WEIR Database Documentation

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# Table Documentation

## WICST Schema

### wicst.soils [soil\_archive]

Table holding information related to soil fertility. Routine fertility, and deep core samples are included here.

| Column Name | Type | Description |
| --- | --- | --- |
| year | FLOAT<8> | year of soil sample |
| plot\_id | FLOAT<8> | ID of plot soil samples were taken from |
| section | VARCHAR<255> | Location within plot soil samples were taken |
| coordinate | VARCHAR<255> | Location within plot-section soil samples were taken |
| season | VARCHAR<255> | season soil sample was taken |
| soil\_date | DATETIME | When the soil sample was taken, if known |
| soil\_tier | VARCHAR<255> | type of soil fertility |
| depth | VARCHAR<255> | Range of soil depth used for soil analysis |
| ph | FLOAT<8> | pH of soil |
| om | FLOAT<8> | Organic Matter Percentage |
| p | FLOAT<8> | Soil Test Phosphorus in ppm |
| k | FLOAT<8> | Soil Test Potassium in ppm |
| ca | FLOAT<8> | Calcium |
| mg | FLOAT<8> | Magnesium |
| cec | FLOAT<8> | Cation Exchange Capacity |
| b | FLOAT<8> | Boron |
| mn | FLOAT<8> | Manganese |
| z | FLOAT<8> | Zinc |
| s | FLOAT<8> | Sulfur |
| cu | FLOAT<8> | Copper |
| fe | FLOAT<8> | Iron |
| bph | FLOAT<8> | Buffer pH |
| nit\_real | FLOAT<8> | Nitrogen in lbs/acre |
| nit\_est | FLOAT<8> | Estimated Nitrogen lbs/acre |
| lab\_source | VARCHAR<255> | Where the soil was analyzed |
| comments | VARCHAR<255> | comments about soil nutrient observations |

1. Data Details
   1. soil\_tier [routine fertility | fall nitrates | deep fertility]
      1. What type of soil fertility test and what soil source
   2. depth [0-6 in | 6-12 in | 0-12 in | 12-24 in | 24-36 in]
      1. What range of depth did the soil data come from.
         * This should be the targeted soil horizon for sampling that the observations represent
         * Routine fertility should be 0-6 in in depth
         * Fall nitrates should have three target depths 0-12 in, 12-24 in, 24-36 in.
   3. lab\_source
      1. The location where the analytic soil tests done.
   4. soil\_tier [ fall nitrates | deep fertility | routine fertility ]
      1. Type of soil sample Each soil sample has a set of target depths, see data details for depth
         * fall nitrates - assessment of nitrate in 1 ft soil intervals during the fall
         * deep fertility - measurements from deep sample cores
         * routine fertility - recurring measurements of soil nutrients
   5. nit\_est
      1. NO3-N in the soil estimated by lab. Estimates for 24-36 in depth samples are estimated from 1 and 2 ft samples.
   6. season [fall]
      1. season of soil sampling Exact dates for soil samples are not complete, but season of soil sample sufficient for estimate of time when backfilling data
   7. comments
      1. Additional comments about soil observations. Comments are in the format ’source: “comment”’, and delimited by |.

### wicst.carbon [soil\_archive]

Table holding soil organic carbon measurements for WICST.

| Column Name | Type | Description |
| --- | --- | --- |
| year | FLOAT<8> | year of soil sample |
| plot\_id | VARCHAR<255> | ID of plot soil samples were taken from |
| section | VARCHAR<255> | Location within plot soil samples were taken |
| coordinate | VARCHAR<255> | Location within plot-section soil samples were taken |
| depth | VARCHAR<255> | The targeted sampling depth category |
| min\_depth\_inch | FLOAT<8> | Actual minimum limit of soil sampling depth in inches |
| max\_depth\_inch | FLOAT<8> | Actual maximum limit of soil sampling depth in inches |
| cn\_method | VARCHAR<255> | Method used to quantify carbon and nitrogen |
| number\_composited | FLOAT<8> | Number of soil samples that have been composited for observation |
| nit | FLOAT<8> | Nitrogen percentage measured |
| nit\_kriged | FLOAT<8> | kriged estimate of nitrogen as percentage |
| nit\_kriged\_variance | FLOAT<8> | variance of kriged estimate of nitrogen |
| soc | FLOAT<8> | Soil organic carbon percentage |
| soc\_kriged | FLOAT<8> | kriged estimate of soil organic carbon as percentage |
| soc\_kriged\_variance | FLOAT<8> | variance of kriged estimate of soil organic carbon |
| soc\_equipment | VARCHAR<255> | Equipment used for SOC measurement |
| bulk\_density\_g\_cm3 | FLOAT<8> | Bulk density in g/cm^3 |
| soc\_mg\_ha | FLOAT<8> | soil organic carbon in megagrams/hectare |
| soc\_mg\_ha\_method | VARCHAR<255> | method of calculating soc\_mg\_ha |
| esm\_reference | VARCHAR<255> | Free text description for conserved reference mass in soc\_mg\_ha calculation |

