Critical Infrastructure Data R&D: LandScan USA, HiFLD Support, & Foundation Energy Data

Mark Tuttle
Geographic Information Sciences and Technology,
Oak Ridge National Laboratory

ORNL is managed by UT-Battelle, LLC for the US Department of Energy
Critical Infrastructure (CI) Data Development

- Leverage existing internally developed spatial databases to create accurate & authoritative national critical infrastructure data layers
  - Schools: Public/Private K12; Higher Education (2009 - Present)
  - Prisons/Correctional Institutions (2009 - Present)
  - Rail: Network (routable), Rail Yards, Rail Tunnels (2009 – 2016)
  - Day care point database (2010 – Present)
  - Solid Waste Facilities (2012 - Present)
  - Mobile Home Parks (2012 - Present)
  - Hospitals (2013 - Present)
  - Energy Infrastructure Data (2013 - Present)
  - Major Sports Venues (2014 - Present)
  - National Shelters (2015)
  - Nursing Homes/Assisted Living (2015 - Present)
  - Fixed Rail Transit (2015)
  - Law Enforcement (2017 - Present)
  - Colleges & Universities Polys (2017 - Present)
  - Convention Centers (New in 2018)
Why …

LandScan USA

Night

Day
LandScan USA Model:

Schools Processing:

Updated Enrollments & Correct Location:
Schools: K-12 and Higher Education

• Three National Schools Layers: Public (K-12), Private (K-12) and Colleges & Universities

• US Department of Education, NCES is the authoritative data source updated annually:
  – CCD: Common Core Data for Public (K-12)
  – PSS: Private School Survey for Private (K-12)
  – IPEDS: Integrated Postsecondary Education Data System for Colleges and Universities

• School point geo-located on building

• American Red Cross/FEMA NSS shelter ids conflated to respective school layer

• Selected DCIP, BEI, and IICD attributes included in school layers
Colleges and Universities

Multiple Campuses – One Enrollment

NCES & HIFLD College & University Layer
One record for Roane State Community College:

Enrollment: 6,281
Day Care Centers: MOTIVATION

• No National Level Day Care Database exists
• Day Care Centers house one of the most vulnerable population (6 weeks - 5+ years)
• Around 9% of the total population are in Day Care at a given point of time
Day Care Centers: DATA SOURCES

- Over 53 Data Sources
- Data for 35 States Publicly Available
# Day Care Centers: DATA FORMATS

**ABC Learning Center**  
Lic. #753  
Wanona Phillips, Owner/Director  
Kimberly Phillips, Camp Infolink Middle School  
151 East Park Street, Carson City, 89706  
Telephone: (775) 885-3150  
Center/Nursery: 75 Children  
20 children Birth-2yrs  
May 1-31, 2008  
*Accepted Child Care Subsidy through DHHS? Yes*

**Capital Christian Child Development Center**  
South Lic. #728  
Kristi Callahan, Center Director  
1600 Snyder Avenue, Carson City, 89701  
Telephone: (775) 883-3355  
Preschool: (775) 883-3355  
Ages: 2 yrs - 6 yrs  
11 a.m. - 6 p.m.  
*Accepts Child Care Subsidy through DHHS? No*

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<table>
<thead>
<tr>
<th>Center Name</th>
<th>License Number</th>
<th>Owner/Director</th>
<th>Address</th>
<th>Telephone</th>
<th>Types of Care</th>
<th>Capacity</th>
<th>Days of Operation</th>
<th>Accepts Child Care Subsidy through DHHS?</th>
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<tbody>
<tr>
<td>ABC Learning Center</td>
<td>#753</td>
<td>Wanona Phillips</td>
<td>151 East Park Street, Carson City, 89706</td>
<td>(775) 885-3150</td>
<td>Nursery, Center</td>
<td>75</td>
<td>Monday - Friday</td>
<td>Yes</td>
</tr>
<tr>
<td>Capital Christian Child Development Center South</td>
<td>#728</td>
<td>Kristi Callahan</td>
<td>1600 Snyder Avenue, Carson City, 89701</td>
<td>(775) 883-3355</td>
<td>Preschool</td>
<td>25</td>
<td>Monday - Friday</td>
<td>No</td>
</tr>
</tbody>
</table>
Day Care Centers: CLASSIFICATION

• What types of Day Care Centers to include/exclude?
• Over 100 ‘Types’ of Day Care Centers
• Can be Grouped into 5 major types:
  – Day Care Centers
  – School Child Care
  – Church Based
  – Group Home Child Care
  – Family Home Child Care
Critical Infrastructure (CI) Data Development

- Leverage existing internally developed spatial databases to create accurate & authoritative national critical infrastructure data layers
  - ✔ Schools: Public/Private K12; Higher Education
  - ✔ Prisons/Correctional Institutions
  - ✔ Day care point database
  - ✔ Solid Waste Facilities
  - ✔ Hospitals
  - ✔ Major Sports Venues
  - ✔ Nursing Homes/Assisted Living
  - ✔ Law Enforcement
  - ✔ Colleges & Universities Polys
  - ✔ Convention Centers
Mobile Home Parks

