Sustainable Development and Circular Economy

Natural Resources Industries Mining, Forestry and Oil and Gas

Industrial Revolution 4.0 and Natural Resource Industries

Big Data, GIS and Energy

SJ Camarata

Esri, Inc.

VISION

Applying . . .

THE SCIENCE OF WHERE

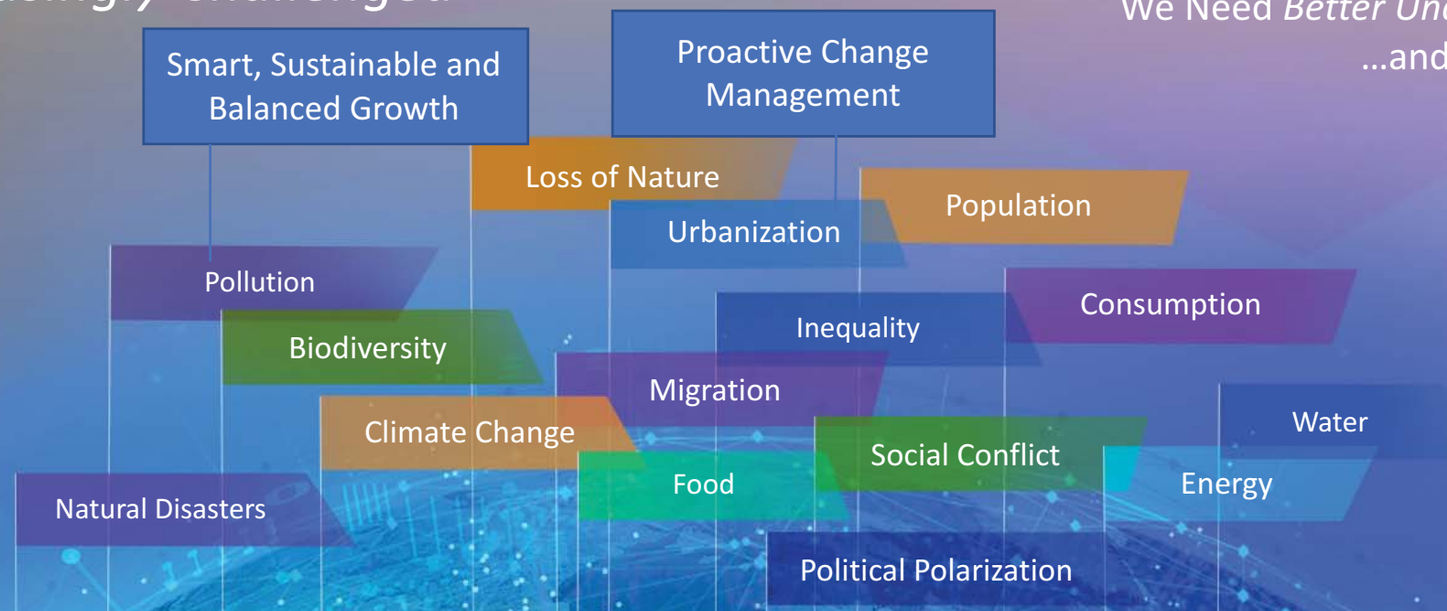
The Science of Geography

The Technology of GIS

Everyone and Everything is Located Somewhere

OUR WORLD

Is Increasingly Challenged

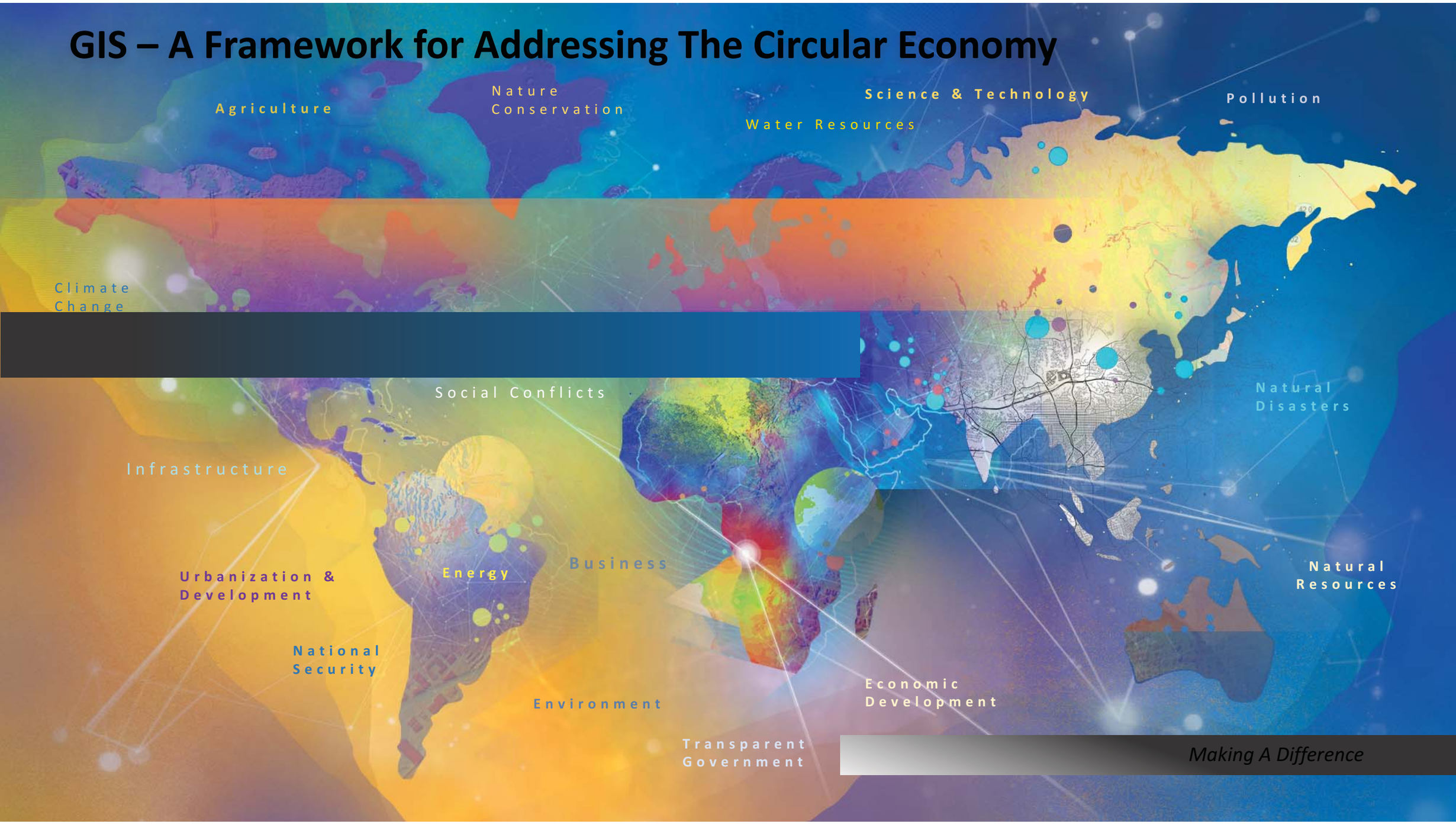