1. Data Details
   1. coordinate [“south” | “north” | “center”]
   2. depth [“0-6 in” | “6-12 in” | “0-12 in” | “12-24 in” | “24-36 in”]
      1. Depth categorizations of soil sampling observations. These represent the intended soil sample, even if full depth was not achieved
   3. min\_depth\_inch
      1. When target sampling depth was not obtained, these numbers provide a more accurate interval for soil collected
   4. max\_depth\_inch
      1. When target sampling depth was not obtained, these numbers provide a more accurate interval for soil collected
   5. number\_composited
      1. Some observations are composited from multiple samples from the field.
         * 0 - observation is not representative of any soil samples, for example for kriged estimates
         * 1+ - when 1 or greater, the number of samples composited in the field for the observation
   6. soc
      1. The soc column refers to the mass % carbon of the soil sample, as determined by dry combustion using a Flash EA 1112 CN Automatic Elemental Analyzer. %C was considered equivalent to %SOC for these soils. Samples for %SOC analysis were collected by combining 3 samples taken 19 cm apart (0, 19, and 38 cm). This was done to ensure that samples were collected in-row, between-row, and at an intermediate location in all of the maize plots, to account for variation in SOC between rows of maize.
         * See Dietz et al. ([2024](#orga7e8188))
   7. soc\_kriged
      1. see nit\_kriged
   8. nit\_kriged
      1. Bulk soils were sampled on a 30 x 30 grid in 1989 as described in Dietz et al. ([2024](#orga7e8188)) and segmented into 0-15, 15-30, 30-60, and 60-90 cm depth increments. Samples were analyzed for N (and C) using dry combustion. Bulk soil N (g N / 100 g soil) was interpolated using a kriging process similar to that described in Dietz et al. ([2024](#orga7e8188)) for C interpolation. Briefly, spherical variogram models using were fitted to each depth separately using the gstat package in R. Starting values for nugget, psill, and range were determined by visual inspection of semi-variograms. Due to low spatial autocorrelation in the 30-60 and 60-90 cm depths, the variogram models did not fully meet convergence criteria. However, visual inspection of the model vs. semi-variogram indicated that the model fits were acceptable. The low spatial autocorrelation in the 30-60 cm and 60-90 cm depths results in high variance and limited range of estimated values. However, for N balance purposes, the high variance of N estimates is likely acceptable.
         * See WICST\_N\_kriging\_graphs\_2024-01-14.pdf for graphs of the kriging process.
         * See also Gräler, Pebesma, and Heuvelink ([2016](#org2b5c13e)) kriging details in R
   9. cn\_method [“dry combustion” | “mid infrared reflectance”]
      * + dry combustion - considered the standard for elemental analysis
        + mid-infrared reflectance - predicts SOC concentration based on absorbed mid-infrared light. Cheaper but less accurate.
   10. soc\_mg\_ha\_method [“depth based” | “equivalent soil mass”]
       * + depth based - uses the soil depth interval to estimate soil mass, multiplying by bulk density and soil carbon percentage for carbon stock
         + equivalent soil mass - To determine C stocks, rather than using depth from surface, we used cumulative mineral soil mass from the surface as it is a reference system that remains stable over time (i.e., not impacted by changes in bulk density or changes in organic matter). This “equivalent soil mass” or ESM method accounts for compaction, expansion, and addition or loss of organic matter, ensuring the same section of the soil profile is considered each time. For this dataset, these calculations were performed using R code provided by Von Haden, Yang, and DeLucia ([2020](#org4322452)) with the 1989 %SOC and BD for each sampling location (e.g. subplot within each plot) as the baseline.
           - See Von Haden, Yang, and DeLucia ([2020](#org4322452)) a clear and thorough explanation of ESM and its importance.

