Advanced Geospatial Analytics using Derived Data for Monitoring SDGs

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Web GIS Is the Modern GIS Architecture

Helping Everyone Do Their Work Better

Distributed

. . . and Interconnected

Communities

End Users and Developers

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

UNSD

Senegal

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

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

Palestine

http://www.sdg.org

Tanzania

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

Philippines

Colombia

Mexico

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

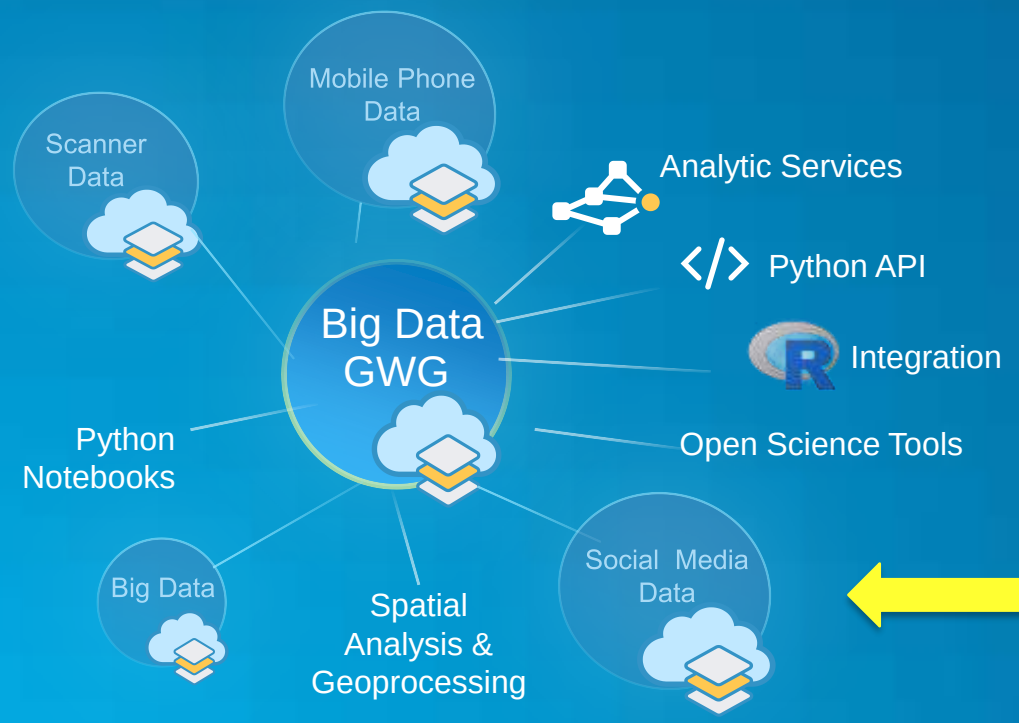
Sub-national
Data
Reporting
OPEN
SDGs
National
Standards Based
Implementation
Enabling
Country Led
Collaboration
Aggregation
Geospatial
Interoperability
Country Owned
Statistical
Integration
Dis-aggregation
Monitoring
GIS
Global

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 . . .

. . 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

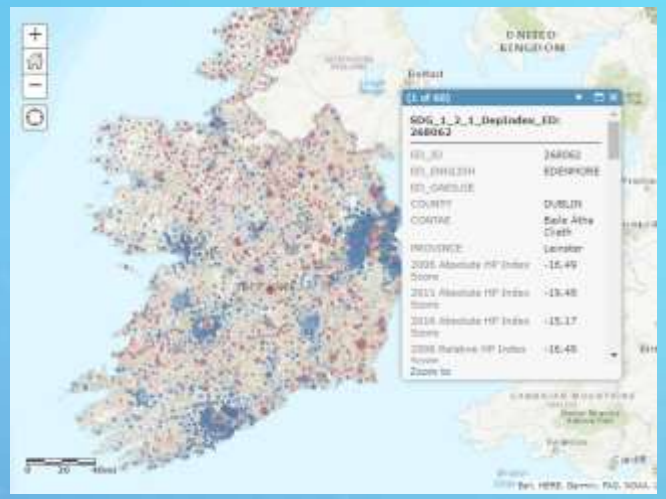
THE GLOBAL GOALS
For Sustainable Development

