SoilSCAPE Network
"Tonzi Ranch" Cal/Val Site

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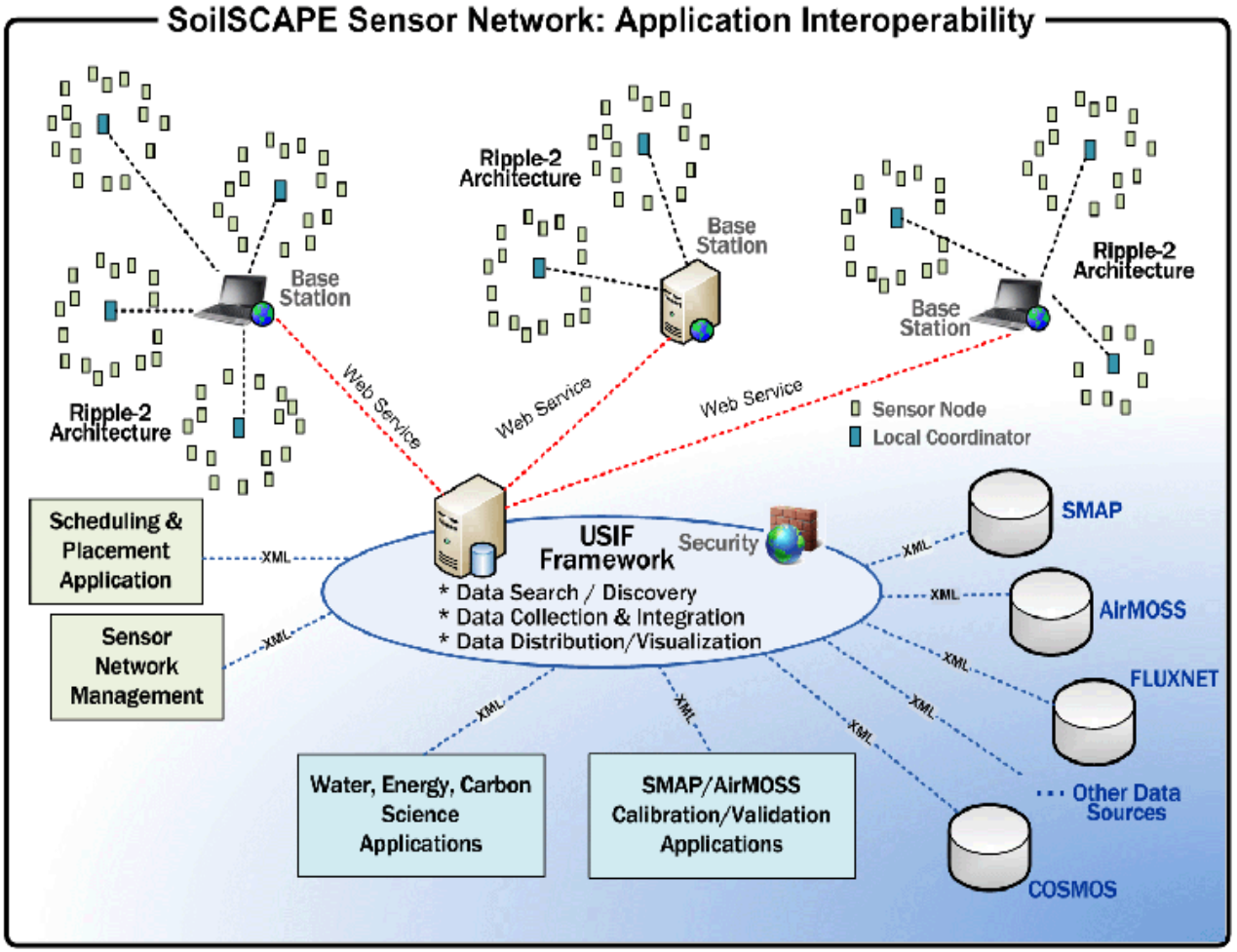
SoilSCAPE Background

