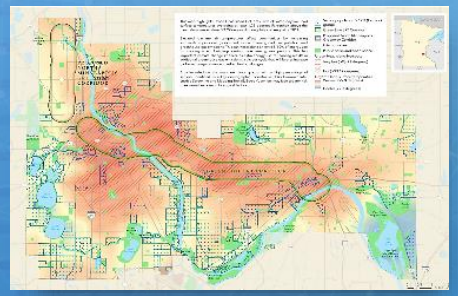


Toronto, Canada

Urban Design

California

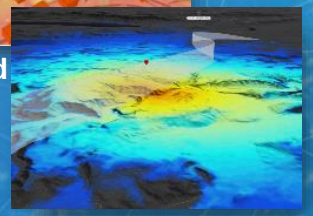
Urban Heat Islands



Minneapolis

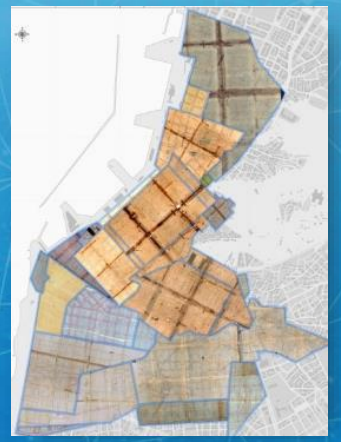
Noise Pollution

Switzerland



Switzerland

Neighborhood



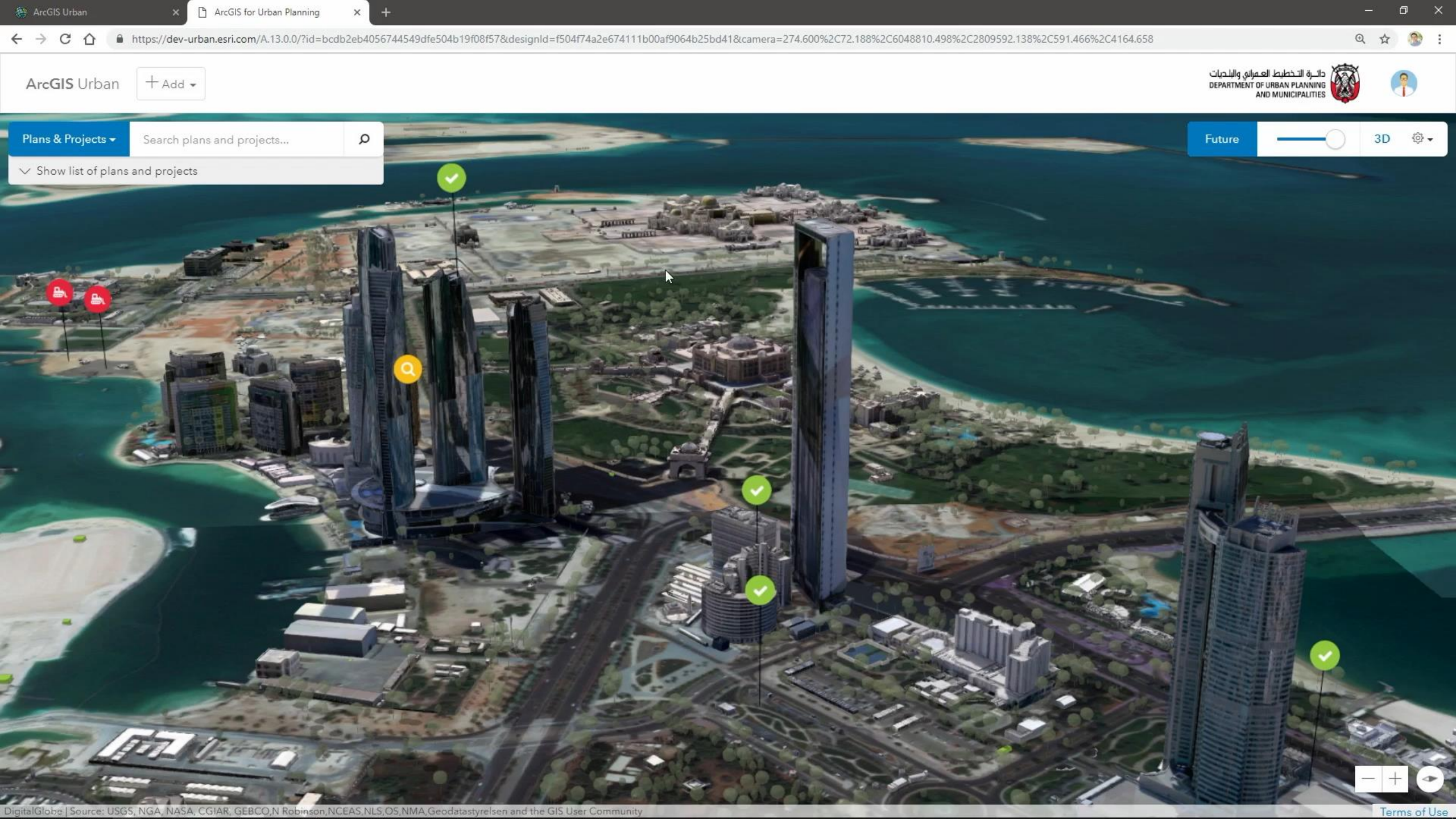
Greece

Zoning

Honolulu

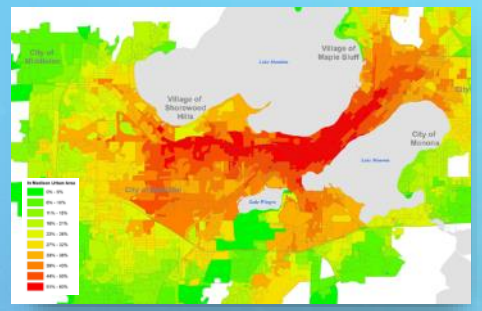
Land Use

Miami-Dade


ArcGIS Urban
ArcGIS for Urban Planning
https://dev-urban.esri.com/A.13.0.0/?id=bcdb2eb4056744549dfe504b19f08f57&designId=f504f74a2e674111b00af9064b25bd41&camera=274.600%2C72.188%2C6048810.498%2C2809592.138%2C591.466%2C4164.658
ArcGIS Urban
Add
دائـرة التـخطيط العمراني والبلديات
DEPARTMENT OF URBAN PLANNING AND MUNICIPALITIES
Plans & Projects
Search plans and projects...
Show list of plans and projects
Future
3D
DigitalGlobe | Source: USGS, NGA, NASA, CGIAR, GEBCO,N Robinson,NCEAS,NLS,OS,NMA,Geodatastyrelsen and the GIS User Community
Terms of Use