The Evidence Is Clear…

We Need *Better Understanding*…
…and *More Collaboration*

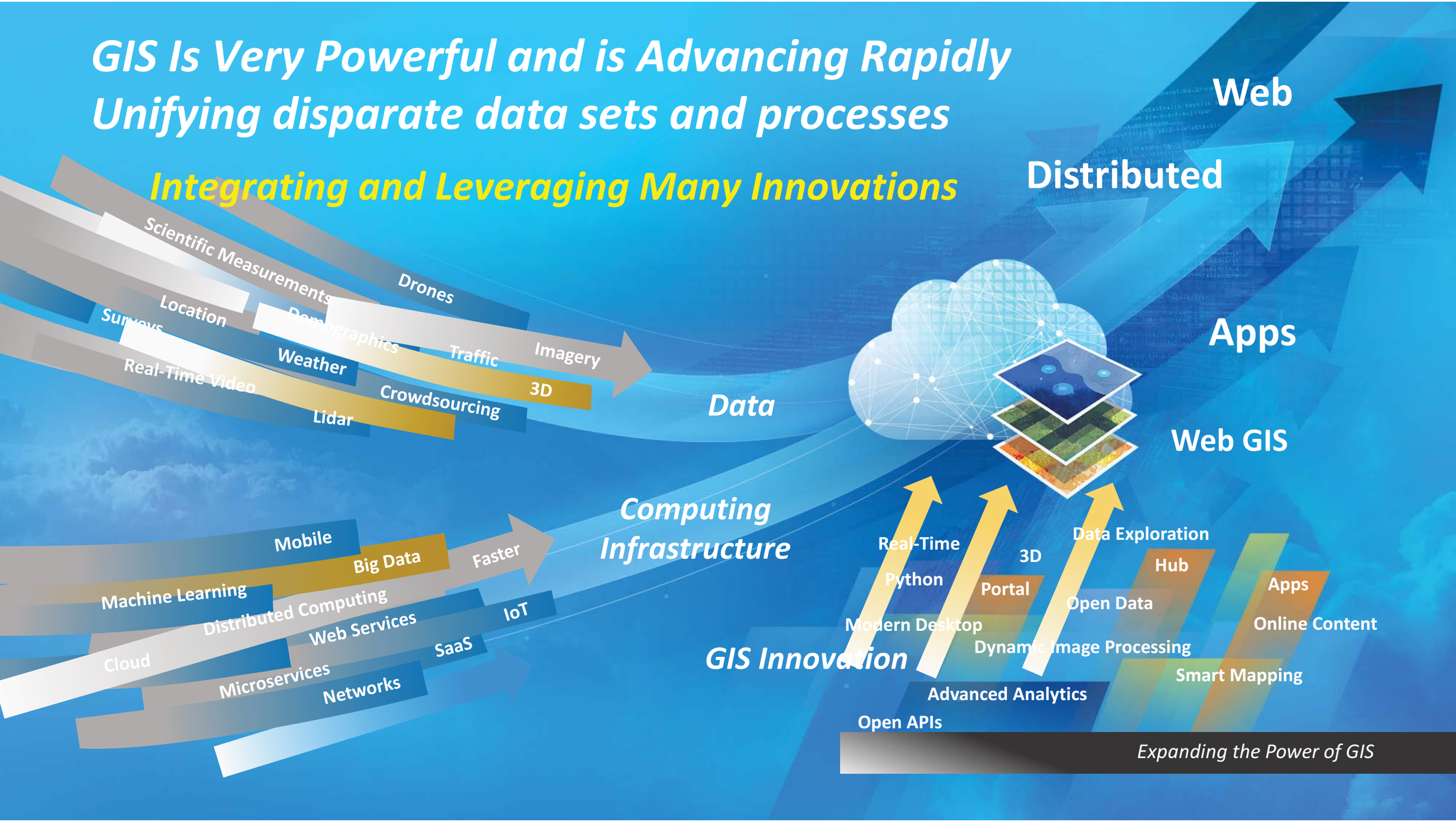
…and *Action*

GIS – A Framework for Addressing The Circular Economy



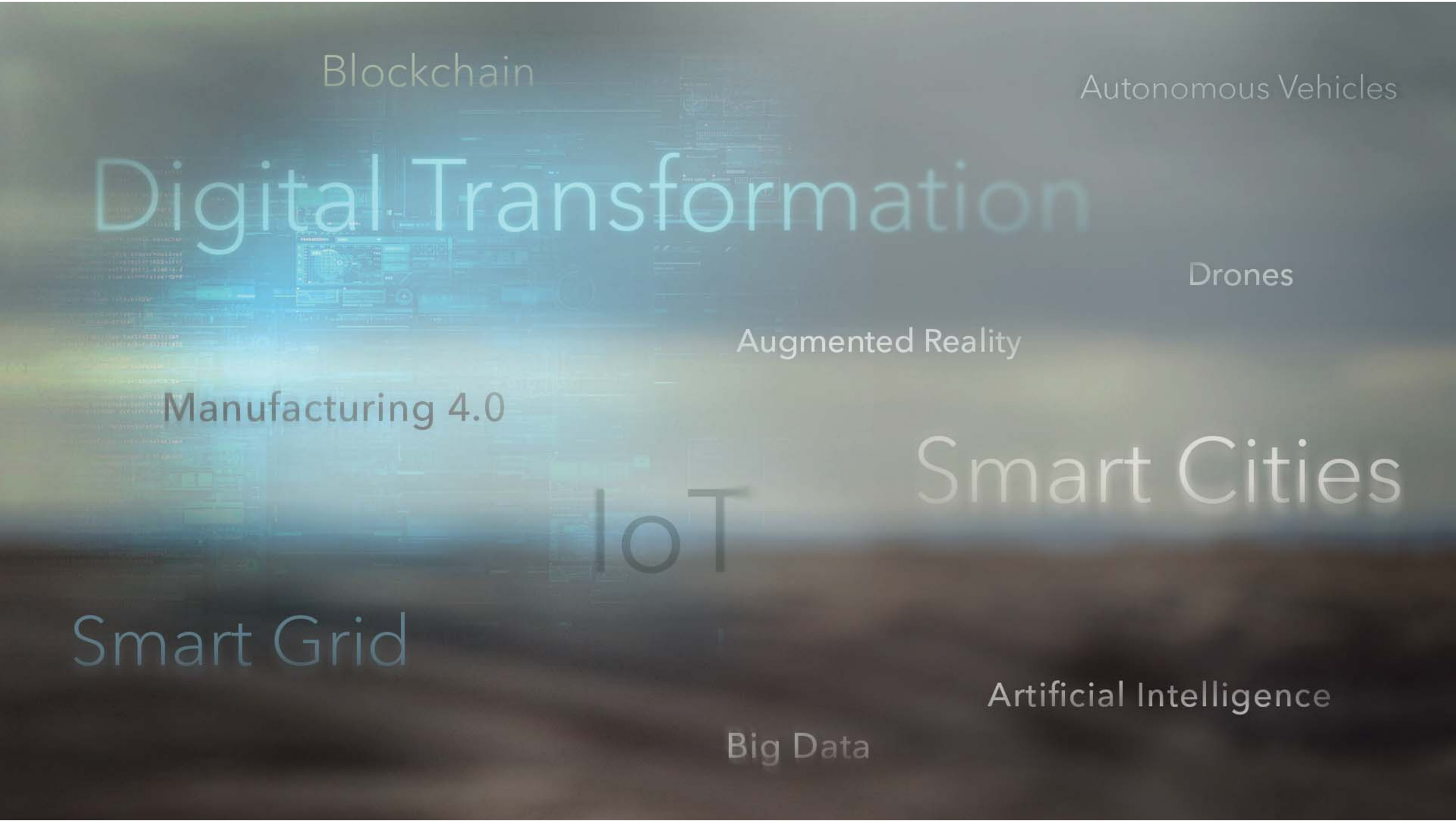
Integrate Multiple Mission Critical and Operational Systems and Data Assets

Leveraging location as your ultimate "foreign key"


GIS Is Very Powerful and is Advancing Rapidly
Unifying disparate data sets and processes
Integrating and Leveraging Many Innovations