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

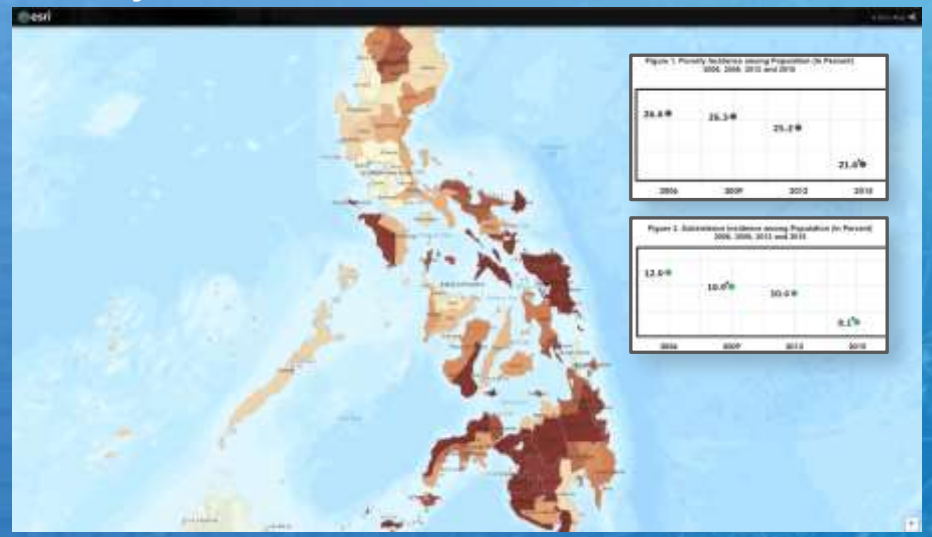
1 NO POVERTY

Population Below Poverty Line



Ireland

Poverty Incidence



Philippines

2 ZERO HUNGER

Food Supply

UN-Yemen

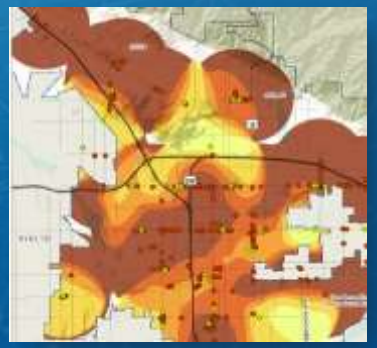
Crop Rotation

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

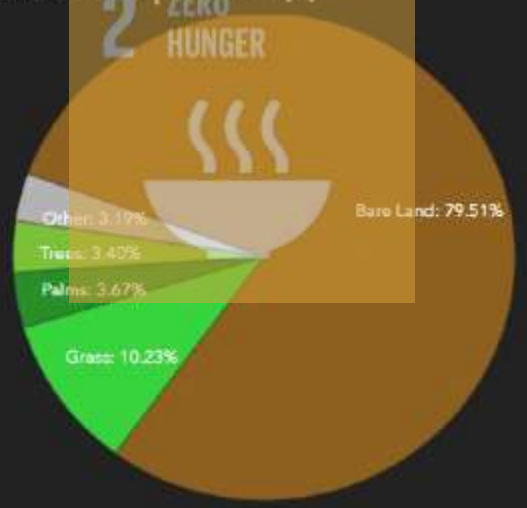
Animal Farms Receiving Fodder Subsidies

The animal farms colored green are receiving

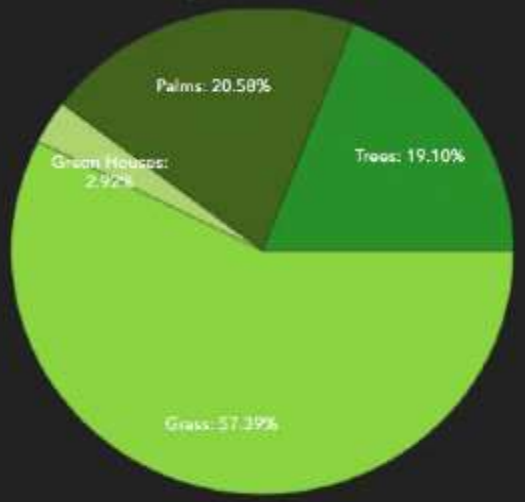
Land Cover Distribution

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

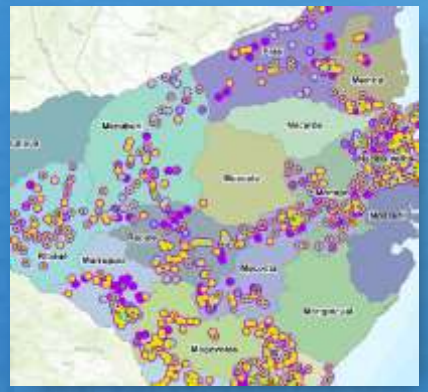
Total Oxyge...

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

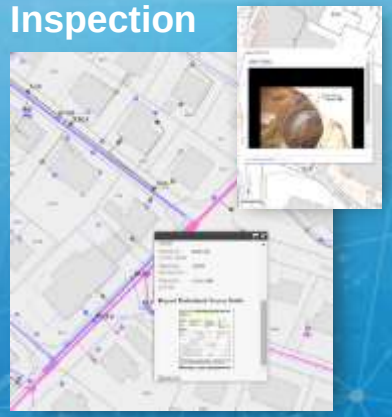
Water Monitoring

Los Angeles

Drainage Network Modeling

Washington

Sewer Inspection



Switzerland

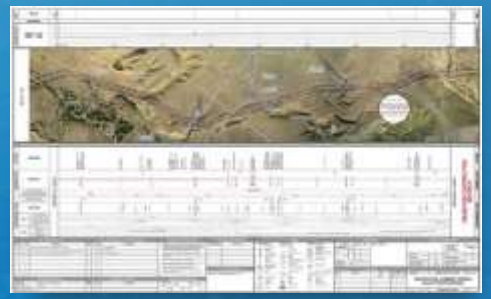
Work Order Management

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:

