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N – Monitoring and Impacts in Portugal

FACULDADE · DE · CIÊNCIAS UNIVERSIDADE · DE · LISBOA

UNIVERSIDADE DE LISBOA

Centro de Biologia Ambiental

nitrogen

a major threat to biodiversity, impact is expected to increase;

TABLE 2.1 | Status and trends of biodiversity-related parameters according to the 2010 indicators

Arrows indicate the direction of trends (broad arrows indicate a high level of confidence about the trend; narrow arrows indicate low confidence; red arrows indicate a trend that is negative for biodiversity; green arrows indicate a trend that is positive for biodiversity). The quality of the data and indicators are shown by the stars at the right hand side.

★★★ good indicator methodology with globally consistent time course data;
★★ good indicator, but no time course data;
★ indicator requires further development and/or limited data.

FOCAL AREA: Status and trends of the components of biological diversity

- Trends in extent of selected biomes, ecosystems, and habitats
- Trends in abundance and distribution of selected species
- Change in status of threatened species
- Trends in genetic diversity of domesticated animals, cultivated plants, and fish species of major socio-economic importance
- Coverage of protected areas

FOCAL AREA: Ecosystem integrity and ecosystem goods and services

- Marine Trophic Index
- Connectivity – fragmentation of ecosystems
- Water quality of aquatic ecosystems

FOCAL AREA: Threats to biodiversity

- Nitrogen deposition
- Trends in invasive alien species

FOCAL AREA: Sustainable use

- ...ystems under sustainable management
- Ecological footprint and related concepts

FOCAL AREA: Status of traditional knowledge, innovations and practices

- Status and trends of linguistic diversity and numbers of speakers of indigenous languages ★

FOCAL AREA: Status of access and benefit sharing

- ? Indicator of access and benefit-sharing to be developed

FOCAL AREA: Status of resources transfers

- Official development assistance (ODA) provided in support of the Convention ★

† for forests; data not available globally for all biomes, ecosystems and habitats

Chapter 2 | Page 43

FOCAL AREA: Threats to biodiversity

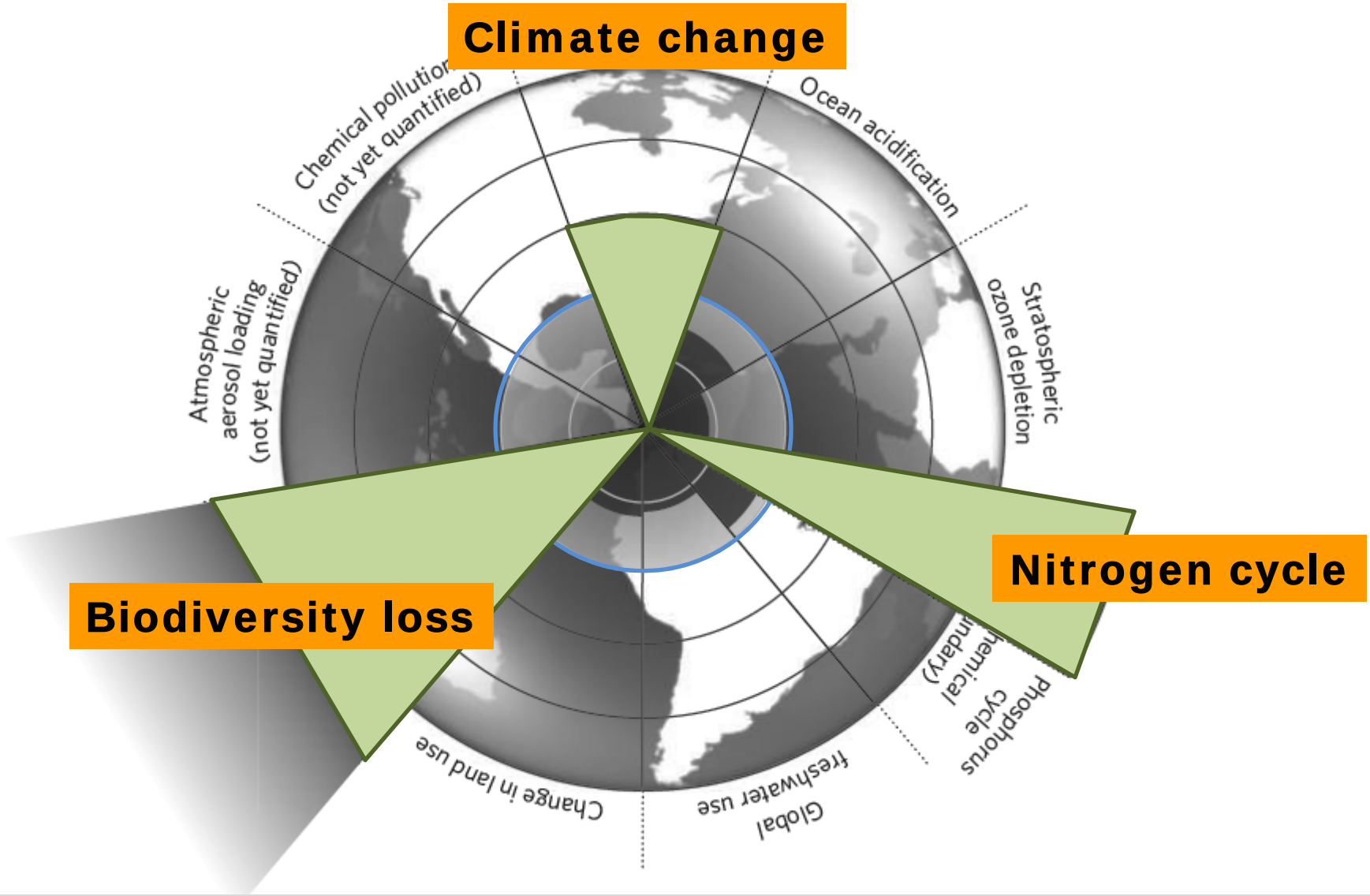
- Nitrogen deposition
- Trends in invasive alien species

FOCAL AREA: Sustainable use

Secretariat of the Convention on Biological Diversity (2006) ***Global Biodiversity Outlook 2***. *Montreal*, www.biodiv.org/GBO2

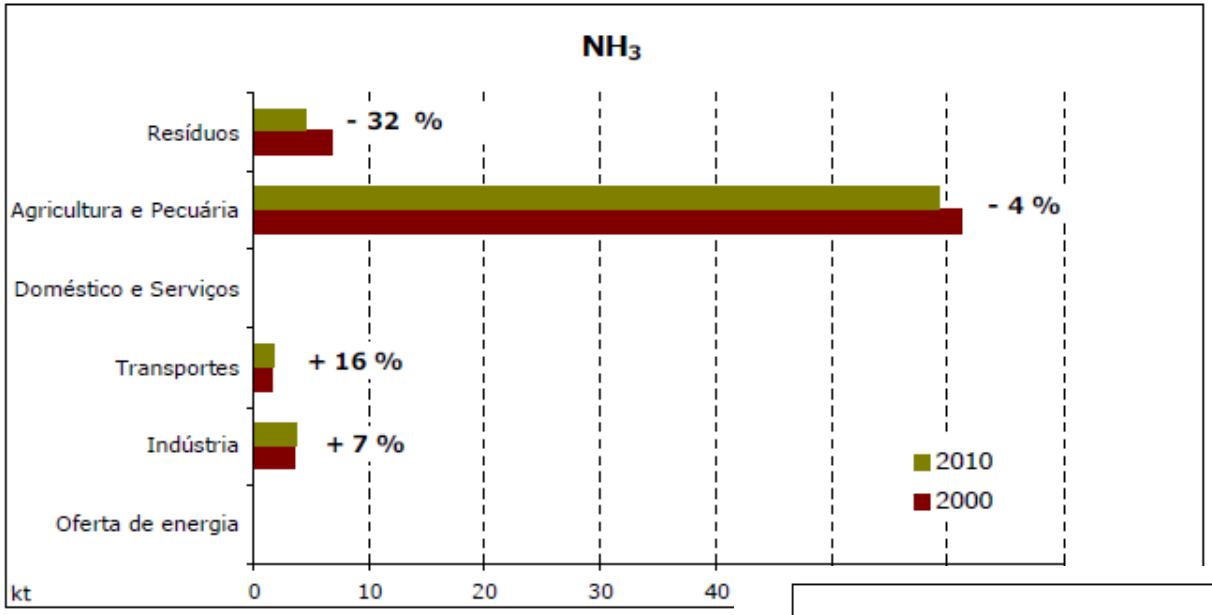
nitrogen

a major global change driver; rate of change is greater than safety boundary



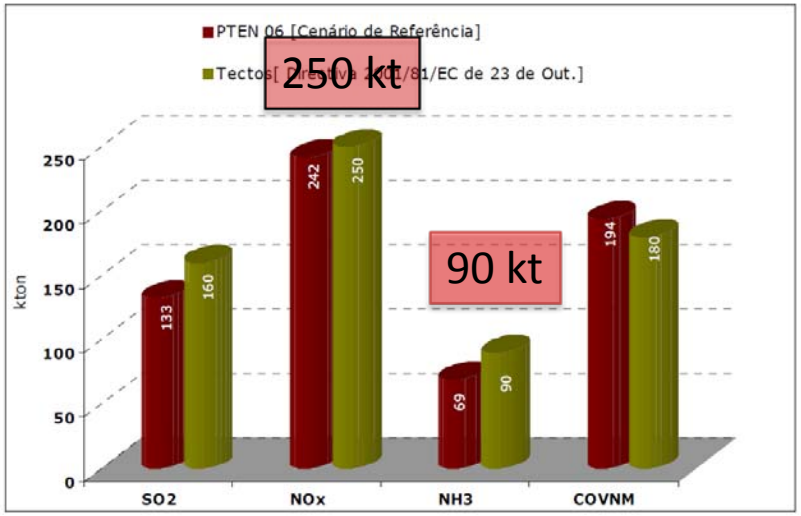
Rockstrom J, et al (2009) **A safe operating space for humanity**. **Nature** 461:472-475.

