Does organic nitrogen play a significant role in the nitrogen cycle of temperate ecosystems?

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Organic N Compounds (operationally)

High molecular weight >1 kDa

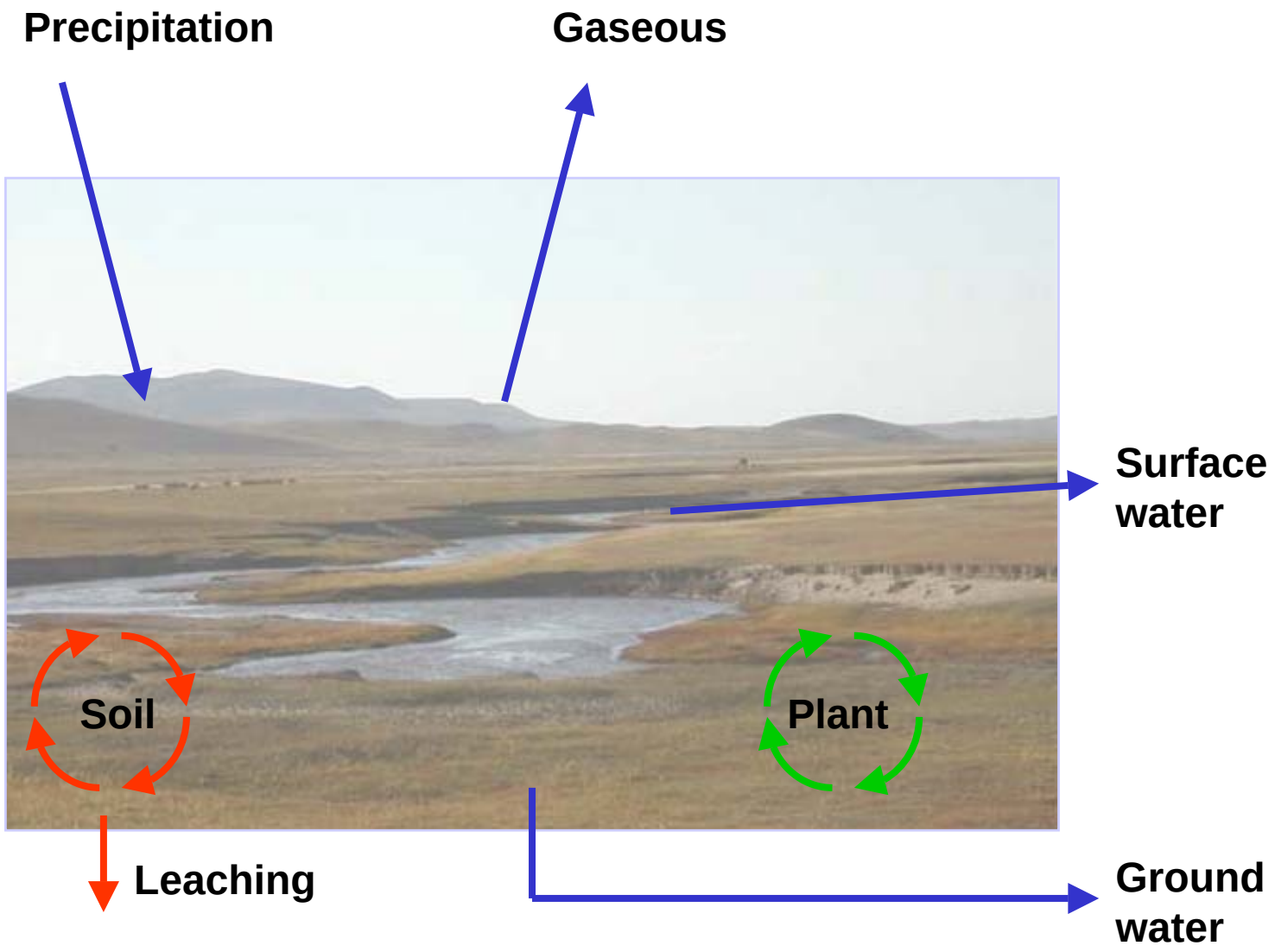
- Proteins Enzymes
  Modified bacterial wall proteins
  Dissolved combined amino acids (DCAA)
- Nucleic acids (DNA, RNA)
- Humiclike substances

Low molecular weight <1 kDa

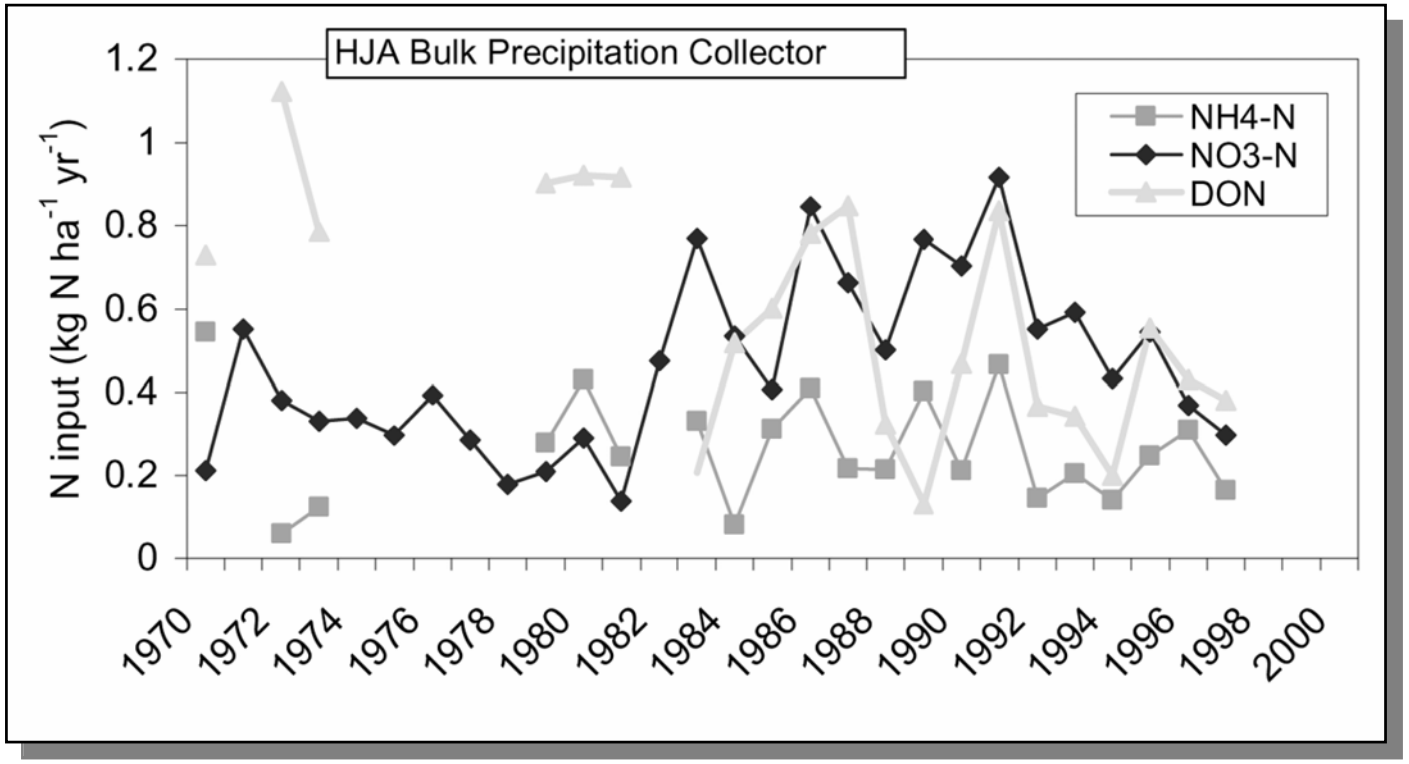
- Urea
- Peptides (part of DCAA pool)
- Dissolved free amino acids (DFAA)
- Amino sugars
- Purines
- Pyrimidines
- Pteridines
- Amides
- Methyl amides