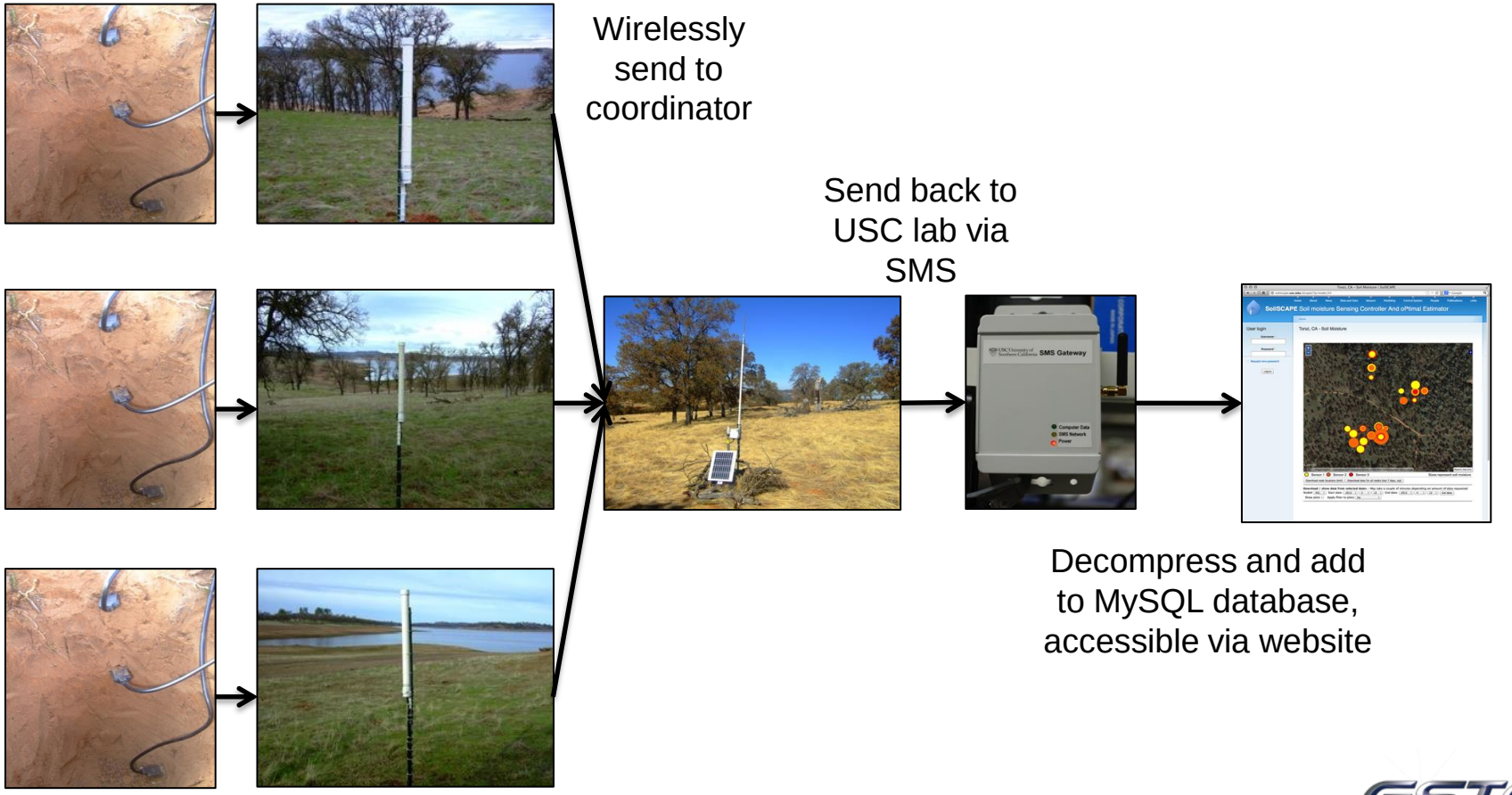
Generalized SoilSCAPE Framework



SoilSCAPE Network Overview

Architecture Design

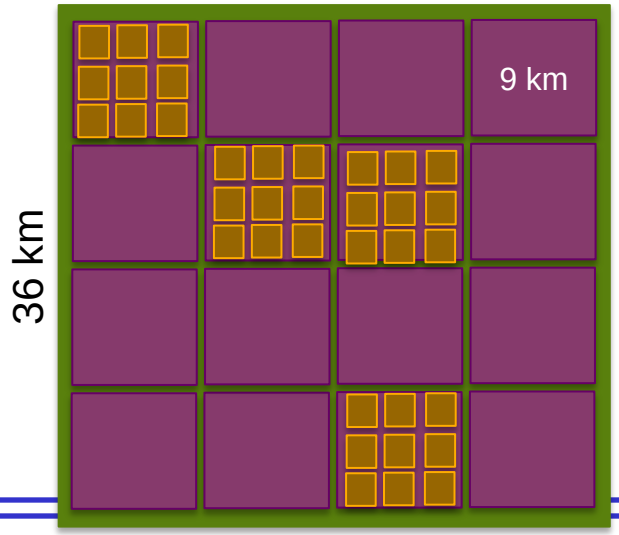
Collect data from 3 or 4 sensors: typical depths are 5 cm, 15 cm, 40-50 cm, 90 cm

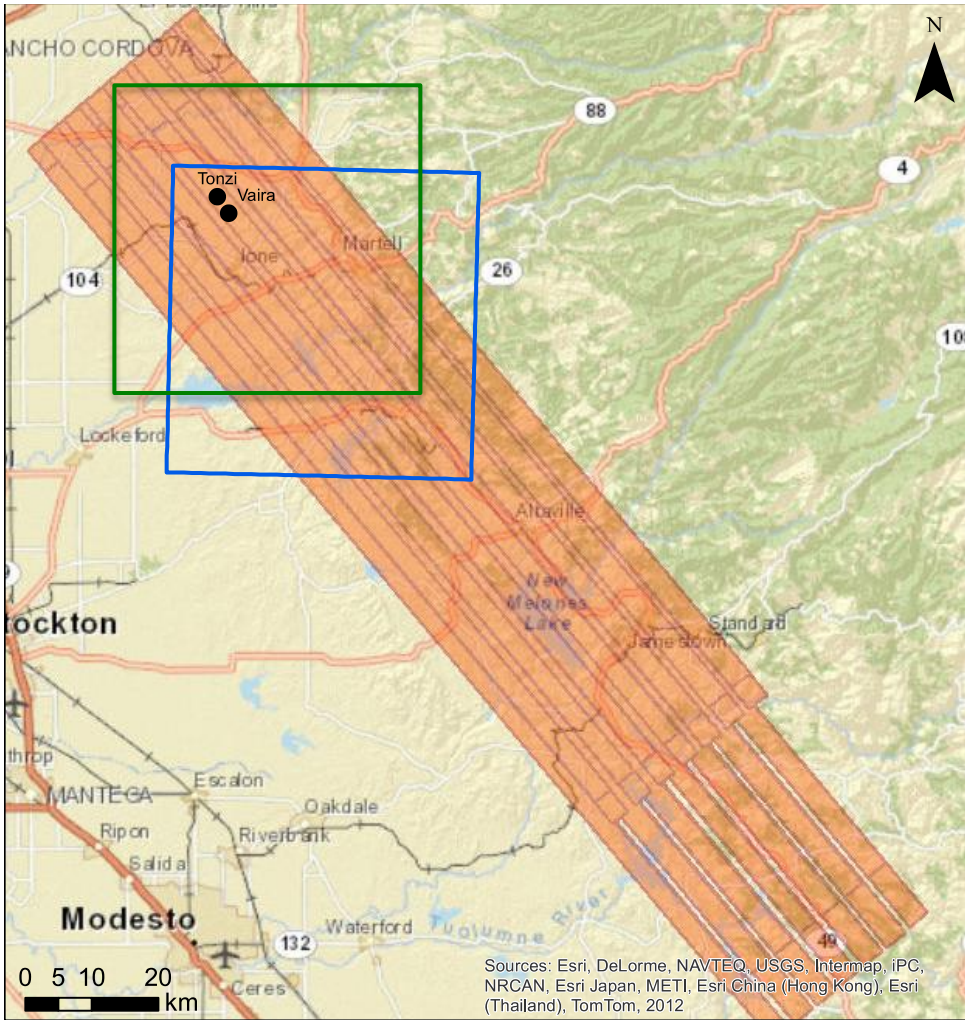


Overlap with AirMOSS Flight Lines

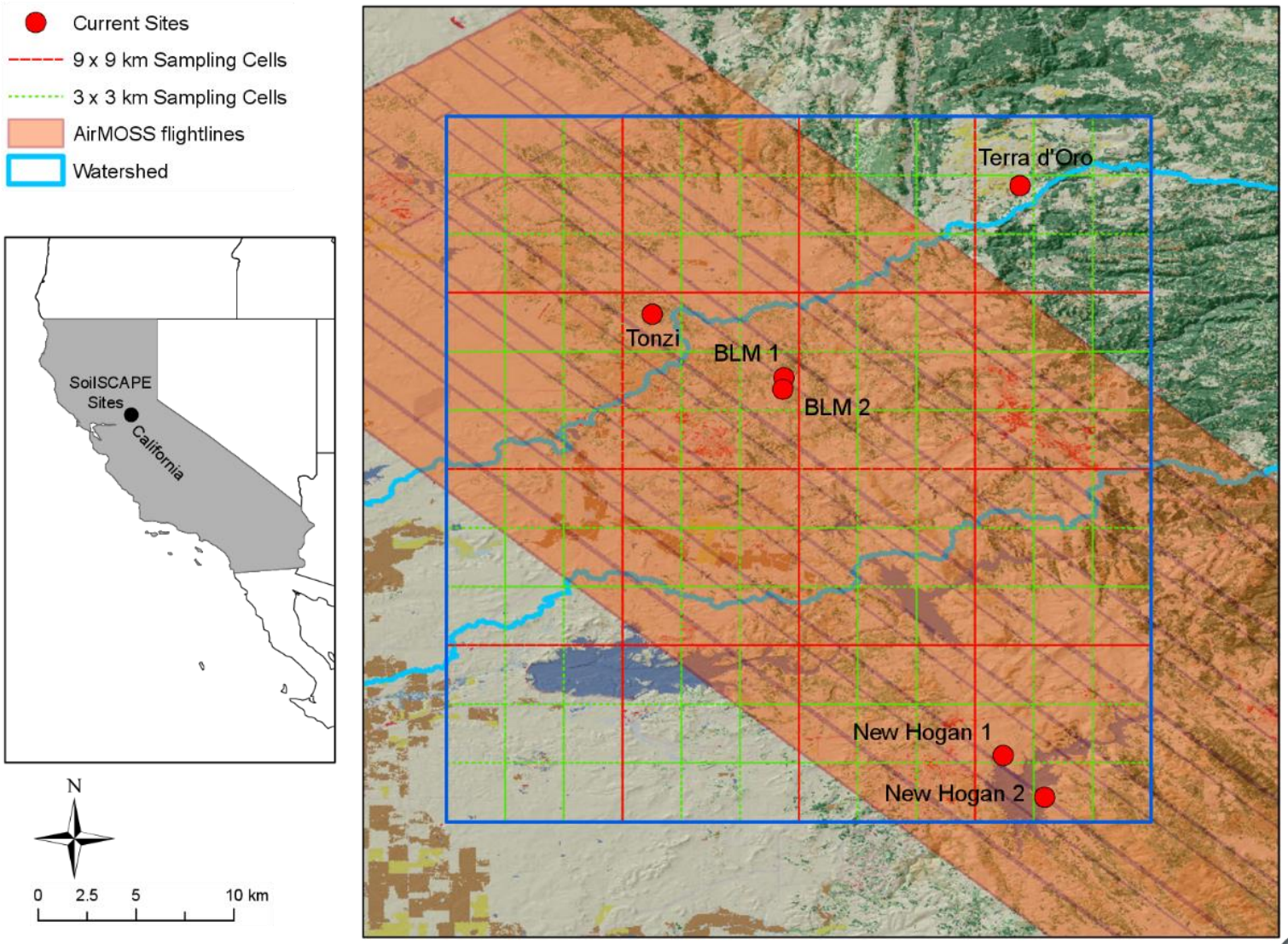
Sampling design

- Designed to fit in with SMAP Cal/Val requirements: two 3 km cells and two 9 km cells within a 36 km cell; 3 km and 9 km cells not mutually exclusive
- 36 km grid placed to fit within planned AirMOSS flight lines.
- Location of two 9 km cells within 36 km grid chosen to maximize land cover and soil class diversity within both cells
- 3 km cells and node locations within these defined using class weights





