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

- End Users and Developers
- Organizations
- Teams
- Individuals
- Communities

Leveraging Web Services

Sharing and Collaboration

Engaging Everyone

Distributed and Interconnected
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

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

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

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

http://www.sdg.org

A Global Network of Collaboration Is Emerging
Open SDG Data Hubs
Are enabling in-country collaboration and action
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

- Big Data
- Mobile Phone Data
- Python Notebooks
- Scanner Data
- Spatial Analysis & Geoprocessing
- Social Media Data

Python API
Integration
Open Science Tools

Create … Publish … Share

UNSD Federated Information System for the SDGs

- Palestine
  - Palestine Central Bureau of Statistics
- Philippines
  - Philippine Statistics Authority
- Mexico
  - Instituto Nacional de Estadística y Geografía (INEGI)
- UAE
  - Federal Competitiveness & Statistics Authority
- Ireland
  - Central Statistics Office & Ordnance Survey Ireland
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
<table>
<thead>
<tr>
<th>Target</th>
<th>Goal</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.4 1.5</td>
<td>No poverty</td>
<td>1.4.2</td>
</tr>
<tr>
<td>2.3 2.4 2.6</td>
<td>Zero hunger</td>
<td>2.4.1</td>
</tr>
<tr>
<td>3.3 3.4 3.9 3.d</td>
<td>Good health and well-being</td>
<td>3.9.1</td>
</tr>
<tr>
<td>4.1</td>
<td>Quality education</td>
<td>5.1</td>
</tr>
<tr>
<td>5.1</td>
<td>Gender equality</td>
<td>5.1</td>
</tr>
<tr>
<td>6.1 6.2 6.4 6.5 6.6 6.a 6.b</td>
<td>Clean water and sanitation</td>
<td>6.3.1 6.3.2 6.4.2 6.5.1 6.6.1</td>
</tr>
<tr>
<td>7.1</td>
<td>Affordable and clean energy</td>
<td>7.1.1</td>
</tr>
<tr>
<td>8.1</td>
<td>Decent work and economic growth</td>
<td>8.1</td>
</tr>
<tr>
<td>9.1 9.4 9.5 9.a</td>
<td>Industry, innovation and infrastructure</td>
<td>9.1.4 9.1</td>
</tr>
<tr>
<td>10.1 10.2 10.3</td>
<td>Reduced inequalities</td>
<td>10.1</td>
</tr>
<tr>
<td>11.1 11.3 11.4 11.5 11.6 11.7 11.b 11.c</td>
<td>Sustainable cities and communities</td>
<td>11.1.1 11.2.1 11.3.1 11.5.1 11.7.1</td>
</tr>
<tr>
<td>12.1 12.4 12.8 12.a 12.b</td>
<td>Responsible consumption and production</td>
<td>12.1.1</td>
</tr>
<tr>
<td>13.1 13.2 13.3 13.b</td>
<td>Climate action</td>
<td>13.1.1</td>
</tr>
<tr>
<td>14.1 14.2 14.3 14.4 14.6 14.7 14.a</td>
<td>Life below water</td>
<td>14.3.1 14.4.1 14.5.1</td>
</tr>
<tr>
<td>15.1 15.2 15.3 15.4 15.5 15.7 15.8 15.9</td>
<td>Life on land</td>
<td>15.1.1 15.2.1 15.3.1 15.4.1 15.4.2</td>
</tr>
<tr>
<td>16.a</td>
<td>Peace, justice and strong institutions</td>
<td>16.a</td>
</tr>
<tr>
<td>17.1</td>
<td>Partnerships for the goals</td>
<td>17.1.1 17.1.2</td>
</tr>
</tbody>
</table>
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
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

Animal farms colored green are receiving fodder subsidies.
Land Cover Distribution

- Farms Count: 35
- Open Water Storage: 61.2 Hectares
- Grass: 6.3 Hectares
- Impervious Structures: 11.9k Square meters

Green Cover per Farm(s)
- Palm: 20.5%
- Tree: 19.16%
- Grass: 57.35%

- Goats Count: 258
- Cattle Count: 0
- Camels Count: 0
- Sheep Count: 165

Oxygen Production: 634.8 Cubic meters

The information shown in the dashboard describes all the farms in the current map extent.
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

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/

Solar Containers for rural communities
Walking and Transit Model
Wisconsin
Traffic Management
Germany
Public Transit
Washington
Recycling Communications
Postal Delivery
Pennsylvania
Rail Status Monitoring
USA
Smart Routing (UPS)
Los Angeles
Postal Delivery
Pennsylvania
Walking and Transit Model
Wisconsin
Traffic Management
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Public Transit
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Recycling Communications
Postal Delivery
Pennsylvania
Rail Status Monitoring
USA
Smart Routing (UPS)
Los Angeles
Monday, September 7, 2015

5,815,109 people movements in total

Mode of transport
Number of movements by mode of transport:

- Private: 2,097,203
- Train: 1,915,506
- Plane: 220,401

Time of day
Number of movements by time of day:

- 00:00: 4
- 01:00: 6
- 02:00: 8
- 03:00: 10
- 04:00: 12
- 05:00: 14
- 06:00: 16
- 07:00: 18
- 08:00: 20
- 09:00: 22
- 10:00: 24
- 11:00: 26
- 12:00: 28
- 13:00: 30
- 14:00: 32
- 15:00: 34
- 16:00: 36
- 17:00: 38
- 18:00: 40
- 19:00: 42
- 20:00: 44
- 21:00: 46
- 22:00: 48
- 23:00: 50
Predicting Environmental Phenomena
Where Seagrasses Grows, Empirical Bayesian Kriging (EBK), Random Forest classifier

```python
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
Using Deep Learning to Assess Palm Tree Health

- 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
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)

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.

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

1. Access to quality data
2. Technical challenges
3. Legal challenges
4. Political/regulatory challenges
5. Social challenges
6. Business/commercial challenges

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

Example quotes from position papers:

- Capitalizing on the immense volume of data available and use AI to tackle the world's greatest challenges.
- Distinct, 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 SDGs
  - Simulate implications
  - Predict outcomes of measures taken
  - Provide recommendations for policy makers.
Vision

GIS
Is Enabling a Sustainable World