Berman & Bronk, 2003, *Aquat Microb Ecol* 31:279-305

Role of organic N



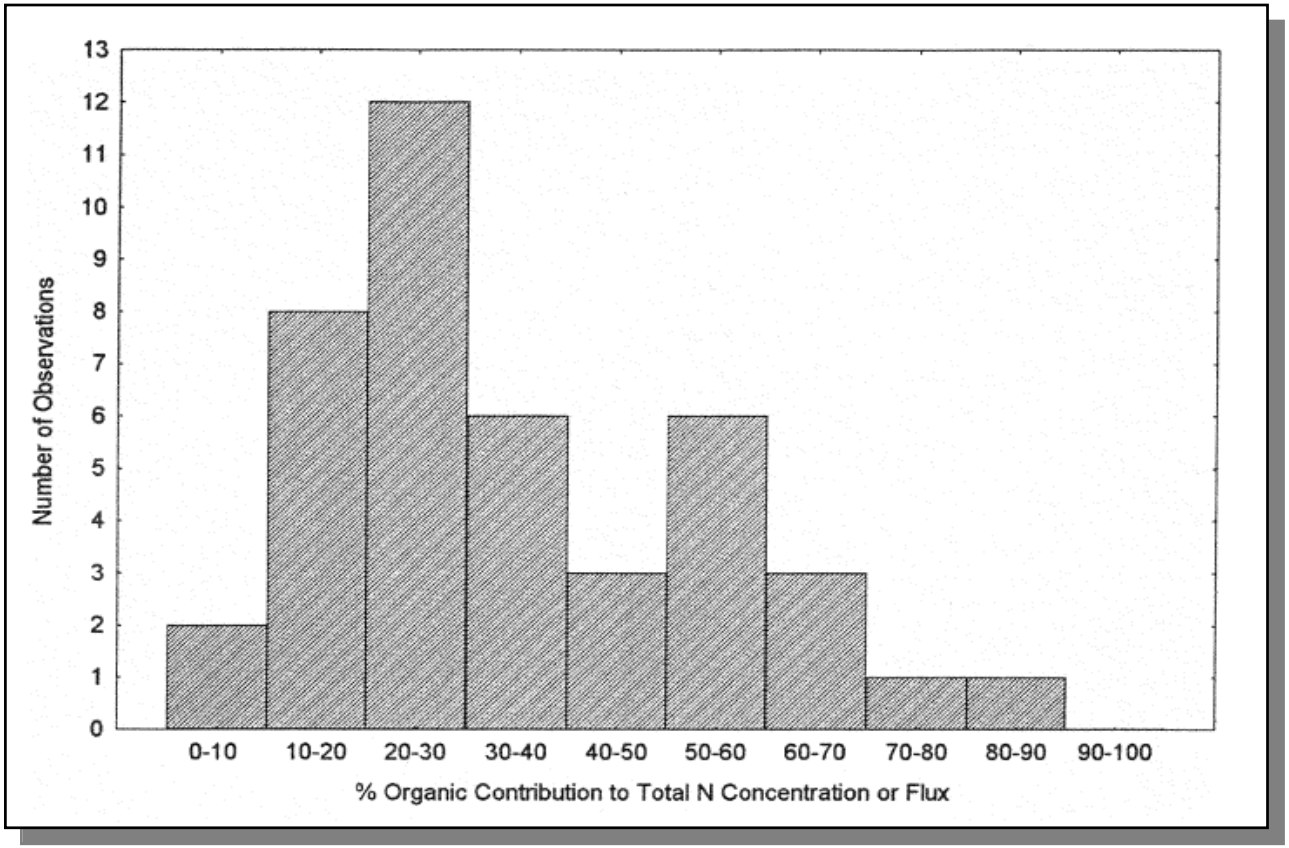
DON in precipitation



NO_3^-, NH_4^- and DON inputs (kg N ha^{-1} yr^{-1}), HJ Andrews, Oregon

Willett et al. 2004, *J Env Qual* 33:201-209

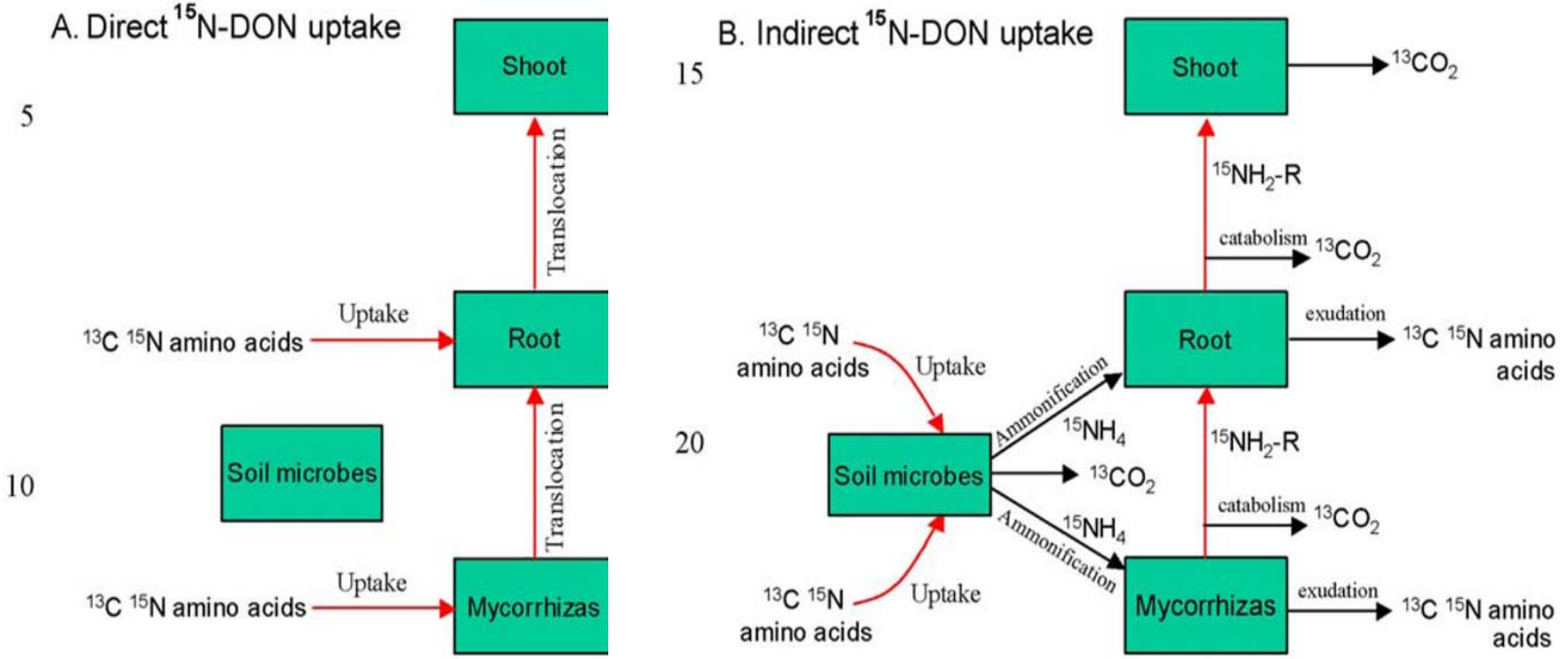
DON in precipitation



Histogram of % organic N contribution to deposition concentrations or fluxes

Neff et al. 2002, *Biogeochemistry* 57/58:99-136

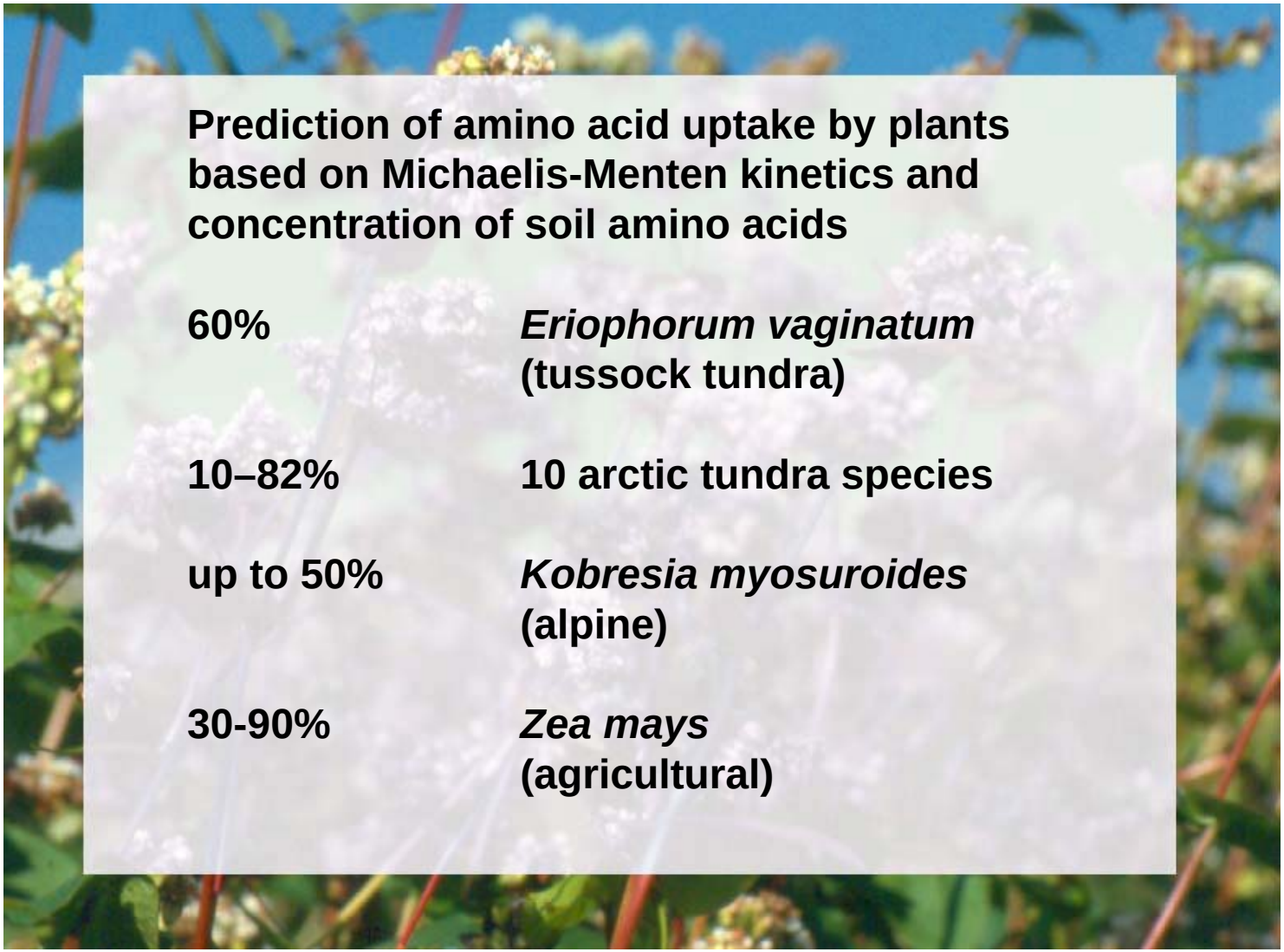
DON and plant nutrition



Fate of ^{15}N/^{13}C labelled amino acids during plant DON uptake

Jones et al. 2005, *Soil Biol Biochem*, 37:413-423

DON and plant nutrition

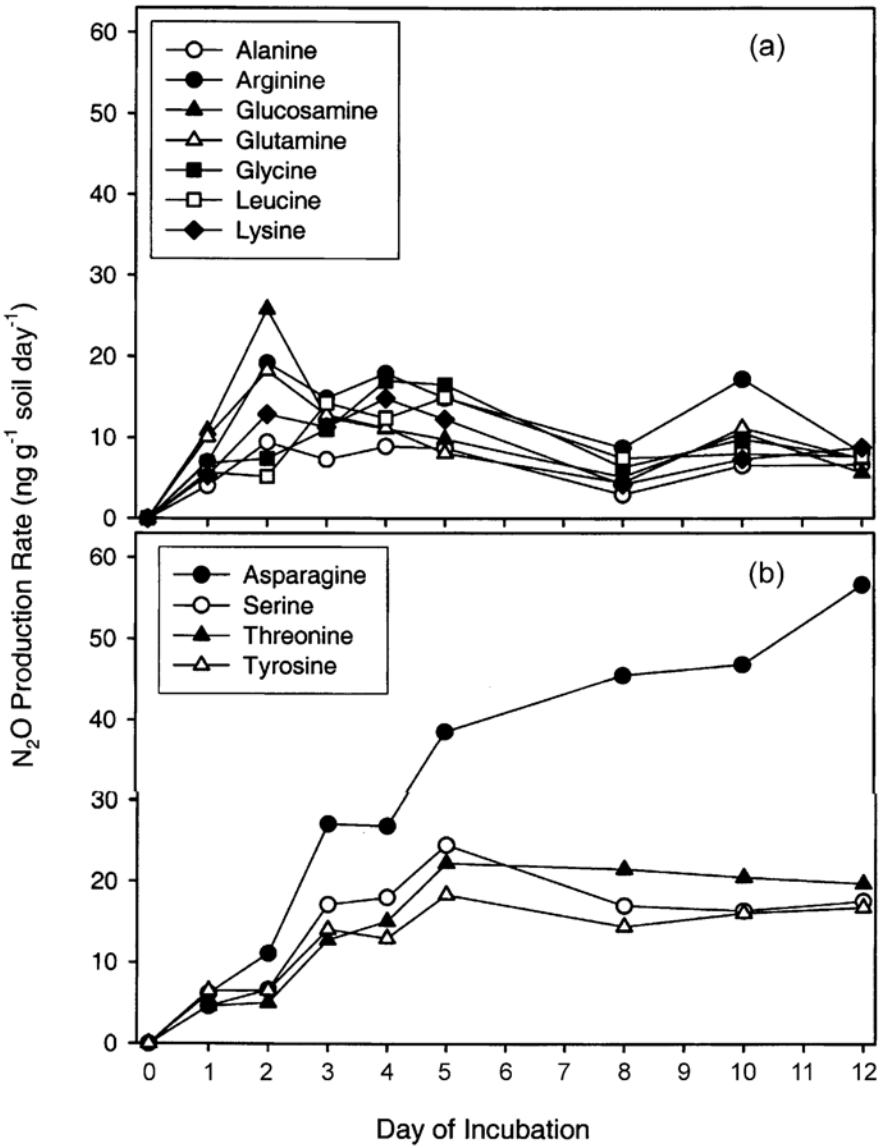


Prediction of amino acid uptake by plants based on Michaelis-Menten kinetics and concentration of soil amino acids