SoilSCAPE Deployment Status (1)



SoilSCAPE Deployment Status (2)

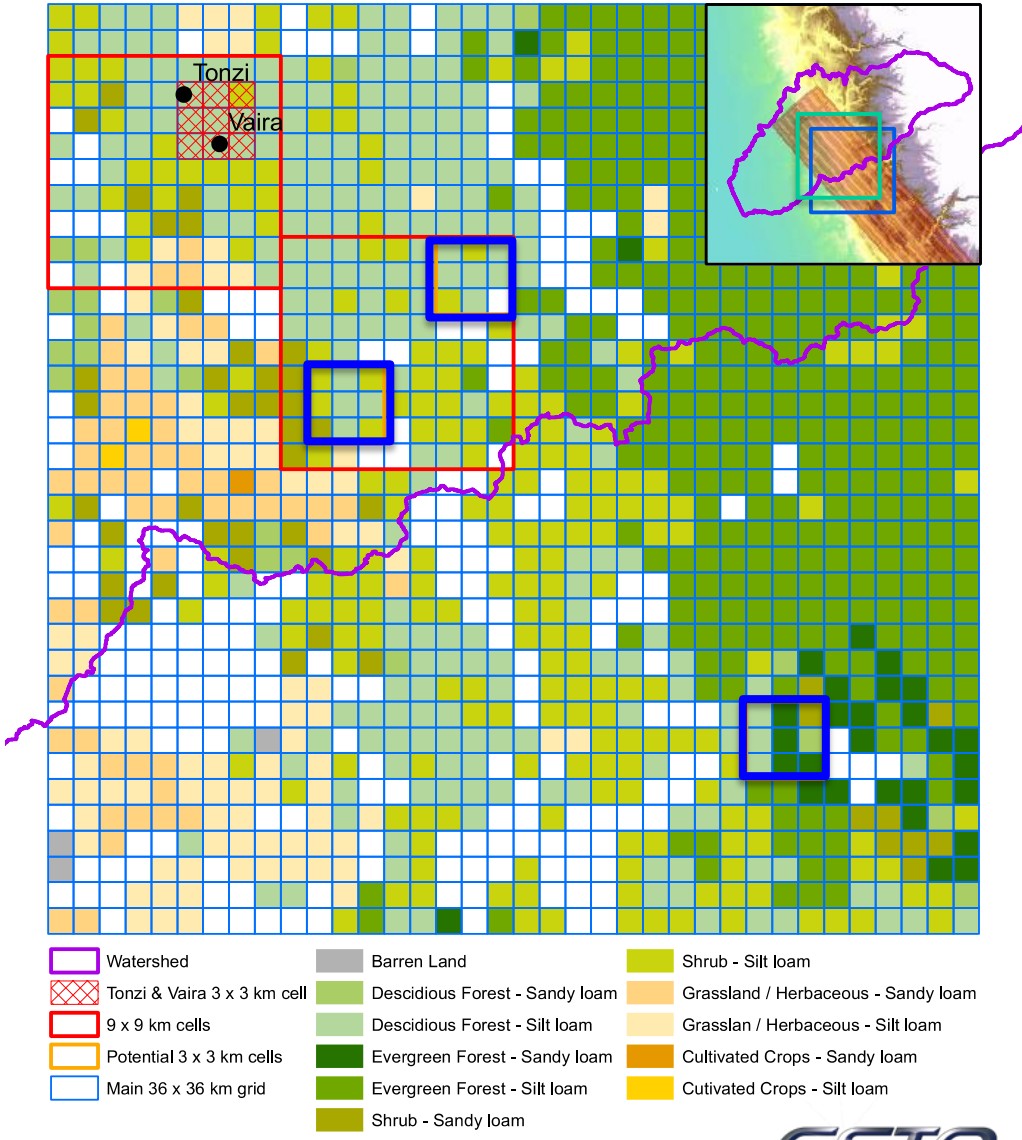
- Six clusters within the super-site:
  - Tonzi ranch: 19 nodes + LC (summer 2012)
  - New Hogan Army Corps of Engineers site (1): 15 nodes +LC (October 2012)
  - New Hogan Army Corps of Engineers site (2): 19 nodes + LC (December 2012)
  - Terra d'Oro site: 27 nodes + LC (Apr 2013)
  - Bureau of Land Management 1: 16 nodes + LC (July 2013)
  - Bureau of Land Management 2: 15 nodes + LC (July 2013)
  - Total of 111 sets of sensors for California supersite.

- All data transmitted to Data Server in near-real-time:
  - Improvements to data quality – manually and automatically flagging data.
  - Data automatically being downloaded by JPL – was used in Phase 1 SMAP Cal/Val rehearsal – first site with automated SDS-run scripts.
  - Added suite of network monitoring tools.

Sampling Design Considerations (1)

