**Geospatial data and remote sensing in the LTAR network**

**Background**

Virtually all of the data produced by the LTAR network monitoring effort can be analyzed as parameters of geospatial models. Geospatial data includes any geo-coded data resulting from field data collection covering a wide range of quantitative and qualitative data types. For LTAR network sites, primary field data will include time and geo-coded sensor data and field observations, and imagery from static, airborne and space-borne platforms. Secondary data may include datasets derived from primary data as well as published data and their derivations (e.g., land cover maps or vegetation indices produced from satellite-based reflectance data).

To be useful for geospatial modeling, LTAR data are in need of a standardized geospatial framework. Standardizing geospatial data parameters across the LTAR network will:

* Augment the existing data streams (e.g. hydro-meteorological data) with geospatial information that can be used for spatio-temporal monitoring and change modelling;
* Facilitate the development of datasets across multiple LTAR network sites
* Facilitate broader analyses at regional and continental scale, including multi-network applications (e.g., LTAR + LTER);
* Require identifying and following agreed upon best practices for geospatial data creation and database development (DataONE 2015; Strasser et al. 2012) including the data life cycle, geospatial parameters (datum, projection, resolution, spatial accuracy, etc.), and geospatial data structure.

There are certain pieces of critical LTAR information that can best be represented as geospatial data (e.g. boundaries, management units, etc), while there are other datasets that are best derived from airborne or space-borne sensors, which can provide highly important datasets that greatly increase the efficiency of analysis (e.g. multi-spectral imagery of broad areas).

While much effort has been expended in planning the collection of hydrologic, meteorological and biological data for LTAR sites, additional focus is needed to identify best practices for the geospatial characteristics of these data. At the same time, attention is needed to identify those additional datasets that are geospatial in nature, and that meet common critical information needs across the LTAR network.

**Temporal and Spatial Scale**

At fine scales, temporal and spatial grain are determined by the monitoring protocols developed within each subject area (biology, meteorology, etc.). At intermediate scales, LTAR network sites operate within management units of properties that are financed and managed at sub-decadal periods of months to years. At broad scales, LTAR network sites are nested within regions of similar environmental and cultural characteristics, such as a watershed, an ecoregion (Omernik and Griffith 2014) or a state, whose broader characteristics are subject to decadal changes in governance, climate and land surface transitions.

Caution must be exercised in data integration to ensure that model interpretations are based upon the coarsest resolution of data available. For example, if a dataset of 1:24,000 is combined with a dataset of 1:1000, the results will be no more accurate or precise than the 1:24,000 dataset. For this reason, it is best to identify datasets with respect to their utility in applications that involve spatio-temporal scale considerations. Ideally, a dataset that useful for fine-scale analyses could be aggregated into a coarser scale analysis. However, if the characteristics that allow for this aggregation are not standardized across datasets of similar type and scale, then such integrated analyses will be impossible or very limited, and not very informative. Thus, LTAR needs to develop standardized methods for data aggregation across scales.

Fig. 1. Nested hierarchy of spatial scales of geospatial data relevant to LTAR network studies with examples of data and model types and typical representative fraction scales. Remote sensing and geospatial data within the LTAR network will be applied in studies of various scales ranging, for example, from within field analyses of variability, to the integration of LTAR network data with regional and global change models.

**Further planning:**

* Need more information from LTAR sites:
  + Request input at Archbold LTAR meeting
  + What geospatial data management practices are already in place?
  + Do we need a geospatial rep for each site?
* Data management logistics
  + Option 1: Each site could be responsible for obtaining or creating the required spatial datasets, and uploading them to the LTAR data portal.
  + Option 2: Sites upload boundary layers and any other non-public info, and the publically available data are assembled by NAL or some other centralized location?

**Standardized products:**

An objective of this sub-group is to identify a set of standardized products at critical, defined scales. This set of products will be tailored to leverage data for maximum use in modeling applications (what are the characteristic data requirements of critical global and/or regional models that we are aiming for?).

*Potential Core Spatial Datasets*

1. LTAR-relevant boundary layers at multiple scales:

* Intensive measurement boundaries (fetch areas, vegetation measurement plots, experimental plots etc.)
* Field or pasture boundaries (both for Observatory and for Common Experiment)
* Commercial production system (e.g. farm or ranch) boundaries
* Instrumented watershed boundaries
* Outer boundary (full extent) of each LTAR site (may coincide with one or more of the boundary layers above, or could be different). Need to decide, what are each of the LTAR site’s respective footprints, and how do they compare?

1. Publicly available data clipped to the full extent of each LTAR site:

Suggested datasets for all LTAR network sites include standardized publicly available national datasets already existing for the US (e.g. soils, land cover, hydrology, elevation, geology, and precipitation) extracted to the foot print of the LTAR site (TBD based on Archbold discussion).

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| --- | --- | --- | --- |
| Data type | Title, source and date | Scale or resolution | Comment |
| Elevation | NED 10m, NRCS 2014 (based on USGS 2011) | 10m |  |
| Soils | SSURGO (and gSSURGO), NRCS, 2013-2014 | 1:24000 (and 10m) |  |
| Hydrology | NHDPlusV2  NHD/WBD, USGS | 1:24000 |  |
| Land cover | NLCD, USGS, 2011  CDL, NASS, 2014 (most recent) | 30m  30m |  |
| Geology | USGS and State Geologic Surveys | 1:500,000 |  |
| Multi-spectral imagery | Landsat ETM+  MODIS | 30m  250m  1000m | need to define frequency of data upload. Can we automatically pull clipped data from each satellite pass? e.g. Forwarn |
| Aerial photography | NAIP, FSA, 2013-2015 | 1m |  |
| Precipitation | PRISM? |  |  |
| Socio-economic | Agriculture Census, USDA  FIA, US-FS  Economic Census, USDoC  Demographic information | County scale  County/State scale  Census tract |  |
|  |  |  |  |

Considerations for publically available data:

* Need to decide on which editions of these published dataset to use.
* Do we maintain older versions of these data? We will likely want to archive land cover at various points as it changes.

Multispectral and hyperspectral satellite data considerations:

* Some sites may already have ongoing efforts to gather and archive multispectral data
* What common multispectral products should we focus on retrieving for all LTAR network sites?
* Possible sensor candidates include Landsat ETM+, MODIS, SMAP, ALOS (possibly NISAR post-2020), but there are many others.

1. Derived data:

* Evaluation of whether/how vegetation indices (e.g. NDVI, EVI) estimate ANPP, phenology, and other products (nutrients, soil moisture) across the network?
* Change and trend products (e.g. land cover, surface temp., etc.)?

1. Other remotely sensed data at finer scales (tier 2?):

* UAV data: panchromatic and CIR
* NEON hyperspectral data (depends on overlap with LTAR site?)
* A sub-meter accuracy elevation dataset (e.g. LIDAR derived elevation) that can be used to map fine scale field measurements.
* “Hydrologically enforced” DEM
* Field measurements (e.g. NDVI, etc.)

**References**

DataONE. 2015. 'Best Practices', DataONE, Accessed 4 January. <https://www.dataone.org/best-practices>.

Omernik, JamesM, and GlennE Griffith. 2014. 'Ecoregions of the Conterminous United States: Evolution of a Hierarchical Spatial Framework', *Environmental Management*, 54: 1249-66.

Strasser, Carly, Robert Cook, William Michener, and Amber Budden. 2012. "Primer on Data Management." In. Albuquerque, NM: DataONE.