60%	***Eriophorum vaginatum*** **(tussock tundra)**
10–82%	**10 arctic tundra species**
up to 50%	***Kobresia myosuroides*** **(alpine)**
30-90%	***Zea mays*** **(agricultural)**

Lipson & Näsholm 2001, *Oecologia* 128:305-316

DON and trace gas evolution



N_2O production rate for low (a) and high (b) flux substrates

Incubation experiment of soil samples

McLain et a. 2005, *Soil Biol Biochem*, 37:289-299

DON in soil systems

… DON increase with increasing inorganic N deposition

(Yesmin et al. 1996, *Water Res* 30:2171-2177)

… $NH_4^+NO_3^-$ addition: increase in NO_3^- leaching, no change in DON

(Hagedorn et al. 2001, *Geoderma* 100:173-192)

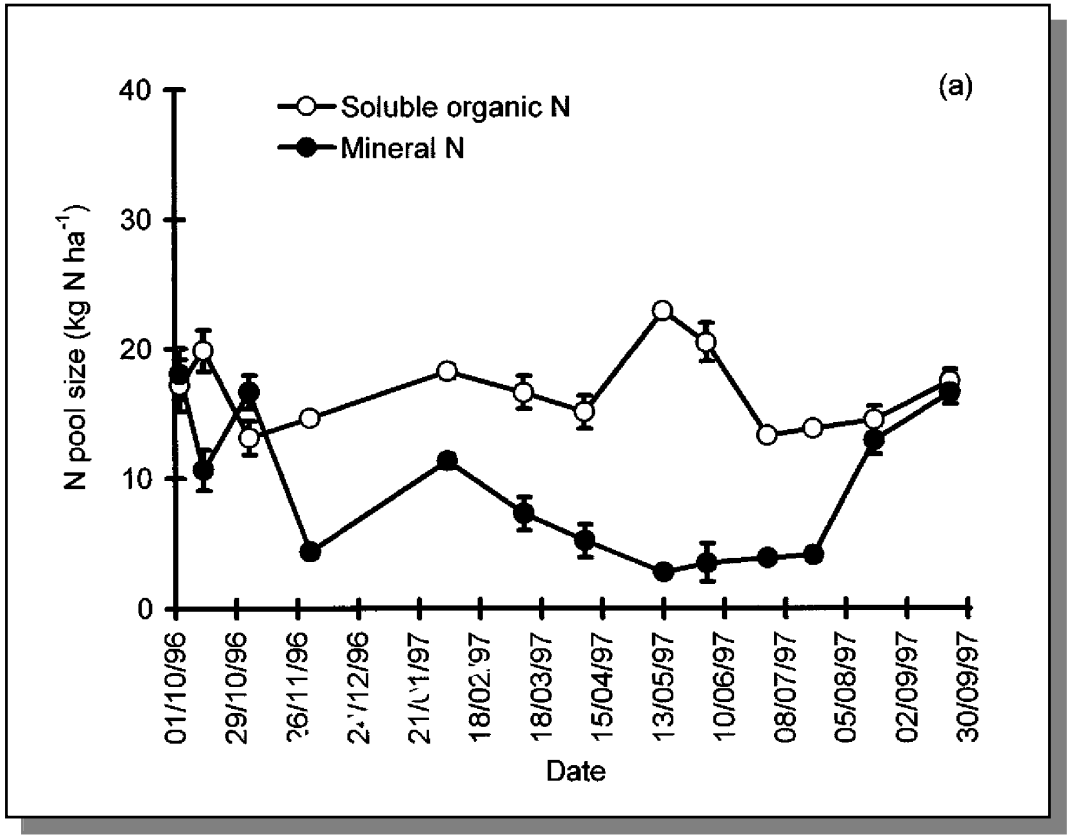
… DON outputs did not respond to increased inorganic N loads