Scientific Measurements
Drones
Location
Surveys
Demographics
Traffic
Imagery
Weather
Real-Time Video
Crowdsourcing
3D
Lidar
Data
Mobile
Big Data
Faster
Machine Learning
Distributed Computing
Web Services
IoT
Cloud
SaaS
Microservices
Networks
Computing Infrastructure
Web
Distributed
Apps
Web GIS
Real-Time
3D
Data Exploration
Python
Portal
Hub
Apps
Open Data
Modern Desktop
Online Content
Dynamic Image Processing
GIS Innovation
Smart Mapping
Advanced Analytics
Open APIs
Expanding the Power of GIS

Web GIS Enables a Whole New Scale of GIS

A Powerful Platform For Integration in the Circular Economy
Interconnecting Systems and Expanding Collaboration


Blockchain
Autonomous Vehicles
Digital Transformation
Drones
Augmented Reality
Manufacturing 4.0
Smart Cities
IoT
Smart Grid
Artificial Intelligence
Big Data


Discover the Digital Twin

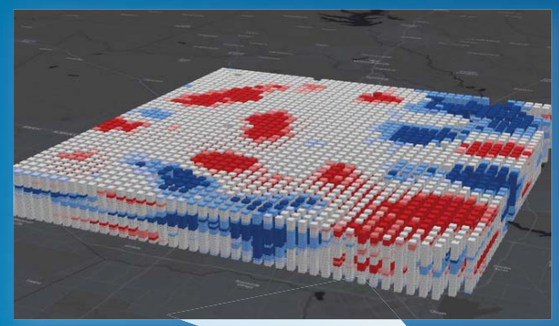
Big Data Spatial Analytics | Faster and Massively Scalable

