De impact van bosstructuur en -samenstelling op bosrandeffecten van N-depositie:

Maatregelen tegen N-effecten in gefragmenteerde landschappen

Mitigating measures for N in fragmented landscapes

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Intro

- Forest fragmentation

Wade et al. 2003

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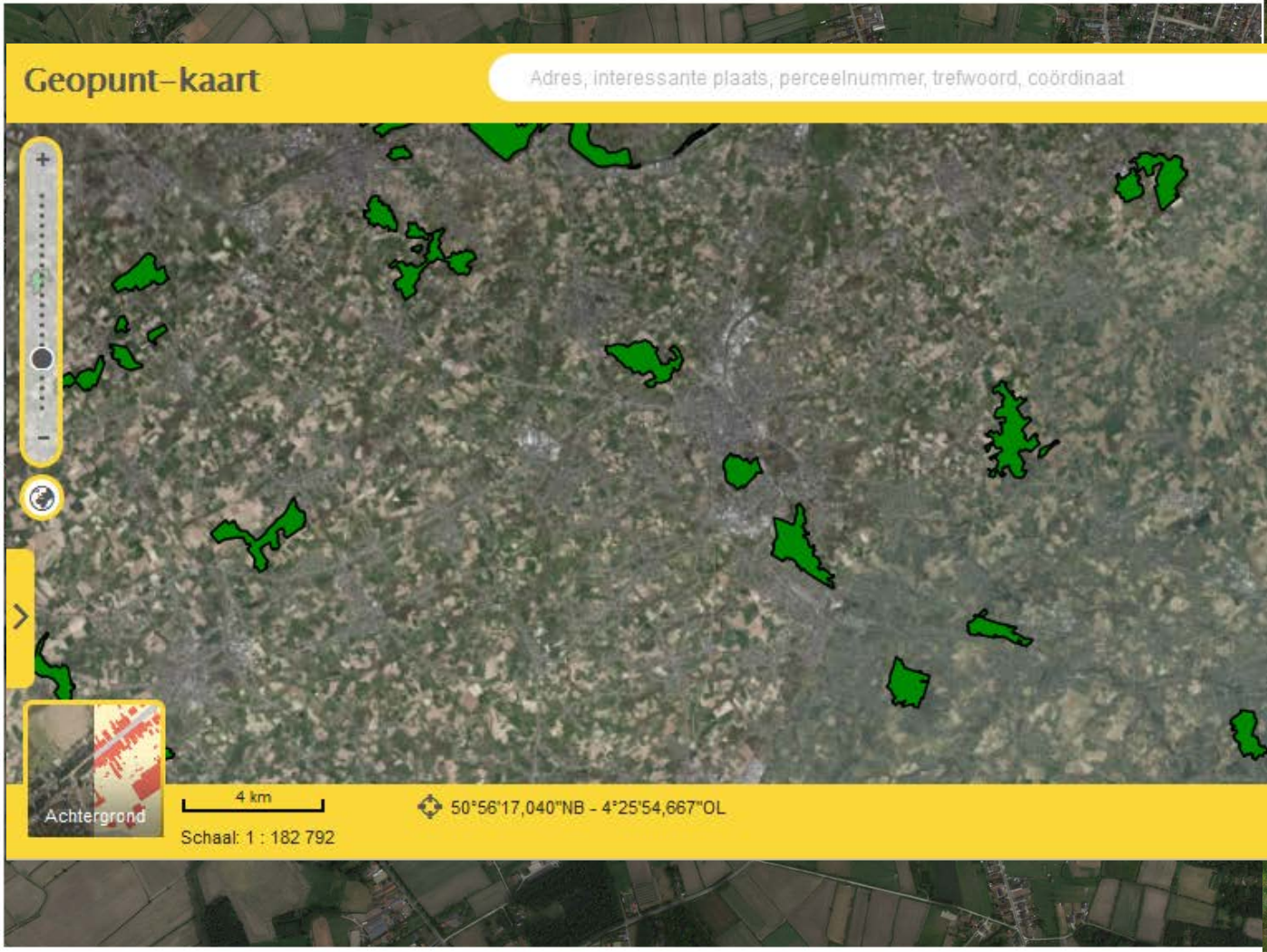

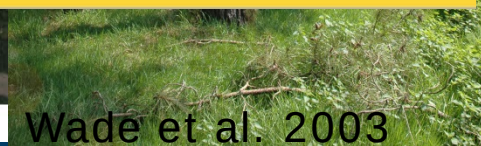

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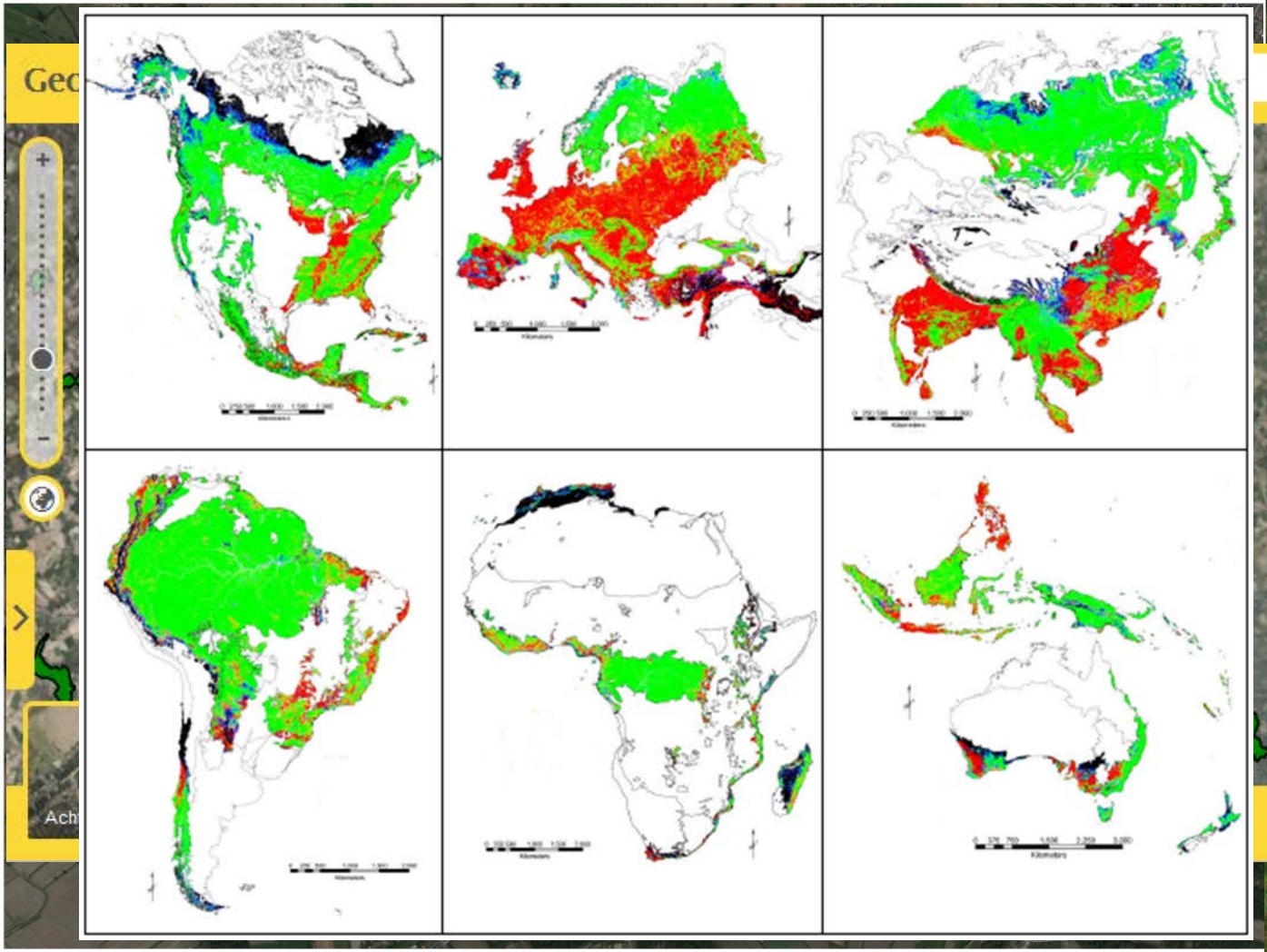
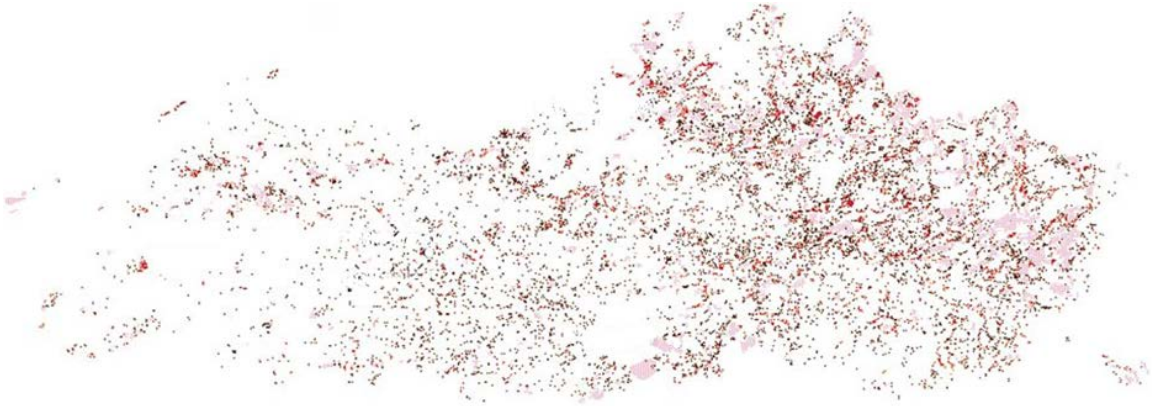


Wade et al. 2003

Intro

- Forest edges
  - border between forest and area with different LC
  - edge habitat is predominant feature in temperate forests
    - Flanders 60% @ 50 m forest edge (De Schrijver et al. 2007)
    - the Netherlands 52% @ 5x edge height (Draaijers et al. 1994)
    - England 74% @ 100 m forest edge (Riutta et al. 2014)
    - EU 40% @ 100 m forest edge (Estreguil et al. 2013)
    - f(species, process)



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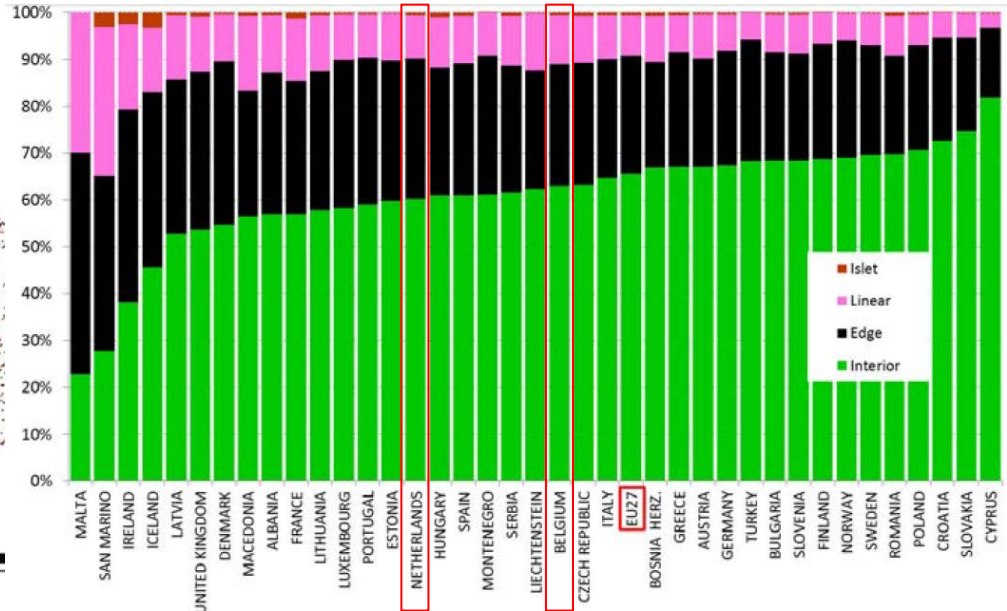