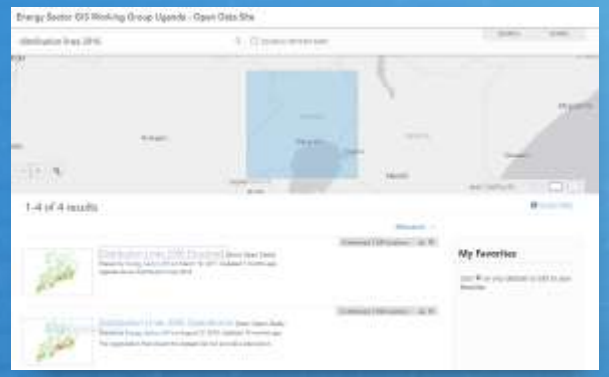
- Uganda (2016): 71 kWh/Capita
- Germany (2014): 7,035 kWh/Capita
- EU (2014): 5,909 kWh/Capita
- World (2014): 3,128 kWh/Capita

Solar Containers for rural communities

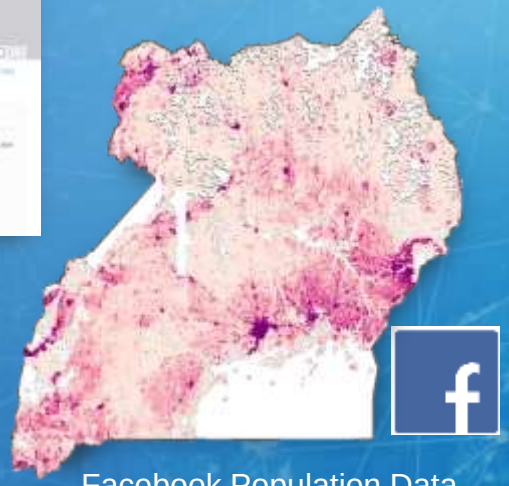
Goal:

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

↓

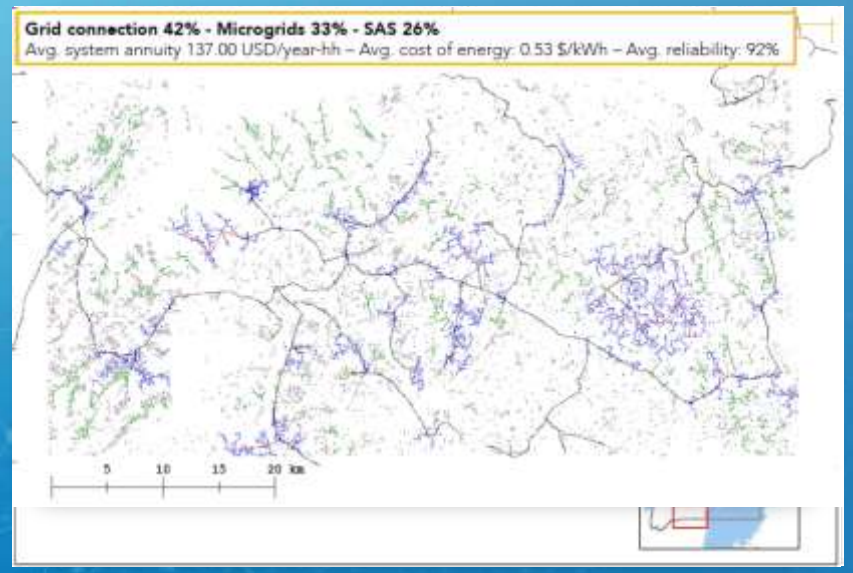
Creating buffer around distribution lines and transformers according to economic data