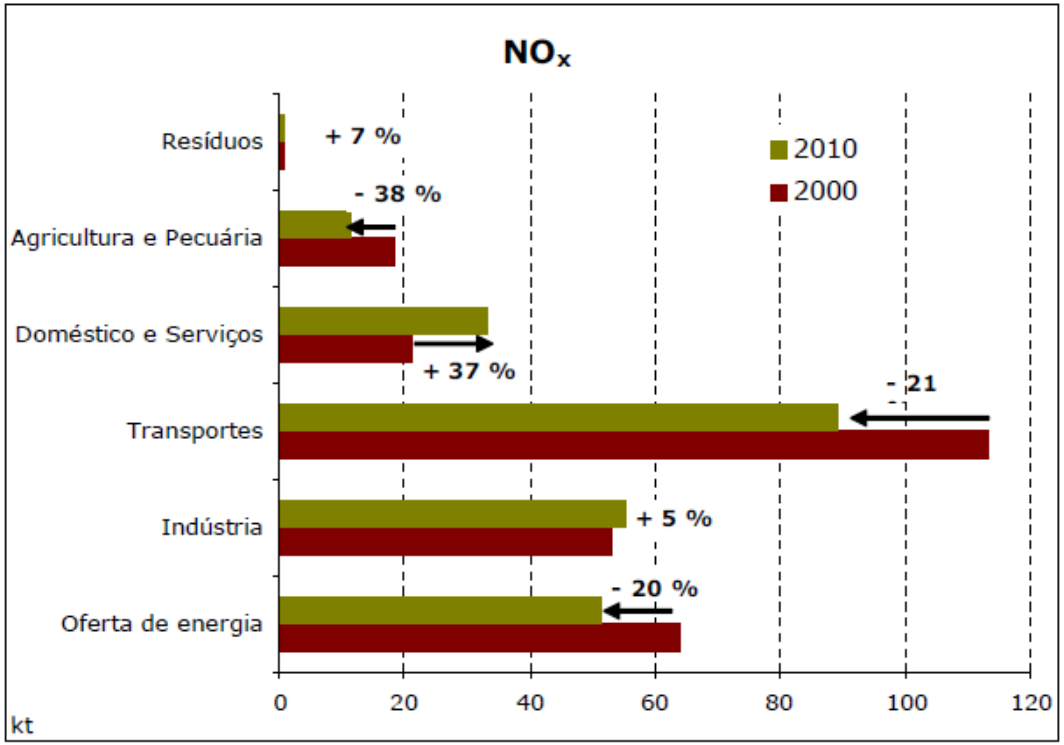
Comparing emissions between 2000-2010



2010 Directiva 2001/81/CE,
Decreto Lei nº 193/2003,
de 22 de Agosto,

SO2-160 kt
Nox-250 kt
COVNM-180 kt
NH3 -90 kt .





Reduction effort by sector except transports

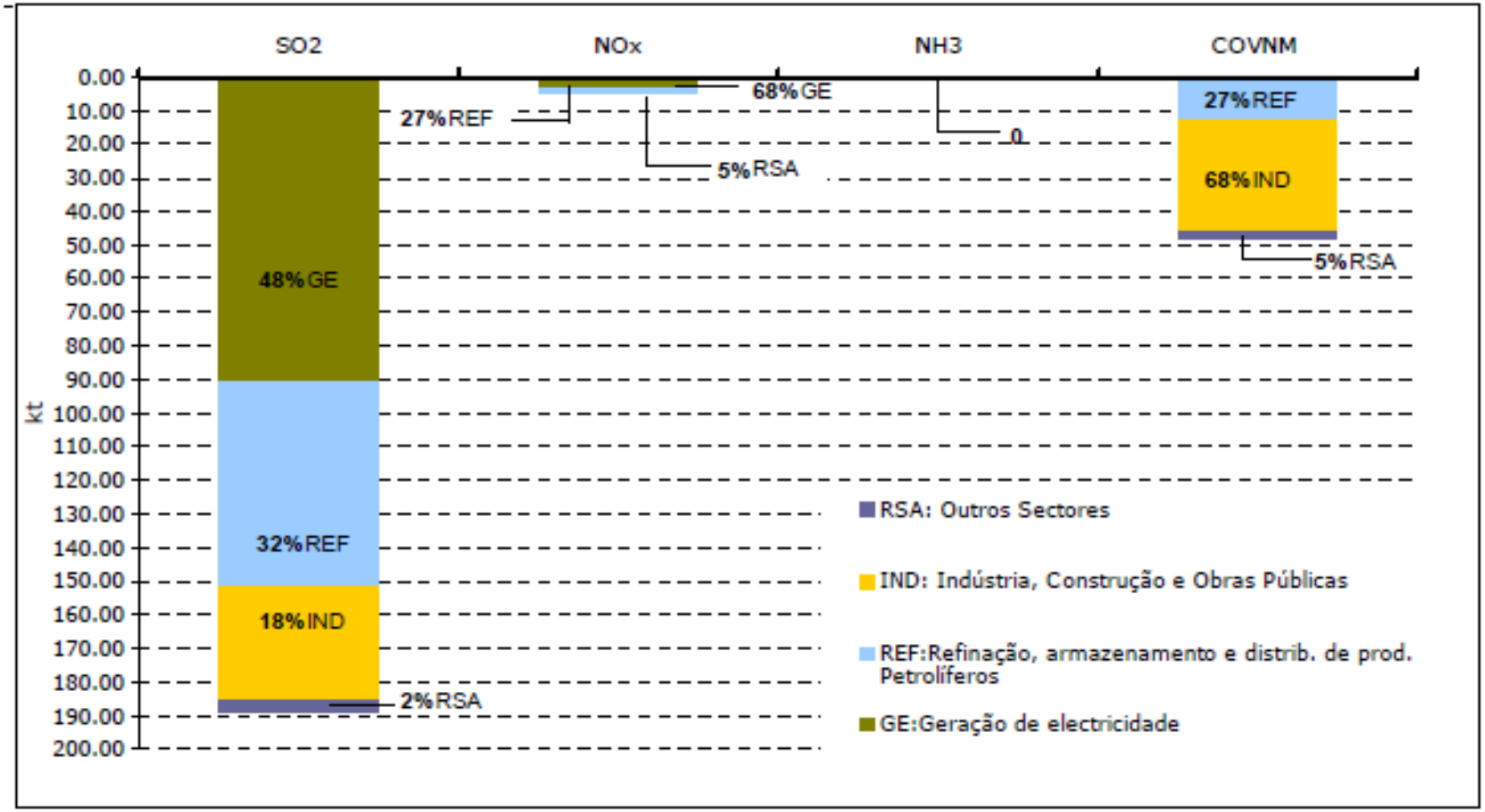
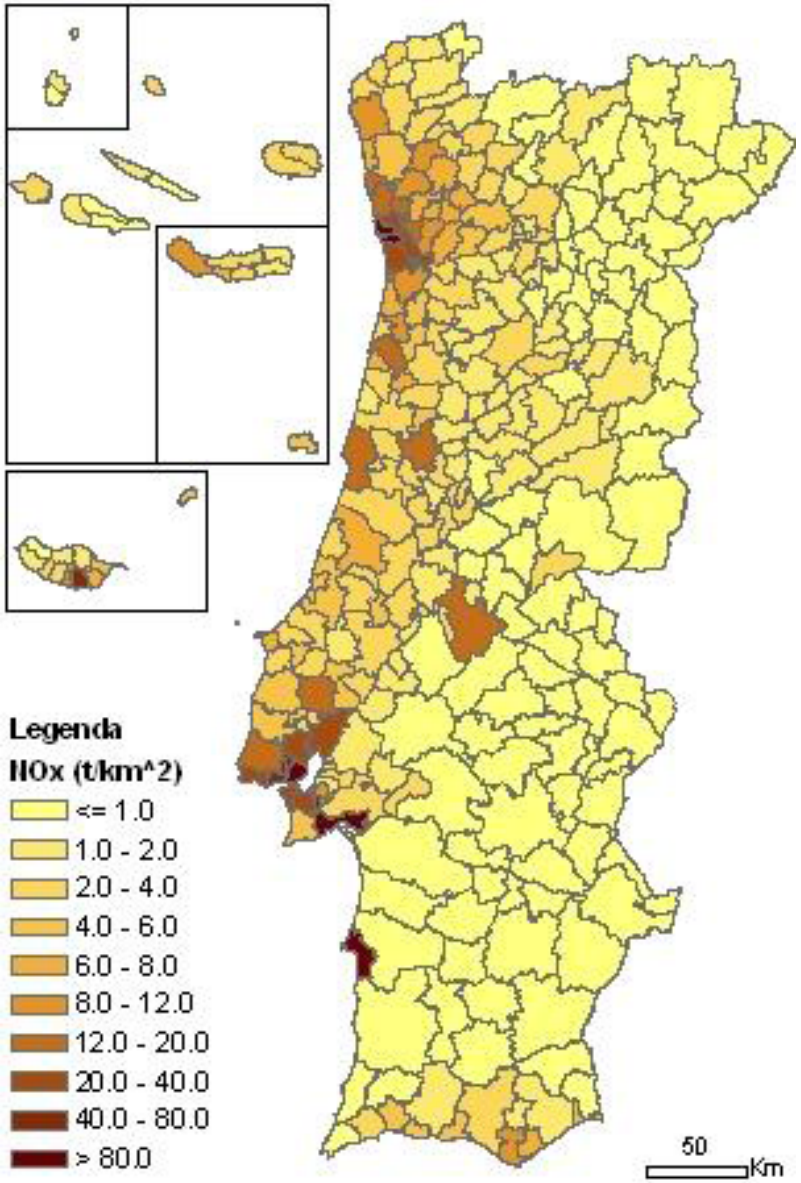