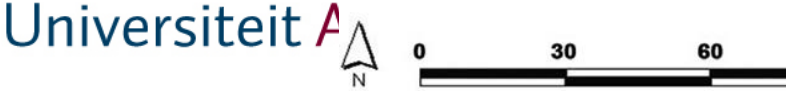

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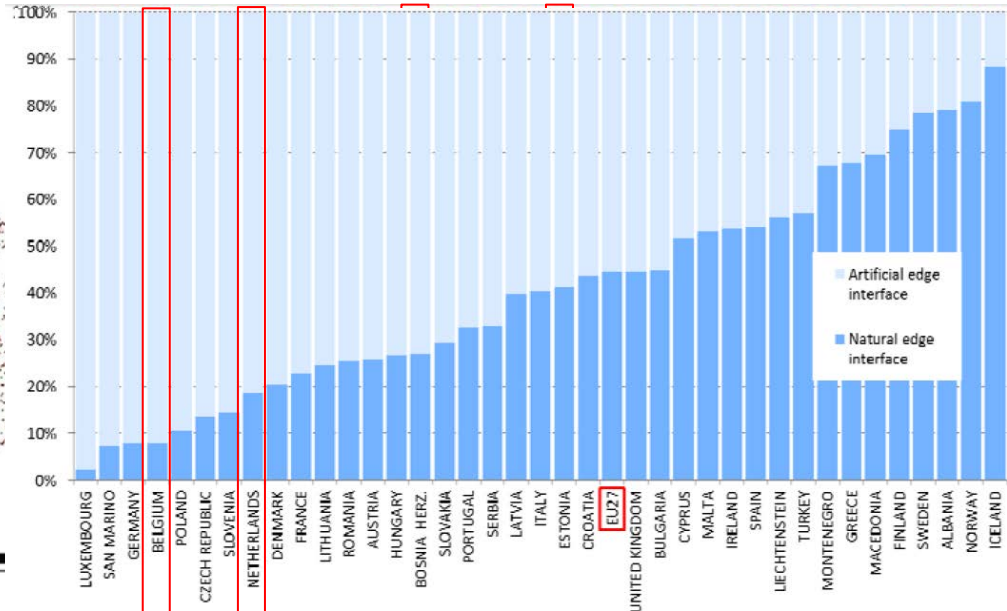
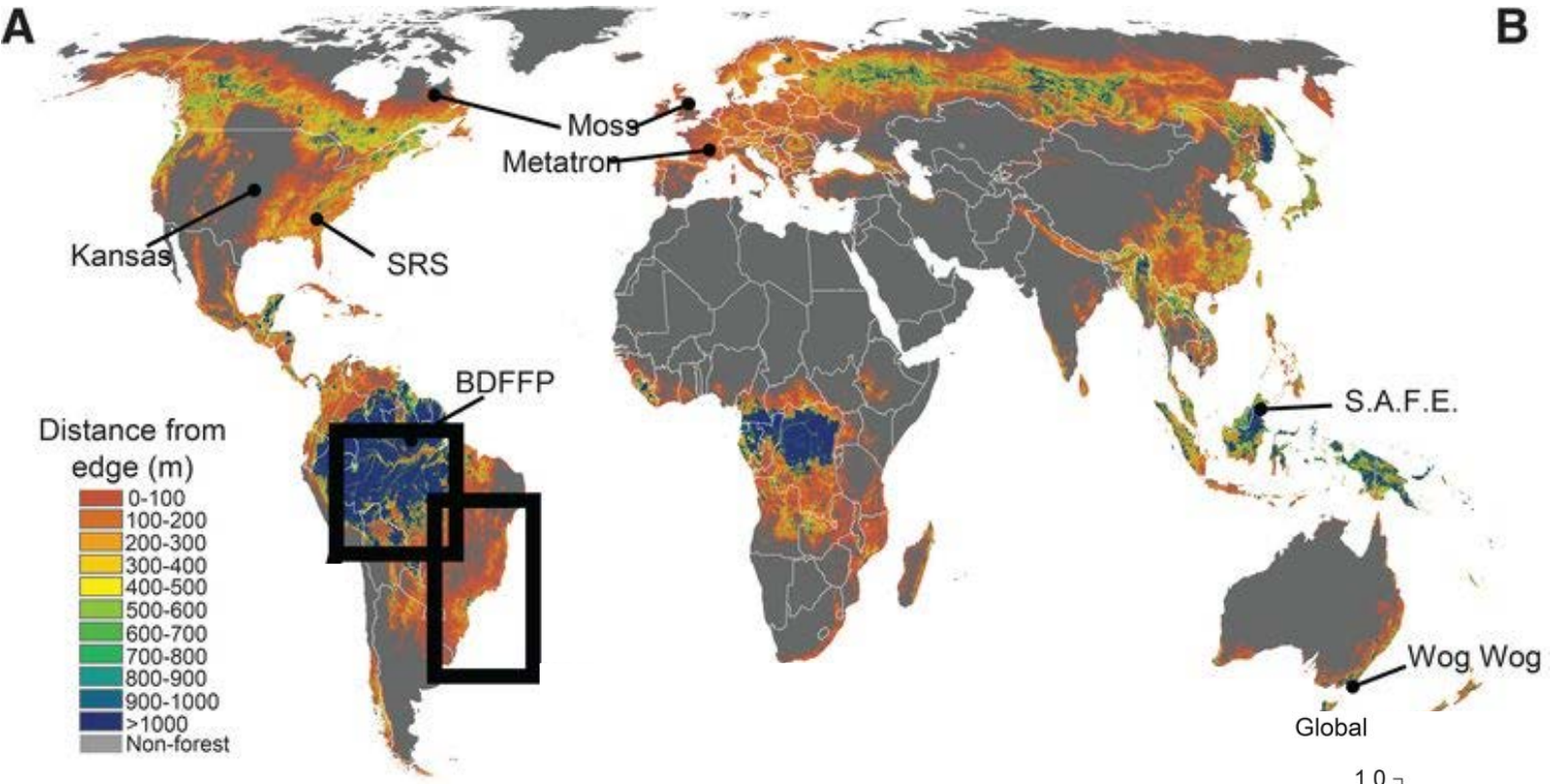
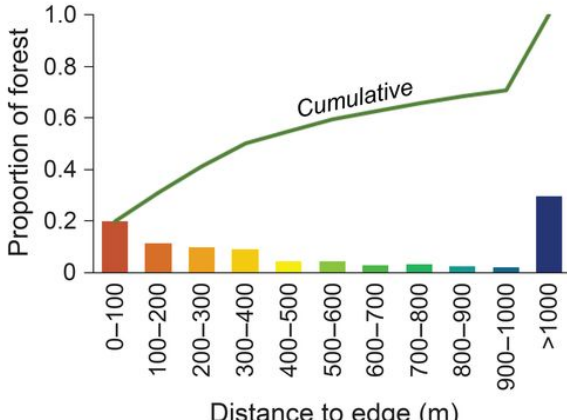


Universiteit A

Intro





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Haddad et al. 2015 Science Advances

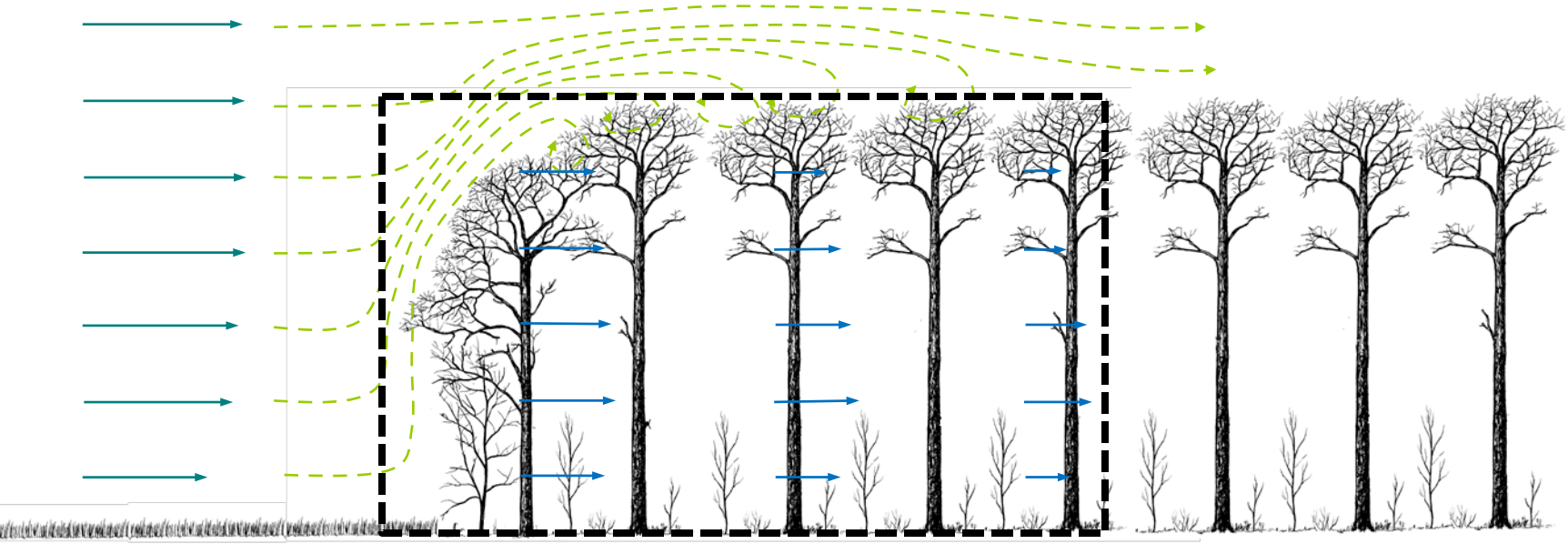
Intro

- Forest fragmentation & forest edges
  - influenced by edge effects:
    - primary effects
      - microclimate: T, RH, ST, SM, PAR, v
      - nutrient input
      - seed flux
    - secondary effects or ecosystem responses
      - forest structure: tree height, age, species composition, CWD, …
      - tree growth & transpiration
      - nutrient cycling
      - floral diversity
      - faunal biodiversity & activity: birds, beetles, detritivores,…
    - influence = f(variable, species, process, study): 3-1000 m
    - edges potential biodiversity hotspots <-> forest cores with core-specialists decline
      - direct (tolerance, preference & facilitation)
      - indirect (competition, predation,…)