Broad soil type and land cover

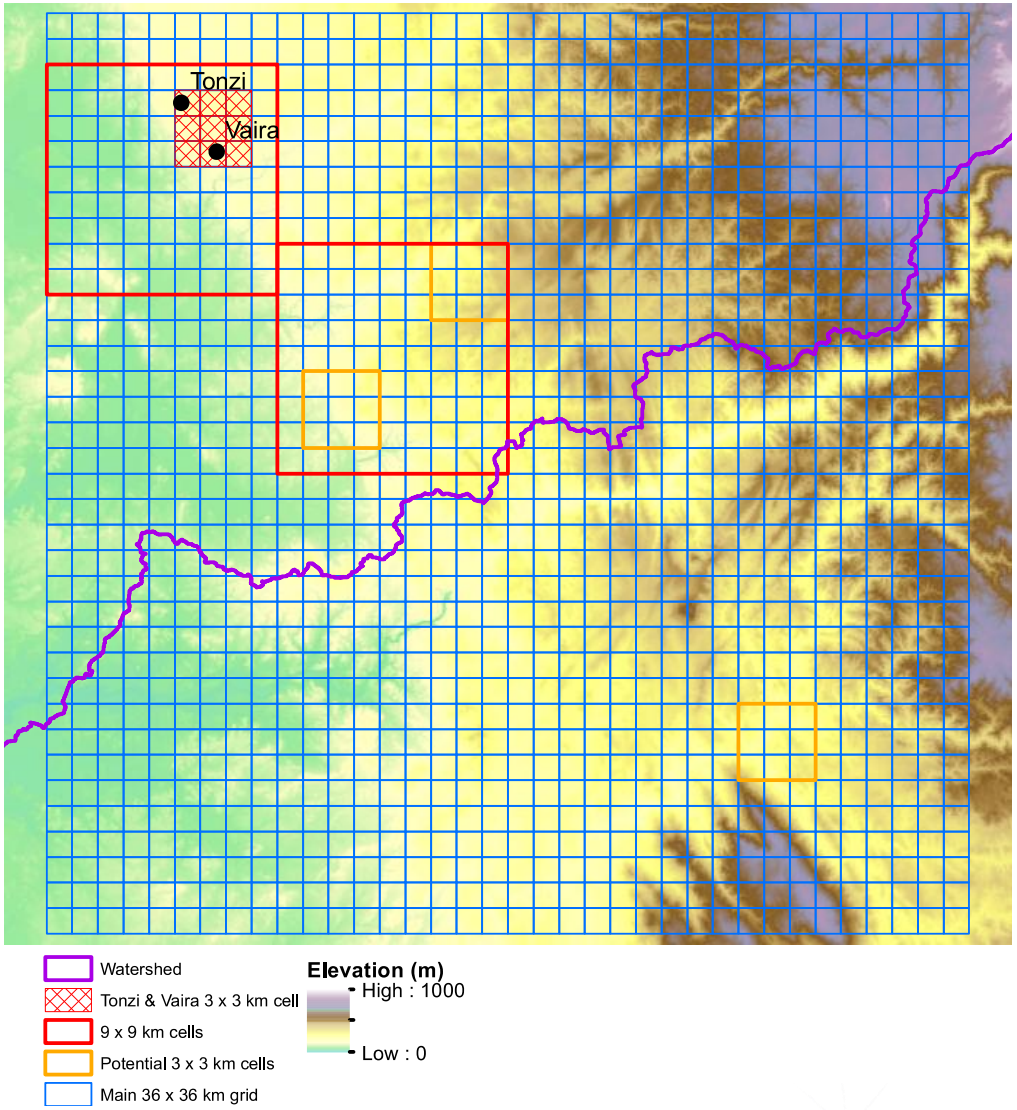
- NLCD land cover types.
- Broad soil types derived from SSURGO data:
  - Silt loam
  - Sandy loam
  - Clay
- Most common class per 1 km grid cell considered.



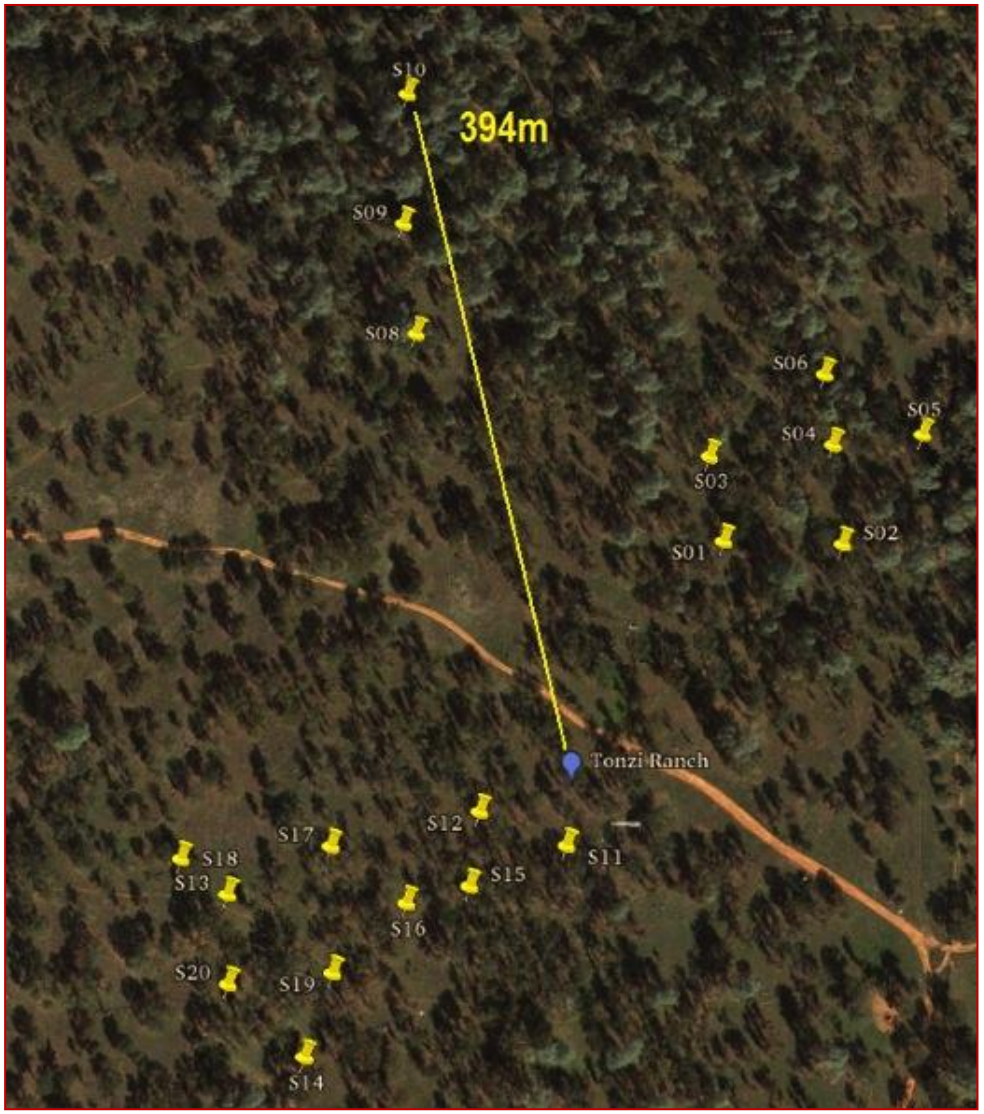
Sampling Design Considerations (2)

Topography

- Used to determine 3 x 3 km sub-cell locations.
- Important consideration for hydrological modeling.



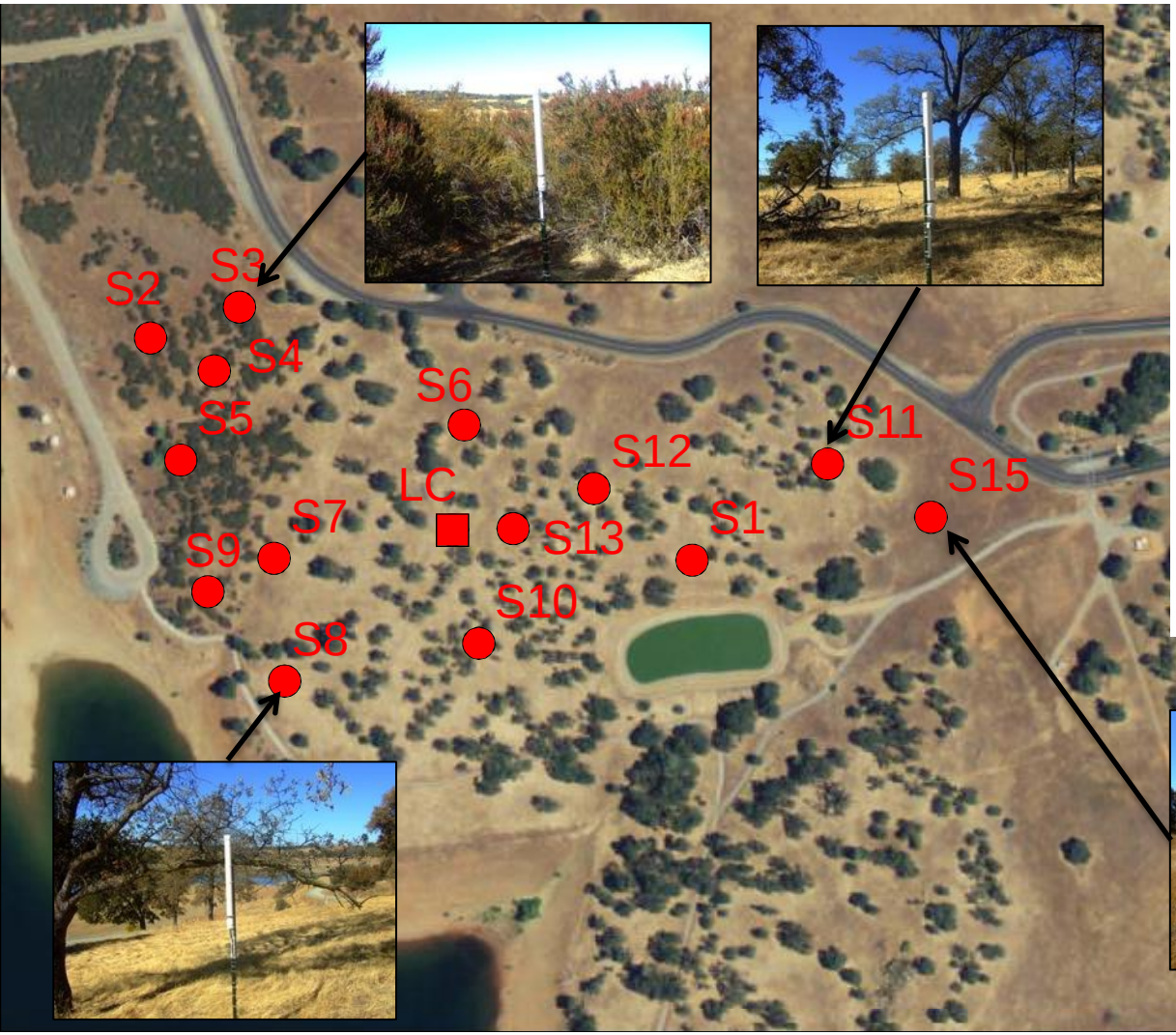
Network Deployment (1)