→

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

→

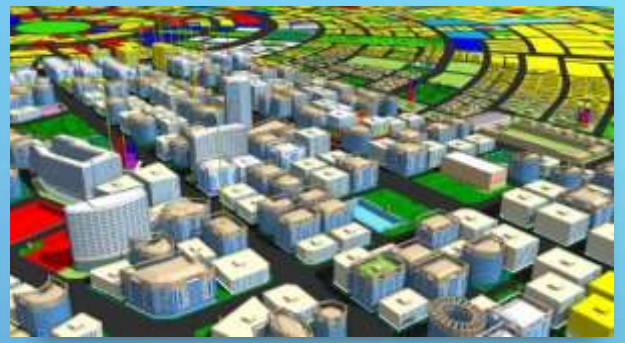
Sharing this information with investors



Electrification Planning in Uganda using Satellite Data

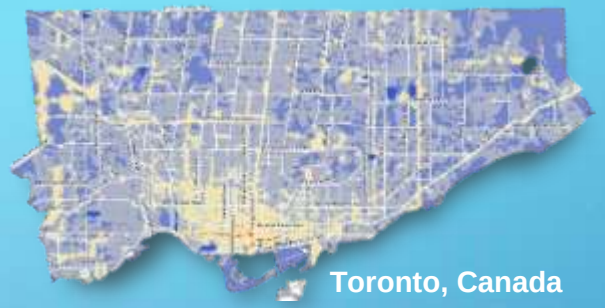
11 SUSTAINABLE CITIES AND COMMUNITIES

Urban Planning



Abu Dhabi, UAE

Vertical Intensification

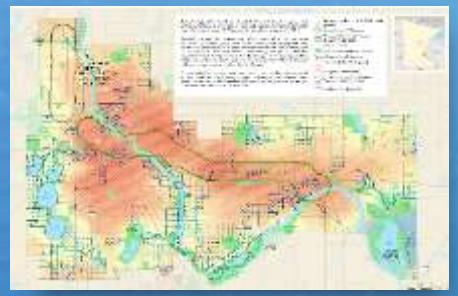


Toronto, Canada

Urban Design

California

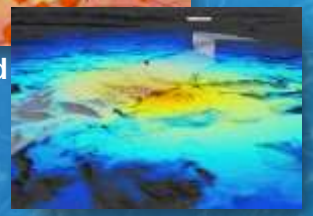
Urban Heat Islands



Minneapolis

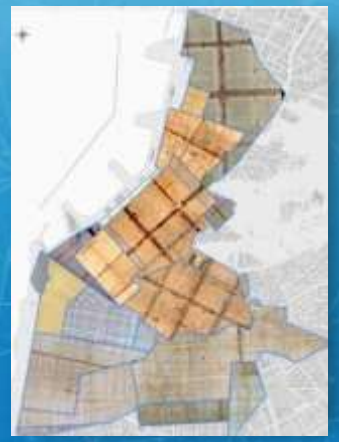
Noise Pollution

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

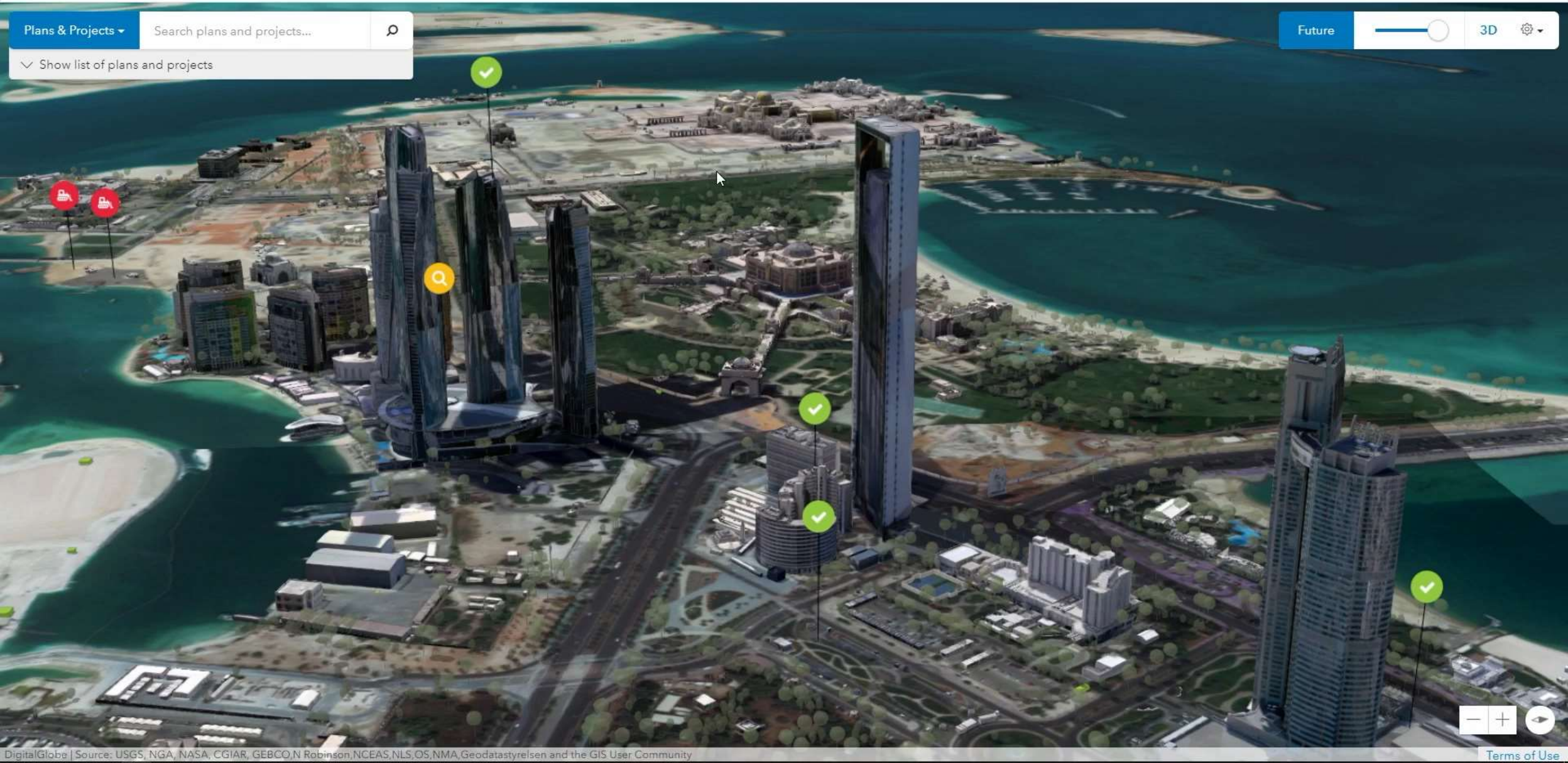
Plans & Projects

Search plans and projects...