(Aber et al. 1998, *BioScience* 48:921-934)

… high DON fluxes after snow melt

(Solinger et al. 2001, *Biogeochemistry*, 55:327-349)

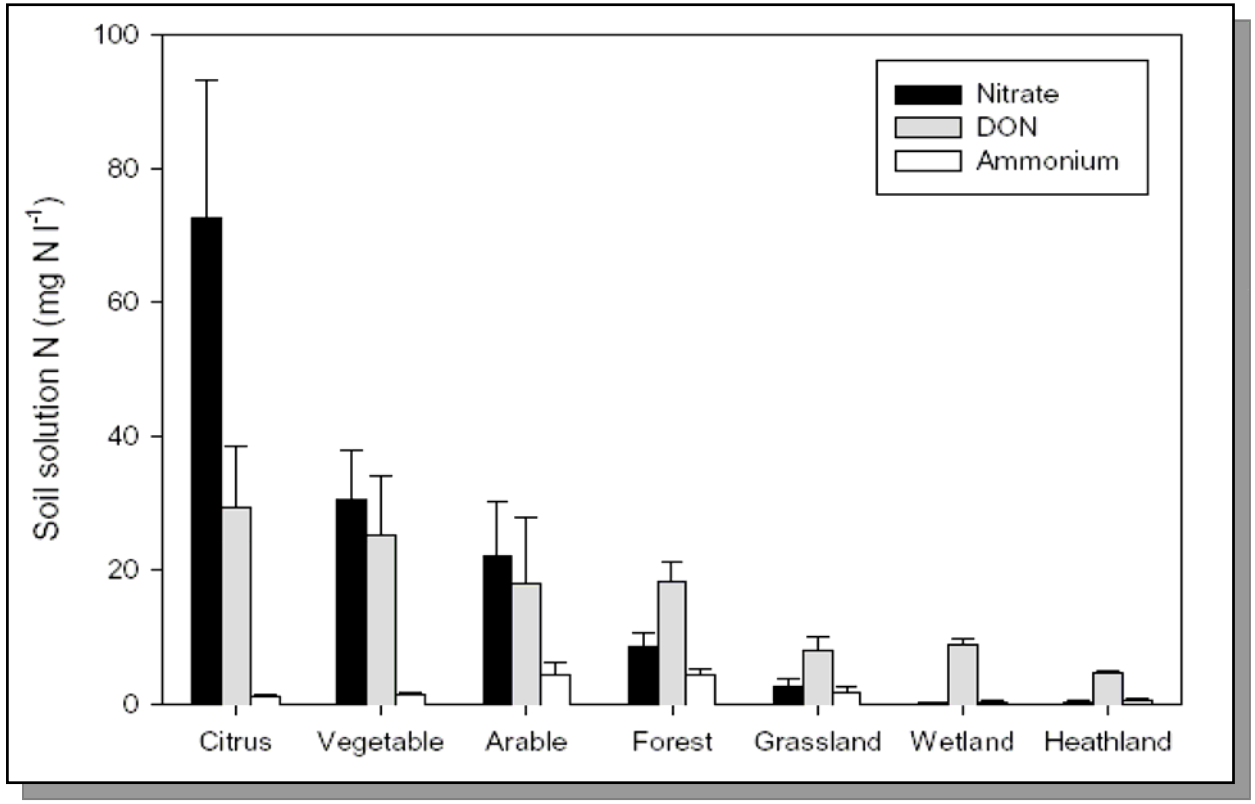
DON in soil systems



N pools under continuous arable plot

Murphy et al. 2000, *Biol Fertil Soils* 30:374-387

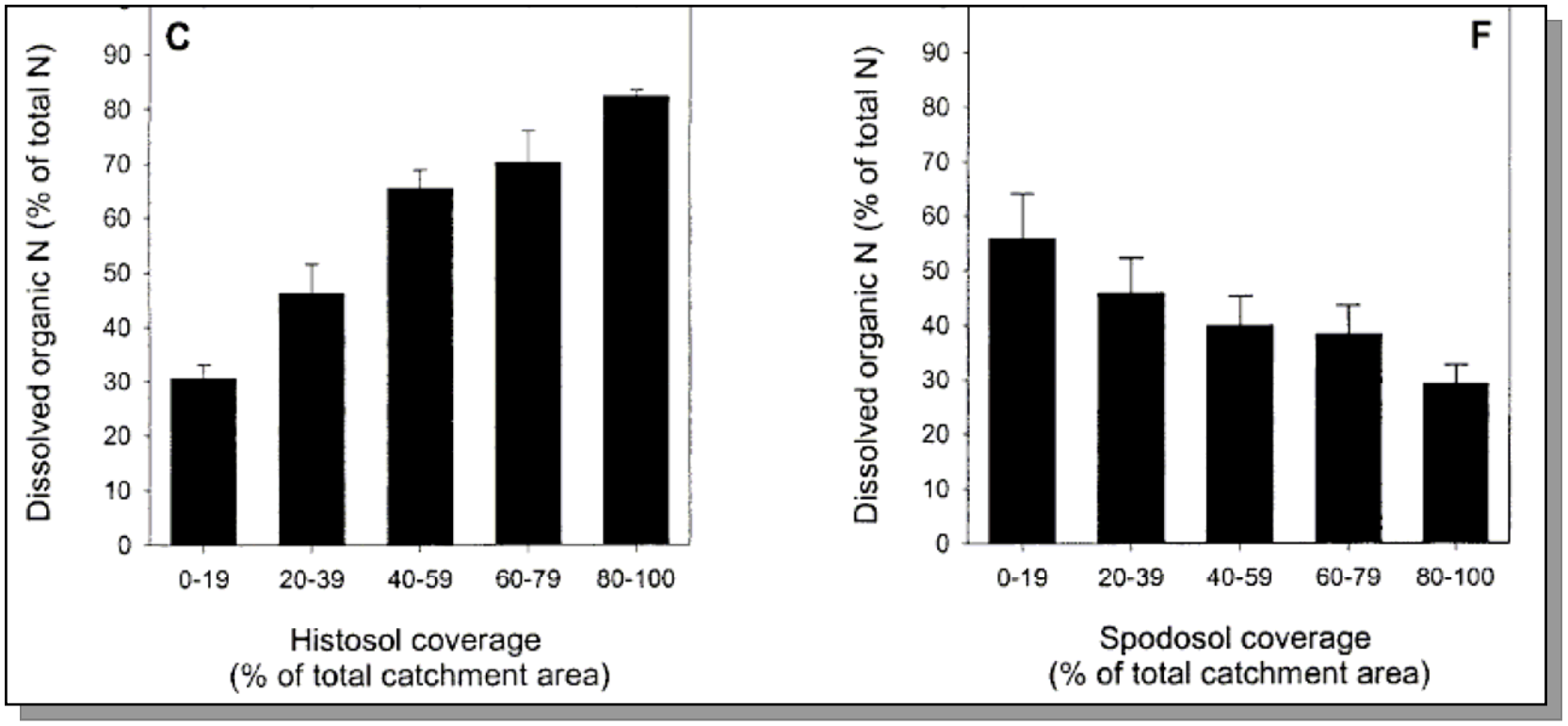
DON in agricultural systems



Concentration of DON, NO_3^- and NH_4^+ in soil solution from contrasting land uses

