CRITICAL LOAD MAPS

- Update
- 4th Edition
- Approval

Found ontheworldgeography.com
PURPOSE

• To Educate

• To Illustrate Critical Loads in the NCLD

• To Identify Data Gaps and Additional Needs
NCLD

Maps
(1) Surface Water Acidity for N & S
(2) Forest Ecosystem Acidity for N & S
(3-7) Empirical Critical Loads for N

Pardo et al. 2011:
• Mycorrhizal Fungi
• Lichens
• Forest Ecosystems
• Herbaceous Plants & Shrubs

Geiser et al. 2010:
• Lichens
Challenges:

• No One Method Can Be Used for All Endpoints

• Each Endpoint Have Their Unique Differences

• CLs Represent Different Spatial Scales

• Not to “Over Represent” the Data

• To Display Uncertainty
EMPIRICAL CRITICAL LOADS for N

• Map the Same as in Pardo et al. 2011
  • Mycorrhizal Fungi
  • Lichens
  • Forest Ecosystems
  • Herbaceous Plants & Shrubs

• Continental U.S. only

• No Aggregation
EMPIRICAL CRITICAL LOADS for N

Pardo et al. 2011
EMPIRICAL CRITICAL LOADS for N

- Lichens - Geiser et al. 2010
- Based on the 4 km PRISM precipitation
- Removed Urban and Agriculture Areas
- No Depiction of Uncertainty
- Northwest Replacement
Based on Geiser et al. 2010

EMPIRICAL CRITICAL LOADS for N
EMPIRICAL CRITICAL LOADS for N

Based on Geiser et al. 2010
FOREST ECOSYSTEM ACIDITY for N & S

- McNulty et al. 2007
- Duarte et al. 2011 & others - Own Sections
  - Map at 1 x 1 km for McNulty et al. 2007
  - Map at 4 x 4 km for Duarte et al. 2011
- Uncertainty – Li and McNulty 2007
SURFACE WATER ACIDITY for S & N

1. Grid Size: 12 x 12 km & 36 x 36 km
2. Multiple CLs Same Waterbody: Average
3. Data Exclusions or Corrections: ALL
   • Sulfate > 400 ueq/L
   • Unbalanced Chloride (e.g. neg. BC – AA)
   • Negative Preacidification Base Cations (BCo) or Weather Rates = 1 meq/m²/yr
   • “Flux to Concentration” Imbalances - Removed
   • Negative CLs = 0.1 meq/m²/yr
4. Maps: S and S+N
5. Criterion Limit: 20 West and 50 East
6. Aggregation Statistic: Ave & 10th
7. Map Scale: 4 bins
8. Uncertainty - Number of sites per grid
Surface Water Critical Load for Acidity

Notes:
(1) ANC Limit: East = 50 µeq/L, West = 20 µeq/L
(2) Excludes values with runoff rate < 15 mm/yr
(3) Negative Critical Loads = 0.1 meq m²/yr
Surface Water Critical Load for Acidity

Critical Load for S+N (meq m\(^{-2}\) yr\(^{-1}\))
10th Percentile at 38 km\(^2\)

- Dark Red: 11 - 50 meq m\(^{-2}\) yr\(^{-1}\)
- Maroon: 51 - 100 meq m\(^{-2}\) yr\(^{-1}\)
- Orange: 101 - 200 meq m\(^{-2}\) yr\(^{-1}\)
- Yellow: 201 - 4215 meq m\(^{-2}\) yr\(^{-1}\)

Notes:
1. ANC Limit: East = 50 μeq/L, West = 20 μeq/L
2. Excludes values with runoff rate >0.15 mm/yr
3. Negative Critical Loads = 0.1 meq m\(^{-2}\) yr\(^{-1}\)
Surface Water Critical Load for Acidity

Critical Load for S+N (meq m⁻² yr⁻¹)
10th Percentile at 36 or 12 km²

- 11 - 50
- 51 - 100
- 101 - 200
- 201 - 4215
- No Data

Notes:
1. ANC Limit: East = 50 μeq/L, West = 20 μeq/L
2. Excludes values with runoff rate >0.15 mm/yr
3. Negative Critical Loads = 0.1 meq m⁻² yr⁻¹
Maps Caveats

• Caveats for each map still need to be developed and finalized

• Three webinar discussion one for each endpoints to compile the list
Presentation

Background – Maps - Database

Surface Water Critical Loads for Acidity

Forest Ecosystem Critical Loads for Acidity

Empirical Critical Loads for Nitrogen
References


Li, Harbin; McNulty, Steven G. 2007. Uncertainty analysis on simple mass balance model to calculate critical loads for soil acidity. Environmental Pollution, Vol. 149: 315-326
Additional Maps
FOREST ECOSYSTEM ACIDITY for N & S

Critical Load for Forests
eq ha\(^4\)yr\(^{-1}\) (1 km\(^2\) Grid)

- 170 - 1,000
- 1,001 - 2,000
- 2,001 - 4,000
- 4,001 - 6,000
- 6,001 - 8,600

Uncertainty
See Li and McNulty 2007

McNulty et al. 2007
FOREST ECOSYSTEM ACIDITY for N & S

Critical Load for Forests
\text{eq ha}^{-1} \text{yr}^{-1} (1 \text{ km}^2 \text{ Grid})

- Yellow: 170 - 1,000
- Light Orange: 1,001 - 2,000
- Orange: 2,001 - 4,000
- Dark Orange: 4,001 - 6,000
- Red: 6,001 - 8,600

Uncertainty
- More Reliable
- Less Reliable

Li And McNulty 2007

McNulty et al. 2007
Maps Caveats

Critical Loads for acidity for Surface waters:
• ANC as chemical criterion was set as 20 μeq/L for western waterbodies, 50 μeq/L for eastern waterbodies
• Values are based on average of most recent 5 years of water quality data with locations being samples many times another only once within that 5 year timeframe

Critical Loads for acidity for Forest Ecosystems:
• Current version of critical load use 2006 CMAQ deposition results

Critical Loads for Nutrient Nitrogen
• Linda et al. 2011 compiled results from a variety of gradients and addition studies. Some of these may have calculated critical loads using incomplete deposition estimates (eg. wet deposition)
• Critical loads are calculated at the ecoregion scale and don’t take into account local plant communities
• Critical loads are expressed as a range of values