+ N input

Intro

- Edge effects on atmospheric deposition



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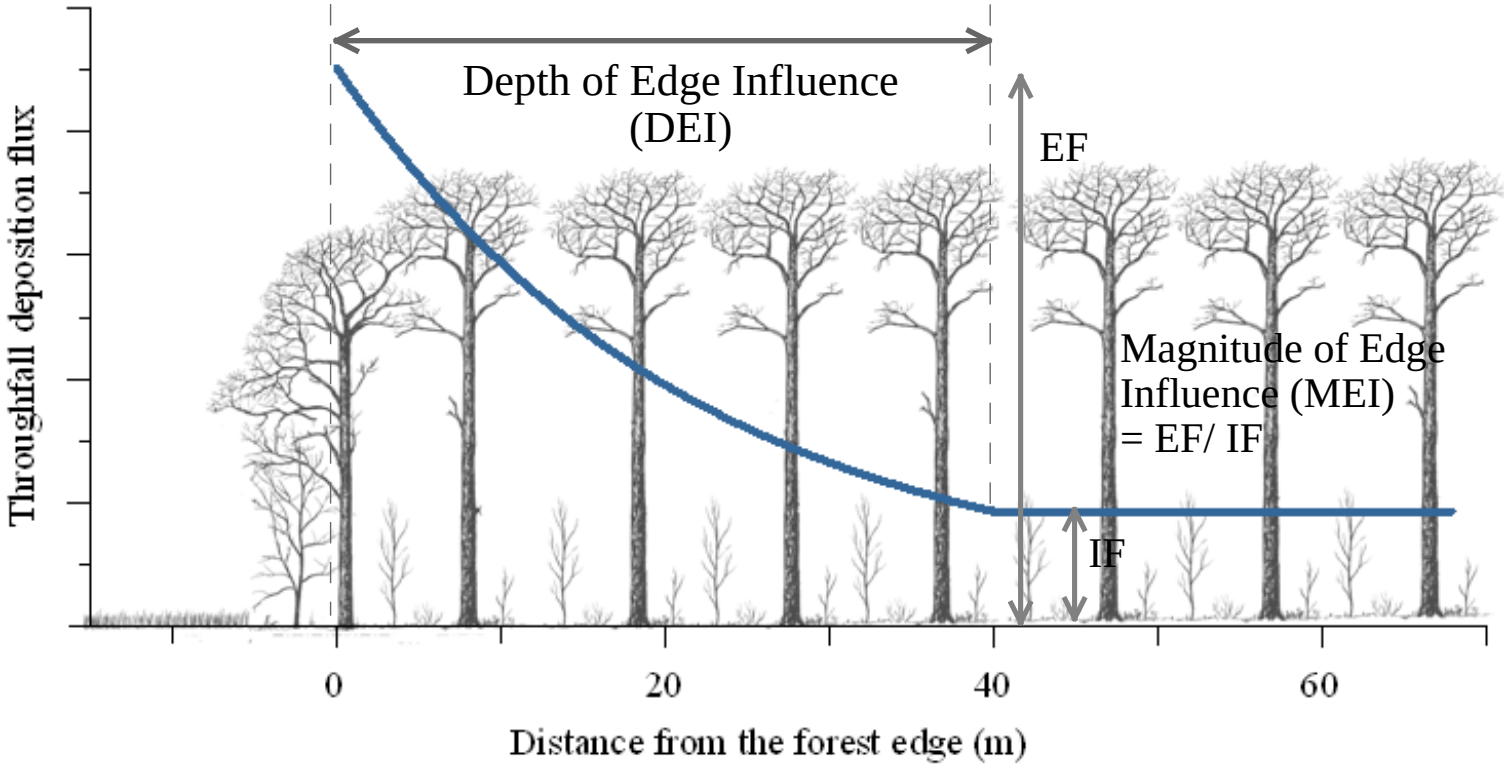
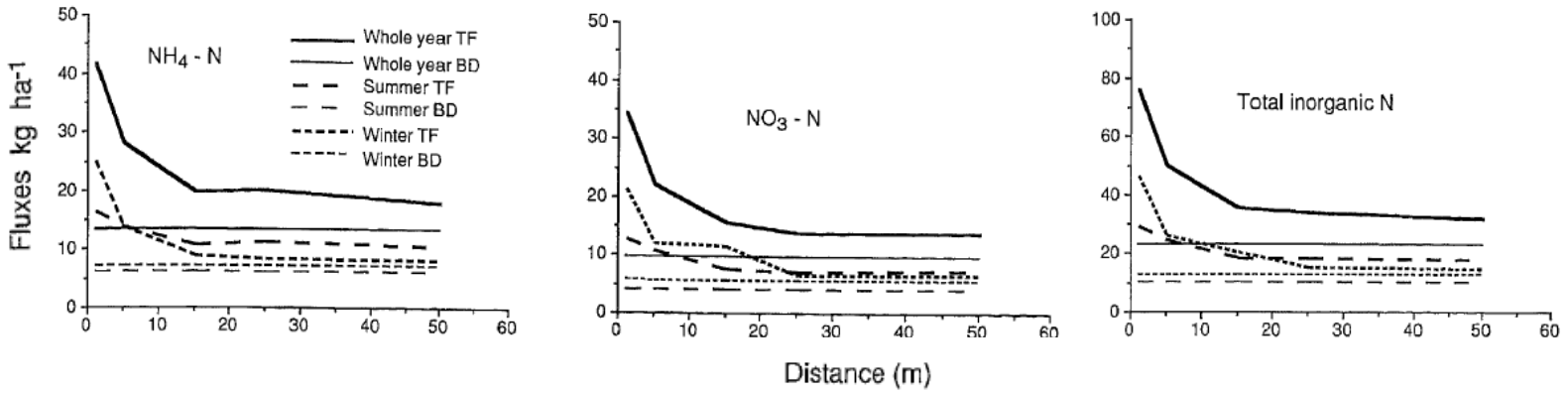


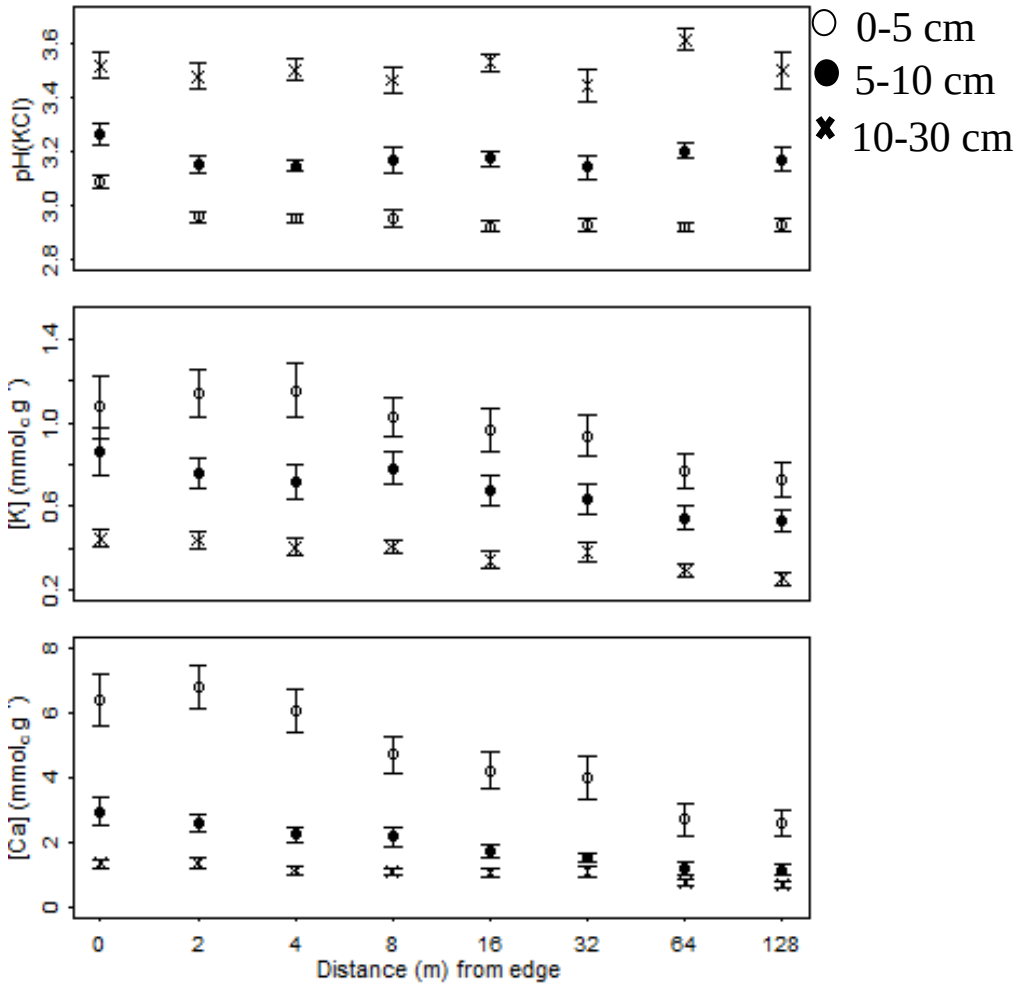
Edge effects on N deposition

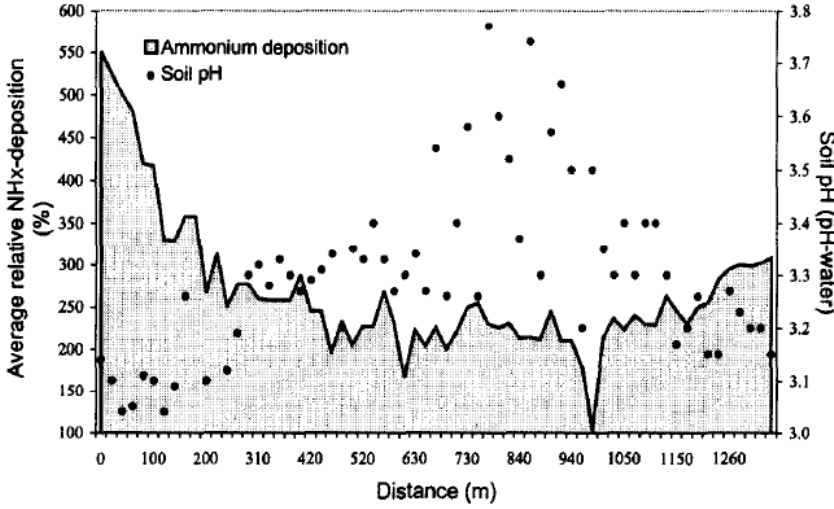
		Country	Region	Forest	FED (m)	FEE SO_4^{2-}	FEE NO_3^-	FEE NH_4^+
1	Beier & Gundersen (1989)	Denmark	50 km N of Copenhagen	*Picea abies*	15	2.60	4.00	2.80
2	Devlaeminck et al. (2005)	Belgium	Flanders	*Fagus sylvatica*	50	/	/	1.22
3	Draaijers et al. (1988)	The Netherlands	The Veluwe	*Pseudotsuga menziessi*	100	1.80	1.50	1.50
4	Draaijers et al. (1988)	The Netherlands	The Veluwe	*Pseudotsuga menziessi*	50	1.30	1.30	1.20
5	Draaijers et al. (1993)	The Netherlands	Utrechtse Heuvelrug	*Larix decidua*	108	1.00	1.00	1.00
6	Draaijers et al. (1993)	The Netherlands	Utrechtse Heuvelrug	*Pinus sylvestris*	63	1.86	1.43	1.63
7	Draaijers et al. (1993)	The Netherlands	Utrechtse Heuvelrug	*Pinus nigra*	43	5.18	3.83	3.78
8	Draaijers et al. (1993)	The Netherlands	Utrechtse Heuvelrug	*Pinus sylvestris*	65	1.00	1.00	1.00
9	Draaijers et al. (1993)	The Netherlands	Utrechtse Heuvelrug	*Larix decidua*	69	1.98	2.42	1.63
10	Draaijers et al. (1993)	The Netherlands	Utrechtse Heuvelrug	*Pinus abies*	49	4.53	2.41	3.89
11	Draaijers et al. (1993)	The Netherlands	Utrechtse Heuvelrug	*Larix decidua*	77	1.00	1.76	1.00
12	Draaijers et al. (1993)	The Netherlands	Utrechtse Heuvelrug	*Pinus sylvestris*	65	1.00	1.00	1.00
13	Hasselrot & Grennfelt (1987)	Sweden	West coast	*Pinus sylvestris*	50	1.5	2.9	2.7
14	Neal et al. (1994)	England	Hampshire	*Fagus sylvatica*	50			1.50-2.00
15	Spangenberg & Kölling (2004)	Germany	Southern Bavaria	*Picea abies*	50-100*	1.00	2.20	1.50
16	Spangenberg & Kölling (2004)	Germany	Southern Bavaria	*Picea abies*	50-100*	1.20	1.80	1.40
17	Spangenberg & Kölling (2004)	Germany	Southern Bavaria	*Picea abies*	50-100*	1.70	1.60	0.70
18	Spangenberg & Kölling (2004)	Germany	Southern Bavaria	*Picea abies*	50-100*	0.60	1.20	1.10
19	Spangenberg & Kölling (2004)	Germany	Southern Bavaria	*Picea abies*	50-100*	0.90	0.60	0.50
20	Spangenberg & Kölling (2004)	Germany	Southern Bavaria	*Picea abies*	50-100*	1.50	2.60	1.80
21	Spangenberg & Kölling (2004)	Germany	Southern Bavaria	*P. abies/ F. sylvatica*	50-100*	0.70	2.20	1.70
22	Weathers et al. (2001)	USA	New York State	Mixed deciduous	25-28	1.12	1.43	1.27
23	Weathers et al. (2001)	USA	New York State	Mixed deciduous	25-28	1.12	1.43	1.27
	Median				50	1.21	1.60	1.50
	Minimum					0.60	0.60	0.50
	Maximum					5.18	3.83	3.78



