# Guide to research data for the $N_2O$ repository

$N_2O$ Network

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## Purpose

This document is a guide for researchers preparing data sets for upload to the $N_2O$ Network repository. It breaks down research data into four broad categories — climate data, soil description, general management parameters and emissions data — and describes them in detail.

Researchers are encouraged to provide data for each category. In addition, they are encouraged to provide a full description of the experimental design and experimental parameters.

This guide does not specify a file format or a logical breakdown for the data package into data sheets or data files; the logical organisation of the package is at the discretion of the researchers.

When preparing a data package, the aim is for other researchers to be able to understand the data based solely on the description provided. Researchers are advised to keep one-off data (e.g. general site description) in a separate data file than high-frequency data (e.g. emissions data).

## 1 Climate data

### Required

**Maximum daily air temperature** - The maximum air temperature measured on that date ($^oC$). Normally at BOM standard height in the shade.

**Precipitation Rain** - Amount of rainfall (mm) during a day. Measured from 9am to 9am.

**Minimum daily air temperature** - The minimum air temperature measured on that date ($^oC$). Normally at BOM standard height in the shade.

**Cumulative solar radiation** - Daily cumulative solar radiation. Measured from midnight to midnight. $MJ/m^2/day$

### Desired

**Max relative humidity** - The maximum relative humidity (%) measured on that date.Measured from midnight to midnight. Also, dew point temperature or vapour pressure.

**Min relative humidity** - The minimum relative humidity (%) measured on that date. Measured from midnight to midnight. Also, dew point temperature or vapour pressure.

Average relative humidity (%) is a standard output from many weather stations and permissible.

**Wind speed** - The daily average wind speed (km/hr)

# 2 Soil description: physical + temporal parameters

## Required: Initial characterisation (*repeated on an annual basis)

**Horizon** - Specific layer in a soil profile. Layers defined as per the Australian Soil Classification Revised Edition (Isbell, 2002).

**Soil depth of horizon (cm)** - Depth of sampling, from the soil surface downwards to 1 metre.

**Replicates** - Number of samples analysed per soil horizon – normally three bulked samples can be used for each depth.

**Soil pH ($CaCl_2$)** - A measure of the logarithm of the reciprocal of hydrogen-ion concentration, it gives a measure on a scale from 0 to 14 of the acidity or alkalinity of the soil. Soil samples are air-dried, sieved (<2 mm) and shaken in 0.01 M CaCl2 (1:5 soil : extract) for 1 h. Samples are centrifuged (10 min at a relative centrifugal force of 850 G) before measuring pH with a glass electrode. Reference: Rayment, G.E and Higginson, F.R. (1992). Australian Laboratory Handbook of Soil and Water Chemical Methods. (Inkata Press, Australia.)

OR

**Soil pH (water)** - A measure of the logarithm of the reciprocal of hydrogen-ion concentration, it gives a measure on a scale from 0 to 14 of the acidity or alkalinity of the soil. Soil samples are air-dried, sieved (<2 mm) and shaken in water (1:5 soil : extract) for 1 h. Samples are centrifuged (10 min at a relative centrifugal force of 850 G) before measuring pH with a glass electrode. Reference: Rayment, G.E and Higginson, F.R. (1992). 'Australian Laboratory Handbook of Soil and Water Chemical Methods'. (Inkata Press, Australia.)

**Bulk density** - Defined as the mass of dry soil per unit bulk volume (e.g. $g/cm^3$). Bulk density determined by measuring the oven-dried mass (105°C) of undisturbed cores. Reference: McKenzie N, Coughlan K and Cresswell H (2002) 'Soil physical measurement and interpretation for land evaluation.' (CSIRO Publishing:Melbourne).

**Sand (%)** - Particles 2 – 0.02mm diameter. Laboratory measurement of particle size distribution using mechanical analysis (pipette method). Reference: McKenzie N, Coughlan K and Cresswell H (2002) 'Soil physical measurement and interpretation for land evaluation.' (CSIRO Publishing:Melbourne).