Figura 3.6

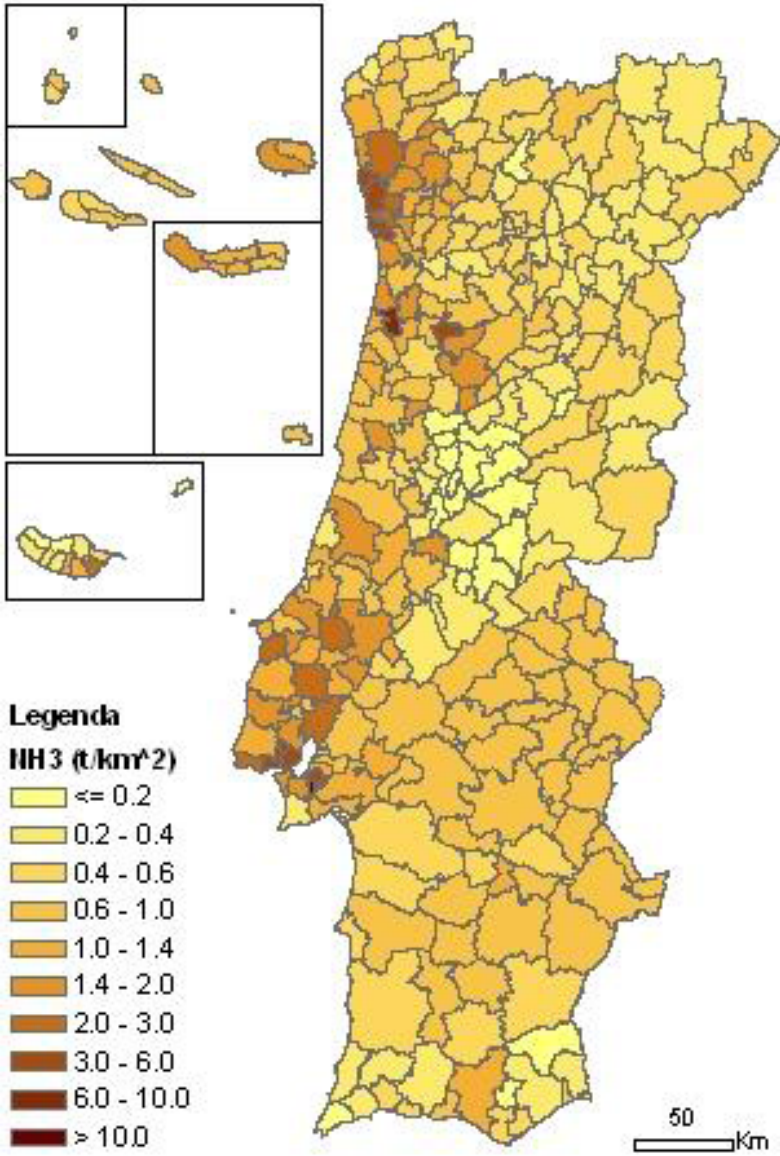
Esforço de redução dos diversos sectores (excepto transportes) devido à implementação dos instrumentos em vigor com excepção da PCIP para para SO_2, NO_x e NH_3