Leveraging Distributed Computing and Parallel Processing

GeoAnalytics Server
Large Observation Collections

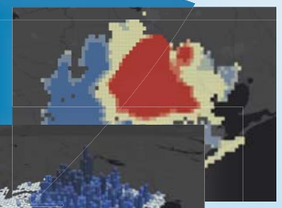
Features / Vectors

- Space-Time Analytics
- Hot Spots
- Density
- Buffer
- Summarize
- Aggregation
- Construct Tracks
- Find Similar
- Spatial Join



Space-Time Cube

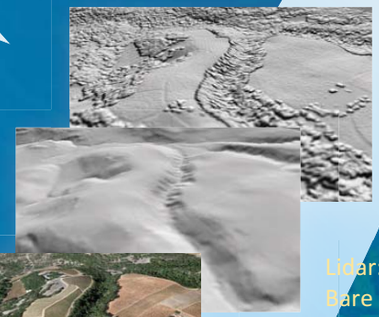
Riparian Areas



Hot Spots

Density

Power Outages
(50+ Million)



Lidar:
First Return

Lidar:
Bare Earth

Imagery

Faster (10x+)

Image Server
Large Imagery Collection

Imagery / Raster

- Image Processing
- Classification
- Change Detection
- Topo
- Suitability
- Density
- Corridors
- Distance
- Proximities
- Interpolation

New In… …isting Data . . .
. . . Also Opening Up Understanding with … new World of Data

Deriving Understanding from Volume, Velocity and Variety

Big Data Analytics and GIS

Ingest, analyze and visualize enormous amounts of data (static, historical, temporal, Real-time/IoT…)

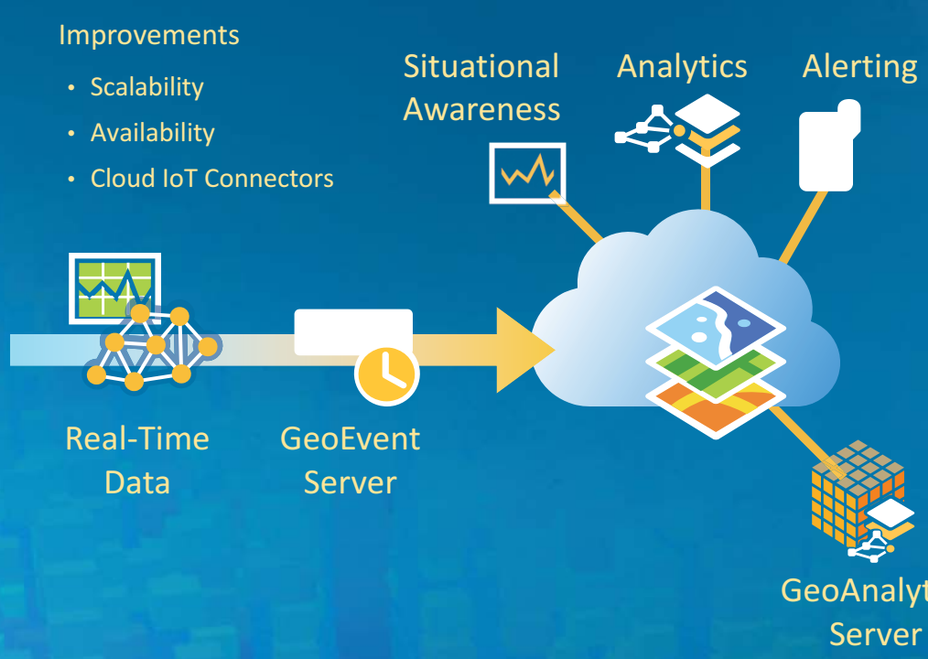
- Turns Raw Data into Wisdom
- Discover and Expose Patterns
- Find Spatial Relationships
- Perform Predictive Modeling
- Get Geographic Insights from Social Media