• Population residing in Mobile Homes are the most vulnerable to hurricanes, flooding, tornadoes, and other natural disasters
• National Mobile Homes was a gap in HIFLD data holdings (and the LSUSA model)
• Data Fusion Approach:
  – Open Source Knowledge Discovery to target geolocations
  – Existing government ancillary datasets
  – Novel and evolving image processing using NGA HR Ortho collection
## Mobile Home Parks

### Open Source Data Collection:

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>City</th>
<th>State</th>
<th>Zip</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thompson Mobile Home Park</td>
<td>19025 Deer Street, MN 56431</td>
<td>Atkin</td>
<td>MN</td>
<td>56431</td>
<td>(218) 927-3120</td>
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<tr>
<td>Rainbow Terrace Mobile Home</td>
<td>1714 Marguerite Avenue</td>
<td>Albert Lea</td>
<td>MN</td>
<td>56007</td>
<td>(507) 373-8017</td>
</tr>
<tr>
<td>Oak Mobile Estates</td>
<td>6045 Highway 10 North West</td>
<td>Anoka</td>
<td>MN</td>
<td>55303</td>
<td>(651) 423-0540</td>
</tr>
<tr>
<td>Cedar Park</td>
<td>12571 Garland Avenue</td>
<td>Apple Valley</td>
<td>MN</td>
<td>55124</td>
<td>(612) 454-2820</td>
</tr>
<tr>
<td>Apple Valley Estates</td>
<td>12001 Penning Ave.</td>
<td>Apple Valley</td>
<td>MN</td>
<td>55124</td>
<td>(612) 454-2727</td>
</tr>
<tr>
<td>Cedar Knolls</td>
<td>12571 Garland Avenue</td>
<td>Apple Valley</td>
<td>MN</td>
<td>55124</td>
<td>(612) 454-2820</td>
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<tr>
<td>Wheel Estates Inc.</td>
<td>3000 3rd Place South</td>
<td>Maple Grove</td>
<td>MN</td>
<td>55119</td>
<td>(651) 647-7216</td>
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<tr>
<td>Stuart’s Whispering Pines</td>
<td>Highway 1 West.</td>
<td>Hastings</td>
<td>MN</td>
<td>55033</td>
<td>(651) 333-1010</td>
</tr>
<tr>
<td>Birchlane Mobile Home Park</td>
<td>507 Jefferson Avenue</td>
<td>Portland</td>
<td>OR</td>
<td>97209</td>
<td>(503) 262-9830</td>
</tr>
<tr>
<td>Skyline Village Mobile Park</td>
<td>2501 Delton Avenue</td>
<td>Portland</td>
<td>OR</td>
<td>97209</td>
<td>(503) 262-9830</td>
</tr>
</tbody>
</table>

**Transform**

**Geolocate**
Mobile Home Parks
Mobile Home Parks

Image Processing: Multi-level Analysis

Input Image

First level

Pixel level features such as intensity, edge orientation

SVM based classified to filter image patches

Second level

Line-based representation and higher-order feature extraction

SVM based classifier for semantic classification

Semantic class detection

Image patch elimination
Mobile Home Parks
LandScan: Global, USA, HD
LandScan Population Project
Improving Knowledge of Population Distribution and Dynamics Around the World

<table>
<thead>
<tr>
<th>LandScan Global</th>
<th>LandScan USA</th>
<th>LandScan HD</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
</tbody>
</table>

- **Spatial Resolution**
  - LandScan Global: 30 arc-seconds (~1 km)
  - LandScan USA: 3 arc-seconds (~90 m)
  - LandScan HD: 3 arc-seconds (~90 m)

- **Temporal Resolution**
  - LandScan Global: Ambient (24 hour average)
  - LandScan USA: Daytime and nighttime
  - LandScan HD: Ambient; daytime and residential distributions on request

- **Modeling Framework**
  - LandScan Global: Top-down (census dependent)
  - LandScan USA: Hybrid top-down/bottom-up
  - LandScan HD: Bottom-up (census independent)

- **Approach**
  - Remote sensing–based global data modeling and mapping
  - Integration of infrastructure and activity databases
  - Data fusion: High resolution building extraction, occupancy data, land use, and POI

Improving Knowledge of Population Distribution and Dynamics Around the World
LandScan Global
More realistic population distribution for consequence assessment

• “Unwarned population”
  – Spatial resolution of 30 arc seconds (~1km)
  – Ambient population (average over 24 hours)
  – Remote sensing based global data modeling and mapping

• Annual Improvements
  – New census information and mid-year population estimates
  – Exploit new spatial data and imagery
LandScan HD: High Resolution Population Distribution and Dynamics

Big Data Fusion
LandScan USA

High Resolution Spatiotemporal Population Distribution for the U.S.