Tonzi Ranch proper

- Private land
- Woody savannah
- Deployed summer 2012
- 20 nodes

Network Deployment (2)



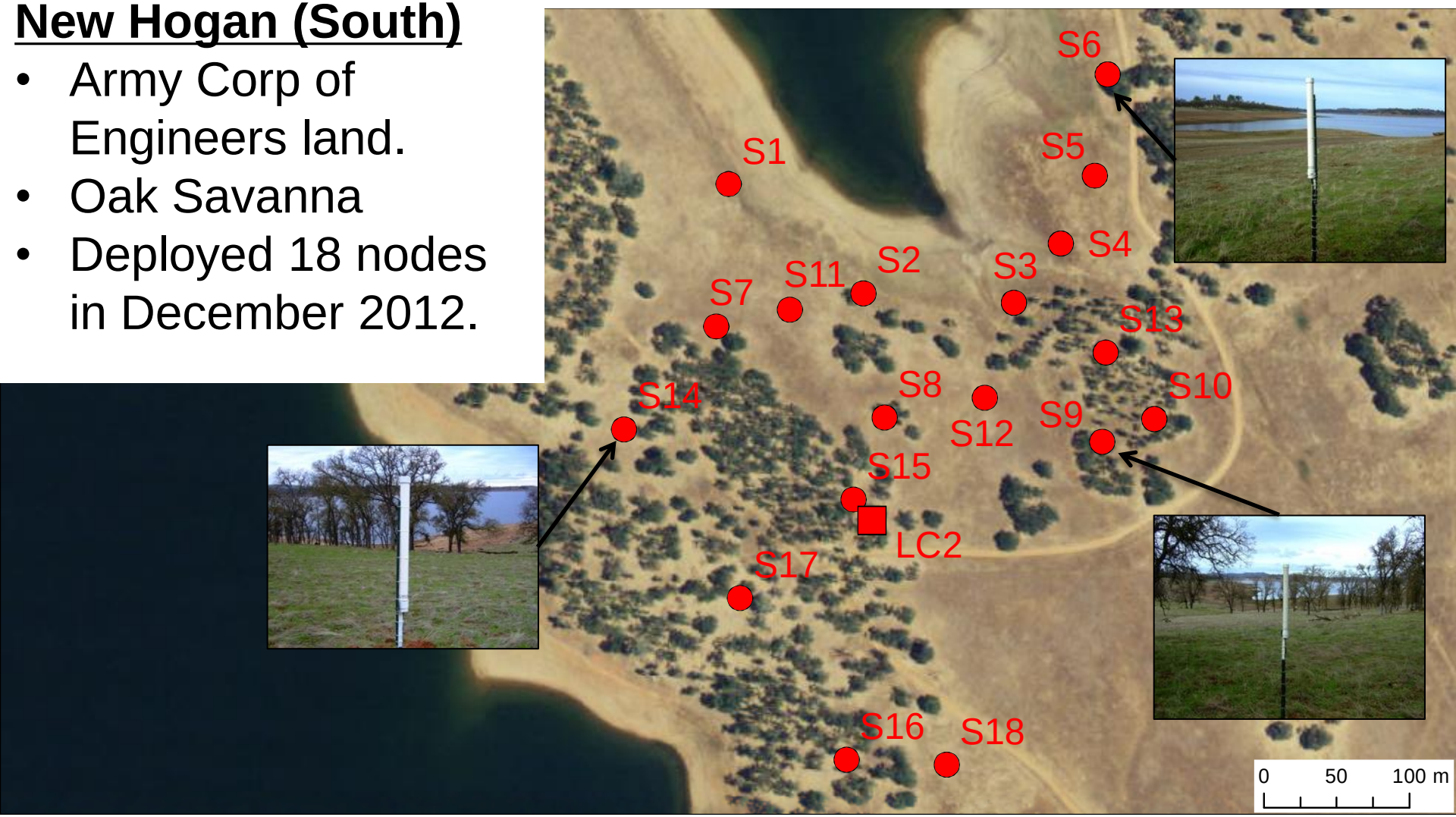
New Hogan (North)

- Army Corp of Engineers land.
- Dense shrub / open woodland.
- Deployed 14 nodes, October, 2012.

Network Deployment (3)

New Hogan (South)

- Army Corp of Engineers land.
- Oak Savanna
- Deployed 18 nodes in December 2012.



Network Deployment (4)

Terra d'Ora

- Site of existing California Irrigation Management Information System (CIMIS) station.
- Vineyard.
- Deployed 27 Nodes, April 2013
- Temperature sensor at LC

Network Deployment (5)

Terra d'Oro

- Dense vines and steep topography can cause some communication problems for furthest nodes.