De Schrijver et al. 2007
Balsberg-Pahlsson & Bergkvist 1995

Acidification





Location near sources!
e.g. near pig & chicken farms

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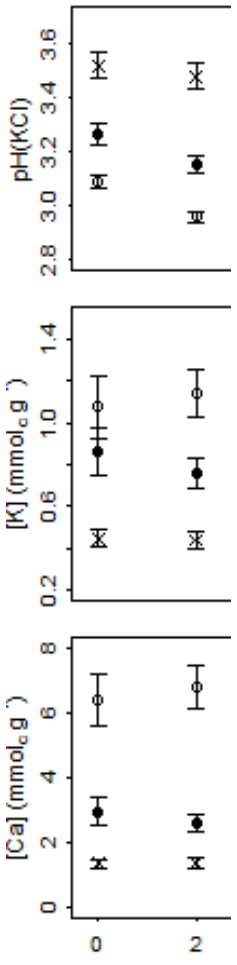
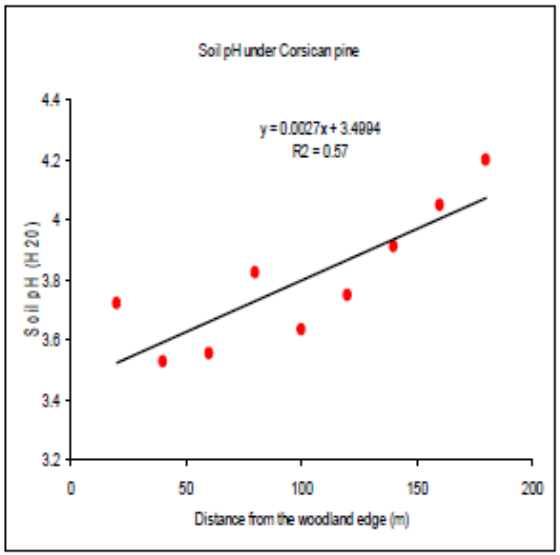
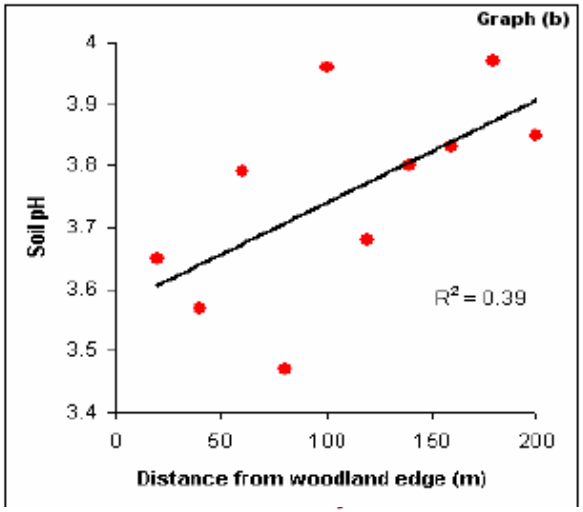
De Schrijver et al. 1998 EnvPoL, Wuyts et al. 2013 WASP, Vanguelova & Pitman 2009

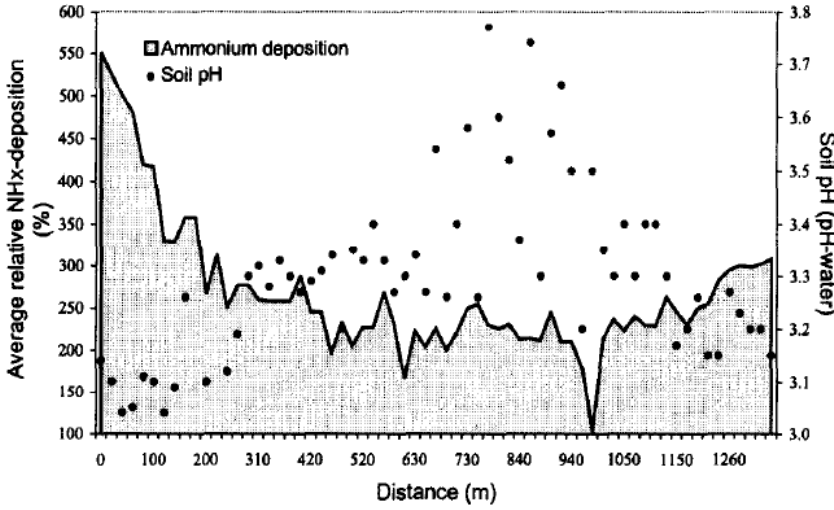
Acidification





0-5 cm
5-10 cm
10-30 cm





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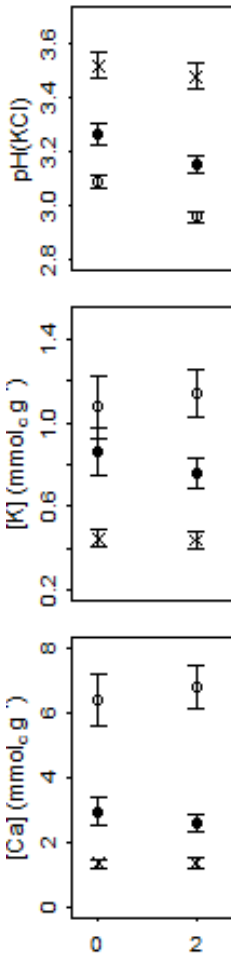

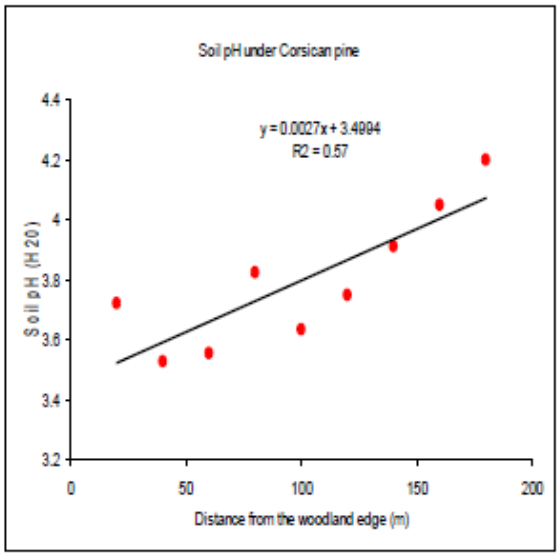

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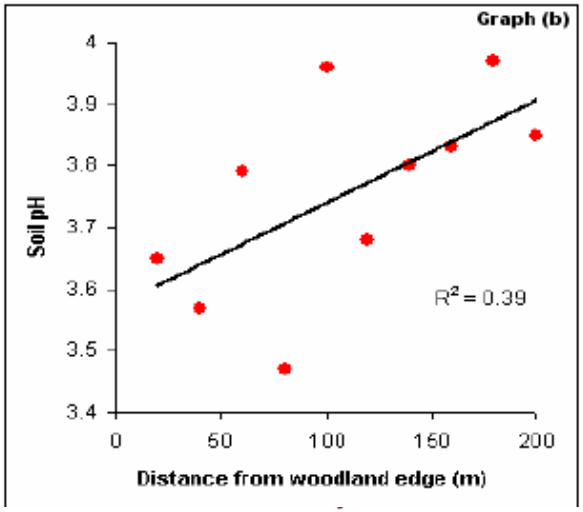

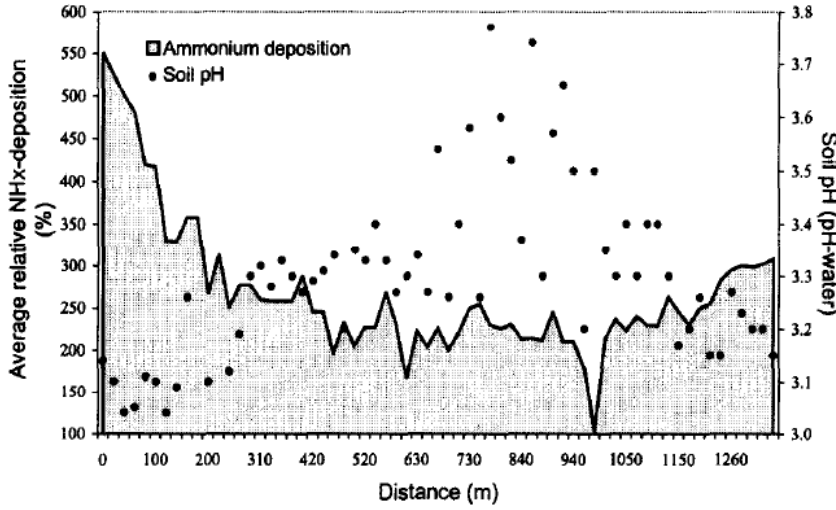

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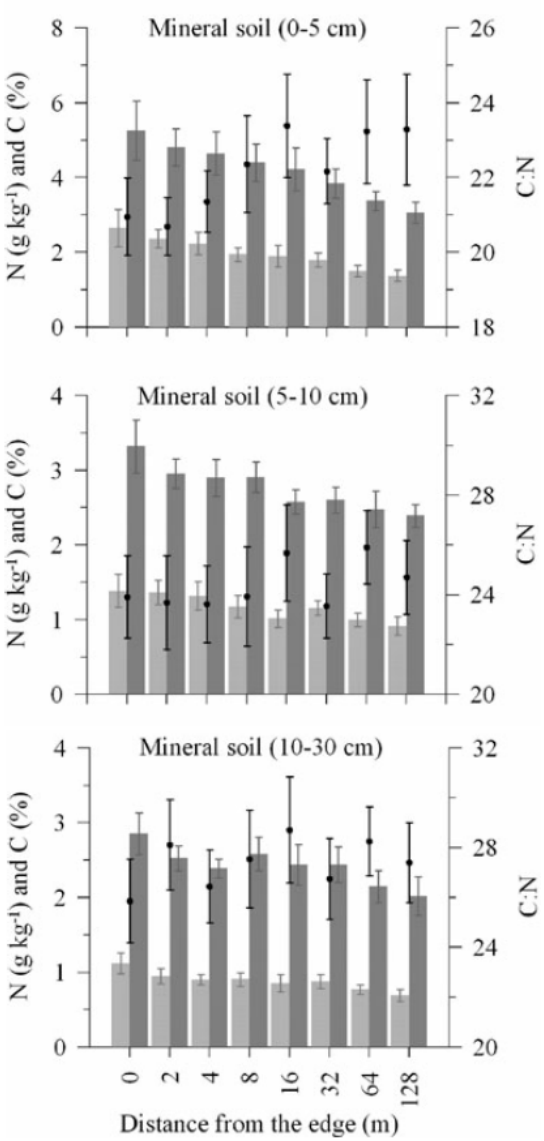
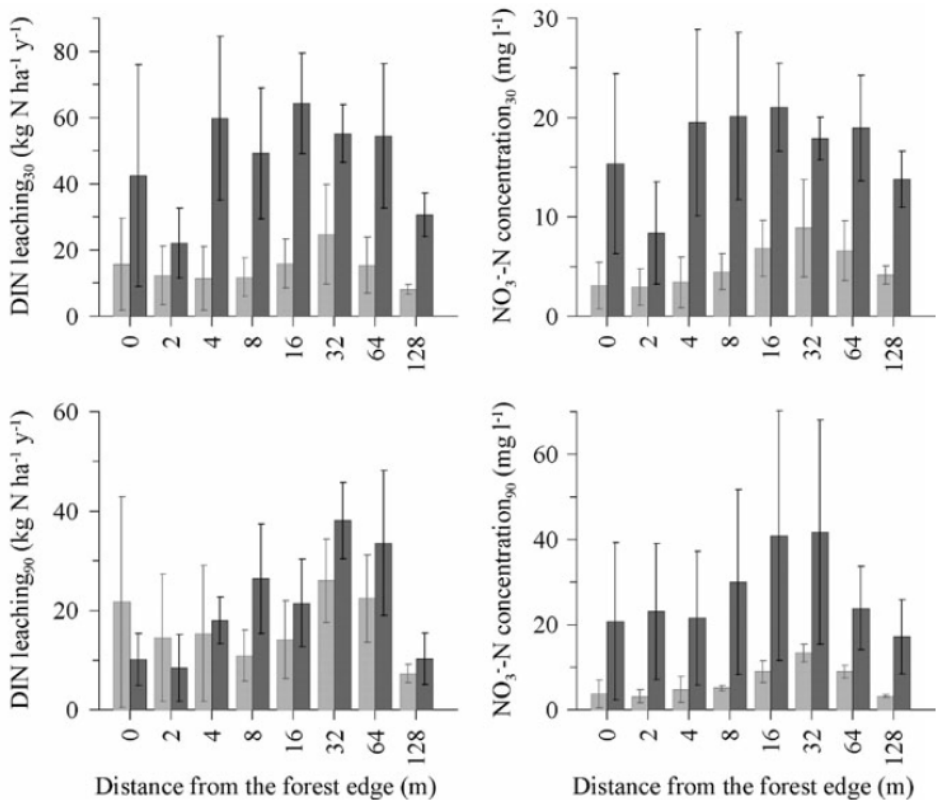
Eutrophication