- Captures diurnal variations of population:
  - Nighttime baseline includes residential and prisoner populations
  - Sub-models for daytime population components:
    - Workers, Students, Daycare, Prisoners, Shoppers, Stay-at-home, Socioeconomic/Demographic Data

- Extensible for special events and tourist location scenarios

- U.S. Govt. foundation-level data: distributed via HIFLD Secure; for use by govt. agencies, primarily for emergency preparedness and response

- **New release:** LandScan USA 2017 (rel. July 2018)
Foundation Energy Data

NGA, DOE, ORNL, INL, LANL, and ANL Partnership

ORNL is managed by UT-Battelle, LLC for the US Department of Energy
Objective:
The overall objective of this effort is to develop Government Off-The-Shelf (GOTS) FOUNDATION ENERGY DATA layers composed of electric grid, natural gas and petroleum infrastructure that will be shareable across all levels of government for:

- Homeland Security
- Homeland Defense
- Emergency Preparedness, Protection, Prevention, Mitigation, Response and Recovery
- Energy modeling and simulation community.
Assessment of the Feasibility of a Government Energy Data Layer

Submitted by

Oak Ridge National Laboratory
Idaho National Laboratory
Argonne National Laboratory

December 10, 2012
Foundation Energy Data Partnership

- **Electrical Energy – Ventyx Contract, Base plus 4 option years, Sep08**
- **Renew Ventyx Contract, 1st option year**
- **Renew Ventyx Contract, 2nd option year**
- **FY11, Renew Ventyx Contract, 3rd option year**
- **Decision Required**
- **FY12, Renew Ventyx Contract, 4th option year**
- **Renew PLATTS Contract, 2nd option year**
- **Renew PLATTS Contract, 1st option year**
- **Oil & Natural Gas Energy – PLATTS Contract, Base plus 4 option years, Sep08**
- **Renew PLATTS Contract, 3rd option year**
- **Decision Required**
- **FY12 HSIP SpendPlan Due**
- **Energy Data Assessment and Planning**
- **FY13 HSIP SpendPlan Due**
- **Renew PLATTS Contract, 4th option year**
- **FY12, Renew Ventyx Contract, 4th option year**
- **Build!**
- **FY11, Renew Ventyx Contract, 3rd option year**
- **FY12, Renew Ventyx Contract, 4th option year**
- **Build!**
By 2020, Foundation Energy Partnership will result in an estimated 58% per year cost reduction.
Foundation Energy Data Partnership

Model and Processes
- Power Flow
- Pipeline Flow
- Smart Grid

Data Sources
- OpenStreetMap
- NPMS
- Open Source

Predictions/Forecasts

Decision Support
- Infrastructure
- Mapping

Values and Benefits
- Situational Awareness
- EA Analysis
- Smart Grid M&S Base

Partnerships

Inputs

Outcomes

Impacts

Enabling the Mission
## Content - Electric

<table>
<thead>
<tr>
<th>Feature Layer</th>
<th>Geometry</th>
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<tbody>
<tr>
<td>Power Plant</td>
<td>Point</td>
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<tr>
<td>Transmission Lines</td>
<td>Line</td>
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<tr>
<td>Substation Points</td>
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<td>Flowgate Lines</td>
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<td>NERC Regions</td>
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<td>NERC Reliability Coordinators</td>
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<td>Holding Company Areas</td>
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<tr>
<td>Control Areas</td>
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<td>Distribution Control Facilities</td>
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<tr>
<td>Planning Areas</td>
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<tr>
<td>Retail Service Territories</td>
<td>Polygon</td>
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<tr>
<td>Independent System Operators</td>
<td>Polygon</td>
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</tbody>
</table>
## Content – Natural Gas/Petro

**Feature Layer** | **Geometry**
--- | ---
Natural Gas Compressor Stations | Point
Oil Refineries | Point
POL Terminals | Point
Oil-Gas Platforms | Point
US Shipping Fairways | Polygon
NG Imports – Exports | Point
Strategic Petroleum Reserves | Point
NG/POL Pipelines | Line
Ethanol Transloading Facilities | Point
Petroleum Ports | Point

**Natural Gas Compressor Stations**

- NG Processing Plants | Point
- NG Receipt - Deliveries | Point
- NG Storage Facilities | Point
- NG Service Territories | Polygon
- Biodiesel Plants | Point
- Ethanol Plants | Point
- NG-LNG Import Terminals | Point
- Gas Meter Stations | Point
- Oil-Gas-Wells | Point
- POL Pump Stations | Point
- Oil-Gas Fields | Polygon
- Oil-Gas Interconnects | Point
Mark Tuttle
tuttlema@ornl.gov
(865) 241-4150