NOx



NOx emissions in 2005 including natural sources

NH_3

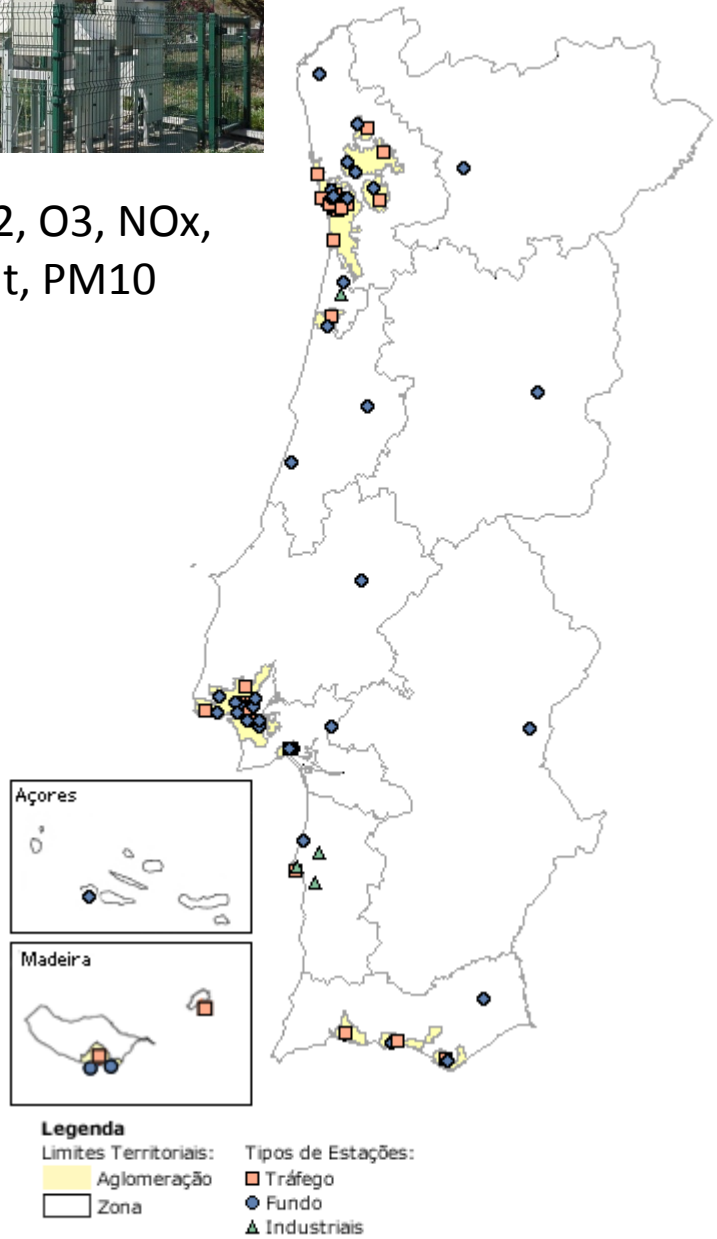


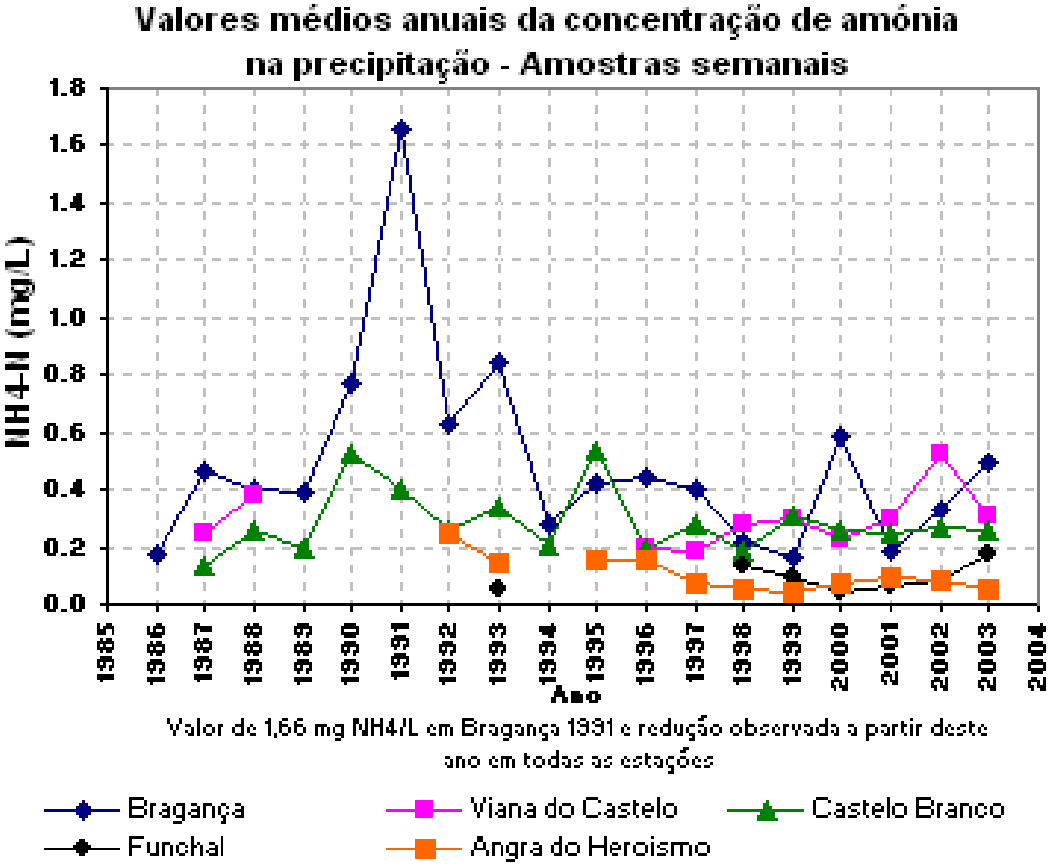
NH_3 emissions in 2005

NOx monitoring

NH_3/NH_4^+ monitoring

SO2, O3, NOx, PMt, PM10



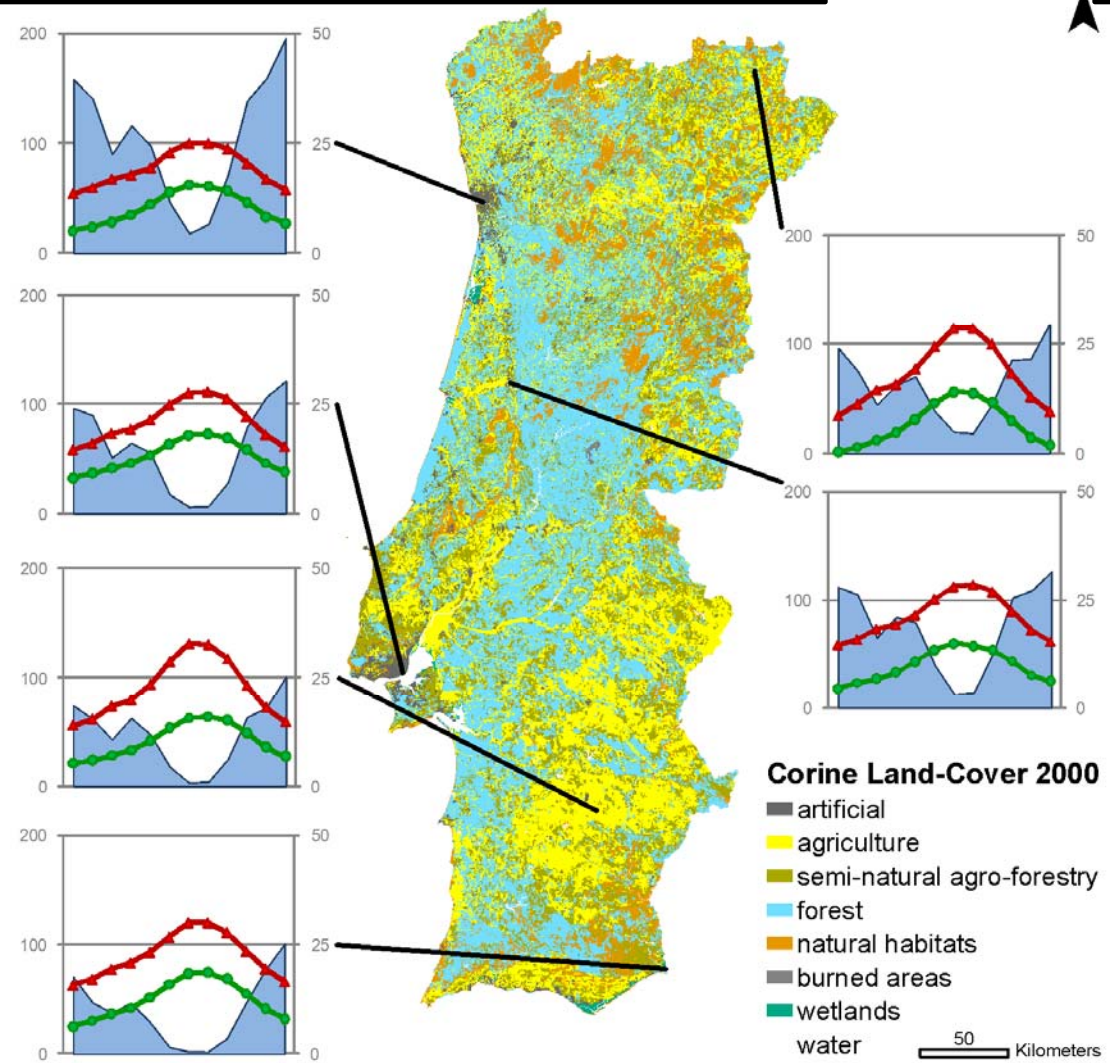


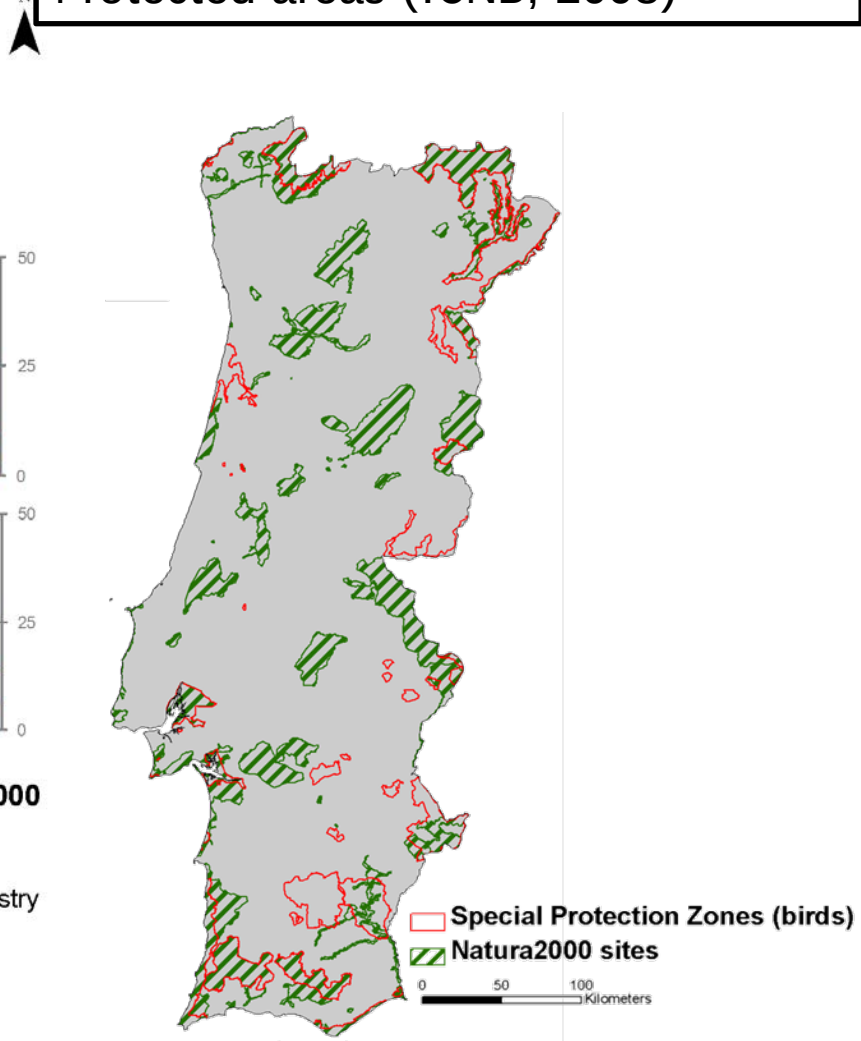
There are 3 monitoring stations for NH_4^+