N in soil



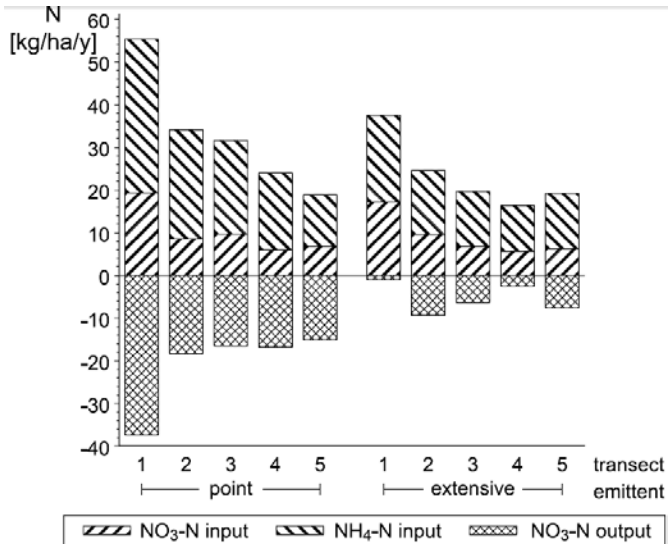
N in soil solution

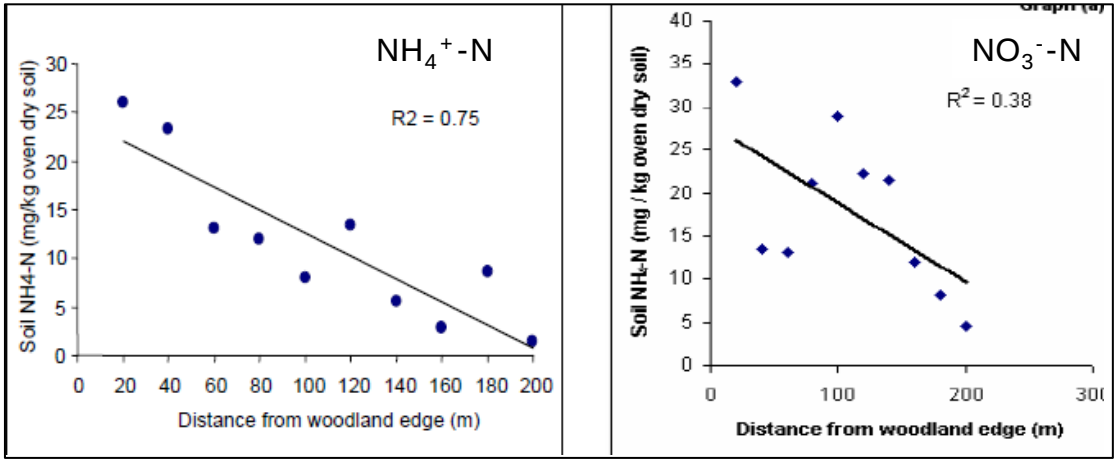


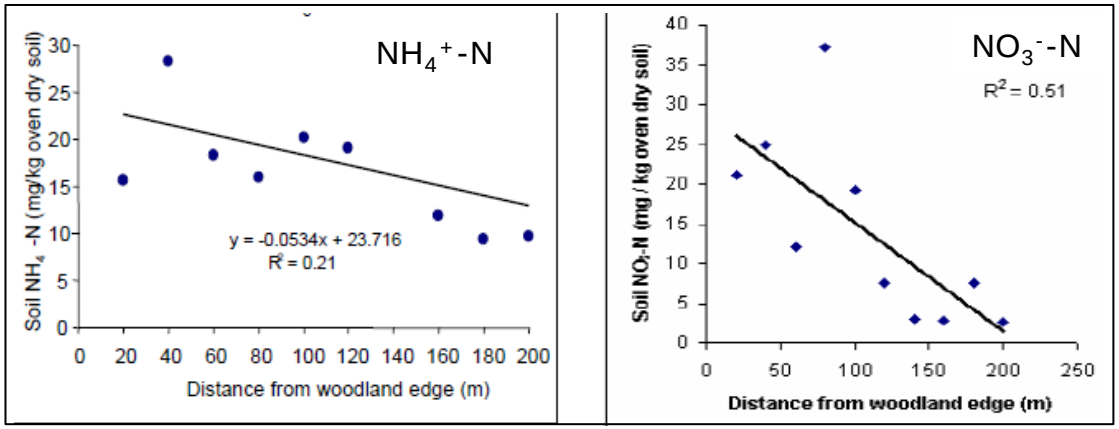
+ hogere NO_3-N concentraties in kleinere bosfragmenten

Wuyts et al. 2011 Ecosyst, 2013 WASP, Callesen et al. 1999 ForEcoMan

Eutrophication







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e.g. near pig & chicken farms
next to agricultural fields due to N fertilizer drift (current or historic!)

Spangenberg & Kölling 2004 WASP, Vanguelova & Pitman 2009, Pocewicz et al. 2007 Ecosyst

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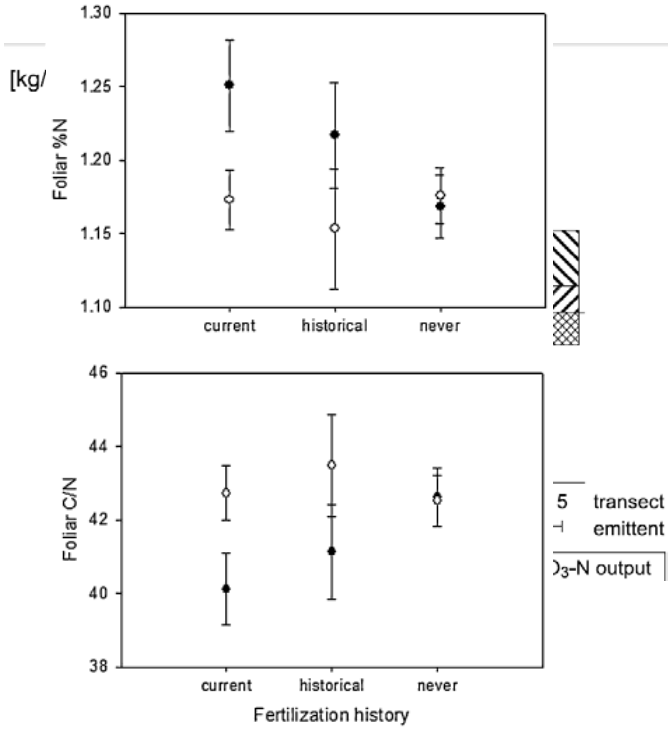

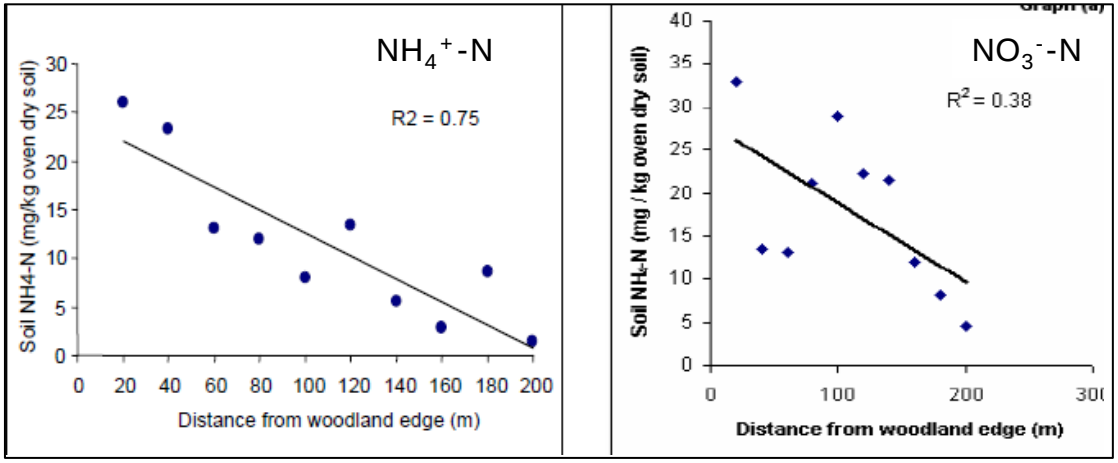

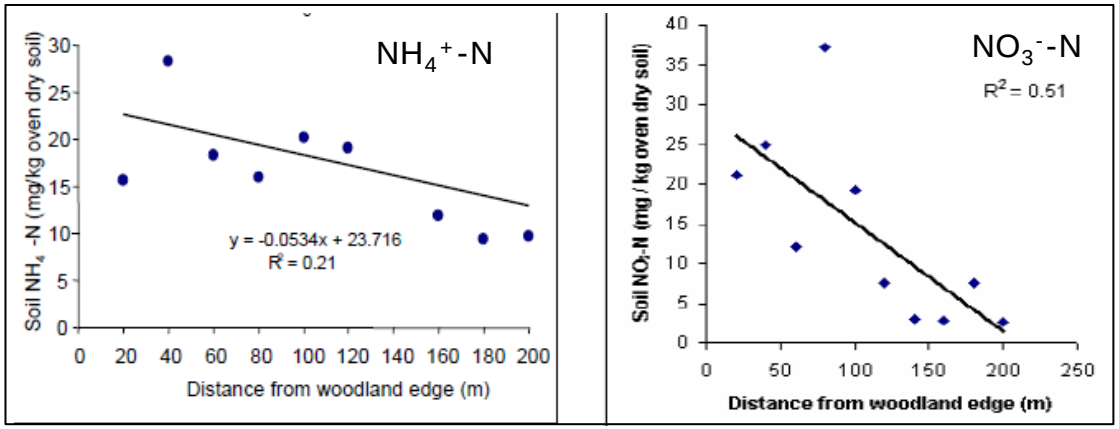

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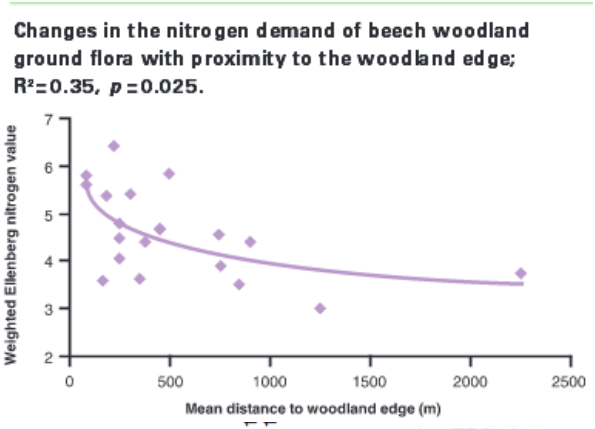
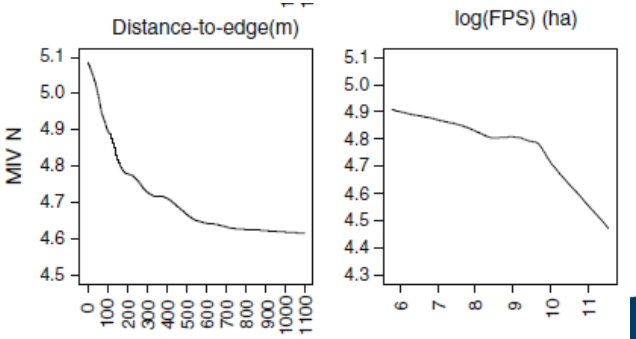
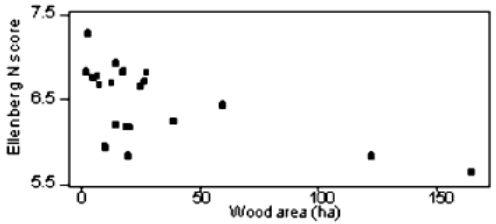
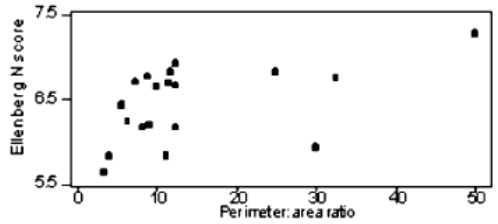
Flora