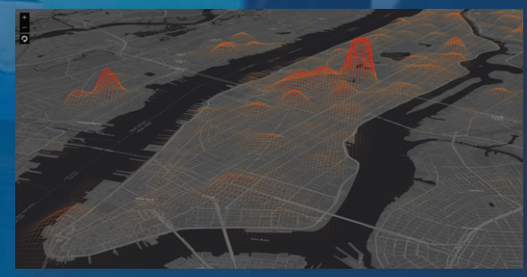
Real-Time GIS Analytics | Integrating Sensor Networks and the IoT

- High-Velocity Data Streams
- Monitoring and Alerting
- Empowering New GIS Apps and Analytics

Improvements

- Scalability
- Availability
- Cloud IoT Connectors





Event Management

Vehicle Tracking

Asset Monitoring

Environment Monitoring

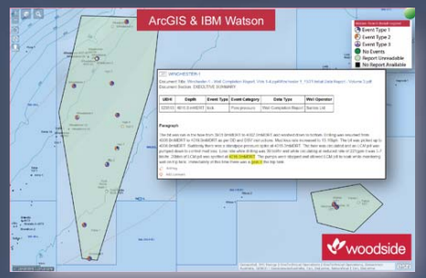
Supporting Real-Time and Post Event Analysis

New Directions and Advancements:

- Cognitive Computing/Machine Learning/Artificial Intelligence
  - Data-driven relationships and predicting outcomes
  - New dimensions, power and capabilities added to spatial analysis capabilities

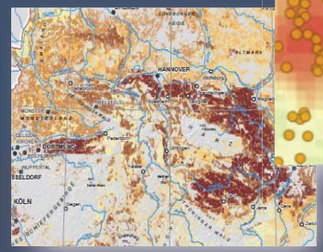
Natural Resource Management

Oil Well Analysis
(Using IBM Watson Deep Learning)



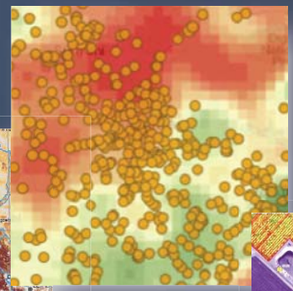
Australia
Woodside Energy, Ltd.

Soil Agriculture Potential



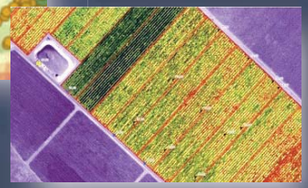
Germany

Environmental Stress on Farms



Ghana
aWhere, Inc.