Impacts on Biodiversity and Conservation

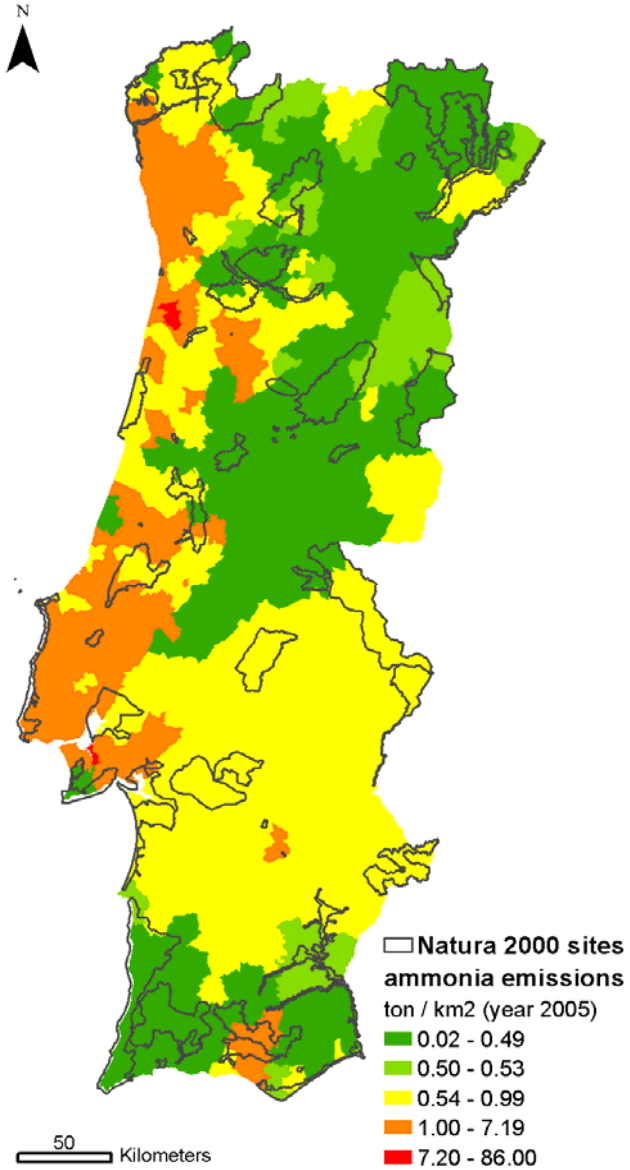
Land-cover and climate

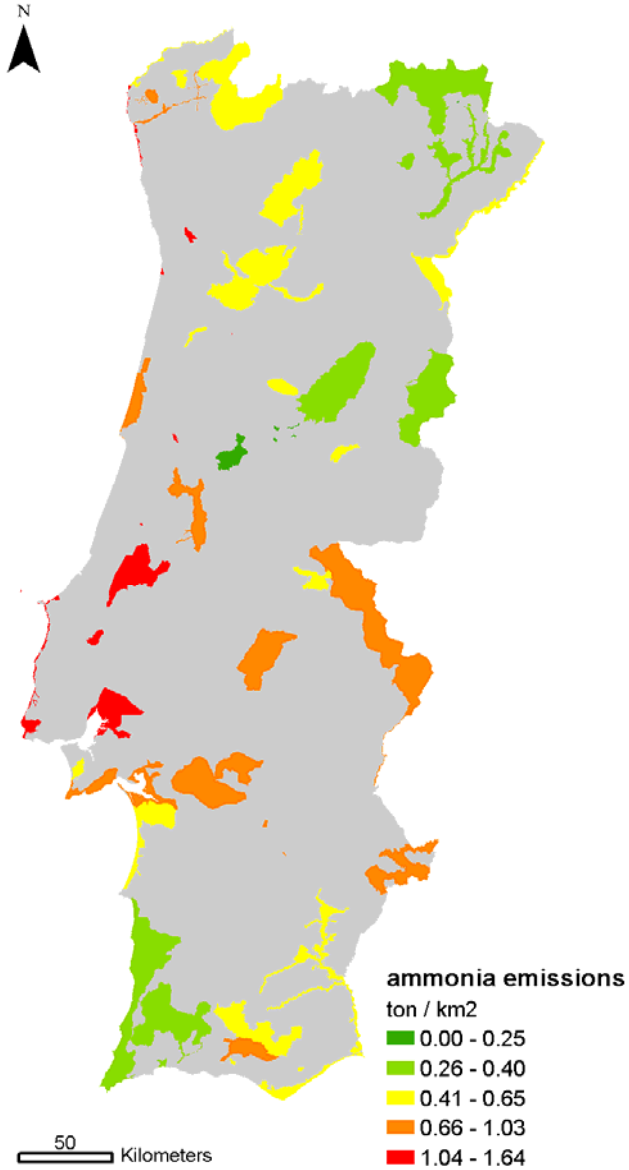
Protected areas (ICNB, 2008)





Map of the distribution of land-cover types from Corine Land-Cover 2000. Climatograms are shown for different areas in continental Portugal.
Values are averages from 1971 to 2000, source IM (2009).

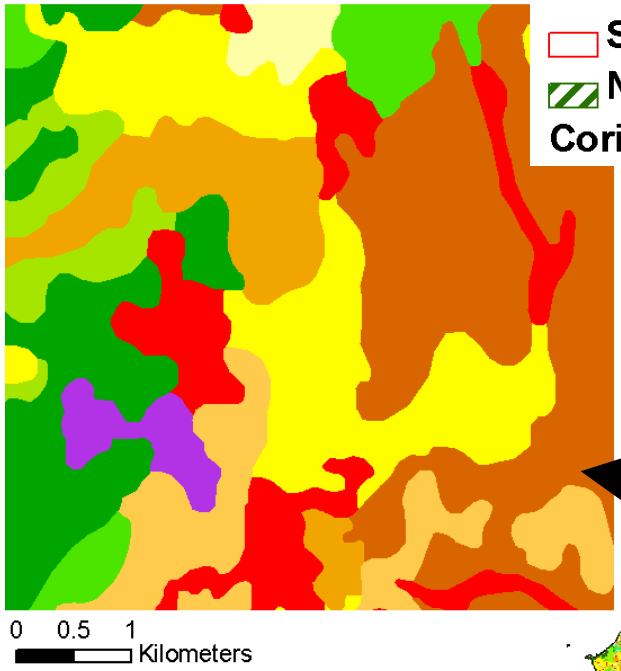


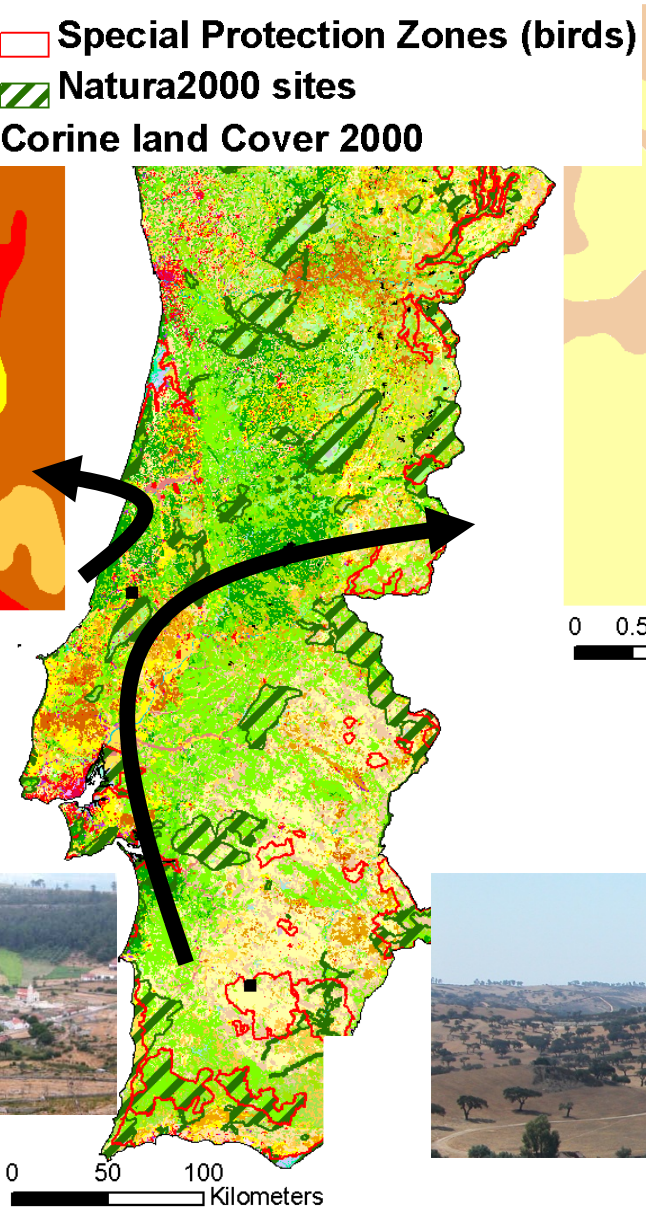


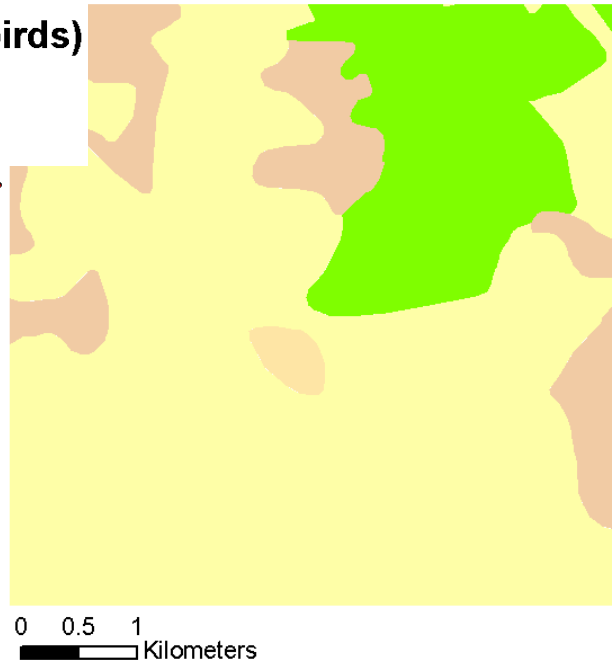
Left - Map of the level of ammonia emissions by council (source APA, 2008) superimposed to the limits of the protected areas in Portugal, Natura 2000 sites in black line. Right – Average value of the NH_3 emissions for the Natura 2000 network in Portugal based on NH_3 emissions information at the council level.