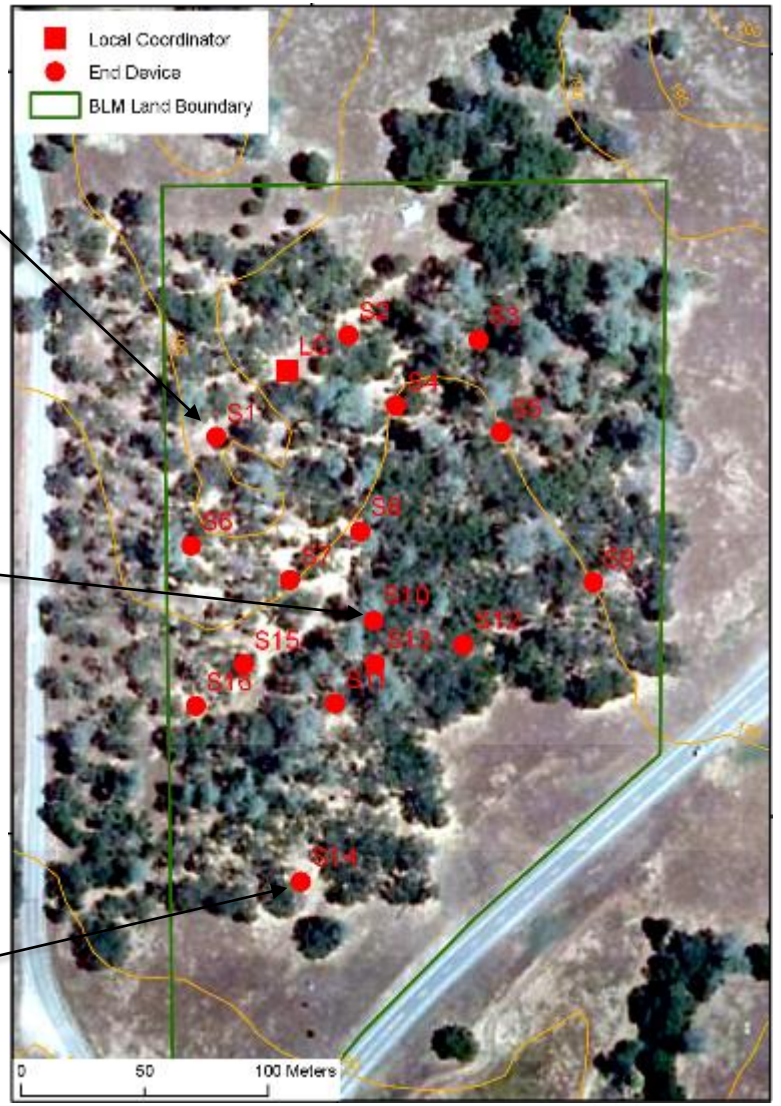
Leaf off (April 2013)

Leaf on (July 2013)

Network Deployment (6)

BLM 1

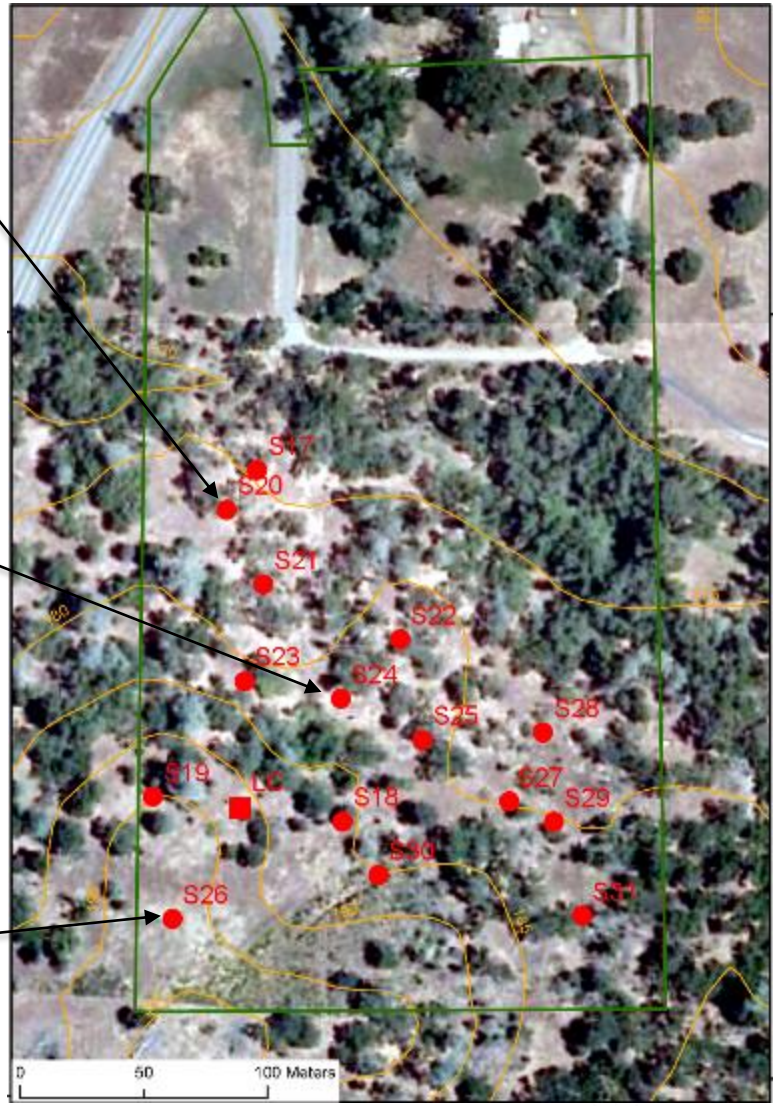
- Owned by Bureau of Land Management.
- Deployed 16 nodes in July 2013.
- Sensors installed at LC.



Network Deployment (7)

BLM 2

- Owned by Bureau of Land Management.
- Deployed 15 nodes in July 2013.
- Sensors installed at LC.



Network Deployment (9)

Deployment Team

USC

- Ruzbeh Akbar
- Mariko Burgin
- Guanbo Chen
- Richard Chen
- Dan Clewley
- Xueyang Duan
- Mark Haynes
- Agnelo Silva
- Kubi Savci
- Pratik Shah
- John Stang
- Jane Whitcomb

MIT

- Aldrich Castillo

Data Distribution / Visualization System (1)

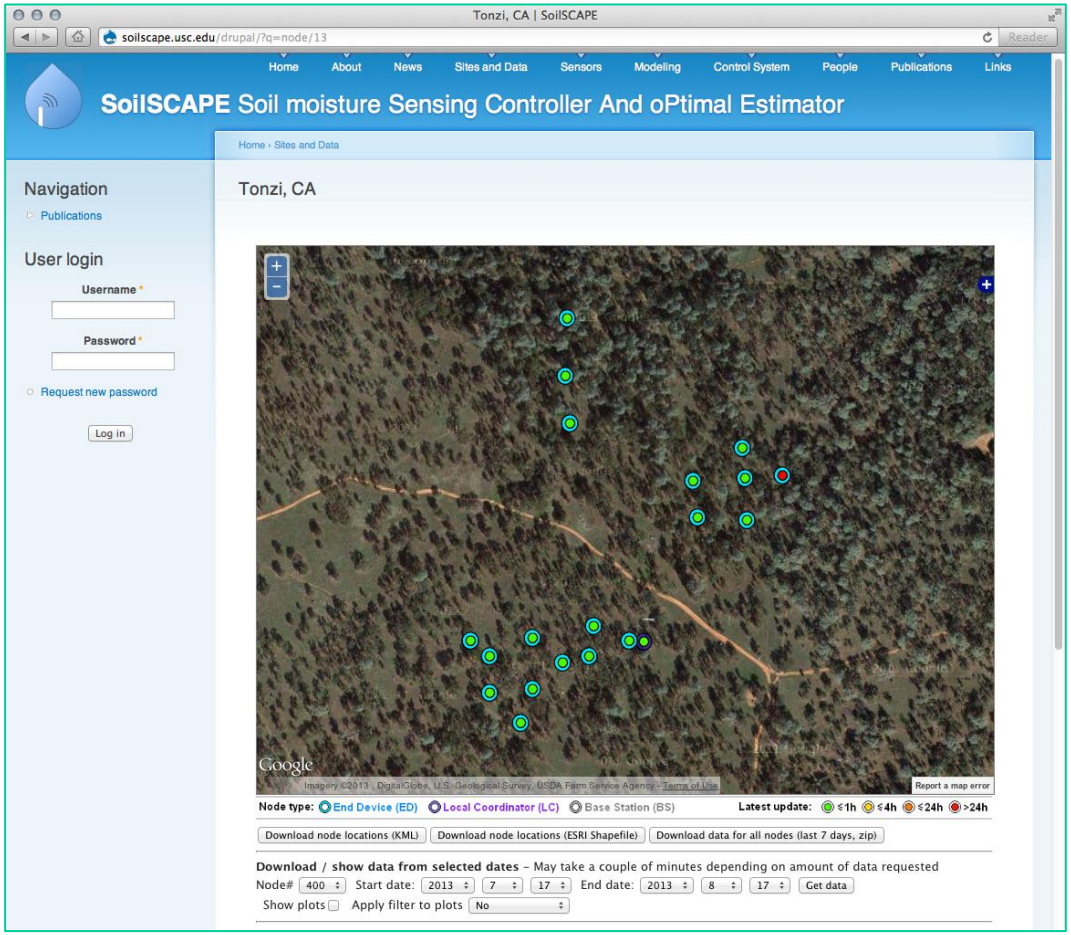
Database of collected data

- Extensive metadata contained in database:
  - Suited for ORNLDAAC requirements and future use
- Flags used for data quality:
  - Manually checking and flagging very noisy regions.
  - Automatically flagging very high / very low measurements.
  - Automatically flagging spikes.
- Currently over 2.2 M measurements:
  - On-site and off-site backups