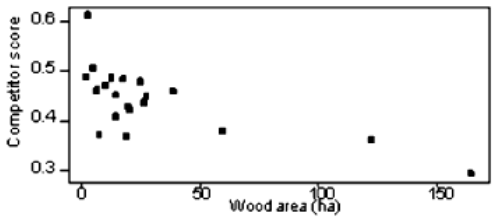
- edge effects of multiple var^{s} difficult to disentangle
  - Ellenberg N & nitrophilous species
    - Ellenberg N ↓ with ↑ distance to edge and forest patch size
    - larger increase in Ellenberg N with time at edges
    - larger woods: lower Ellenberg N and cover of competitors
    - long, thin woods: greater cover of nitrophilous and competitor species and lower cover of stress tolerators

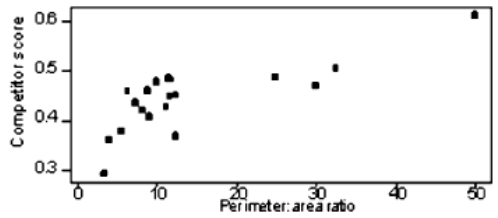


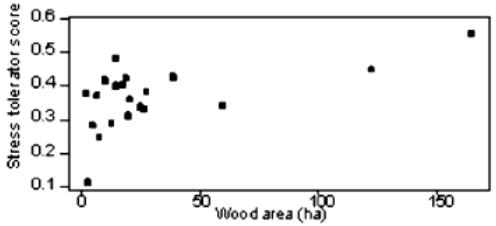


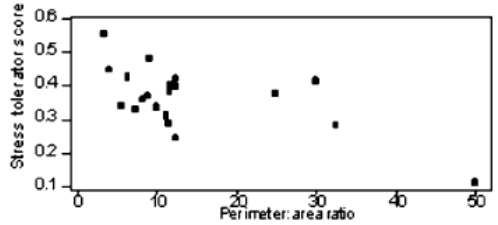








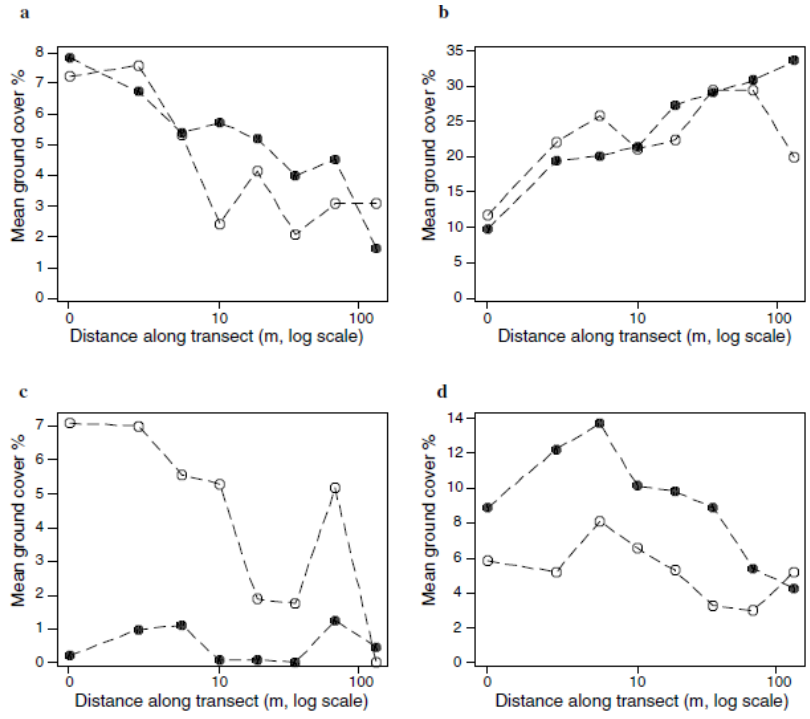




Thimonier et al. 1992, Kennedy 2003, Willi et al. 2005, Bergès et al. 2013

Flora

- edge effects of multiple variables difficult to disentangle
  - comparison arable & non-arable edges
    - higher percentage cover of nutrient demanding species such as the competitive *Urtica dioica* L.
    - out-competing the more stress-tolerant ancient woodland species such as *Carex sylvatica* & *Primula vulgaris*



a) Galium aparine
b) Mercurialis perennis
c) Deschampsia cespitosa (greater cover in non-arable than in arable transects)
d) Glechoma hederacea (higher cover in arable transects)

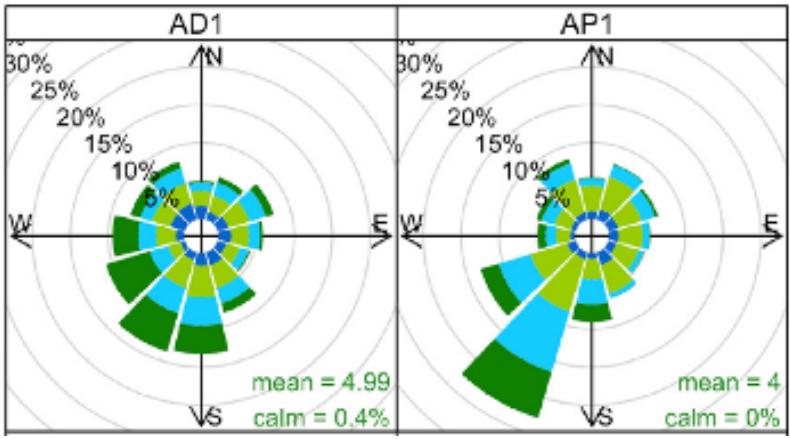
○ non-arable
● arable

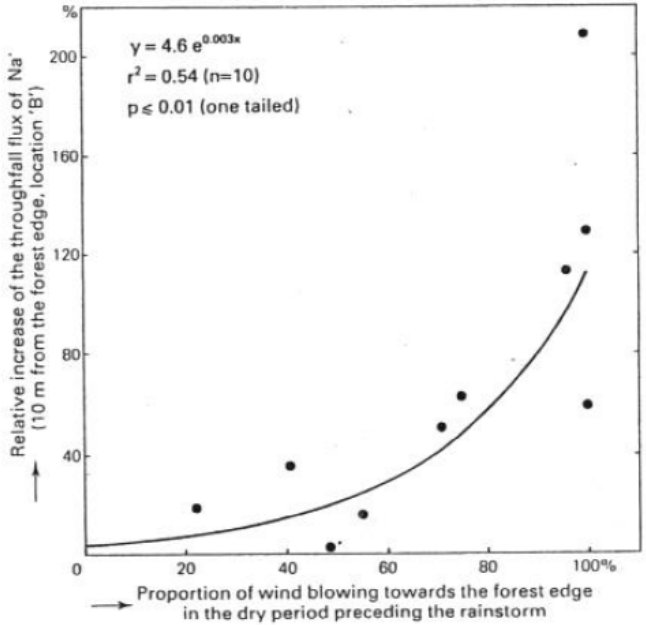
Willi et al. 2005

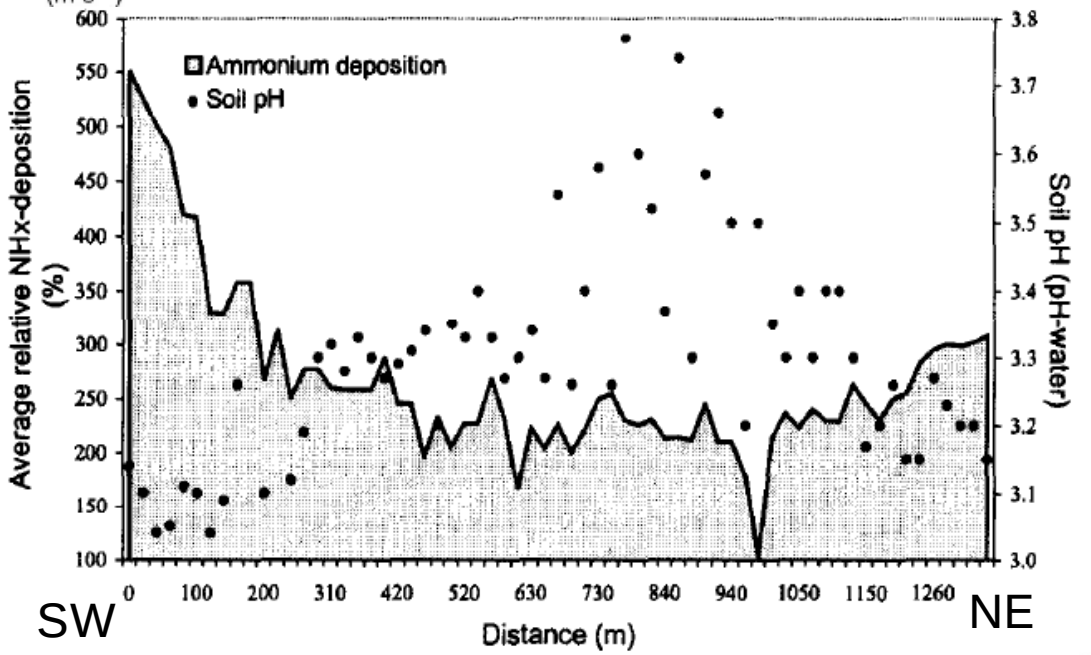
Mitigating measures

- Edge orientation

  wind speed & wind direction







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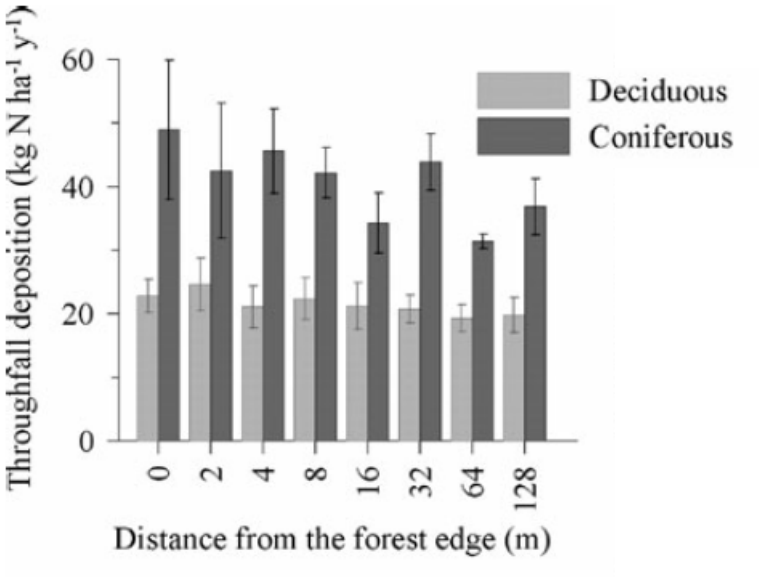
De Schrijver et al. 1998, Draaijers et al. 1988, Hofman et al. 2016

Mitigating measures

- Forest type:

  → MEI - and/or DEI -



	Site code	Cl^-	SO_4^{2-}	NO_3^-	NH_4^+	N+S	N
Oak	Qr1	1.22	1.02	1.07	1.03	1.03	1.02
	Qr2	1.12	1.08	1.12	1.08	1.08	1.08
Birch	Bp1	1.18	1.18	1.10	1.14	1.14	1.07
	Bp2	1.11	1.11	1.07	1.06	1.08	1.06
Pine	Pn1	1.95	1.45	1.56	1.40	1.45	1.45
	Pn2	1.62	1.40	1.31	1.26	1.31	1.26