- highly fragmented and diverse landscapes

- very continuous and homogeneous landscapes







corine land-cover in Portugal, and two types of landscapes

two mediterranean landscapes: continuous cork-oak woodland and matrix type landscape

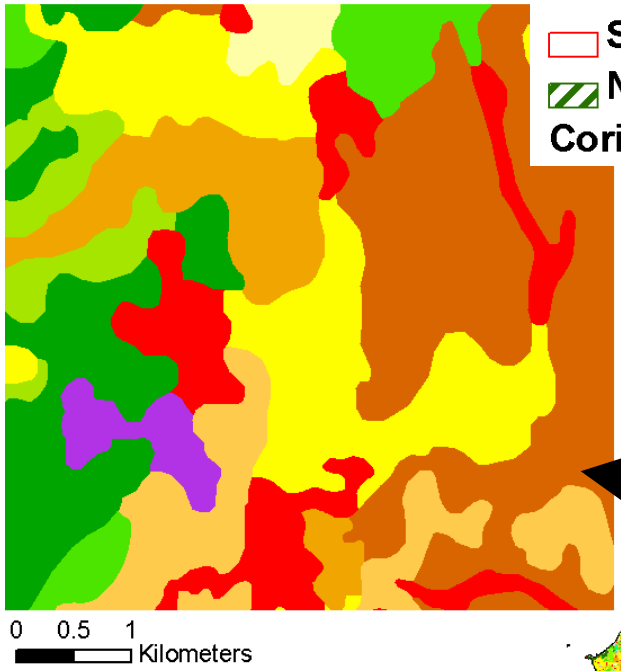
lichens

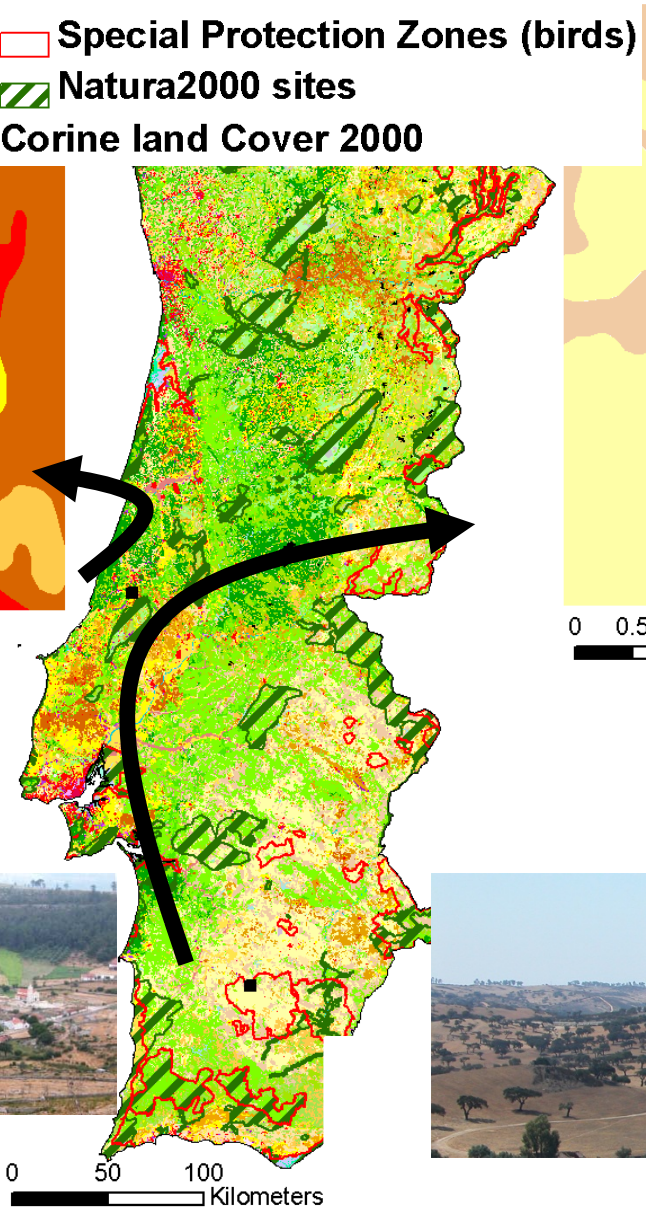
ideal organisms as early warning ecological indicators

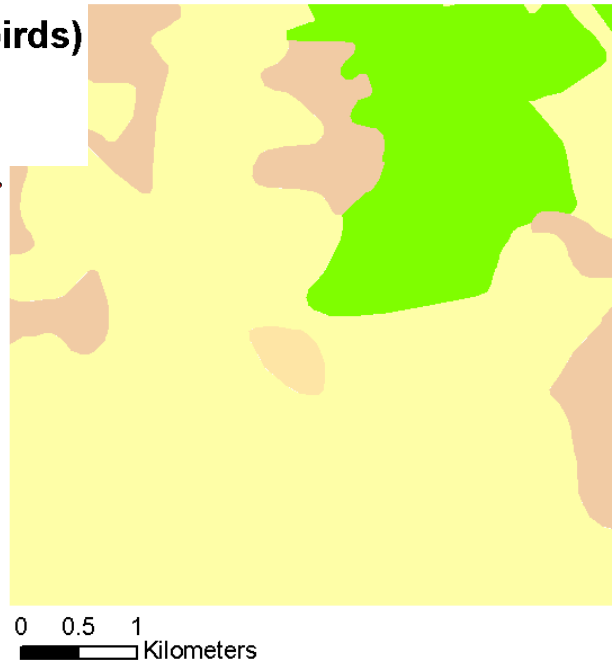
- photosynthetic organism, lichens result of a symbiosis between a fungi and a cyanobacteria and/or green-algae
- absence of cuticle and roots: lichens absorb water and dissolved nutrients and pollutants directly from the atmosphere
- biological perspective and integrative (“is the effect meaningful?”)
- high sensitivity (“early warning indicators”) especially for N
- a standard protocol is available for sampling lichen diversity
- increased spatial detail;
- lichens can be found worlwide;

- highly fragmented and diverse landscapes

- very continuous and homogeneous landscapes







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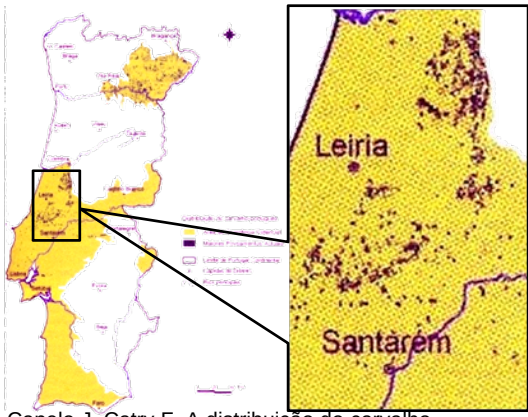
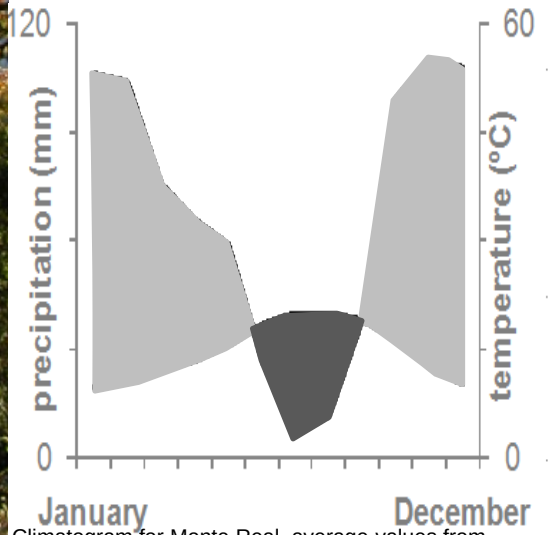
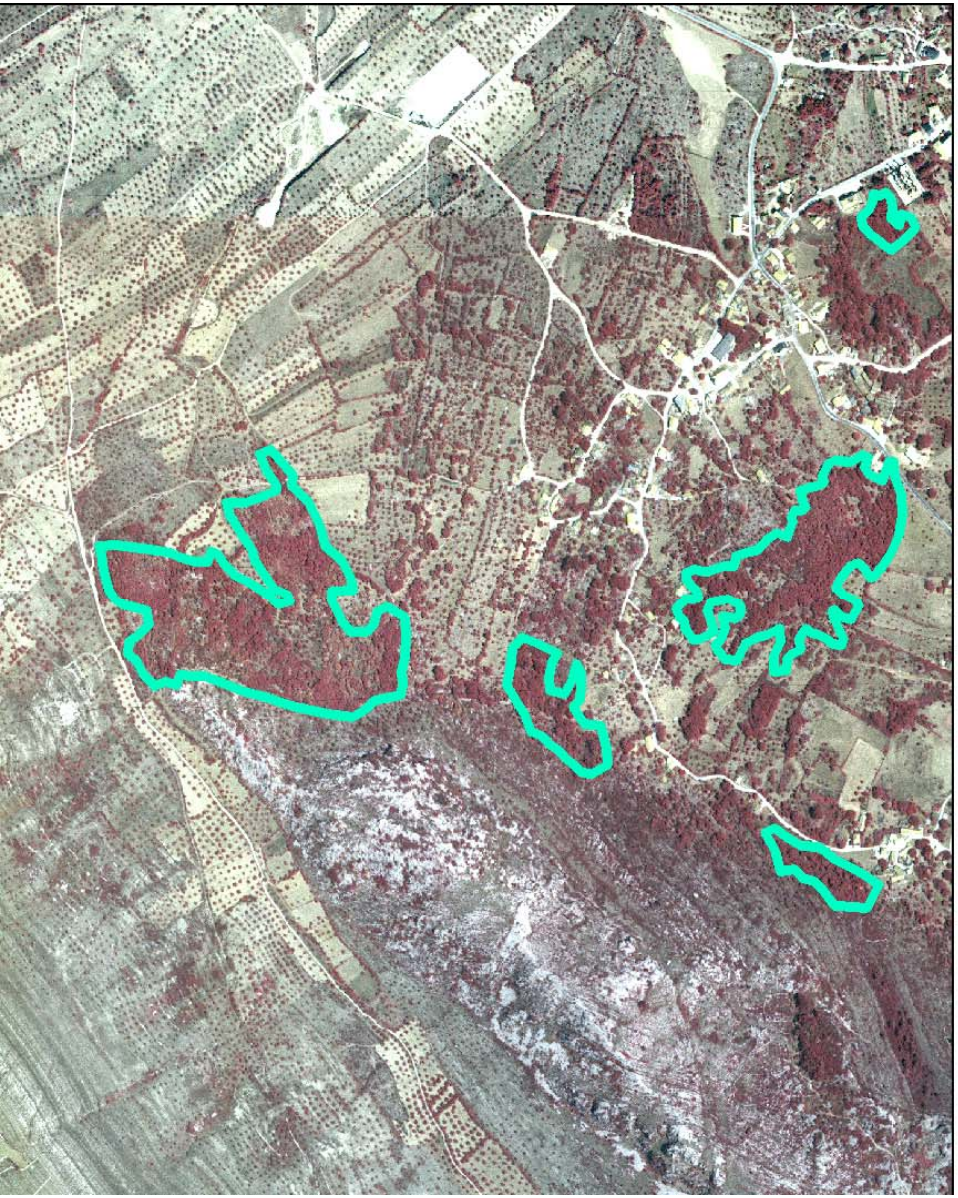