Data Distribution / Visualization System (2)

Project website

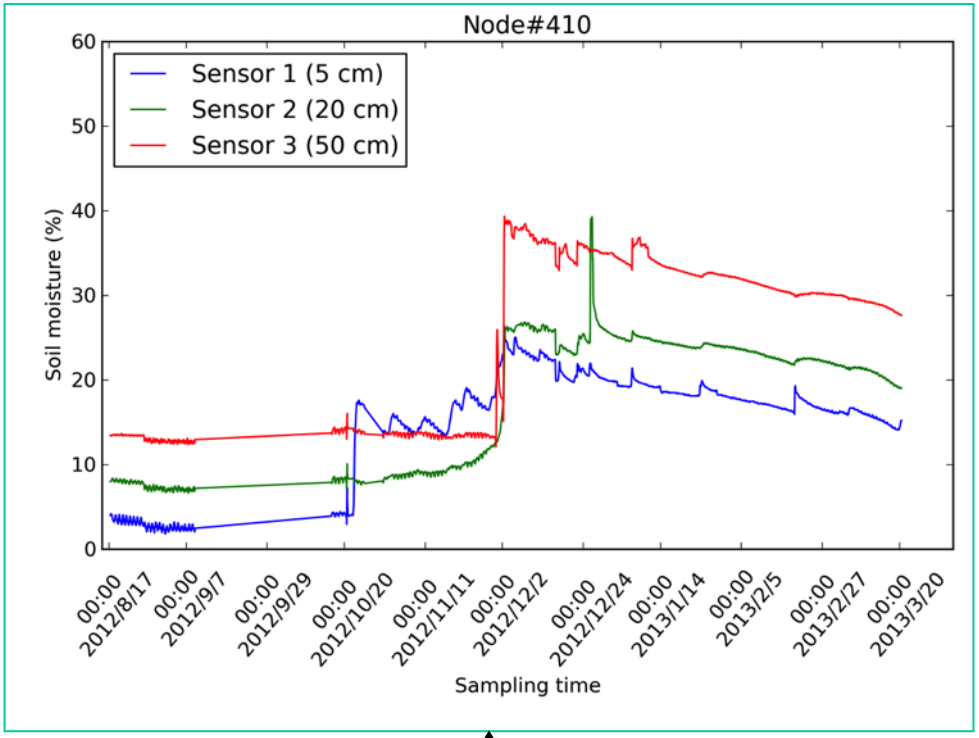
- http://Soilscape.usc.edu
- Project information and data portal.
- Provides maps of sensor status and current moisture.
- Contains information about sites and project.
  - Improved publications search
  - Project twitter feed – used for deployment updates.



Data Distribution / Visualization System (3)

Data distribution

- Data available to download through project website and through ORNL Mercury using custom interface.
- Provided in CSV format.
- Static plots available to download with data – choice of filters.
- Data calibrated and checked as downloaded – always latest version.
- Zip files with last seven days of data generated every hour – for automatic downloads.
- Node locations available in CSV format with downloads and KML / ESRI Shapefile separately.



Download / show data from selected dates – May take a couple of minutes depending on amount of data requested

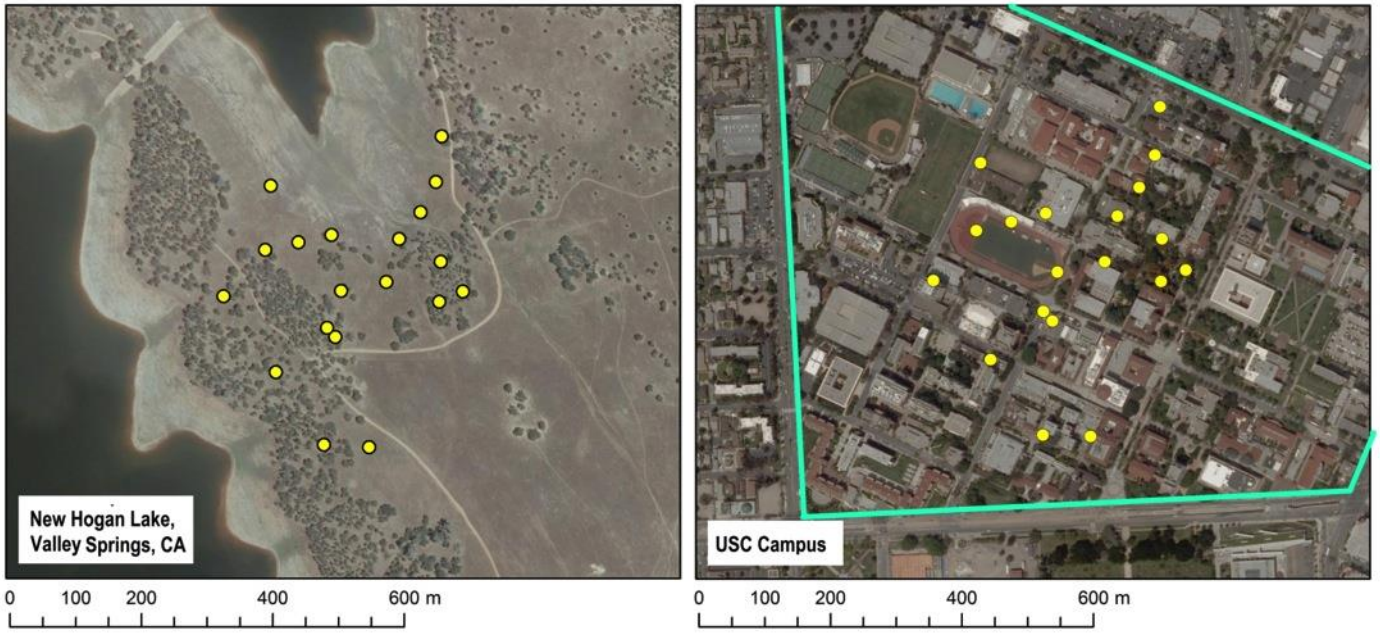
Node# 101 Start date: 2013 2 20 End date: 2013 3 20 Get data

Show plots Apply filter to plots Savitzky-Golay

SoilSCAPE Architecture Benefits (4)

Network coverage and sparsity

- Average distance between LC and ED is 300m, twice the typical distance for low-power 2.4GHz radios
- Average of 2.5 nodes ha^{-2} (~ 1 node per acre). No similar deployment known with this level of sparsity (Note: “sparse” is good!)
- This is possible due to the combination of
  - star-based, static topology, low duty-cycle application, very efficient home-made network protocol