Christou et al. 2005, *Soil Biol Biochem* 37:1560-1563

Soil type



Effect of soil type on DON in rivers of Wales

Willett et al. 2004, *J Env Qual* 33:201-209

DON in aquatic systems

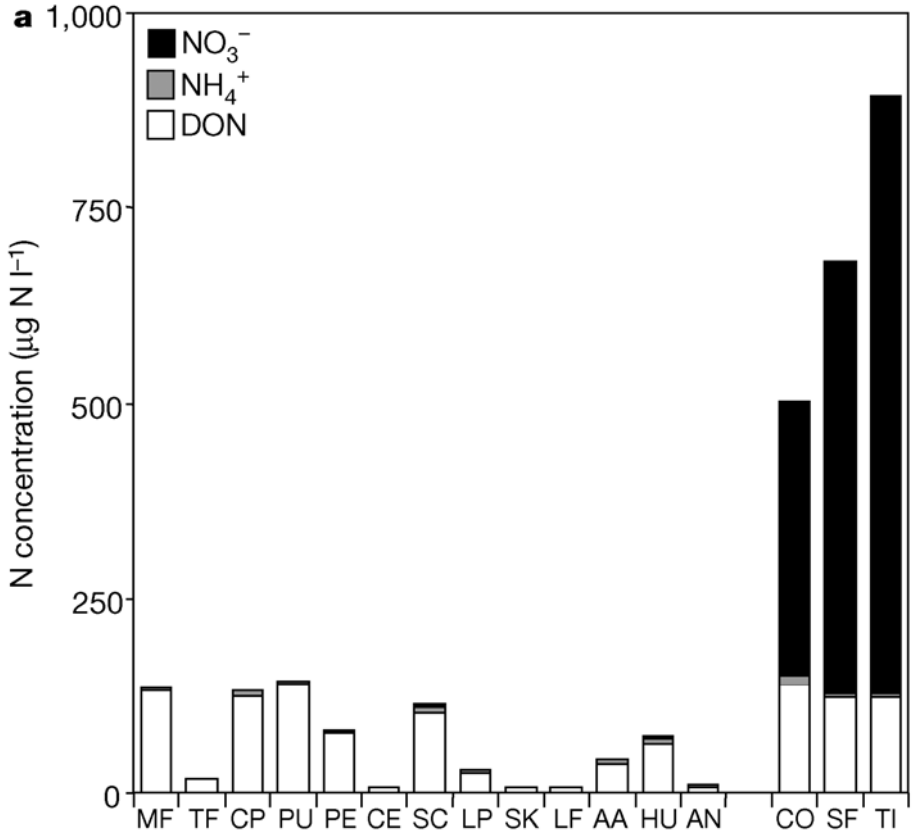
… DON dominates N in drainage water, US undisturbed systems
(McHale et al. 2000, *Biogeochemistry 48:*165-184)

… 28–87% of total dissolved N is organic, US undisturbed systems
(Goodale et al. 2000, *Ecosystems 3:*433-450)

… inorganic N of minor importance, unpolluted forested US catchments
(Perakis & Hedin 2002, *Nature 415:*416-419)

→ **Dominance of NO_3^- is a consequence of human influence**
(van Breemen 2002, *Nature* 415:381-382)

DON in aquatic systems



Hydrologic nitrogen losses from temperate forest watersheds in 13 areas of South America and 3 areas from eastern North America

