## Nationally Integrated Geospatial Information Management: How to Scale SDG Monitoring

Dean Angelides Corporate Director, Esri

# Vision

## GIS

Is Enabling a Sustainable World

## Our World Needs a Nervous System

An Intelligent and Responsive Platform

Creating More Understanding ....Collaboration and ....Action

. . Geography Is Essential

#### Your Work Is Already Creating Geospatial Infrastructure

Intelligent and Responsive . . .

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Integrating All Sources of Data . . .

Creating Digital Nervous Systems for Your Organizations and Countries

> Connecting Everything And Everyone

Applying The Science of Where . . .



A System for Understanding . . . And Collaborative Action



## Integrating Open Science, AI and Machine Learning

**Revolutionizing Spatial Analysis and Data Science** 



## Extending GIS to the Edge

Including and Integrating . . . Challenged Network Environments

Connected and Disconnected Many Apps Edge Computing Nodes Replication (Sync) **Internet of Things** Analytics and Data Management Geospatial **Real-Time Measurement** Infrastructure (Field / IoT / Remote Sensing)

Supporting GIS Workflows in All Environments

Edge Devices

## Supporting and Integrating Advanced Technologies



## **3D** Visualization

#### New and Improved

- 3D Smart Mapping
- Mobile
- Point Clouds
- BIM Support
- Symbology







Symbology



Effects



# Extrusion

**BIM Integration** 

Underground

#### BIM as Scene Layers











Mobile Scene Packages

## Augmented Reality / VR



City Modeling

Lidar

Mobile



## Field Operations Location-Enabling All Aspects of Field Work

**New Capabilities** 

- Tracking
- Offline Workflows
- Preplanned Routes



Tracker

Planning and Management





#### Navigation



Navigator



Data Capture

Autor of the second sec

Survey123

#### Maps & Mark Up



## Spatial Analysis and Data Science



## Hosted Python Notebooks For Integration, Modeling and Automation



## AI, ML and Deep Learning Integrating Open Science



## Real-Time Analytics Integrating Sensor Networks and IoT

Supporting High-Velocity Data Streams Tracking, Monitoring and Alerting

#### Improved

- Performance
- Scalability
- Resiliency
- Cloud Connectors
- Actuation

Sensors

Vehicles

Assets

Real-Time Environment Data





Enterprise Now . . . . . . SaaS Coming

Collapsing the Time from Measurement to Decision Making

#### **Magery** A Comprehensive System for Imagery and Remote Sensing





## Engaging and Interconnecting Communities

Bringing Together People, Organizations and Stakeholders



. . Collaborating Around Common Interests and Initiatives



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

<b>Target</b> 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





#### Population Below Poverty Line



Ireland

#### **Poverty Incidence**



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Philippines





USA

#### **Healthy Food Access**



California

#### **Food Supply**



**UN-Yemen** 

#### Malnutrition



World

Precision Agriculture



**New Zealand** 



### 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





## Water and Sanitation Projects



Mozambique

#### Drainage Network Modeling



Sewer

Sanitation Cleanout

Locations

California

Water Monitoring

Los Angeles



Switzerland

#### Water Quality Monitoring



China

#### Work Order Management

Washington



#### **New Jersey**

#### **Pipeline Alignment**



Montana

1 /



#### **Rooftop Solar Potential**



**Massachusetts** 

#### Solar and Wind Energy



Philippines

**Solar Potential** 

Renewable Energy Connection Network

Southern California

#### Wind Farm Design



Bavaria, Germany

Wind Resources

Singapore



England

# Renewable Energy Monitoring

China



**AFFORDABLE AND** 

#### **Electricity Consumption per** Capita:

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











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





Solar Containers for rural

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



Greece



Honolulu

### Land Use



**Miami-Dade** 



#### Recycling Communications

power of the SUNI Recycling is also available in many

other uplown locations, at all LYNX Blue Line light rail stations, in the

traention penter, and at all of



and requiring containers use the surfs energy to compact the track-and requiring in the containers on maintening costs are necessari. The solar also powers a monitoring device that with the City's Solid Waste Services