Show list of plans and projects

Future

3D

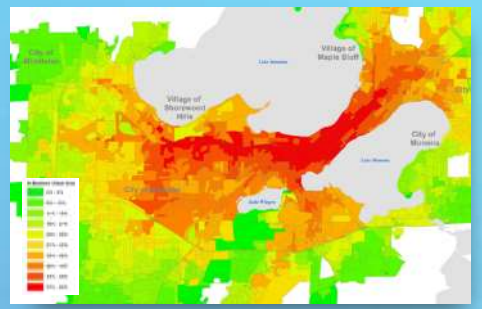


DigitalGlobe | Source: USGS, NGA, NASA, CGIAR, GEBCO,N Robinson,NCEAS,NLS,OS,NMA,Geodatastyrelsen and the GIS User Community

Terms of Use

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Walking and Transit Model



Wisconsin

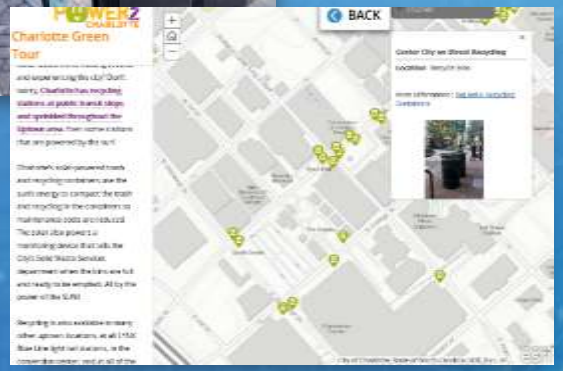
Traffic Management

Germany

Public Transit

Washington

Recycling Communications



Charlotte

Rail Status Monitoring

USA

Smart Routing (UPS)

Pennsylvania

Postal Delivery

Los Angeles

TERALYTICS | ESRI | Esri OD | Esri US Metros | Esri US Metros - Demo

Monday, September 7, 2015

5,815,109 people movements in total

Mode of transport

Number of movements by mode of transport.

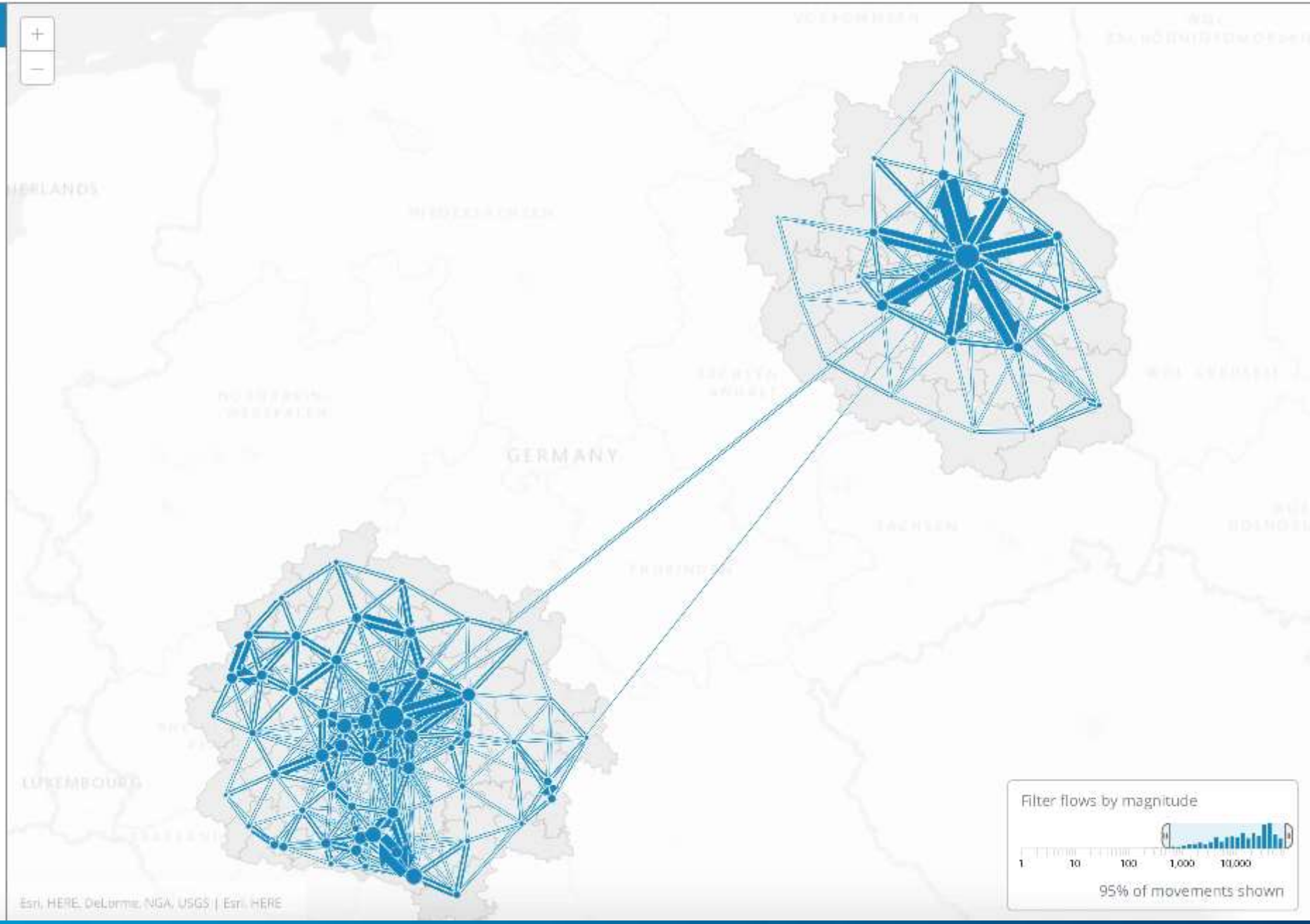
Time of day

Number of movements by time of day.