Capelo J, Catry F. A distribuição do carvalho-português em Portugal p. 83-94. *In* Sande-Silva J (ed) 2007 Os Carvalhais – um património a conservar. Público comunicação social SA – FLAD p. 275



Climatogram for Monte Real, average values from 1956 to 2008

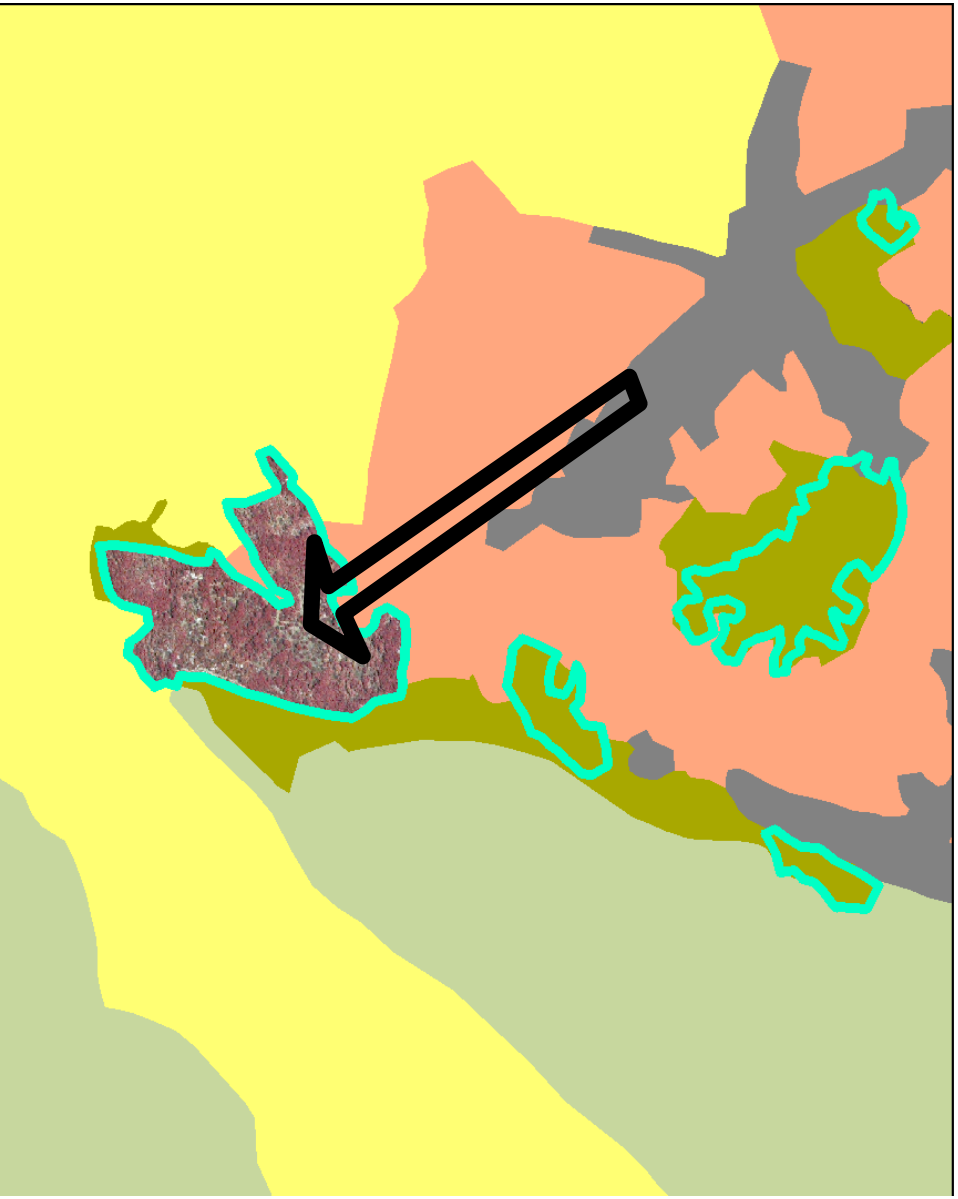
Portuguese-oak woods: a strongly fragmented "pristine" habitat, with a high biodiversity



Portuguese-oak woods

- remnants of ancient forest, in an highly fragmented and diverse human-made matrix

aerial false-color photography of Alvados valley (Natural Park of Serra d'Aire e Candeeiros, showing a few Quercus faginea woods in a human-made matrix



Quercus faginea woods

Land-Cover

- agriculture and pasture
- artificial and urban areas
- woods or high height shrub-land
- low height shrub-land
- olive-groves

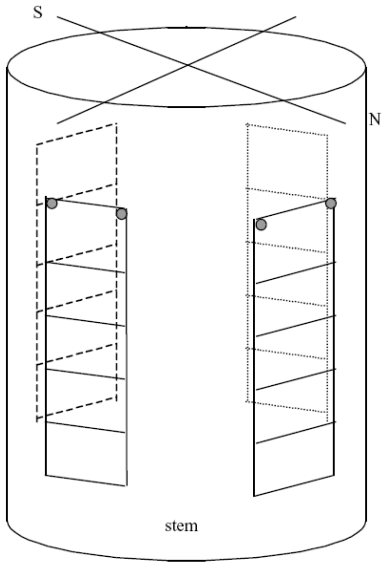
a large (c. 8ha) wood:

- surrounded by low-intensity human activities (olives, agriculture and pasture)

N

0 150 300 Meters

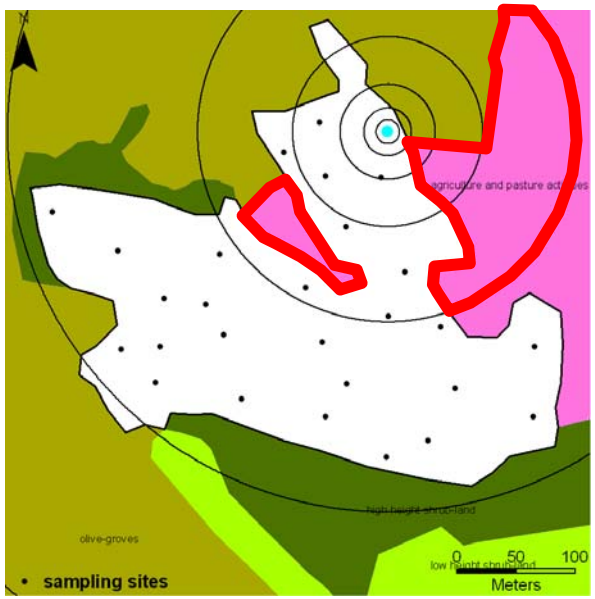
Land-cover around the woods



Lichen Diversity Value (LDV)

