Forest Soil Critical Load for Acidity
McNulty et al., 2007, 2013

Metadata for supporting GIS file

NCLD_FS_McNulty_GIS_v31.gdb

Content

These geographic information system (gis) files contain only critical loads from McNulty et al. 2007, 2013 that are part of the National Critical Load Database v3.1 (NCLD) for Forest Soil (FS) acidification.

Data and Project Citation

McNulty, S.T., Cohen, E.C., Moore Myers, J.A., Sullivan, T.J., & Li, H. 2007. Estimates of critical acid loads and exceedances for forest soils across the conterminous United States. Environmental Pollution, 149: 281-292. DOI: 10.1016/j.envpoI.2007.05.025.

McNulty, S. T, Cohen, E.C., & Moore Myers, J.A. 2013. Climate Change Impacts on Forest Soil Critical Acid Loads and Exceedances at a National Scale. In: Potter, Kevin M.; Conkling, Barbara L., eds. 2013. Forest Health Monitoring: national status, trends, and analysis 2010. Gen. Tech. Rep. SRS-GTR-176

NCLD Database Citation

Lynch, J.A., Phelan, J., Pardo, L.H., McDonnell, T.C., Clark, C.M., and Bell, M.D. 2020. Detailed Documentation of the National Critical Load Database (NCLD) for U.S. Critical Loads of Sulfur and Nitrogen, version 3.1, National Atmospheric Deposition Program, Wisconsin State Laboratory of Hygiene, Madison, WI.

Critical Load Overview

This section provides a description of the "Forest Soil (FS)" CLs of acidity for forest soil. Critical Loads in this dataset represent the amount of S, N, acidifying S, N, and both S and N deposition below which a forest system can receive and maintain a healthy ecosystem. The database currently consists of data from four different studies. Therefore, care should be taken when using these data to aggregate CLs and/or calculate CL exceedances (see table below). When using these data, it is important to consider the following: (1) that these CLs were determined using different models and methods to estimate soil base cation weathering, (2) that various chemical criterions and thresholds are used, (3) that a specific location could have more than one CL, and (4) that different CL represent different spatial scales (eg. 1 km to watershed).

Source	Method	Scale	Location
McNulty et al., 2007, 2013	SMB	1 km^2	Forests nationwide

Critical load is a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge (Nilsson and Grennfelt 1988, UNECE 2004). Porter et al. (2005) informally defined a CL as “the threshold of deposition below which specified harmful ecological effects do not occur.” The NCLD contains three different types of CLs: Steady-State Mass Balance, Empirical, and Target loads (TL). A Steady-State Mass Balance CL is derived from mathematical mass-balance models under assumed or modeled equilibrium conditions. An empirical CL is developed using empirical approaches, which involve observed spatial or temporal gradient studies or experimental manipulations of pollutants. A TL is the deposition load that is selected or determined to provide a level of protection for or recovery of sensitive ecosystem components based on time frame for resource protection, feasibility of emissions reductions, and/or other considerations. It can be determined through management or policy considerations, or by using dynamic process-based models that calculate the deposition load that leads to a desired chemical or biological state of an ecosystem in a given future year (Posch et al., 2003). The TL may be set higher or lower than or equal to the critical load. Target load has sometimes been referred to as “a dynamic critical load.”

Below is a general overview on calculating CL exceedances for all CL types. A more detail and in-depth discussion of exceedances can be found in Chapter VII: Exceedance calculation of the 2015 ICP Modelling and Mapping Manual (see http://icpmapping.org/Latest_update_Mapping_Manual).

Critical load exceedances can be considered with respect to S, N, and combined S and N deposition depending on the type of CL. For the Forest Soil (FS) and Surface Water (SW) for acidification, these CLs exceedance can be considered for S, N, and combined S and N deposition. However, the Empirical (EMP) CLs currently can only be considered with respect to N deposition.

For FS and SW, when considering only S deposition (i.e., N deposition is zero), the exceedance is expressed as the difference between the maximum CL of S (CLmaxS) and total S deposition (Eq. 1). If only N deposition is considered (i.e., S deposition is zero), the exceedance is expressed as the difference between maximum CL of N (CLmaxN) and total N deposition (Eq. 2).

$$\text{Exceedance(s)} = \text{Total S deposition} - \text{CLmaxS} \qquad (1)$$

or

$$\text{Exceedance(s)} = \text{Total N deposition} - \text{CLmaxN} \qquad (2)$$

In most cases, deposition of both S and N contributes to exceedance. Calculating a combined S and N CL exceedance is more complex where both CLmaxS and CLmaxN are taken together with total N and S deposition and the long-term N removal processes in the soil (e.g., N uptake and immobilization) define a “minimum” CL for N (CLminN). Nitrogen deposition inputs below the CLminN do not acidify, but once CLminN is reached, the interment of N deposition above CLminN contributes towards acidification. This creates a “three-node line” on a graph representing the acidity CL (**Figure 1**).