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Walking and Transit Model



Wisconsin

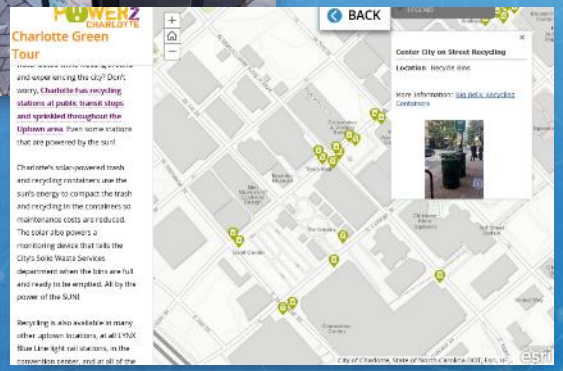
Traffic Management

Germany

Public Transit

Washington

Recycling Communications

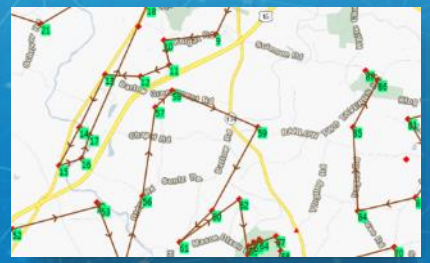


Charlotte

Rail Status Monitoring

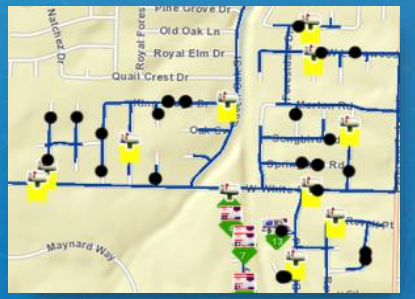
USA

Smart Routing (UPS)



Pennsylvania

Postal Delivery



Los Angeles

Monday, September 7, 2015

5,815,109 people movements in total

Mode of transport

Number of movements by mode of transport.

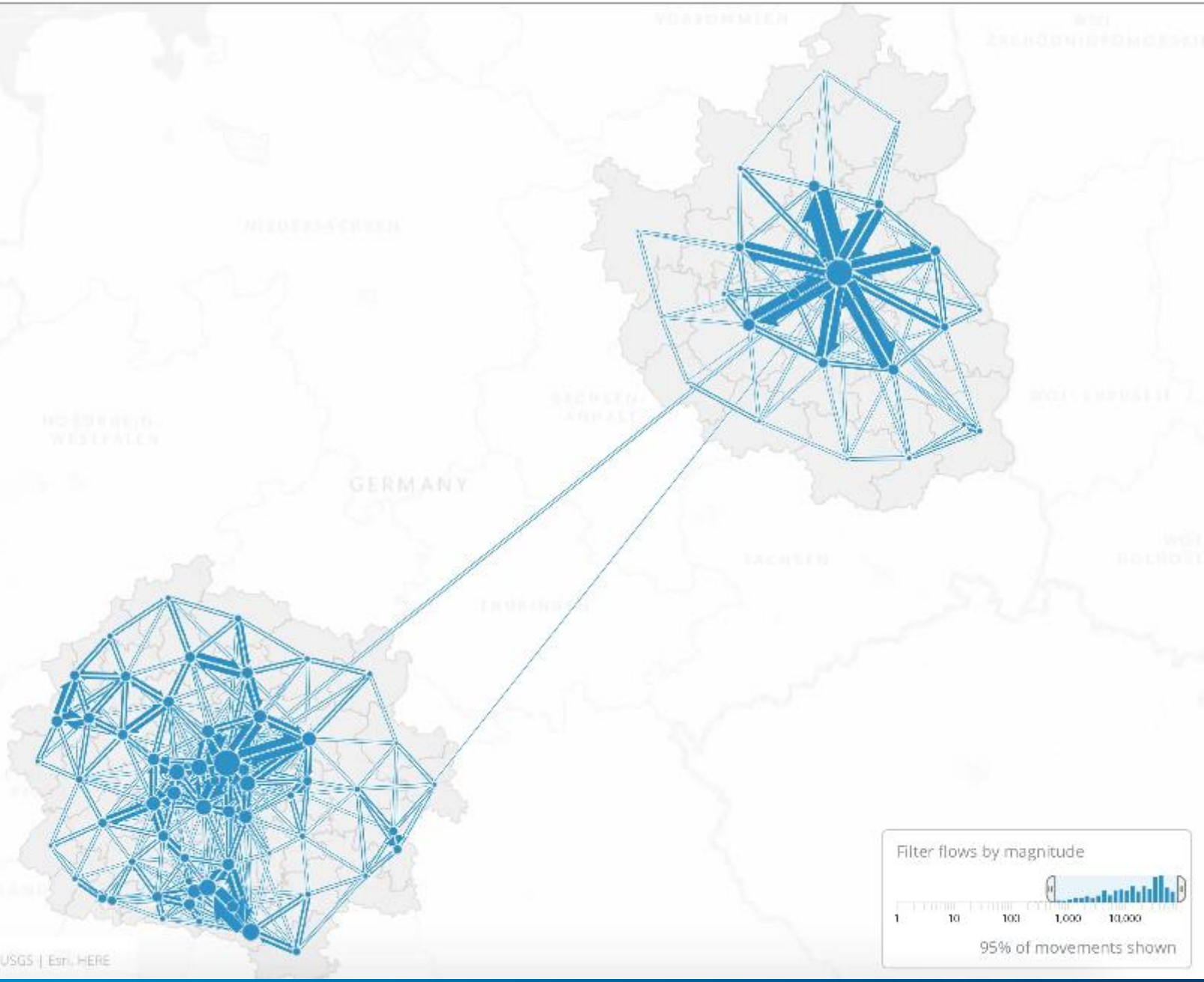
Time of day

Number of movements by time of day.