Perakis & Hedin 2002, *Nature* 415:416-420

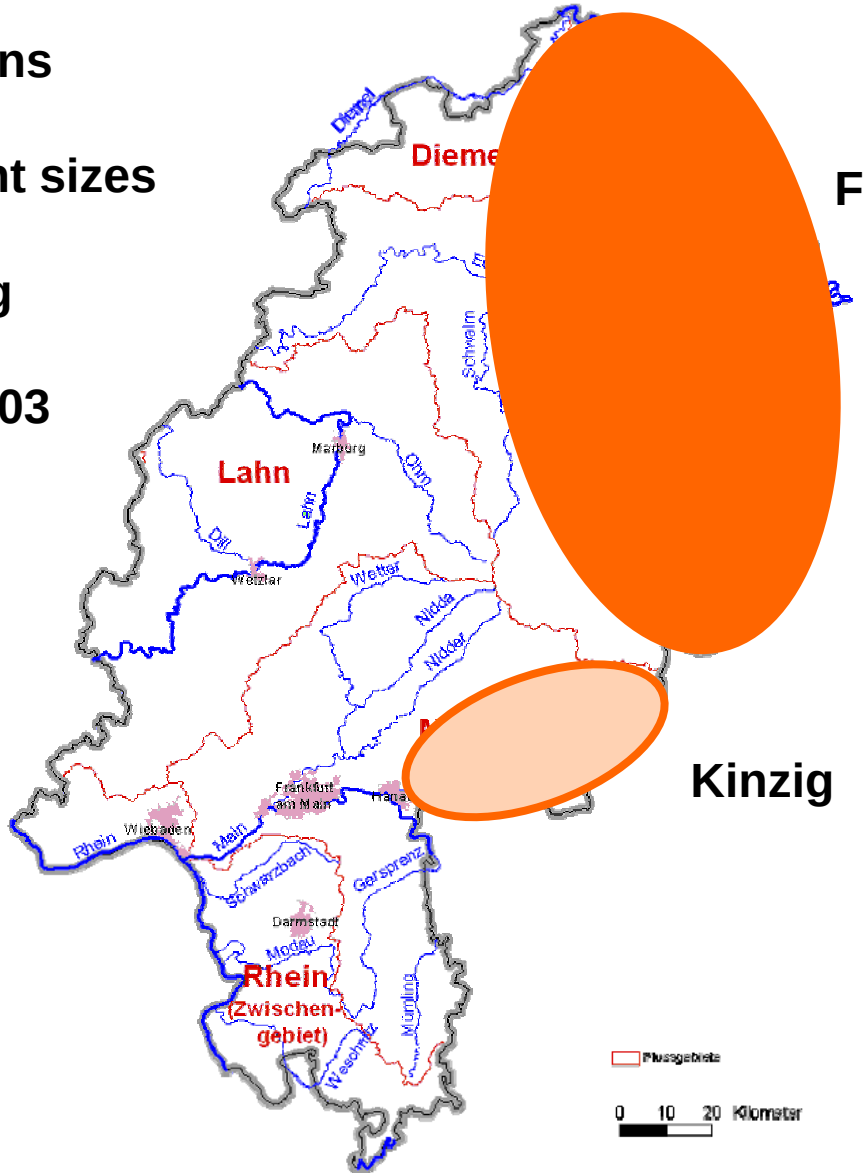
Case study Hessen

66 gauging stations

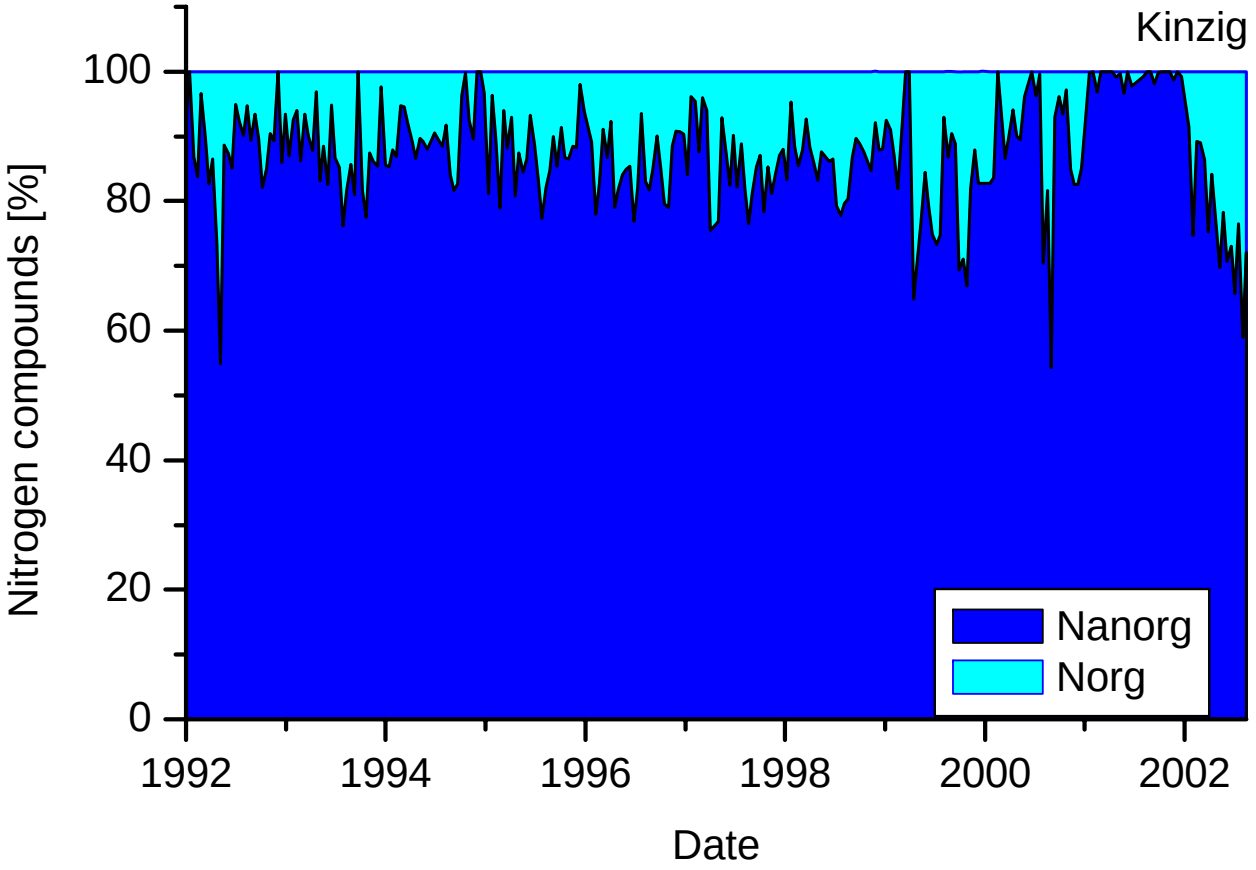
various catchment sizes

monthly sampling

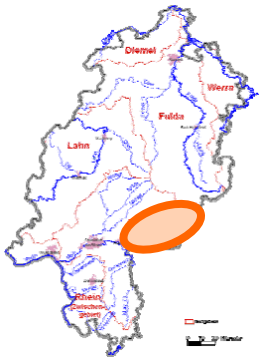
nutrients 1990-2003 and 1999-2003



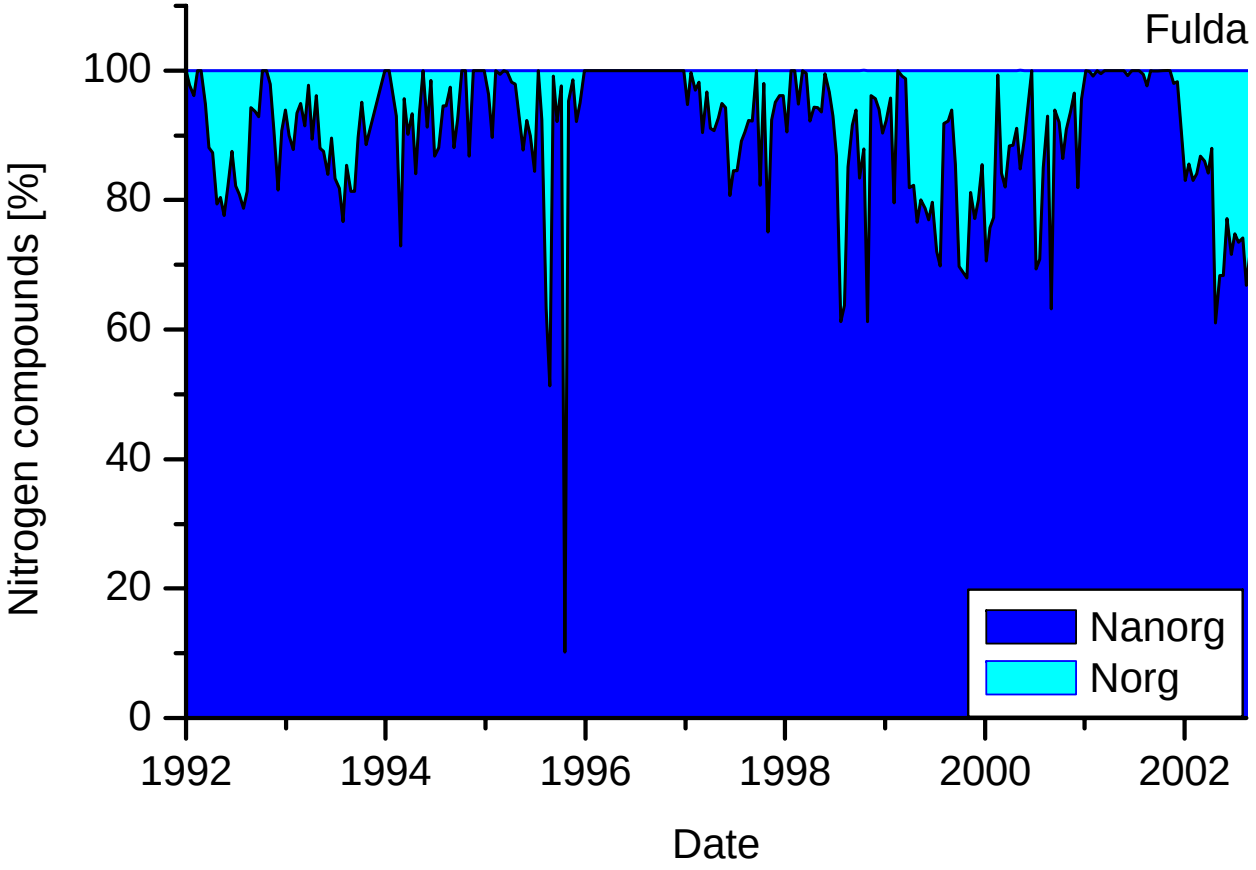
Case study Hessen