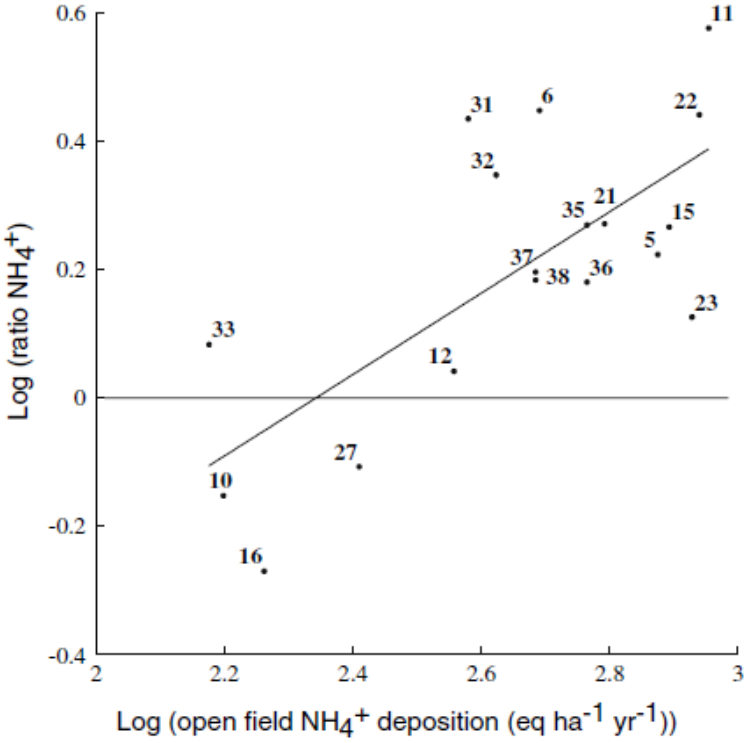
Wuyts et al. 2008 CanJForRes, 2008 EnvPol, 2011 Ecosyst

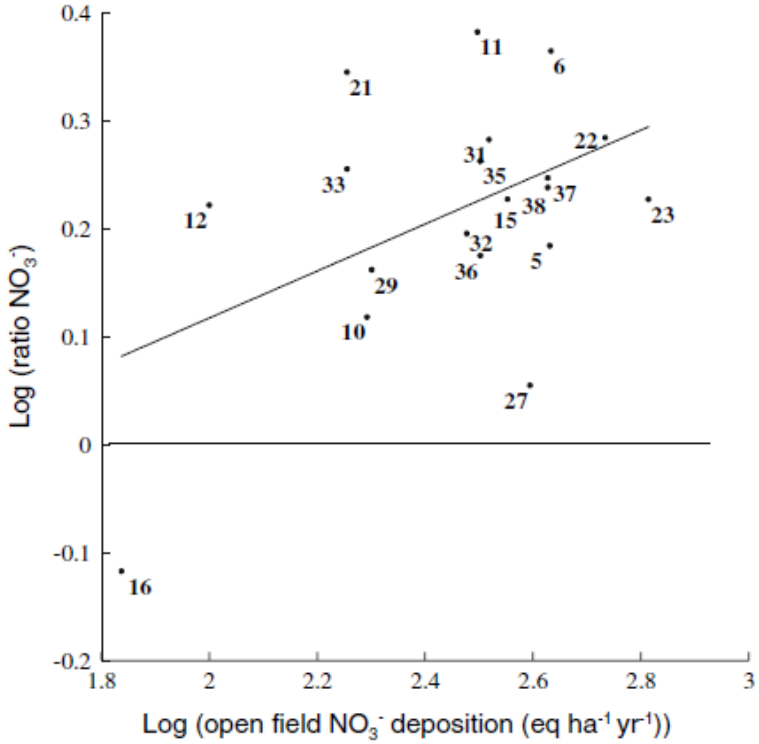
Mitigating measures

- Forest type

  ratio coniferous/deciduous

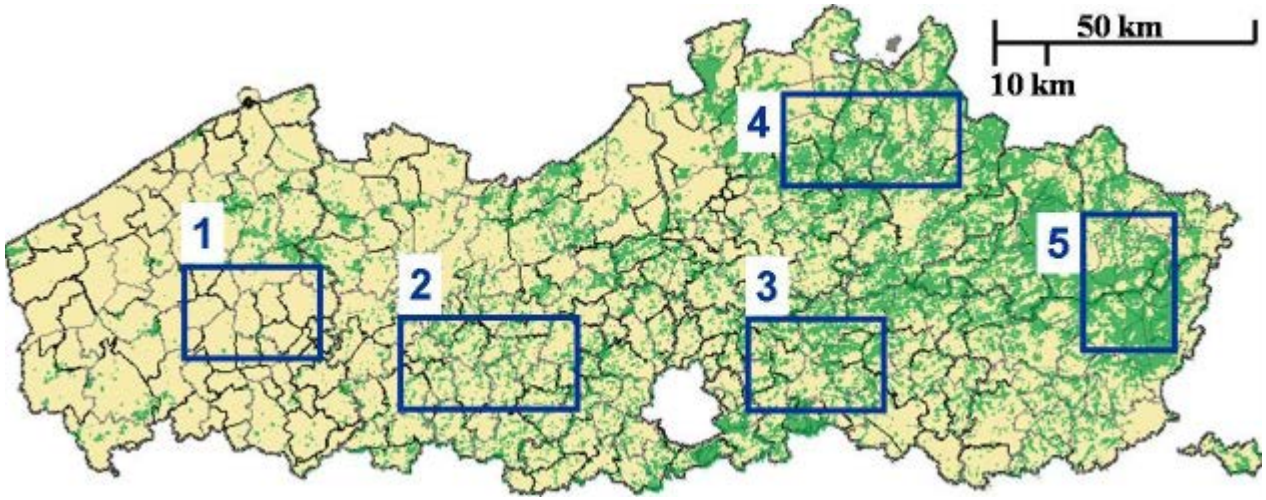
	n^a	Mean	
NH_4^+	18	1.72	(1.47–2.08)[b]
NO_3–	19	1.72	(1.58–1.86)
$NH_4^+ + NO_3^-$	22	1.85	(1.64–2.07)

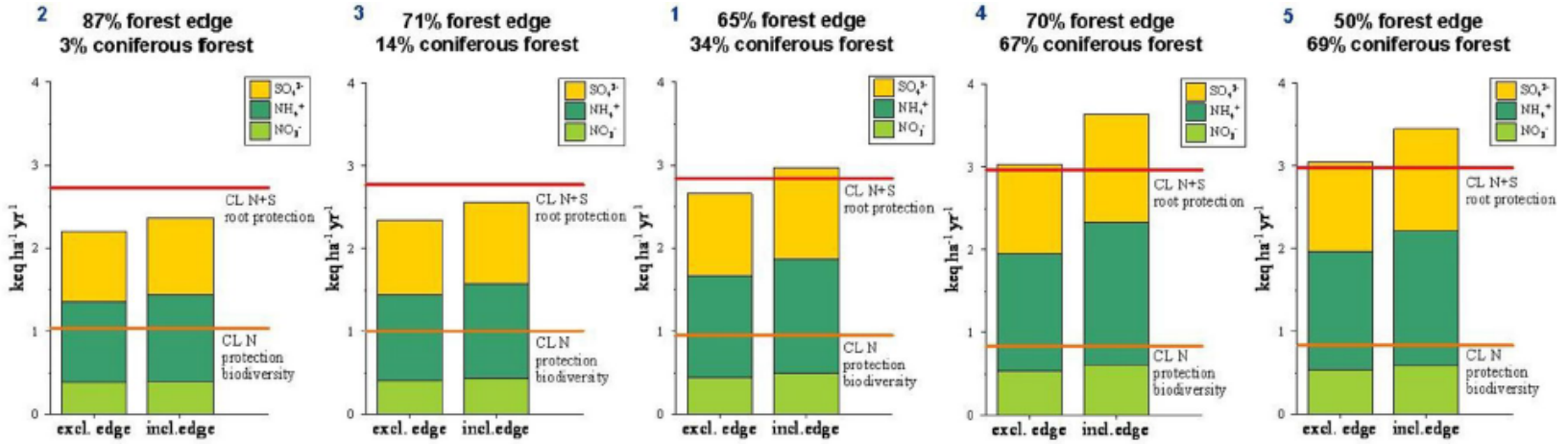




De Schrijver et al. 2007

Mitigating measures





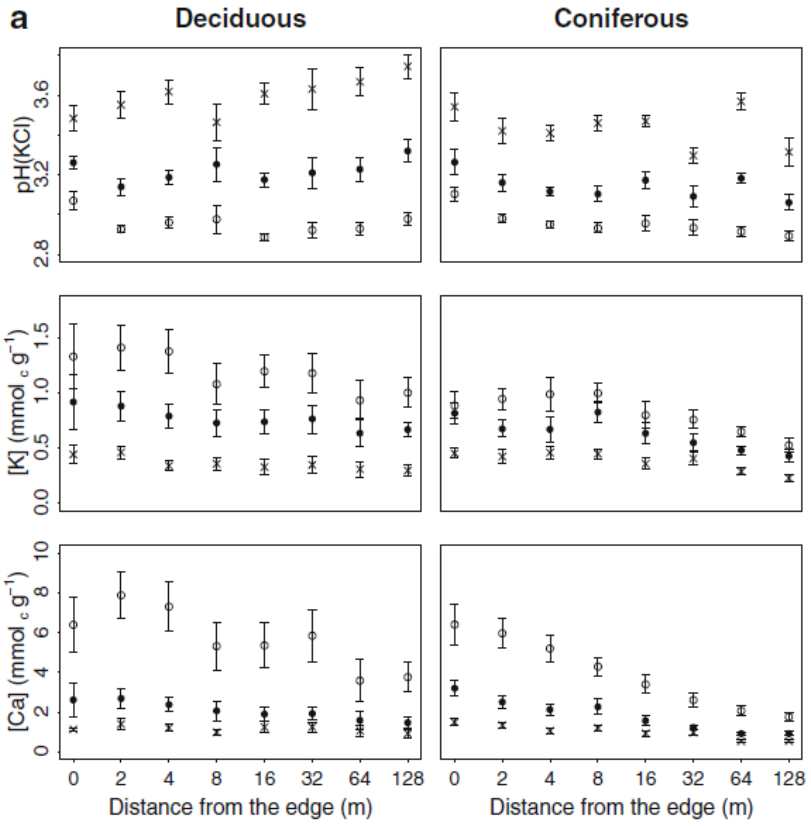
average CL exceedance

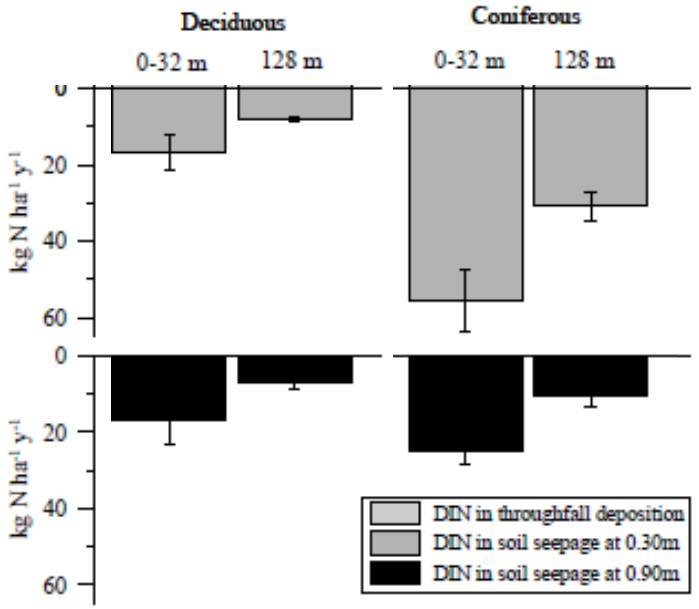
CL N+S	11	37	49	161	126	350	237	793	248	611
CL N	309	397	445	570	727	920	1104	1487	1135	1388

Wuyts et al. 2009 iForest

Mitigating measures

- Forest type





	Leaching 30 cm		Leaching 90 cm	
	$[NO_3^-$-N] (mg l^{-1})	DIN flux (kg N ha^{-1} y^{-1})	$[NO_3^-$-N] (mg l^{-1})	DIN flux (kg N ha^{-1} y^{-1})
WSR				
Forest type				
Deciduous				
0–64 m	7.0 ± 3.2	18 ± 10	9.8 ± 1.0	21 ± 9
128 m	4.2 ± 0.9	8 ± 2	3.3 ± 0.3	7 ± 2
Coniferous				
0–64 m	19 ± 4	55 ± 15	34 ± 20	*31 ± 8*
128 m	14 ± 3	31 ± 7	17 ± 9	*10 ± 5*