Distance

Top Flows

Top Origins



13 CLIMATE ACTION

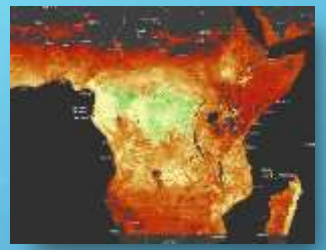
Glacial Melt

Bhutan (ICIMOD)

Desertification Survey

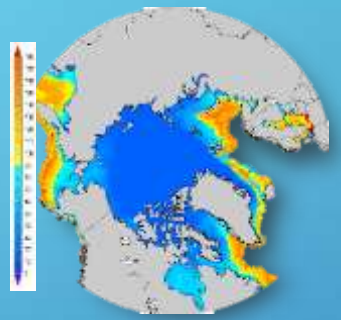
Turkey

Biomass Assessment



Africa

Calculating First Ice Freeze



Monitoring Drought

NOAA

Sea Level Rise

South Carolina

San Francisco

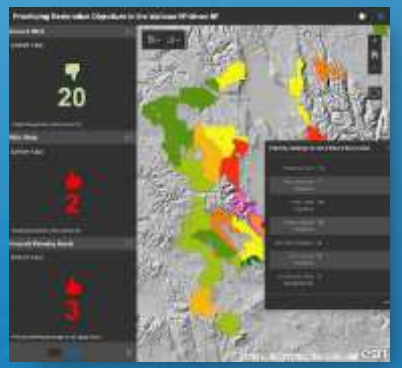
Forest Carbon Reserves

South America

Groundwater Change

California

Forest Restoration



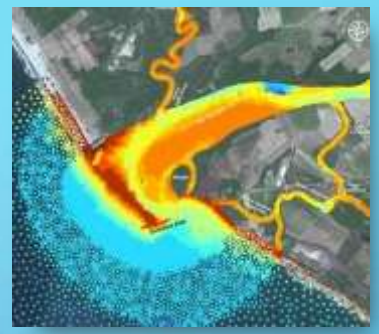
Wallowa-Whitman NF

14 LIFE BELOW WATER

Ecologically Significant Areas

NOAA—Monterey Bay

Sediment Change



Mexico

Marine Sanctuary

California

Reef Health

Cook Islands

Coral Communities

Martinique

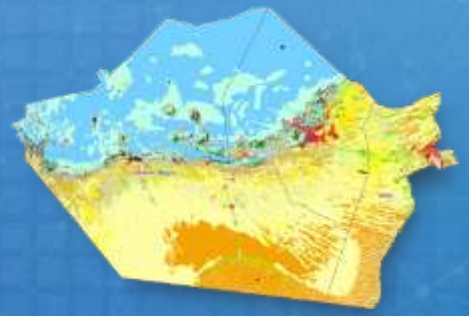
Biodiversity

Philippines

Ocean Modeling

NOAA

Marine and Terrestrial Habitat



Abu Dhabi, UAE

Marine Protection Planning

Australia

14 LIFE BELOW WATER

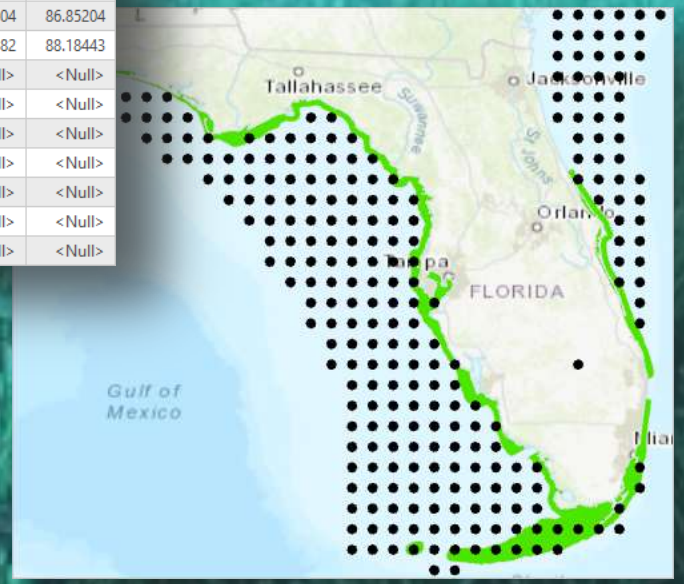
Predicting Environmental Phenomena

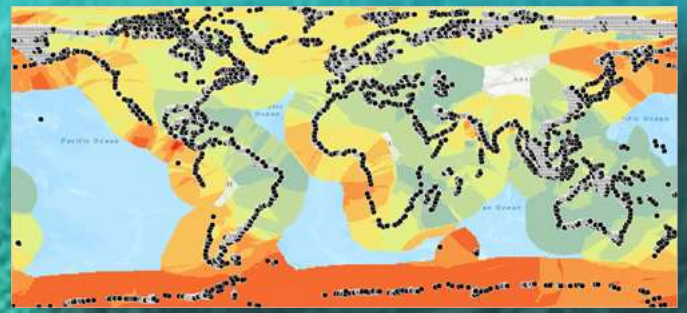
Where Seagrasses Grows, Empirical Bayesian Kriging (EBK), Random Forest classifier