Distance

Top Flows

Top Origins



Filter flows by magnitude

95% of movements shown

13 CLIMATE ACTION

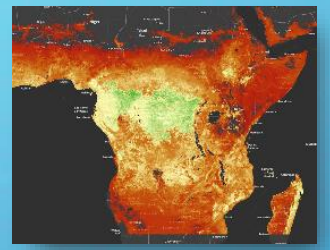
Glacial Melt

Bhutan (ICIMOD)

Desertification Survey

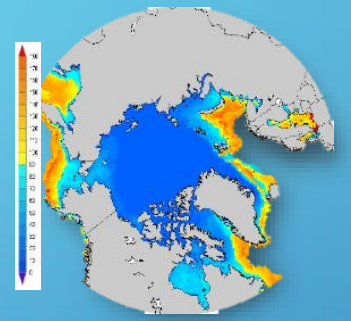
Turkey

Biomass Assessment

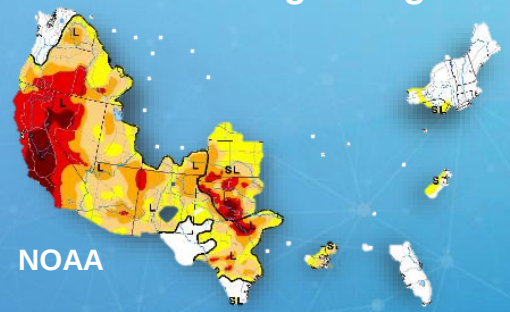


Africa

Calculating First Ice Freeze



Monitoring Drought



NOAA

Sea Level Rise

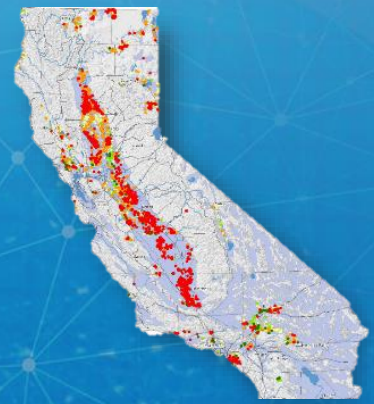
South Carolina

San Francisco

Forest Carbon Reserves

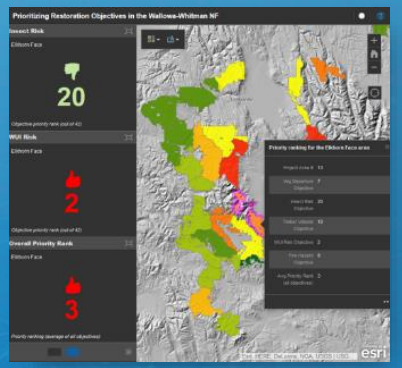
South America

Groundwater Change



California

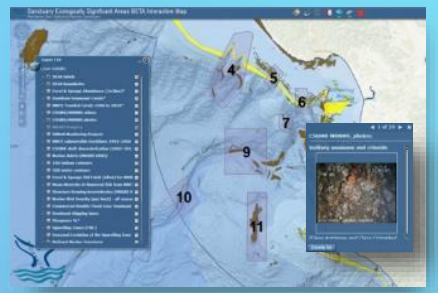
Forest Restoration



Wallowa-Whitman NF

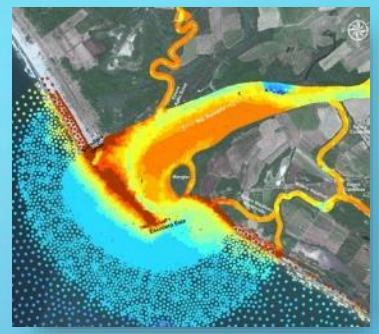
14 LIFE BELOW WATER

Ecologically Significant Areas



NOAA—Monterey Bay

Sediment Change



Mexico

Marine Sanctuary

California

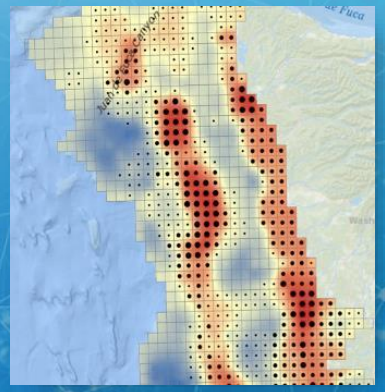
Reef Health

Cook Islands

Coral Communities

Martinique

Ocean Modeling

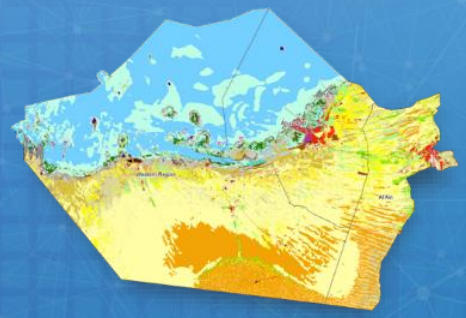


NOAA

Biodiversity

Philippines

Marine and Terrestrial Habitat



Abu Dhabi, UAE

Marine Protection Planning

Australia

14 LIFE BELOW WATER

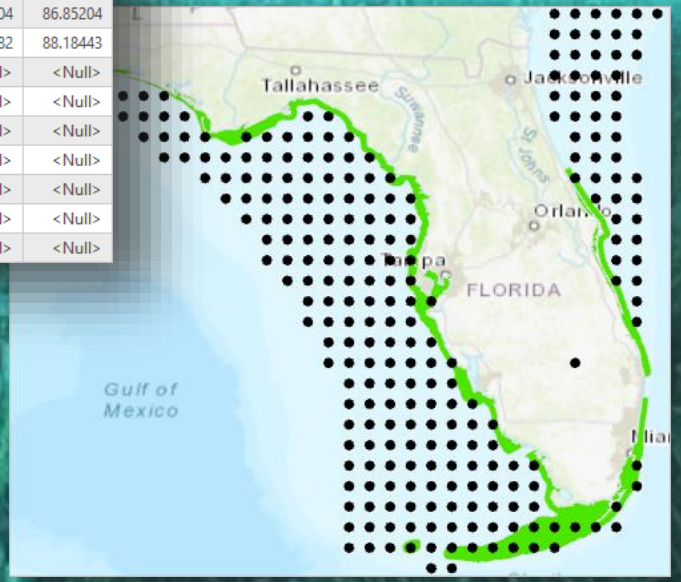
Predicting Environmental Phenomena

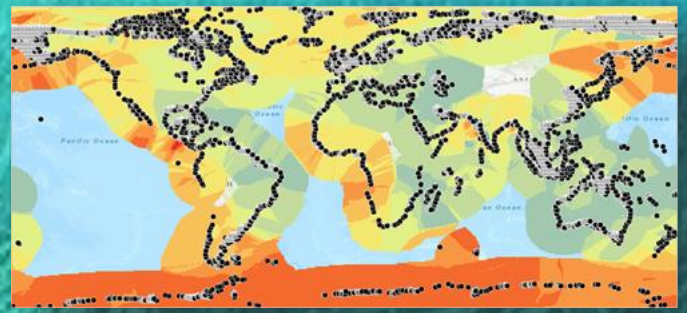
Where Seagrasses Grows, Empirical Bayesian Kriging (EBK), Random Forest classifier

EMU_Global_90m

Field: Add Delete Calculate | Selection: Zoom To Switch Clear Del