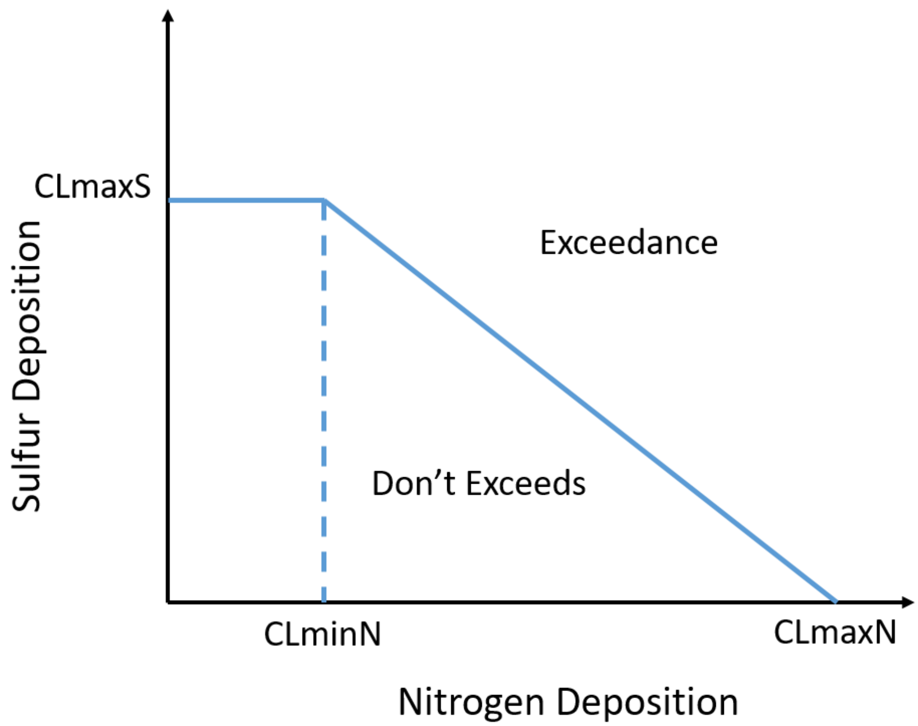

Figure 1. Three-node linear CL functions of S and N, defined by the three quantities CLmaxS, CLminN, and CLmaxN. The area outside the blue line notes deposition pairs of N and/or S resulting in CL exceedance while the area inside notes deposition pairs that do not exceed the CL.

Combinations of deposition above the blue line in Figure 2 would exceed the CL for N and S, while all areas below or on the line represent the area where CLs do not exceed. Deposition of both S and N exceedance is then a two-step calculation process (Eq. 3 and Eq. 4):

When CLminN ≥ Total N deposition, then

$$Ex(N+S) = \text{Total S deposition} - CLmaxS \quad (3)$$

When CLminN < Total N deposition, then

$$Ex(N+S) = \text{Total S + N deposition} - CLmaxN \quad (4)$$

See NCLD Database v3 0 document for more details.

Projection

USA_Contiguous_Albers_Equal_Area_Conic_USGS_version	
Projection: Albers	Geographic Coordinate System: GCS_North_American_1983
False_Easting: 0.00000000	Datum: D_North_American_1983
False_Northing: 0.00000000	Prime Meridian: Greenwich

Central_Meridian: -96.00000000	Angular Unit: Degree
Standard_Parallel_1: 29.5.00000000	
Standard_Parallel_2: 45.00000000	
Latitude_of_Origin: 23.00000000	
Linear_Unit: Meter	

No Data Values

The values -9999, -9999.99, -9999.999 are used in numeric fields and "no data" or "n/a" is used in text fields within the database to represent "(no data)" or "(n/a)" meaning "does not apply."