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

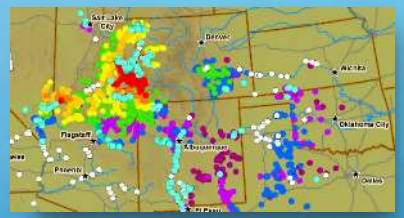
Green Infrastructure

New Jersey

Habitat Corridors

Atlanta

Invasive Species



Southwest, USA

Ecosystem Sensitivity

Bolivia

Watershed

Alaska

Wildlife Imagery

California

Habitat Monitoring

USA

15 LIFE ON LAND

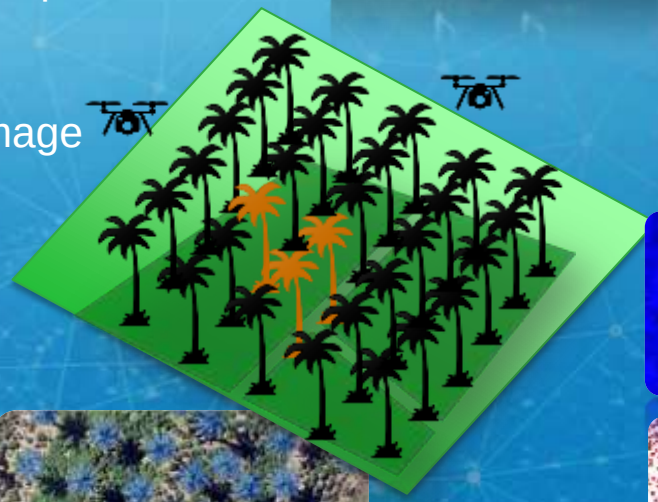
Using Deep Learning to Assess Palm Tree Health

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



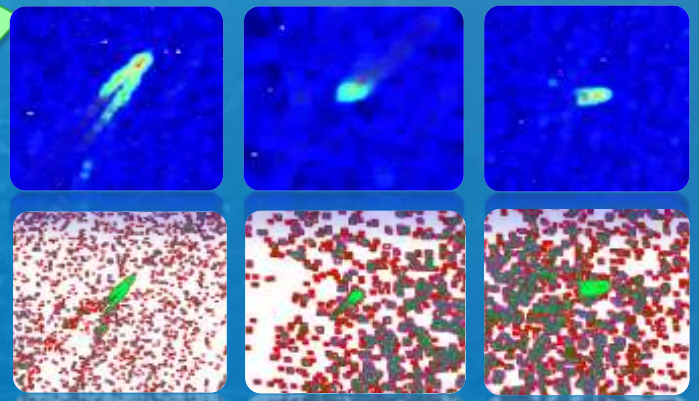
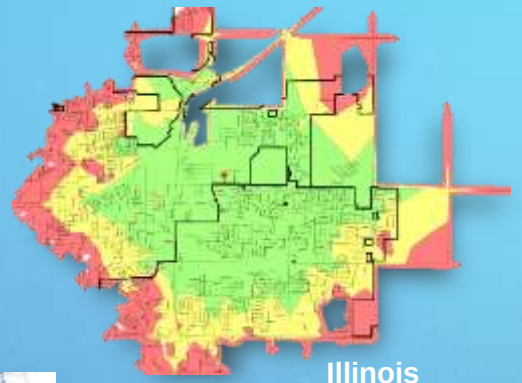


Image Classification to help Infer presence of contamination

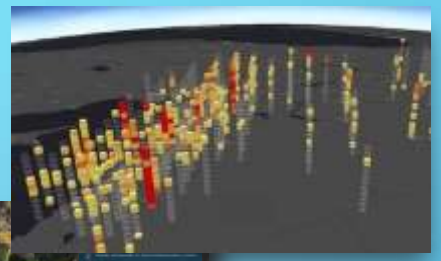
EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