OBJECTID	SHAPE	pointid	temp	salinity	appO2ut	dissO2	nitrate	percO2sat
11	Point Z	24	-1.433144	34.18222	<Null>	<Null>	<Null>	<Null>
13	Point Z	26	-1.439945	34.17537	<Null>	<Null>	<Null>	<Null>
118	Point Z	307	-1.387401	34.32391	<Null>	<Null>	<Null>	<Null>
753	Point Z	1739	-1.600642	34.03786	1.110779	7.211782	22.96304	86.85204
754	Point Z	1740	-1.56238	34.02853	0.997919	7.310482	21.98382	88.18443
871	Point Z	2184	-1.619098	33.9525	<Null>	<Null>	<Null>	<Null>
872	Point Z	2185	-1.678768	33.97821	<Null>	<Null>	<Null>	<Null>
882	Point Z	2211	-1.616092	33.94105	<Null>	<Null>	<Null>	<Null>
884	Point Z	2219	-1.697907	33.92028	<Null>	<Null>	<Null>	<Null>
885	Point Z	2220	-1.68471	33.92426	<Null>	<Null>	<Null>	<Null>
886	Point Z	2221	-1.69101	33.94196	<Null>	<Null>	<Null>	<Null>
887	Point Z	2222	-1.69061	33.93676	<Null>	<Null>	<Null>	<Null>





Empirical Bayesian Kriging

```
from sklearn.ensemble import RandomForestClassifier
import numpy as NUM
import arcpy as ARCPY
import arcpy.da as DA
import pandas as PD
import seaborn as SEA
import matplotlib.pyplot as PLOT
import arcgisscripting as ARC
import SSUtilities as UTILS import os as OS
```

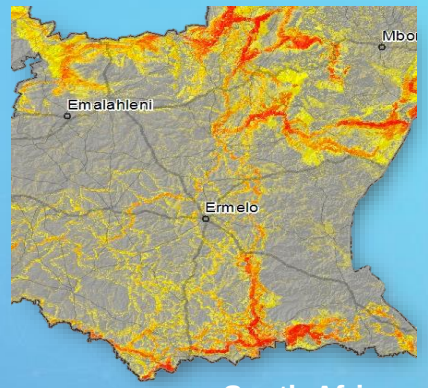
Where does Seagrass grow?

Prediction Variables:

- **Temperature**
- **Salinity**
- **Phosphate**
- **Silicate**
- **Nitrate**
- **Dissolved Oxygen**
- **Type of Ecological Marine Unit**