Vineyard Irrigation



California
Scheid Vineyards

Forest Planning

Latvia State Forests

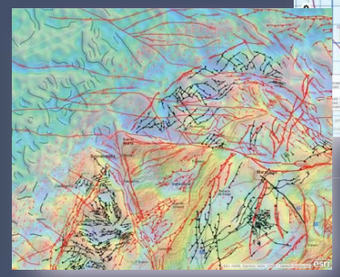
Managing Harvests and Timber Sales

Minnesota
North Point Geographic Solutions

Petroleum Exploration

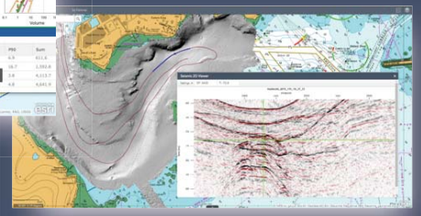
North Sea
Exprodat

Hydrocarbon Prospecting



Southern Caribbean
Getech

Integrating Exploration Data



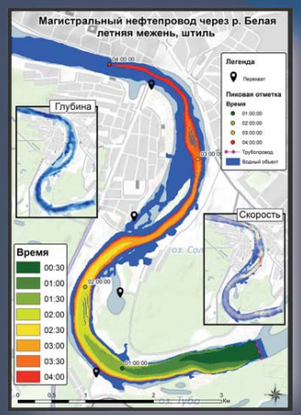
United Kingdom

Modeling Citrus Disease

Florida Department of Agriculture

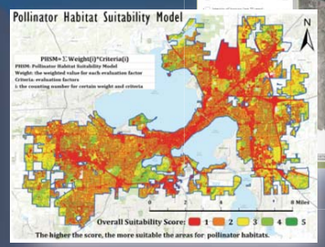
Environmental Modeling and Assessment

Oil Spill Simulation



Russia
IntroGIS

Bee Habitat Suitability

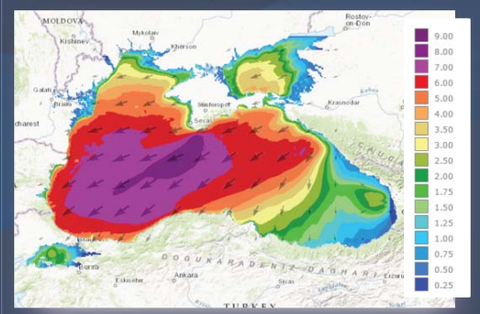


University of Wisconsin

Endangered Insect Habitat

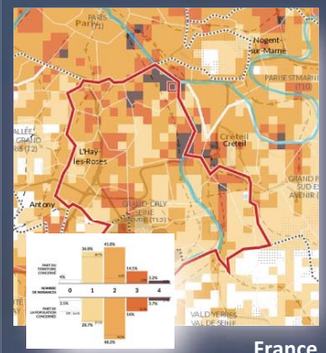
Czech Republic
University of Ostrava

Storm Monitoring



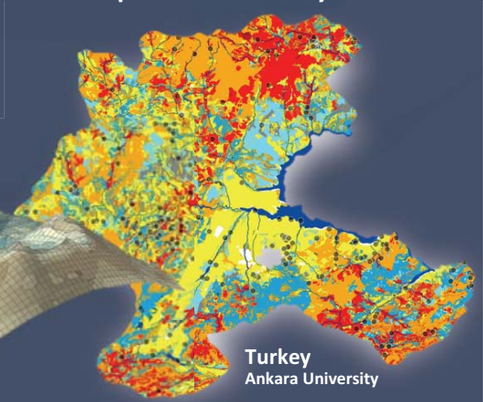
Black Sea
BPI Co.