Outlook

Work Left To Do

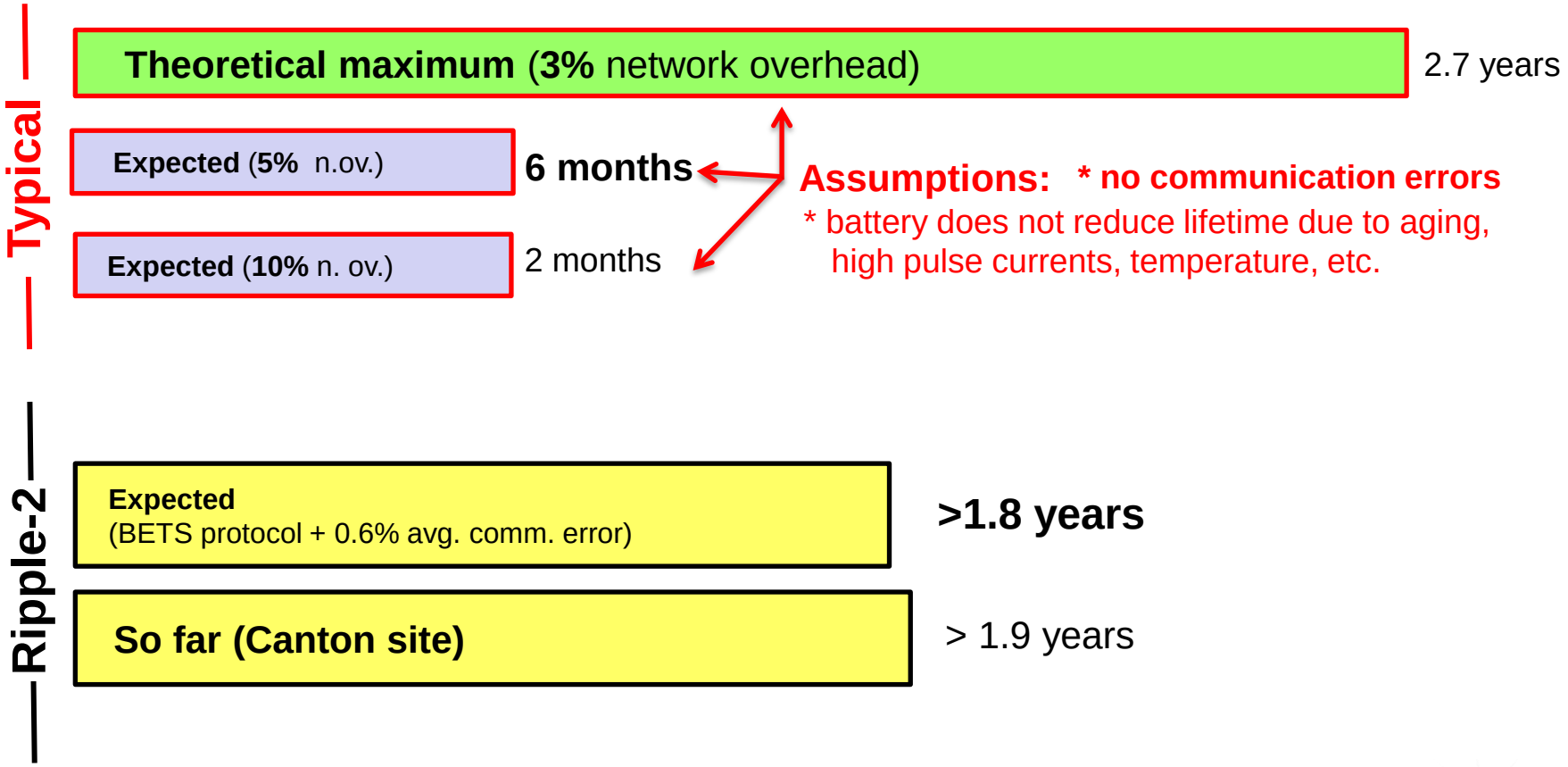
- **Installation of another 30-40 nodes**
  - Targeting areas with crops and/or non-savannah forests
- **Development of site-specific calibration**
  - So far have 6 distinct sites; will have one or two more
  - Each needs its own calibration – in progress
- **Further enhancement of end-to-end reliability for the SMS transmission**:
  - Currently, if the SMS connection fails for multiple attempts, the data are stored at the SD card, not transmitted again when the SMS connection is working
  - Plan is to create a queue to send such data when SMS connection is back
- **Development of scaling functions**
  - Have built radar landscape simulator; parameterized for various locations
  - Currently in process of randomized simulations to develop scaling function
  - Investigate scaling up using AirMOSS root-zone soil moisture retrievals

backup

SoilSCAPE Architecture Benefits (1)

Expected lifetime of nodes

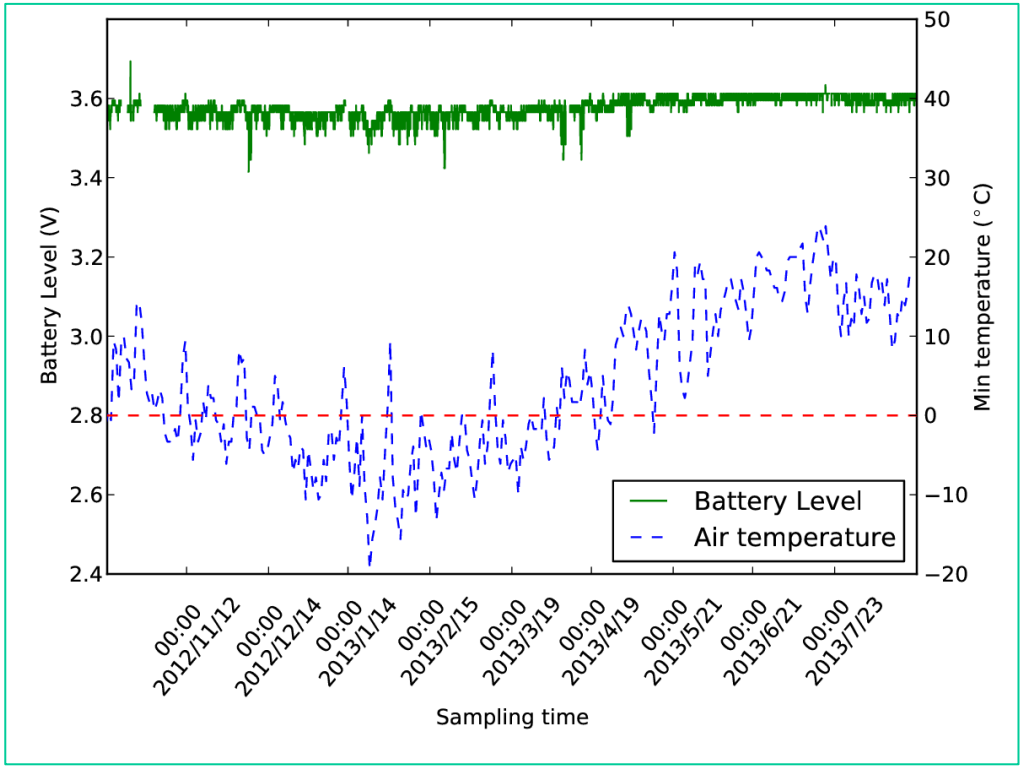
20 min cycles, 3.6V-19Ah non-rechargeable battery.



SoilSCAPE Architecture Benefits (2)

Resiliency to extreme temperatures

- The Ripple-2D node at the Matthaei site (Ann Arbor, MI) was not impacted by low temperatures.



Comparison between air temperature and battery level for Node 211 at Canton

- The solution can be deployed in regions with extreme temperatures.

SoilSCAPE Architecture Benefits (3)

Network coverage and sparsity

Site	Number of Nodes	Node Density (nodes ha^{-1})	Maximum distance from LC (m)
Canton	21	2.65	358*
Matthaei Gardens	10	1.91	178*
Tonzi	19	1.45	340
New Hogan 1	14	1.66	257
New Hogan 2	18	1.05	346
Terra d' Oro	27	1.50	317*
BLM 1	17	4.73	207
BLM 2	16	5.09	145

1 ha = 2.5 acres
1 m = 3.3 ft

* Furthest distance data is currently being received from.