

CHAPTER 5

TIERING SYSTEM

Network development and operations benefit from setting goals and criteria for the data and products they produce. It is necessary to provide a set of guidelines or goals for soil moisture metadata which can be self-assessed for a time series or station. Thus, a tiering system for metadata availability has been developed in conjunction with the [Soil Moisture Data Quality Guidance](#) document (*Soil Moisture Data Quality Guidance*, Chapter 8). The metadata tiering system here was designed to be used in conjunction with the data quality tiering system given in that document. Any tiering system must be comprehensive in the critical and common characteristics for networks, while also being flexible and applicable to the variety of conditions found among the many networks deployed in the past, present, and future. These criteria have been selected after discussions with data users and data providers that identified factors that they use to select data products for application and analysis. Broadly, the tiering system is built on network evaluation of having ‘None’, ‘Some’, or ‘All of the Ideal Criteria’. These tier classifications are intended to provide quick guidance for researchers considering application of a dataset, but it is recognized that some datasets may be of research value regardless of the quality of their associated metadata. Tier classifications can also be used to provide network operators with goals for network upgrades and justification for associated funding.

These elements associated with different tiers can be self-evaluated by the networks themselves but may also be subject to peer review as usually occurs in scientific reviews and publications. Generally, a station would be classified only as high as their lowest tier class among the three tiers, however, there may be some situations where temporal caveats are reasonable.

The metadata standards for each of the three tiers are listed below, in order of least comprehensive (Tier 3) to most comprehensive (Tier 1). Tier 3 is based on what should be considered a bare minimum of metadata necessary to interpret soil moisture sensors measurements and should be relatively easy to achieve for all networks; Tier 2 represents a moderate level of metadata, reflecting an added value for data applications but also requiring more effort in collection; Tier 3 is the most comprehensive level of metadata, requiring more significant effort but representing the most value to the broader user community.

It is noted that networks may not want to make all the information in each tier publicly available for security purposes. For this reason, the only information that we recommend be made fully available to the public are those items listed within Tier 3 (see below), and in certain cases even that information may be generalized to provide additional security. For example, site coordinates may be rounded to fewer decimal places to obscure the exact location of a site.

Tier III: Basic Metadata

(Provides the bare minimum of metadata, all listed items are publicly available, tier may include citizen science-like networks.)

- **Network**
 - Network name and aliases
 - Host institution/affiliation
 - Mission and intended data application
 - Contact information
 - List of all measurement types
 - Frequency of all measurement types
- **Site**
 - Station name/ID
 - State/County
 - Latitude/Longitude
 - Elevation
- **Soil Moisture Sensors**
 - Depths of installation
- **Soils**
 - [NRCS Soil Survey Geographic Database](#) (SSURGO) map unit key

Tier II: Moderate Metadata

(All metadata components for Tier II are publicly available; additionally, the following information is on record, although metadata types listed below may not necessarily be publicly available based on the discretion of the network managers. Network should denote that these metadata exist and level of availability [e.g., public, on-request, not for dissemination].)

- **Network**
 - QA/QC protocols
 - Telemetry and statement of latency
- **Site**
 - Ancillary soil measurements (e.g., soil matric potential or temperature)
 - Ancillary weather measurements (e.g., air temperature, precipitation, etc.)

- **Soil Moisture Sensors**

- Sensor model, manufacturer
- Date installed, if different than site deployment date
- Raw data types and associated units

- **Soils**

- Profile/pedon description
 - Based on [USDA-NRCS classification](#) system/nomenclature
 - Photo of profile or soil core with depth reference (meter stick)
- Texture (sand, silt, clay)
 - Sand, silt, clay percentages at each sensor depth (minimum)
 - Method used to determine percentages (hydrometer, pipette, other)
 - Fraction of coarse fragments by volume
 - Textural class (USDA-NRCS system)
- Organic matter layer
 - Depth
 - % area covered surrounding site
 - Type of vegetation litter: evergreen vs. deciduous
 - Hydrophobicity
 - Changes over time

Tier I: Best Metadata

(Provides high level of detail and high-quality information; metadata supports multiple research applications. All metadata recommendations of Tier II and Tier III are met in addition to following requirements, and these metadata are kept on record internally. Metadata may or may not be made publicly available, based on the discretion of the network manager.)

- **Network**

- Operations and maintenance information
- Installation protocol, including soil moisture sensor orientation(s)
- Metadata update schedule (for items that change with time, such as seasonal photos)

- **Site**

- Photos

- Installation date (and date[s] of relocation, if applicable)
- Slope/aspect/landform (for mountainous sites)
- Land use/land cover (LU/LC)
- Nearby obstructions
- Site maintenance record
- **Soil Moisture Sensors**
 - Sensor calibration type: manufacturer, manufacture year/model, site-specific, etc.
 - Location relative to tower
- **Soils (at each sensor depth)**
 - Bulk density
 - Mineralogy
 - Soil water retention
 - Saturated hydraulic conductivity (K_{sat})
 - Aggregate stability

An itemized list of variables for each tier is given in Appendix A.