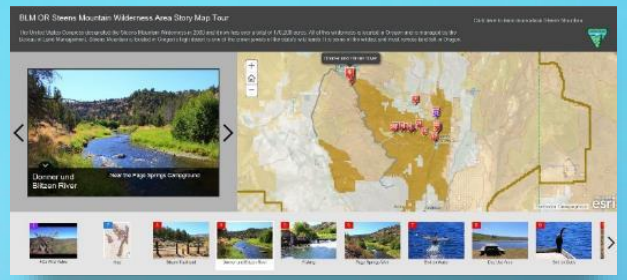
15 LIFE ON LAND

Wildlife Conservation



South Africa

Wilderness Tour

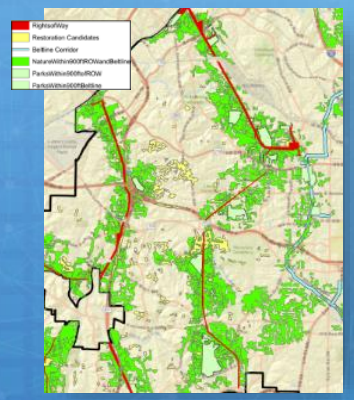


Steens Mountain Wilderness, Oregon

Green Infrastructure

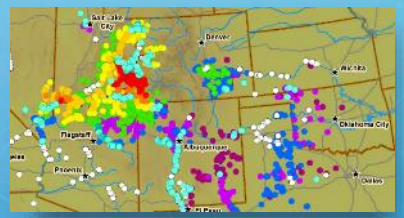
New Jersey

Habitat Corridors



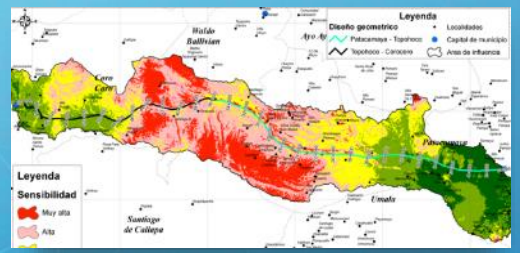
Atlanta

Invasive Species



Southwest, USA

Ecosystem Sensitivity



Bolivia

Watershed

Alaska

Wildlife Imagery

California

Habitat Monitoring

USA

15 LIFE ON LAND

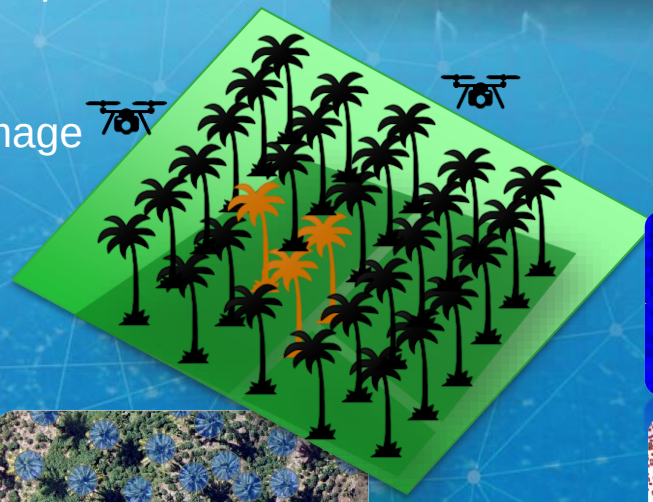
Using Deep Learning to Assess Palm Tree Health

Leaf Spots and Leaf Blights of Palm

Bud Rot of Palm

Graphiola Leaf Spot (False Smut) of Palm

- Harnessing drone real-time capabilities of **monitoring** of crops and plants (e.g. Palm Trees)
- Inferring presence of **fungal** & **bacterial** diseases using image classification enabling an immediate response to identify containment zones & to contain contaminations
- **Benefits:**
  - Supervised Classification for autonomous systems
  - Real-Time Detection & Accelerated Response



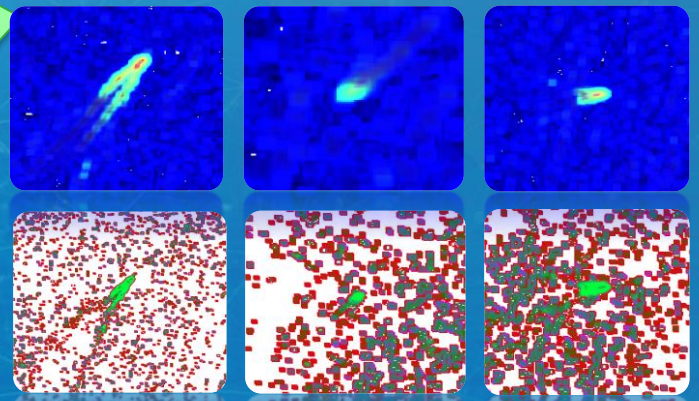
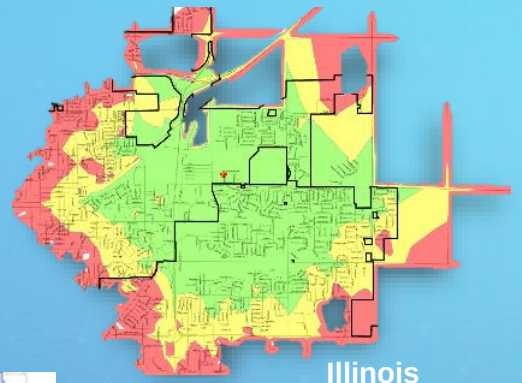


Image Classification to help Infer presence of contamination

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

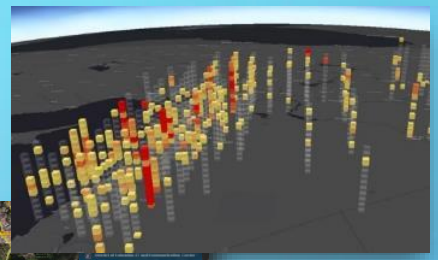
16 PEACE AND JUSTICE STRONG INSTITUTIONS