**Silt (%)** - Soil particles 0.02 – 0.002mm. Laboratory measurement of particle size distribution using mechanical analysis (pipette method). Reference: McKenzie N, Coughlan K and Cresswell H (2002) 'Soil physical measurement and interpretation for land evaluation.' (CSIRO Publishing:Melbourne).

**Clay (%)**- Soil particle < 0.002mm diameter. Laboratory measurement of particle size distribution using mechanical analysis (pipette method). Reference: McKenzie N, Coughlan K and Cresswell H (2002) 'Soil physical measurement and interpretation for land evaluation.' (CSIRO Publishing:Melbourne).

**Total C* (%)**- The amount of carbon in the soil. Determined by dry combustion of air-dried, finely ground soil. Reference: Rayment, G.E. and Higginson, F.R. (1992). 'Australian Laboratory Handbook of Soil and Water Chemical Methods'. (Inkata Press, Australia.)

**Total N* (%)** -The amount of nitrogen in the soil. Determined by dry combustion of air-dried, finely ground soil. Reference: Rayment, G.E. and Higginson, F.R. (1992). 'Australian Laboratory Handbook of Soil and Water Chemical Methods'. (Inkata Press, Australia.)

**Organic C* (%)** - Organic carbon determined using a modified 'Walkley and Black method' or by dry combustion (see Total C). For alkaline soils which may contain $CaCO_3$, removal of carbonates (with sulphurous acid) prior to dry combustion.Reference: Rayment, G.E. and Higginson, F.R. (1992). 'Australian Laboratory Handbook of Soil and Water Chemical Methods'. (Inkata Press, Australia.)

**Particulate C (%)** – Particulate carbon determined by MIR (CSIRO)

**Charcoal C (%)** – Charcoal (inert) determined by MIR (CSIRO)

## Required: High frequency sampling

**Soil Water Content (%)** - Daily (or hourly) volumetric soil water content by depth increment (cm) or gravimetric (i.e. dried soil samples) if bulk density is determined for the site during the study period .

**SE** - Standard error of value in previous column based on replicate plots

**Soil temperature ($^{o}$C)** – Average daily soil temperature at the midpoint of each depth increment, normally coincide with soil water content depth increments.

## Desired: Initial characterisation

**Saturation (%)** - Volumetric water content (by depth increment) when all soil pores are full of water and no air remains in the soil. The matric potential of soil at saturation is zero. Saturation determined in the laboratory using undisturbed cores (1.0 cm in height, 5.37 cm in internal diameter). Reference: McKenzie N, Coughlan K and Cresswell H (2002) 'Soil physical measurement and interpretation for land evaluation.' (CSIRO Publishing:Melbourne).

**Field Capacity (%)** - Volumetric water content (by depth increment) of the soil after rapid drainage has effectively ceased and the soil water content has become relatively stable. The matric potential of soil at saturation is -10 kPa. Field capacity determined in the laboratory using undisturbed cores (1.0 cm in height, 5.37 cm in internal diameter). Reference: McKenzie N, Coughlan K and Cresswell H (2002) 'Soil physical measurement and interpretation for land evaluation.' (CSIRO Publishing:Melbourne).

**Permanent Wilting Point (%)** - Volumetric water content (by depth increment)of the soil at which plants are permanently wilted. The matric potential of permanent wilting point is -1500 kPa. Field capacity determined in the laboratory using undisturbed cores (1.0 cm in height, 5.37 cm in internal diameter). Reference: McKenzie N, Coughlan K and Cresswell H (2002) 'Soil physical measurement and interpretation for land evaluation.' (CSIRO Publishing:Melbourne).

**Saturated hydraulic conductivity (cm/hr)** - The rate that water is transmitted through a soil when the soil is saturated i.e., pores are full of water and no air present. Saturated hydraulic conductivity determined in the laboratory using undisturbed cores (7.04 cm in height, 7.26 cm in internal diameter). Reference: McKenzie N, Coughlan K and Cresswell H (2002) 'Soil physical measurement and interpretation for land evaluation.' (CSIRO Publishing:Melbourne).