### ei.biogeo [soil\_archive]

| Column Name | Type | Description |
| --- | --- | --- |
| year | FLOAT<8> | year |
| seq\_id | FLOAT<8> | sequence for rock river lab samples submission |
| plot | VARCHAR<255> | main plot number |
| section | VARCHAR<255> | section of main plot containing EI |
| cc\_pre | VARCHAR<255> | cover crop preceding main crop |
| cc\_pre\_method | VARCHAR<255> | planting method of cc\_pre |
| cc\_post | VARCHAR<255> | cover crop planted after, or interseeded in main crop |
| cc\_post\_method | VARCHAR<255> | planting method of cc\_post |
| stability\_coef | FLOAT<8> | stand alone soil “stability” coefficient; |
| stability\_coef\_normalized | FLOAT<8> | soil “stability” coefficient min/max normalized using just the SI plots; based on stability\_coef |
| living\_cover\_coef | FLOAT<8> | stand alone soil “living cover (or roots)” coefficient; |
| living\_cover\_coef\_normalized | FLOAT<8> | living cover (or roots) coefficient min/max normalized using only SI plots; based on unadjusted system score for living cover |
| rci\_coef | FLOAT<8> | Rotational Complexity Index (RCI = number of species\*rotation length); see Bowles et al. 2020 |
| rci\_coef\_normalized | FLOAT<8> | RCI min/max normalized using only SI plots; based on unadjusted RCI (i.e., rci) |
| richness\_coef | FLOAT<8> | richness stand alone coefficients |
| richness\_coef\_normalized | FLOAT<8> | richness min/max normalized using only SI plots; based on unadjusted system score |
| cows\_coef | FLOAT<8> | degree of livestock integration taking presence/absence of animals into account as well as livestock manrue; |
| cows\_coef\_normalized | FLOAT<8> | cows min/max normalized using only SI plots; based on unadjusted systems score |
| pox | FLOAT<8> | POxC, mg C oxidized per kg soil |
| pom | FLOAT<8> | POM-C, fraction of total C |
| nit | FLOAT<8> | Total N, % |
| c | FLOAT<8> | Total C, % |
| microbial\_biomass | FLOAT<8> | Microbial biomass, nmol/g soil |
| act\_abundance | FLOAT<8> | Actinobacteria abundance, nmol/g soil (16:0 10 methyl + 17:0 10 methyl + 18:0 10 methyl) |
| amf\_abundance | FLOAT<8> | AMF, nmol/g soil (16:1 w5c), in agricultural soils this may contain bacterial components |
| fun\_abundance | FLOAT<8> | Fungi abundance, nmol/g soil (18:1 w9c + 18:2 w6c), weighted toward saprophytic fungi, not mycorrhizal fungi |
| gram\_negative\_abundance | FLOAT<8> | Gram negative bacteria abundance, nmol/g soil |
| gram\_positive\_abundance | FLOAT<8> | Gram positive bacteria abundance, nmol/g soil |
| protist\_abundance | FLOAT<8> | Protists, nmol/g soil (20:4 w6c) |
| bacteria\_abundance | FLOAT<8> | Bacteria, nmol/g soil |
| act\_percent | FLOAT<8> | Actinobacteria,mol% (16:0 10 methyl + 17:0 10 methyl + 18:0 10 methyl) |
| amf\_percent | FLOAT<8> | AMF, mol% (16:1 w5c) |
| fun\_percent | FLOAT<8> | Fungi, mol% (18:1 w9c + 18:2 w6c) |
| gram\_negative\_percent | FLOAT<8> | Gram negative bacteria abundance,mol% |
| gram\_positive\_percent | FLOAT<8> | Gram positive bacteria abundance, mol% |
| protist\_percent | FLOAT<8> | Protists, mol% (20:4 w6c) |
| bacteria\_percent | FLOAT<8> | Bacteria, mol% |

1. Data Details
   1. no\_till\_stability\_coef
      1. 1/(1+system score), simple inverse of tillage with correction for values <1
   2. living\_cover\_coef
      1. 1/(1+system score), simple inverse with correction for values <1
   3. richness\_coef
      1. richness\_coef = 1-(1/score)
   4. cows\_coef
      1. adding 1 in denominator to account for zeros cows\_coef = 1-1/(score+1)

# Bibliography [soil\_archive]

Dietz, Clarissa L., Randall D. Jackson, Matthew D. Ruark, and Gregg R. Sanford. 2024. “Soil Carbon Maintained by Perennial Grasslands over 30 Years but Lost in Field Crop Systems in a Temperate Mollisol.” Communications Earth & Environment 5 (1): 360. <https://doi.org/10.1038/s43247-024-01500-w>.

Gräler, Benedikt, Edzer Pebesma, and Gerard Heuvelink. 2016. “Spatio-Temporal Interpolation Using Gstat.” The R Journal 8 (1): 204. <https://doi.org/10.32614/RJ-2016-014>.

Von Haden, Adam C., Wendy H. Yang, and Evan H. DeLucia. 2020. “Soils’ Dirty Little Secret: Depth-Based Comparisons Can Be Inadequate for Quantifying Changes in Soil Organic Carbon and Other Mineral Soil Properties.” Global Change Biology 26 (7): 3759–70. <https://doi.org/10.1111/gcb.15124>.