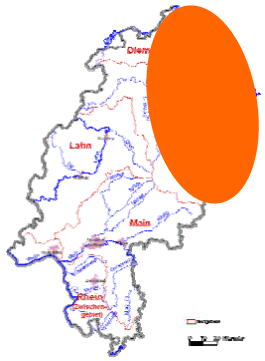
Ratio N_{inorg}/N_{org} 87/13



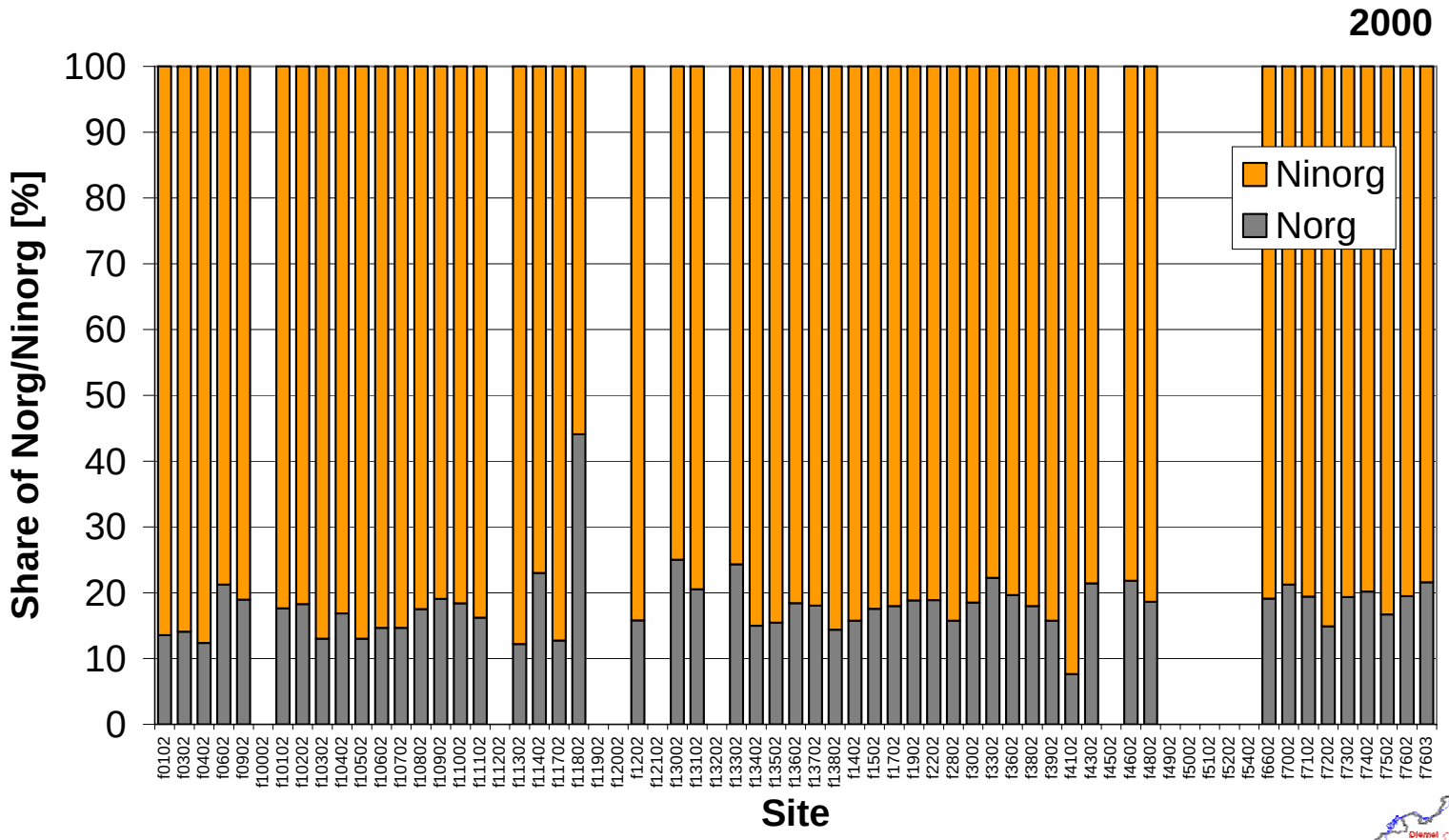
Case study Hessen



Ratio N_{inorg}/N_{org} 92/8

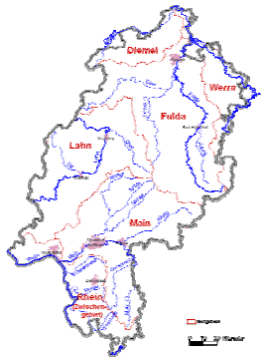


Case study Hessen

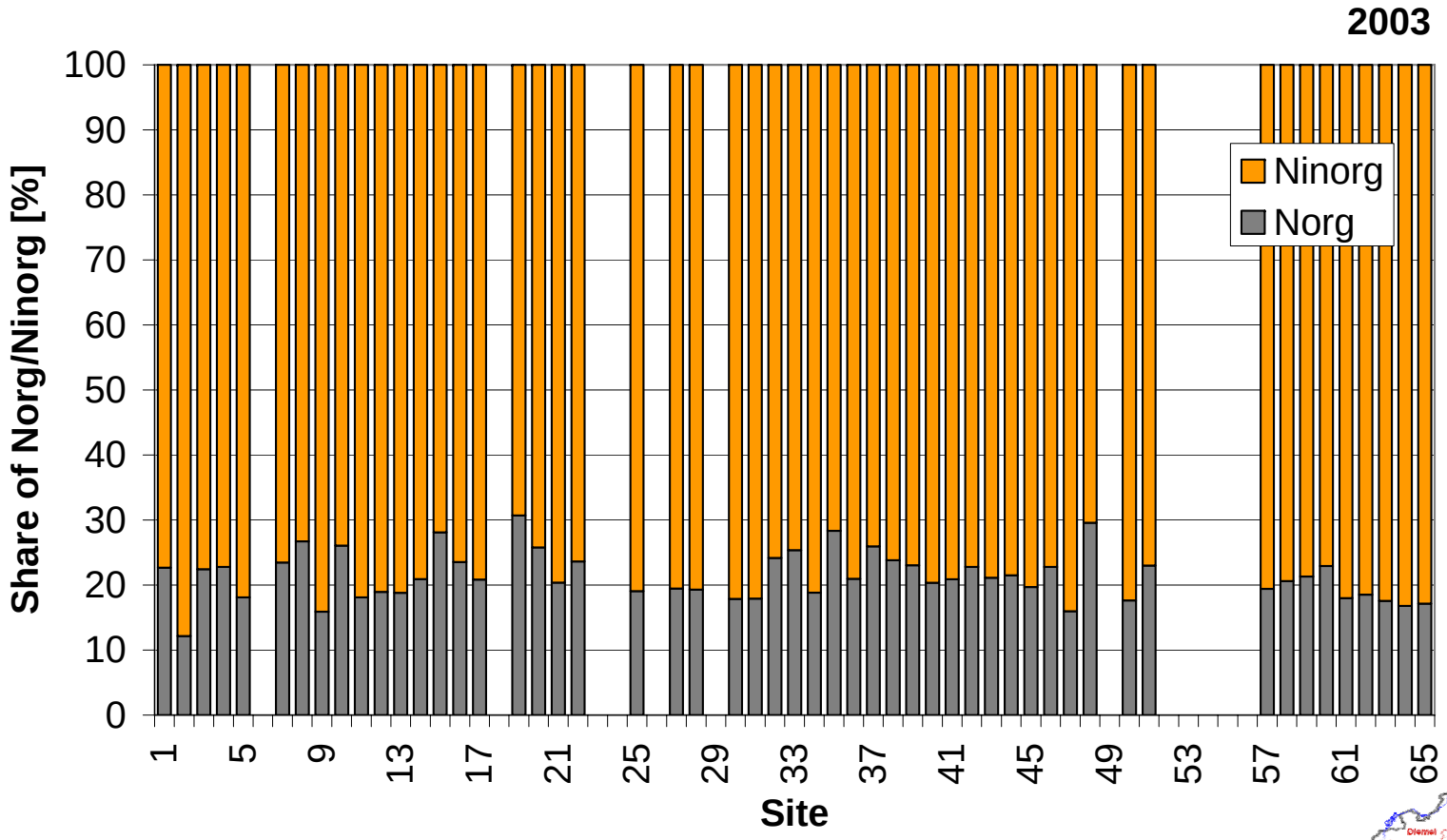


Average 18 % organic N

No correlation with catchment size

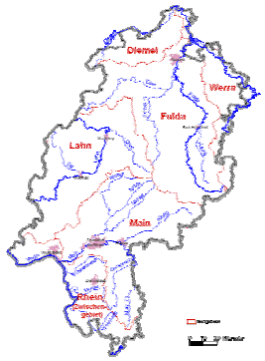