Fire Response Times



Illinois

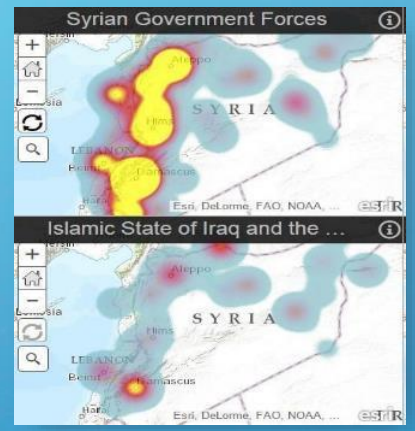
Acts of Terrorism



Infrastructure Protection

DHS

Violence Hot Spots



Syria

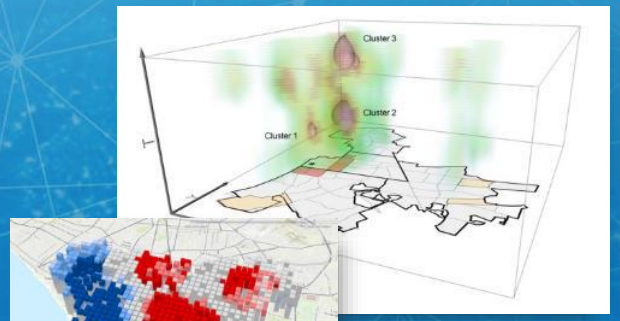
Fire Station Location/Allocation

Texas

Marathon Viewshed

London, England

Spatiotemporal Crime Patterns



Louisiana

Peru

EMS Resources

Tel Aviv, Israel

Officer Involved Shootings

Texas

16 PEACE AND JUSTICE STRONG INSTITUTIONS

City in Motion

Geography-Wide Monitoring

CRM
Demographics, Visitor Lines

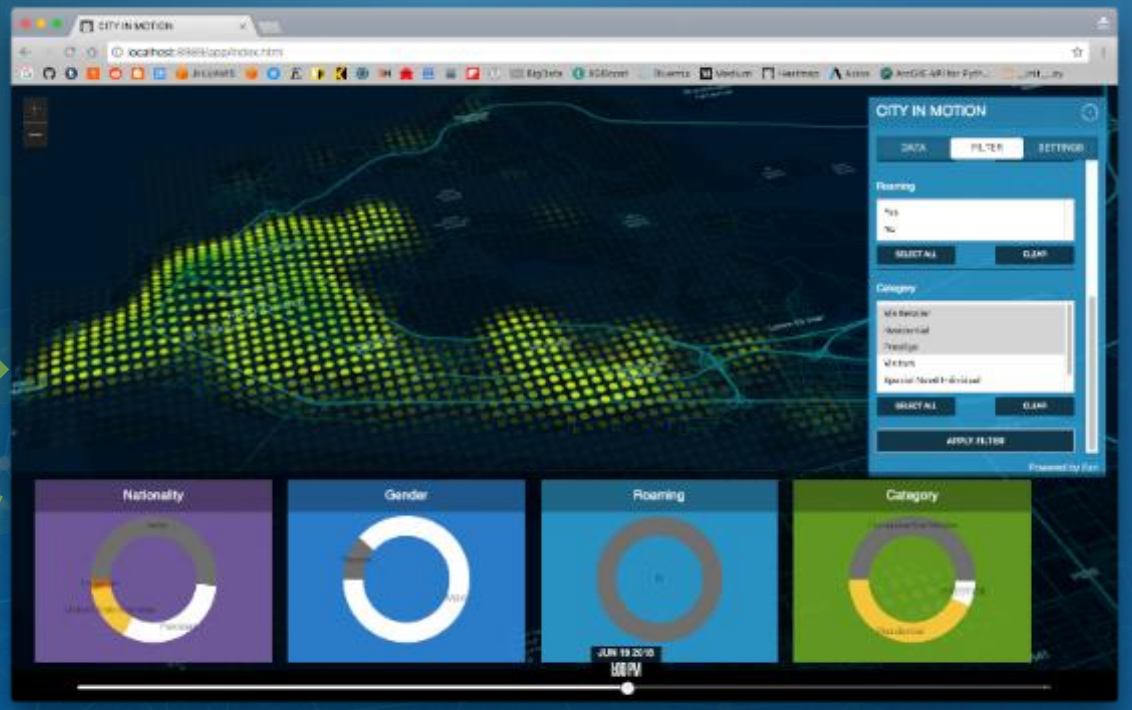
Signaling Network
Movement, Roaming

Analytics
Home/Work Locations

Data Packet Inspection DPI
Web Activity

1 Billion Records Daily

200 GB Daily



City In Motion Application

One Application …. Serves different industries & different tailored use cases

EPIDEMIC DISEASE SPREAD

TOURIST MOVEMENT POI

TRAFFIC IN/ OUT FLOW

CROWD INTELLIGENCE

CRISES MANAGEMENT

One single Application that can serve all

Signaling Data

Analytic Models

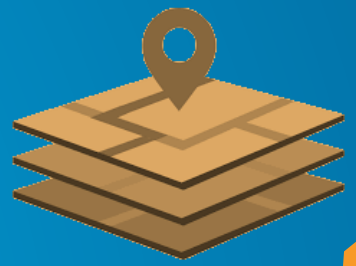
CRM Data

Internet Data

IOT Data

Sky Data

Processing more than 1.5billion records on daily bases and 3TB of data.