**Electrical Conductivity (dS/m)** - A measure of the conduction of electricity through water (by depth increment). Soil samples were air-dried, sieved (<2 mm) and shaken in deionised water (1:5 soil : extract) for 1 h. Samples were centrifuged (10 min at a relative centrifugal force of 850 G) before measuring pH with a probe. Reference: Rayment, G.E and Higginson, F.R. (1992). Australian Laboratory Handbook of Soil and Water Chemical Methods. (Inkata Press, Australia.)

**Cation exchange capacity (cmol/kg)** - Defined as the soils' ability to attract, retain, and exchange cation elements (by depth increment). Rayment, G.E and Higginson, F.R. (1992). Australian Laboratory Handbook of Soil and Water Chemical Methods. (Inkata Press, Australia.).

**Particle Density** - The mass of solid divided by its volume (sometimes referred to as specific gravity) (2.65 g/cm$^3$)

## Desired: High frequency sampling

**Nitrate (kg N/ha)** - Soil $NO_3^-$--N content for each measured depth and sampling date (requires ppm nitrate-N and bulk density)

**SE** - Standard error of value in previous column based on replicate plots

**Ammonium (kg N/ha)** - Soil $NH_4^+$-N content for each measured depth and sampling date (requires ppm ammonium-N and bulk density)

**SE** - Standard error of value in previous column based on replicate plots

**Dissolved organic carbon (g C/kg)** – cold water extractable carbon (by depth increment)

# 3 General management parameters (including crop + yield information)

## Required

**Description** - a general description of the experiment. For example, for an annual crop the planting date, harvesting date, fertilizer date and amount, irrigation date and amount etc. In general, in this section all the information regarding crop management should be added.

**Final grain yield (kg/ha)** - Grain yield. Determined after oven-drying grain at 60$^{o}$C.

## Desired

**Plant stage** - Stage of plant growth using Zadok's scale

**Shoot (kg/ha)** - Dry mass of above-ground plant matter. Determined after oven-drying at 60$^{o}$C.

**Shoot N (%)** - Amount of N in above-ground material. Determined after oven-drying at 60$^{o}$C.

**Shoot C (%)** - Amount of C in above-ground material. Determined after oven-drying at 60$^{o}$C.

**Grain N (%)** - N content of grain. Determined after oven-drying at 60$^{o}$C.

**Grain C (%)** - C content of grain. Determined after oven-drying at 60$^{o}$C.

# 4 Emissions data

## Required

**$N_2O$ Flux (mean $N_2O$-N flux for treatment)** - Daily $N_2O$ flux as gN/ha/day. Value is a mean of three replicates. Alternatively, all values for each replicate can be provided.

**SE** - Standard error of the value in the previous column. Value is calculated from three replicates.

## Desired

**$CH_4$ Flux (mean $CH_4$-C flux for treatment)** - Daily $CH_4$ flux as gC/ha/day. Value is a mean of three replicates.

**SE** - Standard error of the value in the previous column. Value is calculated from three replicates.

**$CO_2$ Flux (mean $CO_2$-C flux for treatment)** - Daily $CO_2$-C emission as kgC/ha/day

**SE** - Standard error of the value in the previous column. Value is calculated from three replicates.

# 5 Land Use History

## Required

Pre-settlement vegetation

Approximate year of first crop or pasture (i.e. first agricultural development at site)

Agronomic history - Approximate year and duration of crops and pasture (or rotation sequences) until present (including residue and grazing management, tillage, amount of fertiliser N/P applied)

## Desired

Agronomic history – Precise information on crop or pasture (or rotation sequences) until present (including residue and grazing management, tillage dates, planting, amount and timing of fertiliser N/P, harvest dates, yields etc)