Case study Hessen

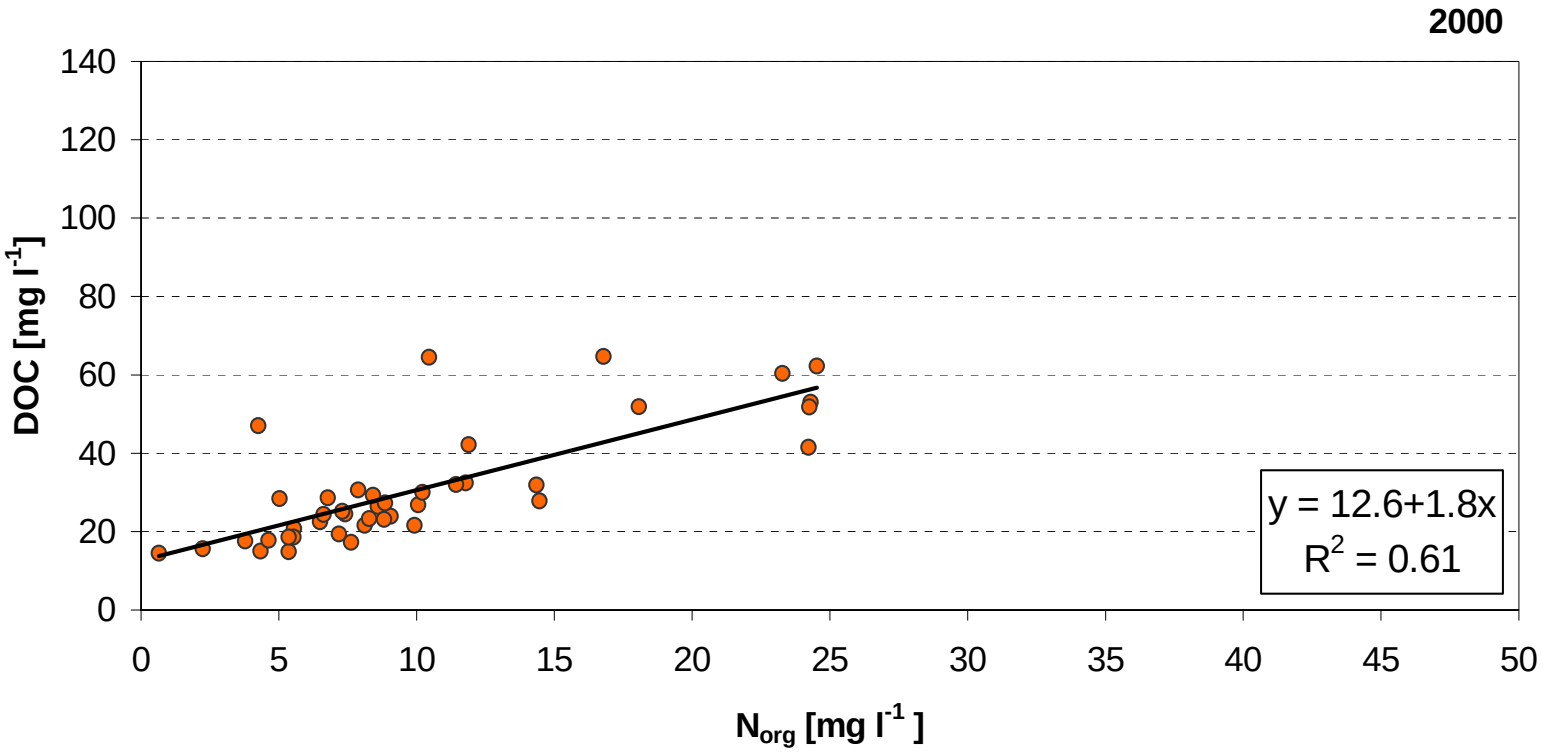


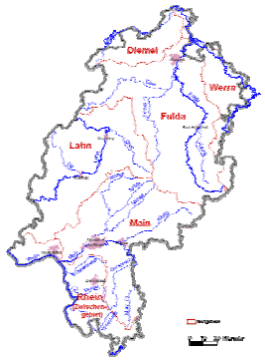
Average 22 % organic N

No correlation with catchment size

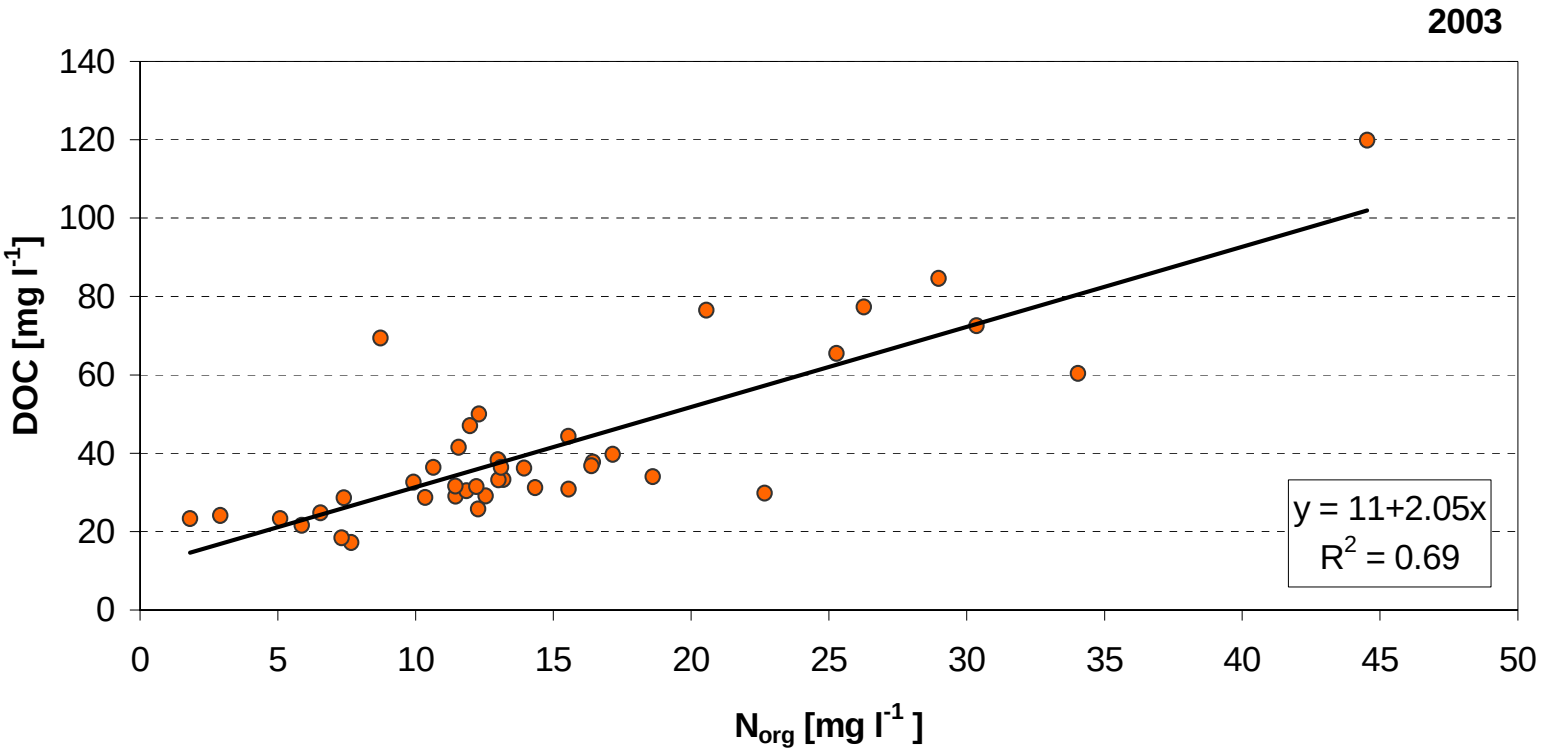


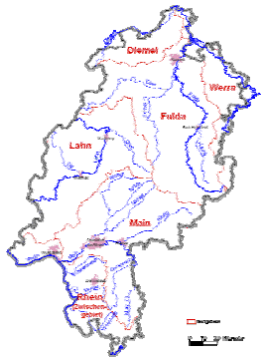
Case study Hessen



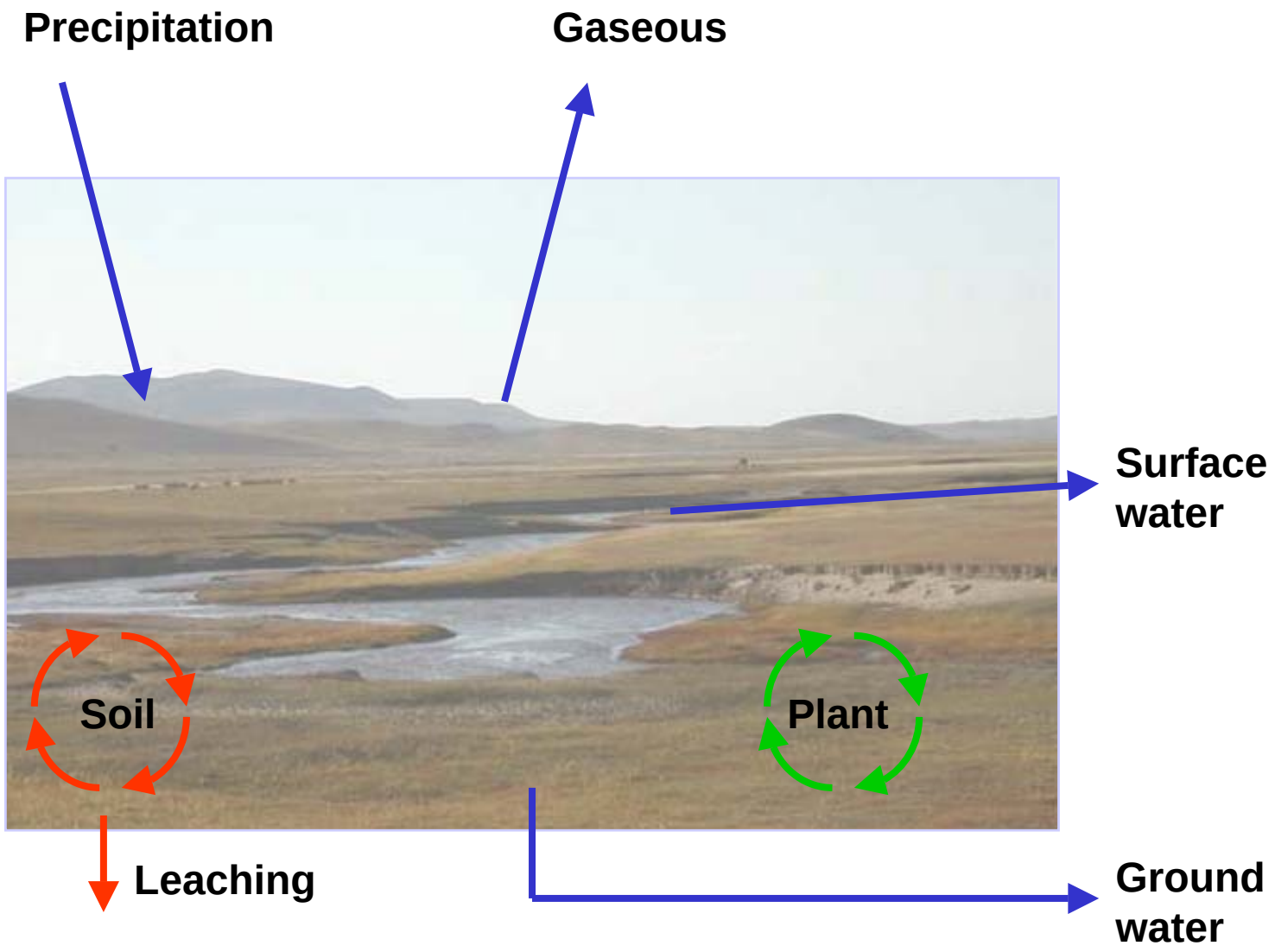


Case study Hessen





Role of organic N



Conclusions