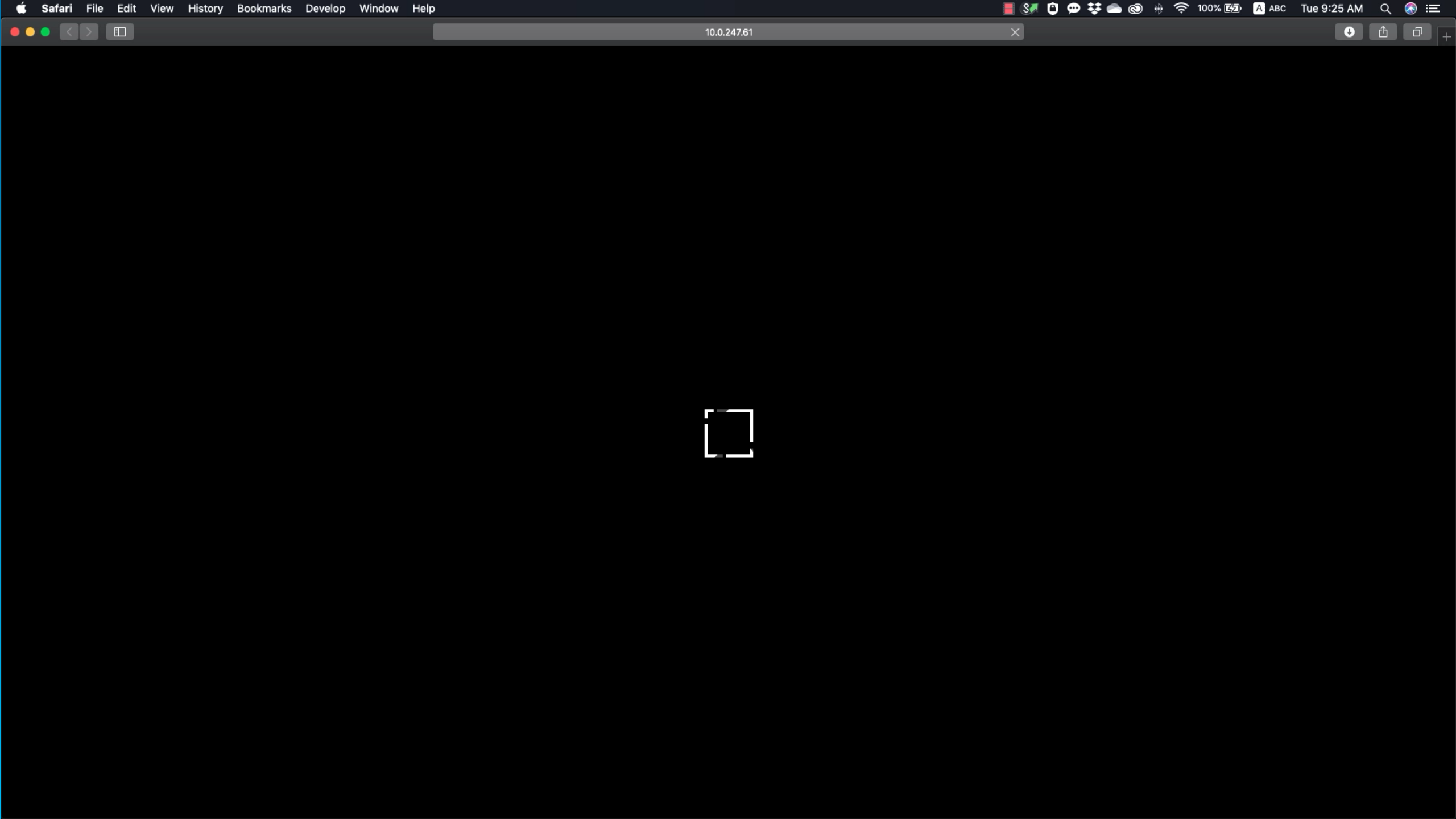
AI GEO Spatial GIS Map

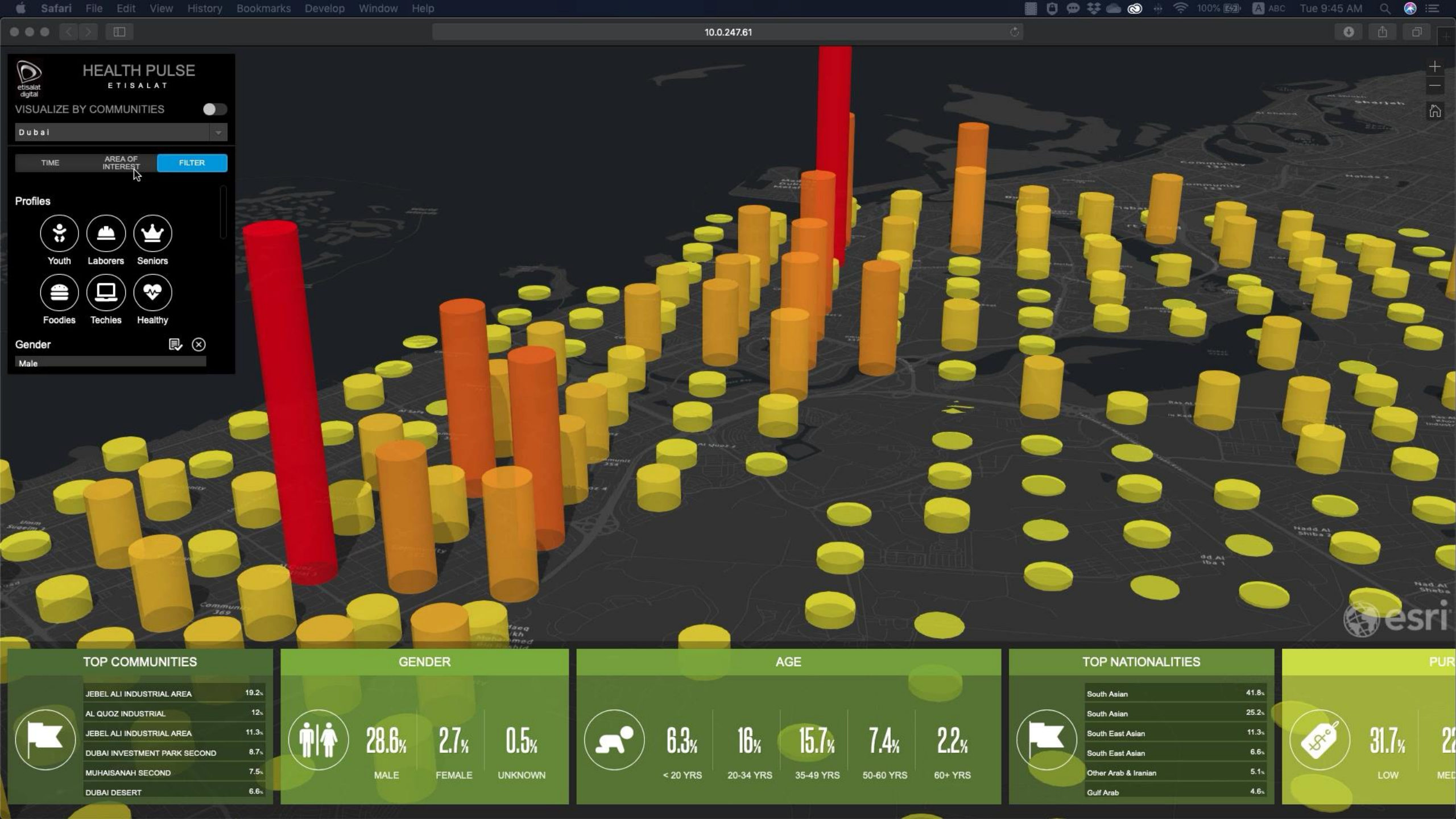
HEALTH TRANSPORT UTILITIES POLICE MORE

INGESTING, ANALYZING and AND VISUALIZING UP TO BILLIONS OF SIGNALS PER SECOND

Welcome to City In Motion

City In Motion Application
City Population Density Application


Safari File Edit View History Bookmarks Develop Window Help
100%
ABC
Tue 9:25 AM
10.0.247.61


Safari File Edit View History Bookmarks Develop Window Help
Tue 9:45 AM
10.0.247.61
HEALTH PULSE
ETISALAT
etisalat digital
VISUALIZE BY COMMUNITIES
Dubai
TIME
AREA OF INTEREST
FILTER
Profiles
Youth
Laborers
Seniors
Foodies
Techies
Healthy
Gender
Male
esri
TOP COMMUNITIES
JEBEL ALI INDUSTRIAL AREA 19.2%
AL QUOZ INDUSTRIAL 12%
JEBEL ALI INDUSTRIAL AREA 11.3%
DUBAI INVESTMENT PARK SECOND 8.7%
MUHAISANAH SECOND 7.5%
DUBAI DESERT 6.6%
GENDER
28.6% MALE
2.7% FEMALE
0.5% UNKNOWN
AGE
6.3% < 20 YRS
16% 20-34 YRS
15.7% 35-49 YRS
7.4% 50-60 YRS
2.2% 60+ YRS
TOP NATIONALITIES
South Asian 41.8%
South Asian 25.2%
South East Asian 11.3%
South East Asian 6.6%
Other Arab & Iranian 5.1%
Gulf Arab 4.6%
PUR
31.7% LOW