Attribute Descriptions

Variable	Explanation	Format
CLID	Unique(!) identifier across all three CL grouping: Forest Soil, Surface Waters, and Empirical Nitrogen.	Text
PRID	Unique(!) identifier of the CL project.	Integer
LOCID	Unique(!) identifier of a particular location (e.g. lake, stream reach, or sample plot), gridded area, or Ecoregion I-IV. Lakes and stream reaches are classified by NHDPlusV2. In many cases, a single lake/stream reach or ecoregion may have more than one CL value. The LOCID can be used to aggregate CLs for a particular location.	Text
CL_Class	Critical load class across all tables: Forest Soil Acidity Surface Water Acidity Empirical	Text
SiteID	Project specific identifier of the site.	Text
LatDD	Latitude (decimal degrees).	Text
LongDD	Longitude (decimal degrees).	Text
CL_Type	Critical load type: Steady-state Target-load Empirical.	Text
CLmaxS	Maximum CL of S (eq/ha-yr).	Double
CLminN	Minimum CL of N (eq/ha-yr).	Double
CLmaxN	Maximum CL of N (eq/ha-yr).	Double
TargetYear	Target load (TLS) year.	Integer
ChemCriterion	Chemical criterion used: molar [Bc]:[Al] molar [Ca]:[Al] Base Saturation	Text
ChemThreshold	Value of the chemical threshold used.	Integer
PrimRef	Publication citation for primary study for the CL.	Text
CL_Unit	Critical load unit: eq/ha-yr	Text

Linking/Joining to Database Tables

NCLD tables (1A, 2A, and 3A) can be joined to this feature dataset by the CLID.

National Critical Load Database (NCLD) Information Use Conditions

Disclaimer

The National Atmopsheric Deposition Program (NAPD) Critical Loads of Atmopsheric Deposition (CLAD) Science Committee National Critical Loads Database (NCLD) for Nitrogen (N) and Sulfur (S) was developed cooperatively with individuals or groups sharing critical load (CL) data and is NOT intended to be comprehensive of all known CLs for the U.S. While substantial efforts are made to ensure the accuracy of data and documentation contained in the NCLD, complete accuracy of the information cannot be guaranteed. The qualities and accuracy of the CLs are best described in the associated research publication(s). It is important to review material and information in the cited papers prior to using the CL data within the NCLD. In addition, any opinions, findings, conclusions, or recommendations as part of these datasets do not necessarily reflect the views of CLAD, NADP, and/or respective members' affiliations.

Use Condition and Citation

The intended use of the NCLD is for scientific, policy-related, and/or educational purposes. Any published use of the database information must acknowledge the original source(s) of the data. Each CL value is linked to its origin source(s) through the RefID field. The proper citations for each RefID can be found in Table 6 of the database. In addition, whenever the Data User presents and/or publishes research based on CLs in the database, NADP and CLAD must be acknowledged. A suggested Acknowledgement is:

"We acknowledge the Critical Loads of Atmospheric Deposition (CLAD) Science Committee of the National Atmospheric Deposition Program (NADP) for their role in making available NCLD_v3.0 datasets"

and please cite:

Lynch, J.A., Phelan, J., Pardo, L.H., McDonnell, T.C., Clark, C.M., and Bell, M.D. 2020. Detailed Documentation of the National Critical Load Database (NCLD) for U.S. Critical Loads of Sulfur and Nitrogen, version 3.1, National Atmospheric Deposition Program, Wisconsin State Laboratory of Hygiene, Madison, WI.

We request one copy of any printed publications using data from the NCLD to be sent to the NADP Program Office at the address below. Citations or electronic copies are acceptable. For online uses, we request that the author notify the Program Office of the URL address of the online publications or website that includes NCLD data. We encourage teachers and professors to send the program office a brief description of how they have used the NCLD in their curriculum. Students who use the NCLD to complete academic assignments are not required to seek permission from the Program Office, but must acknowledge NADP and CLAD in any publications (e.g., a thesis).

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Questions, Errors and Corrections

Please contact NCLD manager, Jason Lynch (US EPA) with any questions about the NCLD or to report errors or corrections at lynch.jason@epa.gov or 202-343-9257.

References

McNulty, S.T., Cohen, E.C., Moore Myers, J.A., Sullivan, T.J., & Li, H. 2007. Estimates of critical acid loads and exceedances for forest soils across the conterminous United States. Environmental Pollution, 149: 281-292. DOI: 10.1016/j.envpoI.2007.05.025.

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Posch, M., J.-P. Hettelingh, J. Slootweg (Eds.). 2003. Manual for Dynamic Modelling of Soil Response to Atmospheric Deposition, Coordination Centre for Effects, Bilthoven, Netherlands (2003) RIVM Report 259101012, 71 pp. www.mnp.nl/cce

Document Information

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