## Walking and Transit Model



Wisconsin

#### **Rail Status Monitoring**



USA

**Management** 



Germany

#### **Public Transit**



Washington



**Postal Delivery** 



Los Angeles

Charlotte

#### CLIMATE Action 13



#### **Glacial Melt**



**Monitoring Drought** 



South Carolina





San Francisco



**Biomass** Assessment



**Forest Carbon** Reserves



**South America** 

## Calculating First Ice Freeze



Forest Restoration



Wallowa-Whitman NF



Africa

Groundwater

Change

## 14 LIFE BELOW WATER



#### Marine and **Terrestrial Habitat**



Abu Dhabi, UAE

#### Ecologically **Significant Areas**



**NOAA**—Monterey Bay

Coral Communities



Martinique



## **Sediment Change**



#### **Biodiversity**



Philippines

NOAA

#### **Marine Sanctuary**



California

#### **Reef Health**



**Cook Islands** 



Australia

## Marine





14 LIFE BELOW WATER



#### **Predicting Environmental Phenomena** Where Seagrasses Grows, Empirical Bayesian Kriging (EBK), Random Forest classifier

#### 🗰 EMU\_Global\_90m ×

Fie	eld: 賱 Add	🕎 Dele	te 🕎 Ca	lculate	S	election:	🕀 Zoom	ົດ 📲 Swi	itch 🗏 C	lear 🙀 Do
⊿	OBJECTID	SHAPE	pointid	temp		salinity	appO2ut	dissO2	nitrate	percO2sat
	11	Point Z	24	-1.43314	4	34.18222	<null></null>	<null></null>	<null></null>	<null></null>
	13	Point Z	26	-1.43994	5	34.17537	<null></null>	<null></null>	<null></null>	<null></null>
	118	Point Z	307	-1.38740	1	34.32391	<null></null>	<null></null>	<null></null>	<null></null>
	753	Point Z	1739	-1.600642	2	34.03786	1.110779	7.211782	22.96304	86.85204
	754	Point Z	1740	-1.5623	8	34.02853	0.997919	7.310482	21.98382	88.18443
	871	Point Z	2184	-1.61909	8	33.9525	<null></null>	<null></null>	<null></null>	<null></null>
	872	Point Z	2185	-1.67876	8	33.97821	<null></null>	<null></null>	<null></null>	<null></null>
	882	Point Z	2211	-1.616092	2	33.94105	<null></null>	<null></null>	<null></null>	<null></null>
	884	Point Z	2219	-1.69790	7	33.92028	<null></null>	<null></null>	<null></null>	<null></null>
	885	Point Z	2220	-1.6847	1	33.92426	<null></null>	<null></null>	<null></null>	<null></null>
	886	Point Z	2221	-1.6910	1	33.94196	<null></null>	<null></null>	<null></null>	<null></null>
	887	Point Z	2222	-1.6906	1	33.93676	<null></null>	<null></null>	<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



#### **Habitat Corridors**



Atlanta

#### Wildlife Conservation



Watershed



#### Vilderness Tour

Wildlife Imagery

Invasive Species



**Steens Mountain Wilderness, Oregon** 

#### **Ecosystem Sensitivity**



**Green Infrastructure** 

Bolivia

#### Habitat Monitoring



California



#### 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









Image Classification to help Infer presence of contamination



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





**Fire Station** Location/Allocation



Texas

#### **EMS** Resources



Tel Aviv, Israel

#### **Fire Response Times**



**Marathon Viewshed** 

London, England

**Protection** 



DHS

Acts of Terrorism

#### Violence **Hot Spots**



Syria

#### **Officer Involved Shootings**



Texas

## Spatiotemporal Crime Patterns



Peru

16 PEACE AND JUSTICE STRONG INSTITUTIONS

## City in Motion

Geography-Wide Monitoring



**CRM** Demographics, Visitor Lines



Analytics

Home/Work Locations



Signaling Network Movement, Roaming

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Data Packet Inspection DPI Web Activity 1 Billion Records Daily

