AI4SDG – roadmap to a Global Data Commons to achieve the Sustainable Development Goals (1/2)

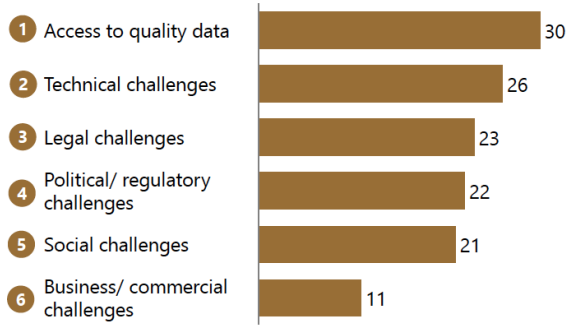
Strategic support by: McKinsey&Company

We invited global technology leaders to submit their views on what it would take to make Global Data Commons a reality

The Global Data Commons aims to deploy AI to help achieve the SDGs

- Capitalizing on the immense volume of data available and use AI to tackle the world's greatest challenges
- Detect, present and help scale-up use cases for AI enabling the 17 SDGs
- The use of AI for Sustainable Development Goals will allow us to:
  - Monitor progress towards the achievement of SDG
  - Simulate implications
  - Predict outcomes of measures taken
  - Provide recommendations for policy makers

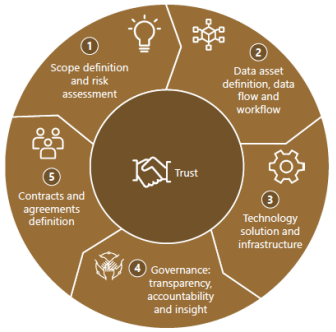
The position papers discuss several challenges that prevent the implementation of a GDC



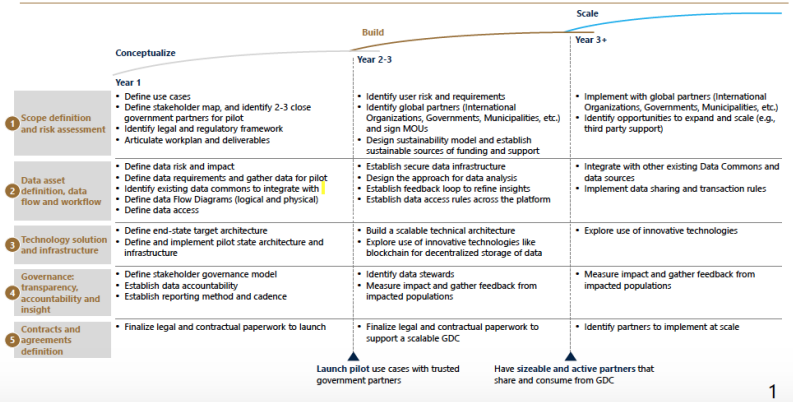
Example quotes from position papers

1. "...we are faced with a daunting task of both mining all this data and applying it effectively in ways that could be beneficial beyond singular applications." – Xprize, 2019
   "Data commons present one way to [increase the diversity and accessibility of data] through facilitating both public and secure collaborations across industries and disciplines, lowering barriers to data collection and sharing" – Berkman Klein Center, 2019
2. "Commercial and government organizations have traditionally built silos of IT systems and data stores each are largely incompatible with each other" – MIT, 2019
   "Even though every day, huge amount of data is captured from citizens, the fact is that 80% of this data is locked within propriety data repositories of huge technology companies" – LTI, 2019
3. "It is important to keep in mind that the regulatory framework invariably lags several steps behind the new technology" – Simmons & Simmons, 2019
   "Developing countries [...] should benefit from a special ethical attention in this context and gain capacity to develop their own sustainable science capacities together with new capacities on processing big data and producing their own solutions based on artificial intelligence" – IRD, 2019
4. "A plethora of legal regimes around the world govern the collection and use of data, which some might consider too restrictive" – Paul Hasting, 2019
   "[...] data security obligations tend to be rather high-level and can be difficult to navigate, as they often require entities to implement "reasonable" or "appropriate" security mechanisms, without specifying what mechanisms satisfy such requirements" – Covington, 2019
5. "[...]consumers fear they are losing control over their personal data and becoming increasingly vulnerable to privacy rights violations" – Element AI, 2019
   "Global governance system for emerging intelligent technologies and systems must [...] accommodate cultural differences" – IEEE, 2019
6. "Need to "assess current state and commercial viability of techniques to establish a good data encryption framework that works for data owners requiring privacy preservation technologies for data sharing in the GDC" – AI Singapore, 2019
   "The proliferation of actionable data for business, governments and civil society demands new set of methodologies of data accumulation, data verification, and conclusion to ensure data are fit-for-purpose." – ADEC Innovations, 2019

Our review of the position papers indicates that we can follow an iterative and systematic approach to creating the Global Data Commons



1. Articulate use-case context and scope
   - Identify stakeholders, associated risks and rewards
   - Identify legal and regulatory context
   - Identify rights and responsibilities for using data
   - Articulate collaboration workplan and deliverables
2. Identify minimal required datasets and associated characteristics
   - Define interoperability with existing data commons
   - Identify use-case specific data considerations i.e., anonymization, pseudo anonymization etc.,
   - Map out end-to-end data lifecycle i.e., dataflow from origination to end-user distribution
   - Map out workflow process for entire data value chain i.e., ingestion, storage, analytics, distribution etc.,
   - Define data control levers such as: access rights and duties, etc.,
3. Determine required technology architecture
   - Determine technology requirements and select best-practice technology solutions/ implementations where applicable
4. Define governance model
   - Define stakeholder management model
   - Define compliance risk management standards and procedures
   - Define KPIs and reporting standards
5. Identify required agreements and contracts to be implemented
   - Tailor-fit standard templates to specific use-case context



القمة العالمية للحكومات
WORLD GOVERNMENT SUMMIT


Vision
GIS
Is Enabling a
Sustainable World


esri
THE
SCIENCE
OF
WHERE