Environmental Nuisance Modeling



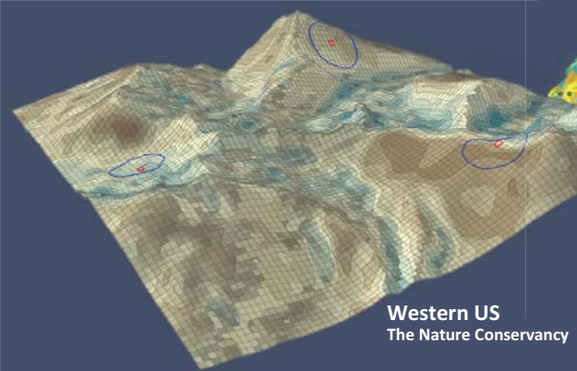
France
n-Sphere

Landscape Character Analysis



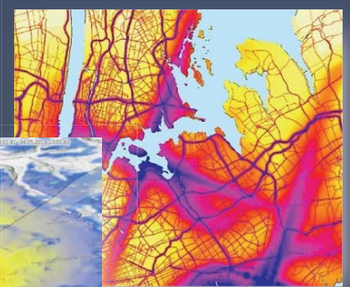
Turkey
Ankara University

Landscape Resiliency Modeling



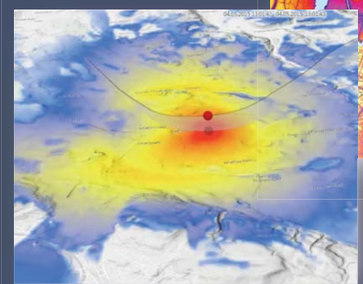
Western US
The Nature Conservancy

Aircraft Noise Monitoring



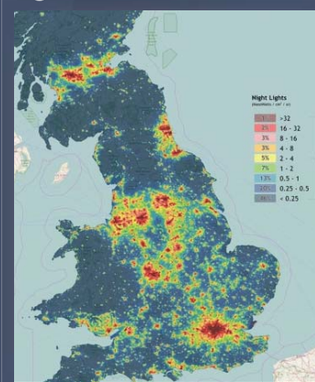
USDOT

Noise Pollution



Switzerland
n-Sphere

Light Pollution



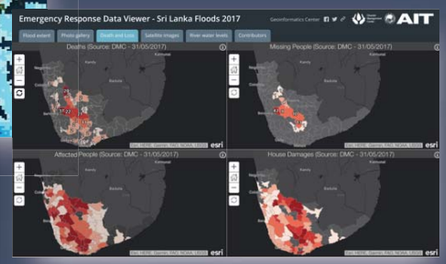
United Kingdom
LUC

Preparing for and Responding to Disasters

Volcanic Monitoring

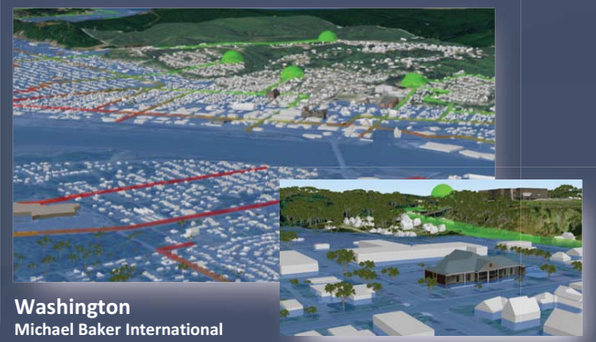
Japan
JAXA

Damage Assessment



Sri Lanka
Geoinformatics Center

Tsunami Evacuation Routes

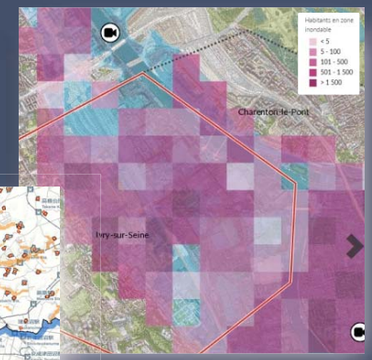


Washington
Michael Baker International

Liquefaction Risk

Japan
Funibashi City

Wildfire Risk



France
Caroviz

Hurricane Modeling

Georgia
Glynn County GIS

Flood Impacts

British Columbia
Kerr Wood Leidal Associates Ltd.

Interactive Plume Modeling

Europe
Eurocommand

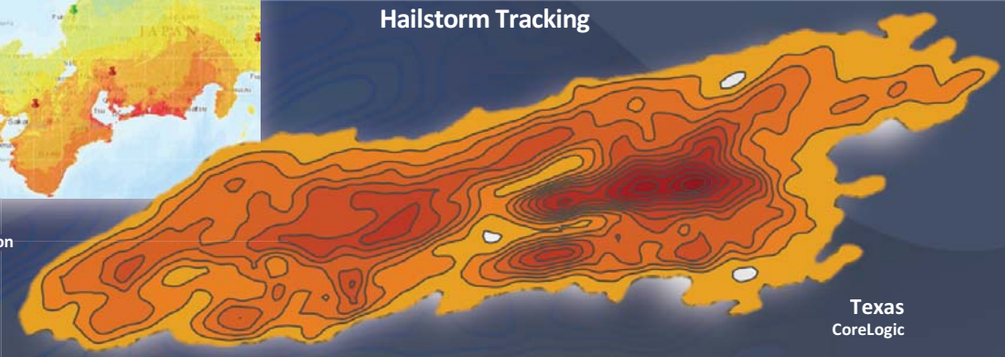
Emergency Management Center

Germany

Disaster Preparedness

Japan
Kajima Corporation

Hailstorm Tracking



Texas
CoreLogic

GIS and Forestry

40 years of GIS application to the global forest products industry

Agriculture

Increasing efficiency and minimizing risk

Factors Beyond Control

- Weather
- Pest, disease
- Soil type
- Soil nutrition
- Yield
- Markets
- Prices

Management Practices

- What to plant
- When to plant
- Where to plant
- How many inputs to apply (water, fertilizer, pesticides)
- How to manage production through season
- When to harvest
- How best to market products

Mechanisms to support decision-making

- Imagery – NDVI as a proxy for crop health
- Field observations
- Tradition
- Ag Extension
- Cooperatives / Associations
- Input companies marketing

Metrics…

Strategies …

Information …

Transformational Impacts

- ☑ ***Smarter*** way to operate the Business Enterprise
- ☑ Operational **Efficiencies**
- ☑ Environmental **Leadership**
- ☑ Cost Reduction **Strategies**

$20 Million

Knowing is not enough . . .

. . . we must apply.

Being willing is not enough . . .

. . . we must do.

— Leonardo da Vinci