Fire Response Times



Illinois

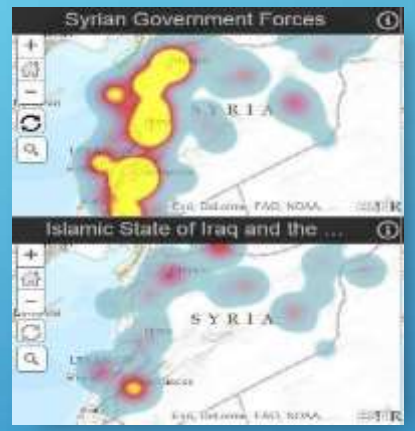
Acts of Terrorism



Infrastructure Protection

DHS

Violence Hot Spots



Syria

Fire Station Location/Allocation

Texas

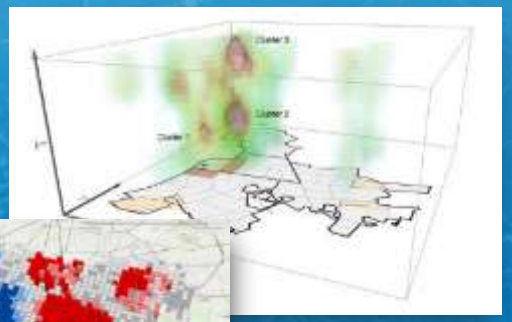
Marathon Viewshed

London, England

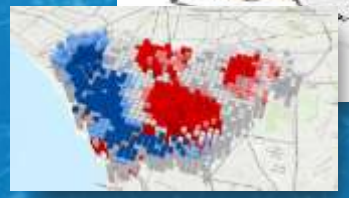
EMS Resources

Tel Aviv, Israel

Spatiotemporal Crime Patterns



Louisiana



Peru

Officer Involved Shootings

Texas

16 PEACE AND JUSTICE STRONG INSTITUTIONS

City in Motion

Geography-Wide Monitoring

CRM
Demographics, Visitor Lines

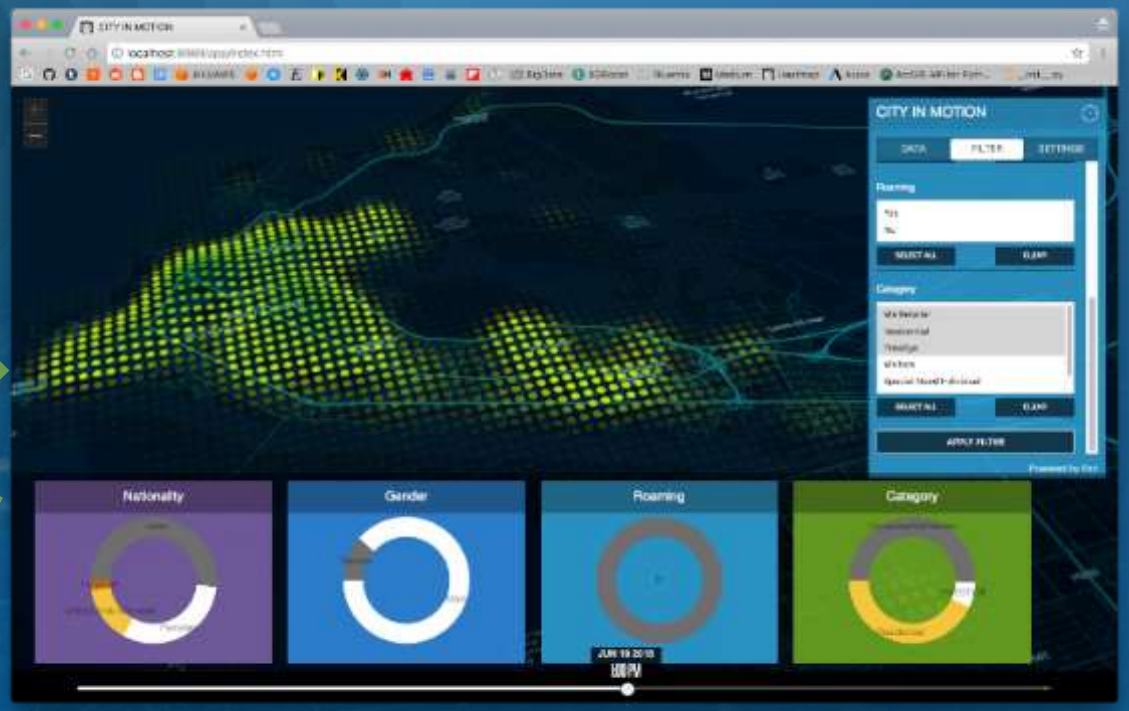
Signaling Network
Movement, Roaming

Analytics
Home/Work Locations

Data Packet Inspection DPI
Web Activity

1 Billion Records Daily

200 GB Daily



Welcome to City In Motion

City In Motion Application
City Population Density Application

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

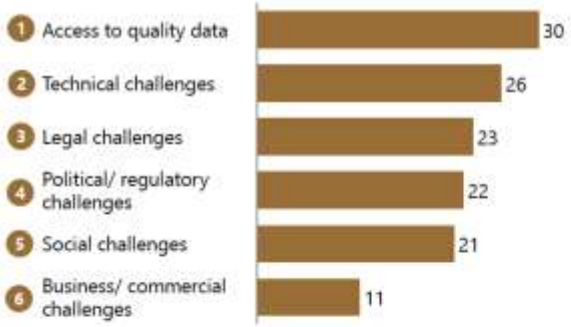
Strategic support by: McKinsey&Company

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

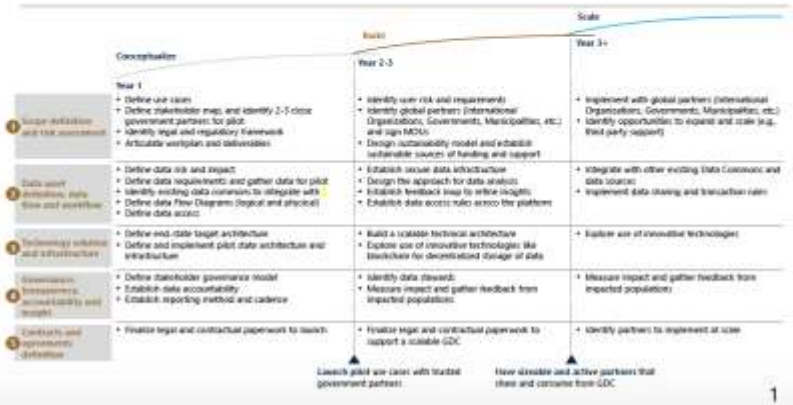
- Capitalizing on the immense volume of data available and use AI to tackle the world's greatest challenges
- Detect, present and help scale-up use cases for AI enabling the 17 SDGs
- The use of AI for Sustainable Development Goals will allow us to:
  - Monitor progress towards the achievement of SDG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

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



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WORLD GOVERNMENT SUMMIT

Vision

GIS

Is Enabling a
Sustainable World

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THE SCIENCE OF WHERE