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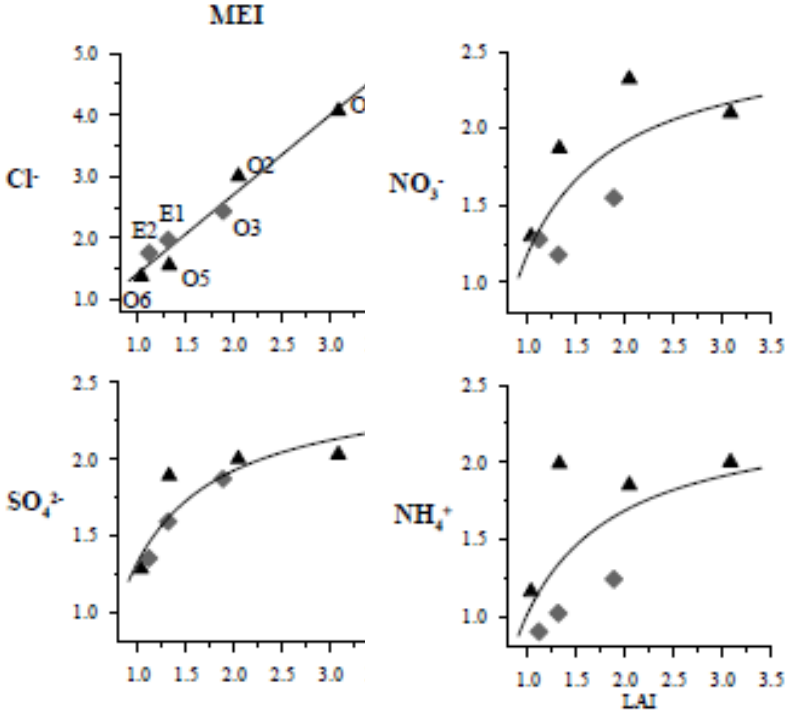
Wuyts et al. 2011 Ecosyst, 2013 WASP

Mitigating measures

- Forest structure
  - LAI: MEI +
  - crown depth (~LAI): MEI +
  - stem density (~LAI): DEI –
  - ~ modelstudies

P. nigra & P. sylvestris



Wuyts et al. 2009 AtmEnv
Wiman & Agren 1985 Atm Env

Mitigating measures

- Forest structure
  - LAI: MEI +
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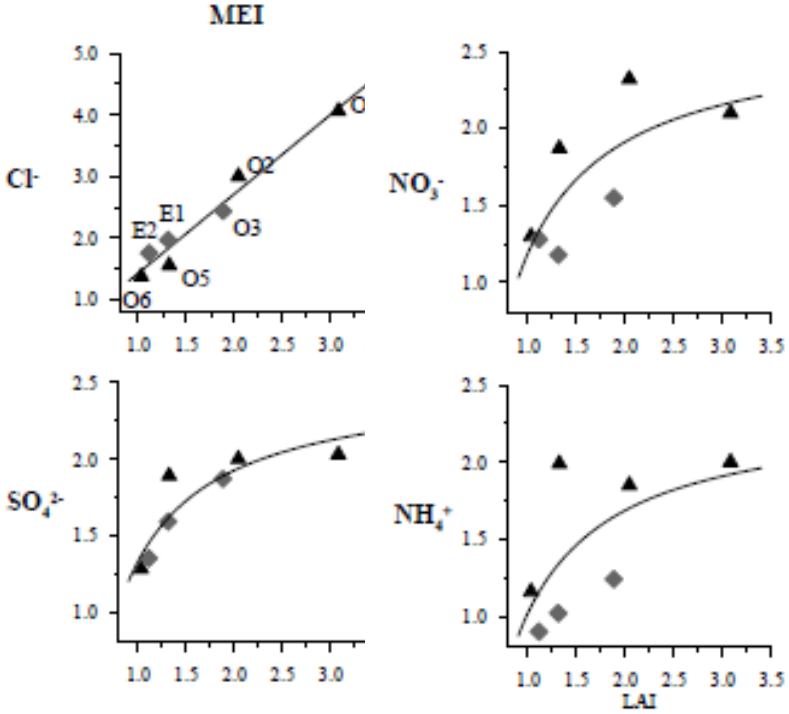

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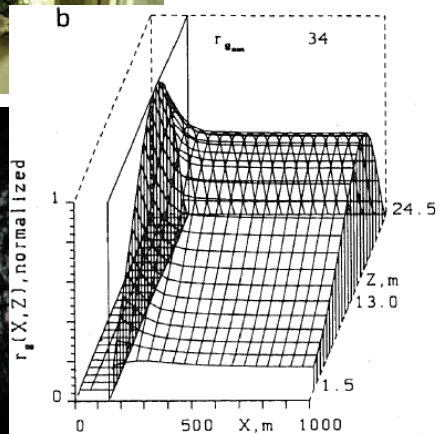
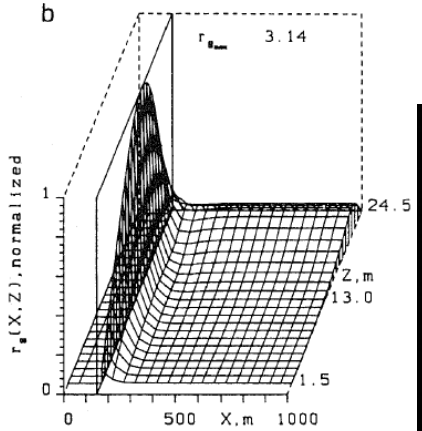
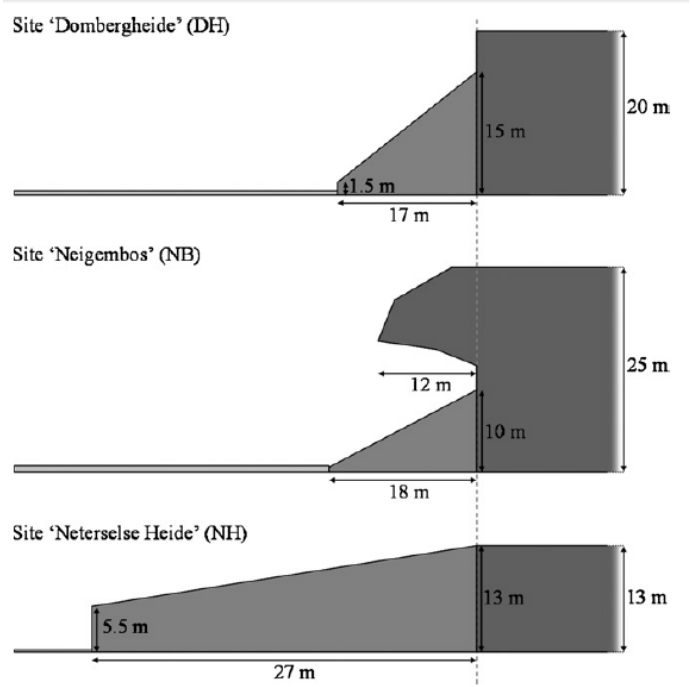




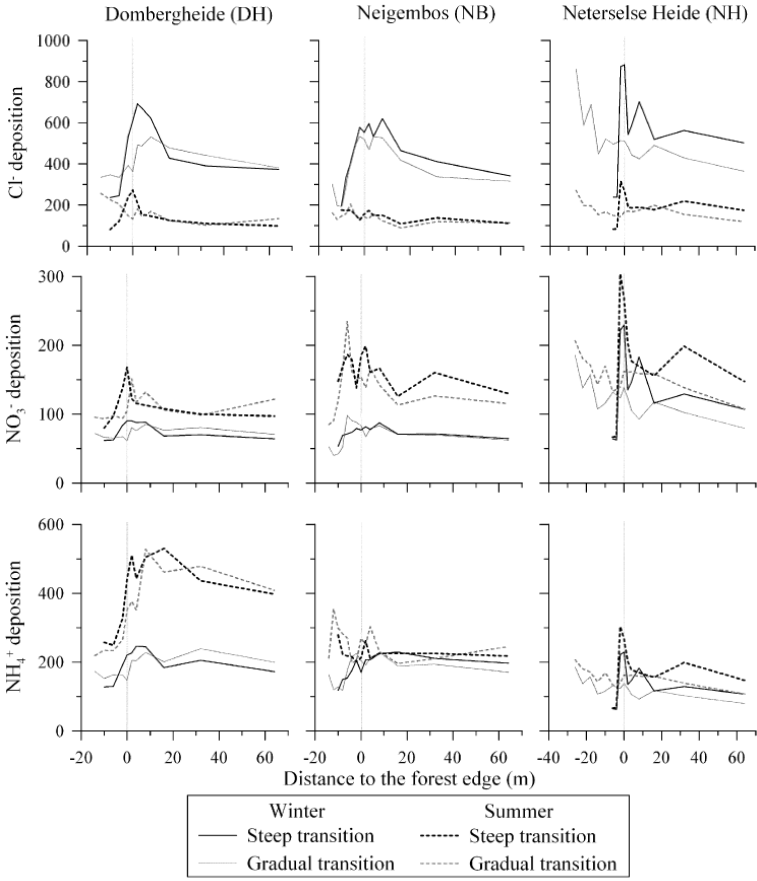
Mitigating measures

- Edge structure

→ gradual edge: MEI & DEI -



shape & size!



Site	Period	DEI (m)		MEI (–)	
		Steep	Gradual	Steep	Gradual
DH	Winter	53.3	24.9*	1.50	0.97*
	Summer	27.1	14.2	1.47	1.02*
NB	Winter	19.6	24.9	1.19	1.21
	Summer	27.2	21.3	1.32	1.22
NH	Winter	49.8	16.0*	2.27	1.91†
	Summer	53.3	17.7*	1.56	1.21*

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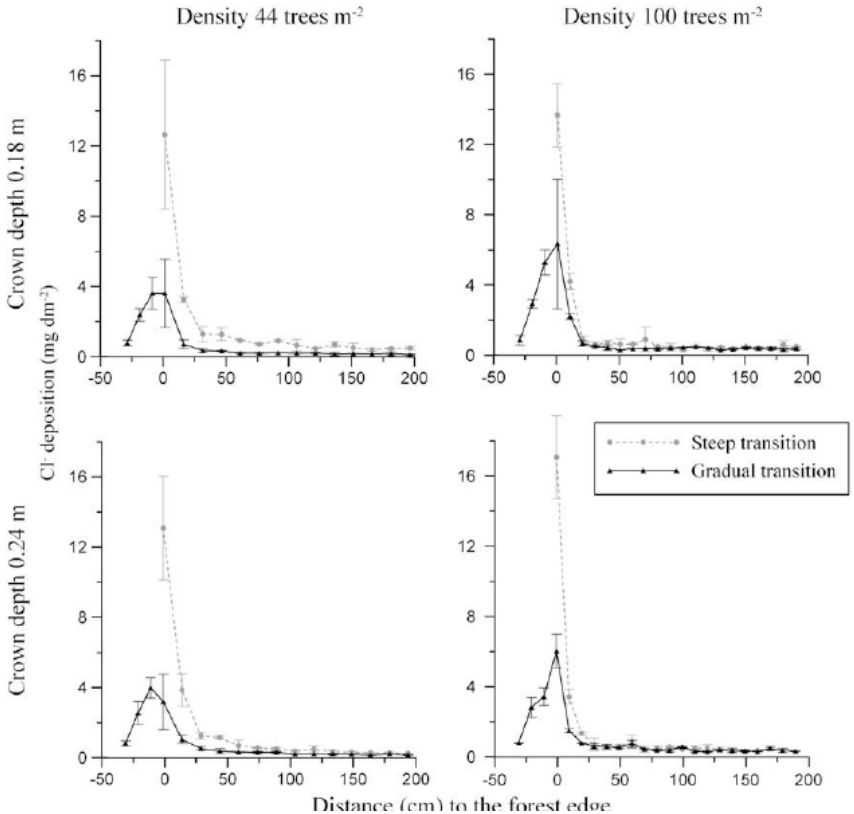
Wuyts et al. 2009 ForEcoMan

Mitigating measures

- Edge structure

  → gradual edge: MEI -



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Wuyts et al. 2009 AtmEnv

Take-home message

- increased N input in edges
- relevant? fragmented landscapes (> 40% forest edge)
- result?
  - increased N availability in soil & soil solution
  - (soil acidification)
  - in vicinity of N sources (farms, agricultural fields, traffic?)
- mitigating measures?
  - avoid creation of new edges
  - forest type conversion
  - canopy density/LAI through early & frequent thinning
  - layout of gradual transitions at steep edges
    - e.g., with herbaceous fringe, shrub belt and forest mantle
    - ~ conservation & promotion of biodiversity ('high quality edges')
    - forest receding *vs* forest expansion: protect forest core!
- priorities?
  - SW-facing edges

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