$$\sum_{a}^{d} \frac{\sum_{1}^{n} freq}{n}$$

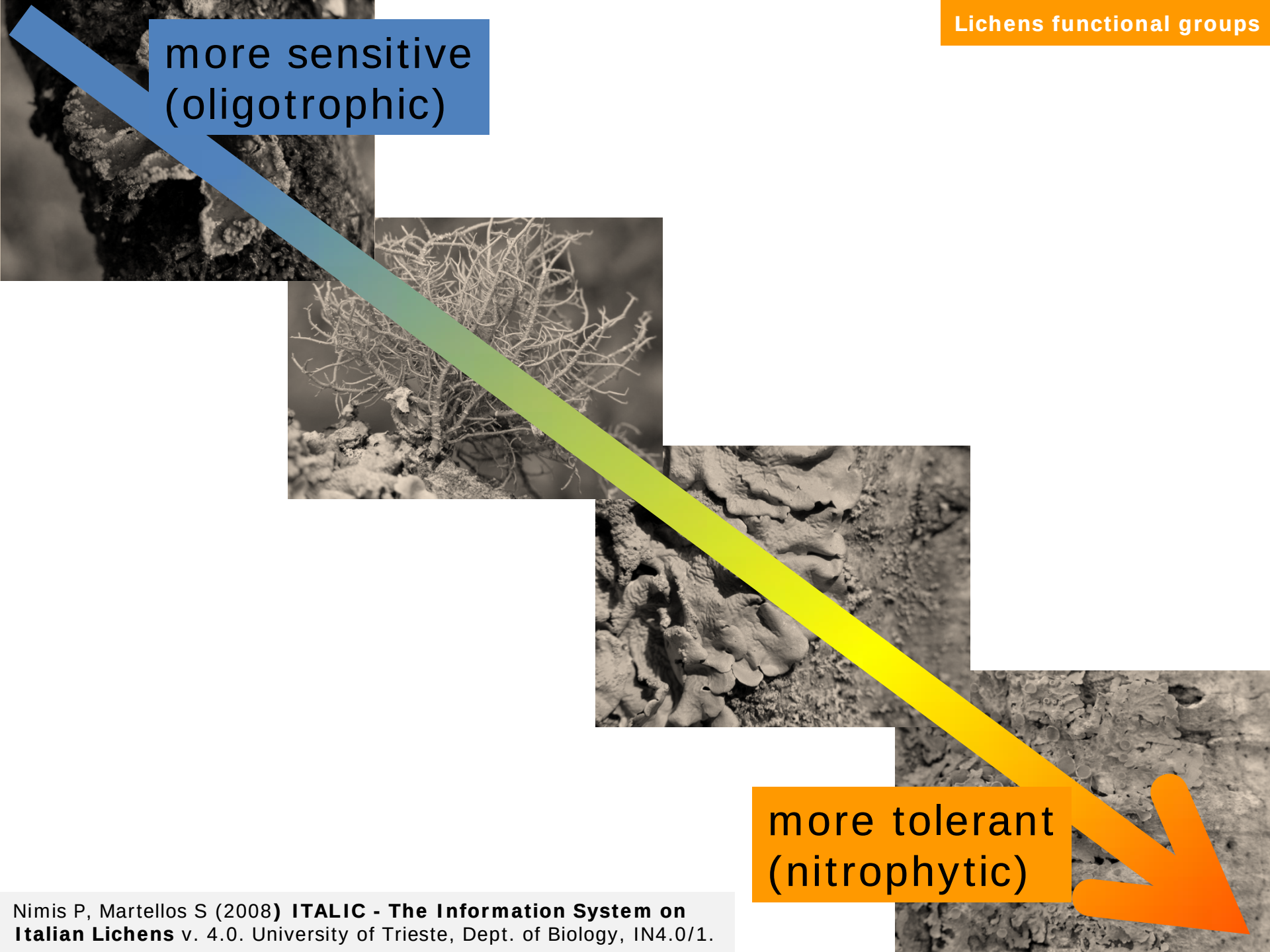
Asta, J., Erhardt, W., Ferretti, M., Fornasier, F., Kirschbaum, U., Nimis, P.L., Purvis, O.W., Pirintsos, S., Scheidegger, C., van Haluwyn, C., Wirth, V., 2002. Mapping lichen diversity as an indicator of environmental quality. In: Nimis, P.L., Scheidegger, C., Wolseley, P.A. (Ed.), Monitoring with Lichens- Monitoring Lichens, Nato Science Program-IV, Kluwer Academic Publisher, The Netherlands, volume IV, 273-279.



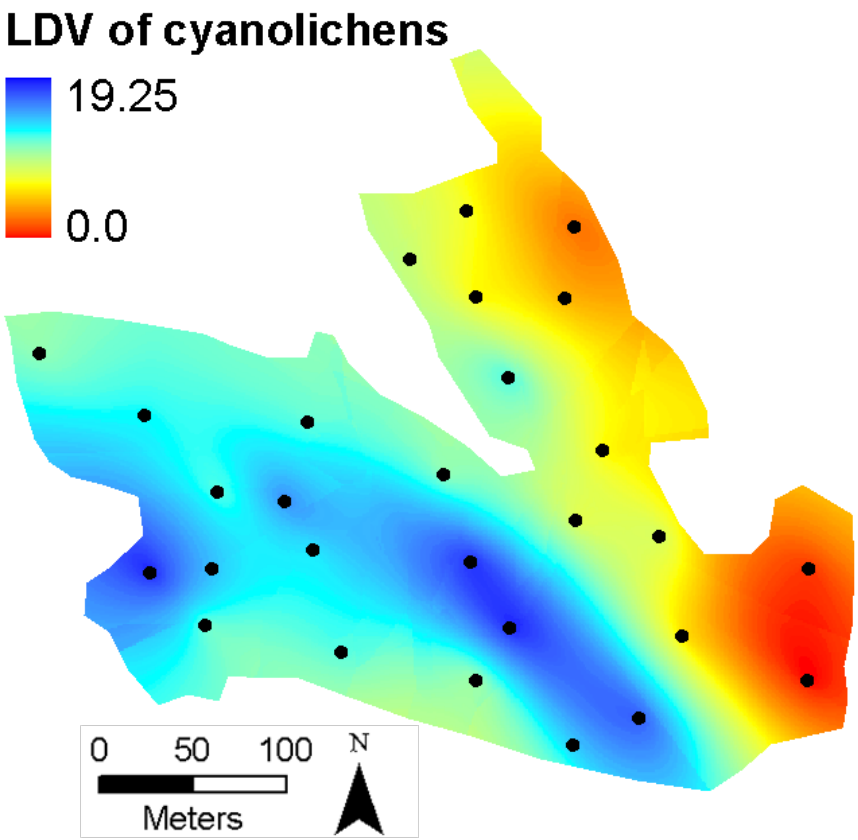
area occupied by agriculture at a distance of 160m from each sampling site

Pinho P, Augusto S, Máguas C, Pereira M, Soares A, Branquinho C (2008) Impact of neighbourhood land-cover in epiphytic lichen diversity: analysis of multiple factors working at different spatial scales. Environmental Pollution. 151: 414-422.

methods used: Lichen diversity value and area occupied by agriculture in the neighborhood

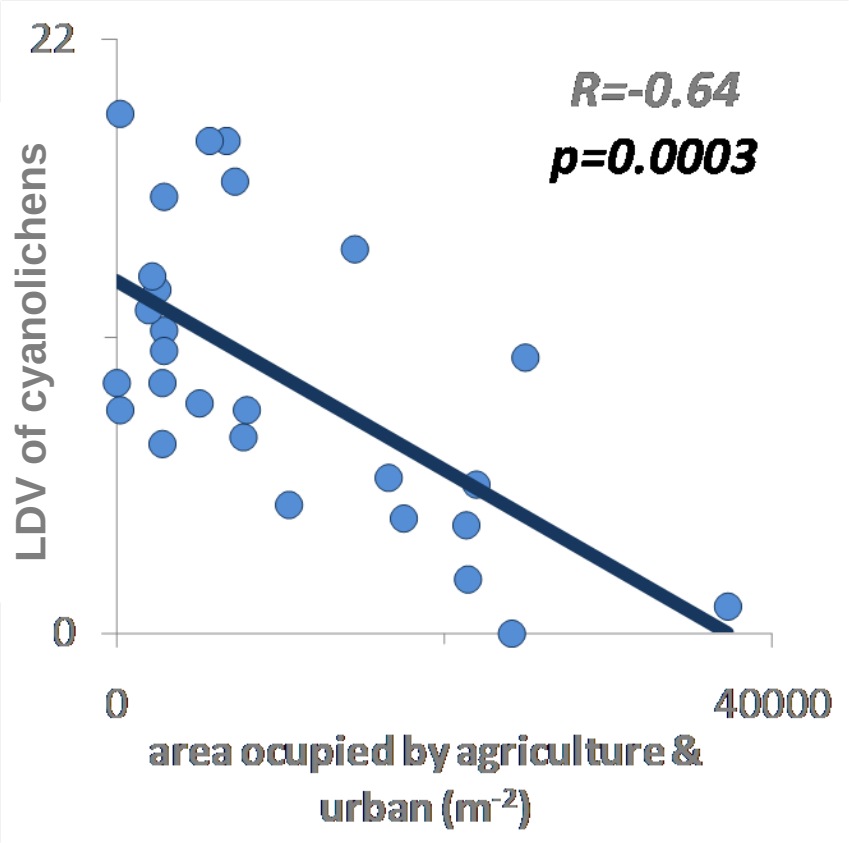


Nimis P, Martellos S (2008) **ITALIC - The Information System on Italian Lichens** v. 4.0. University of Trieste, Dept. of Biology, IN4.0/1.



- influence of neighboring agriculture areas in cyanolichens
- effected detected up to 100m inside the wood

interpolation of the LDV of cyanolichens



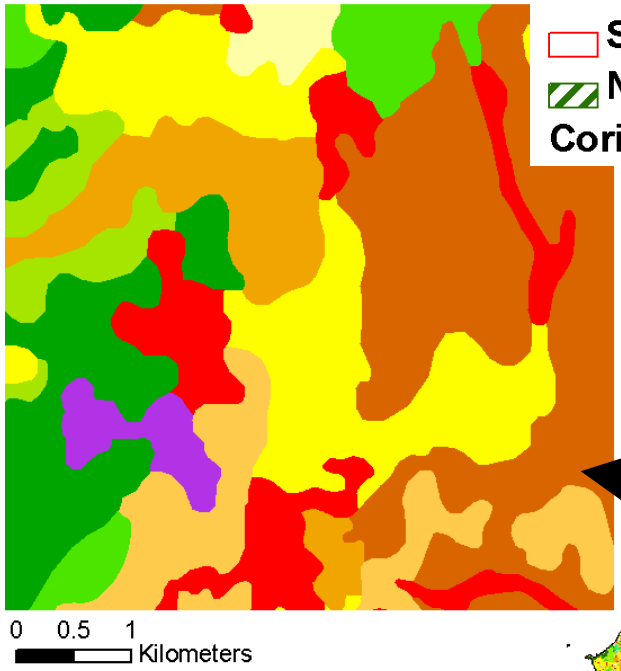
Management around “pristine” sites:

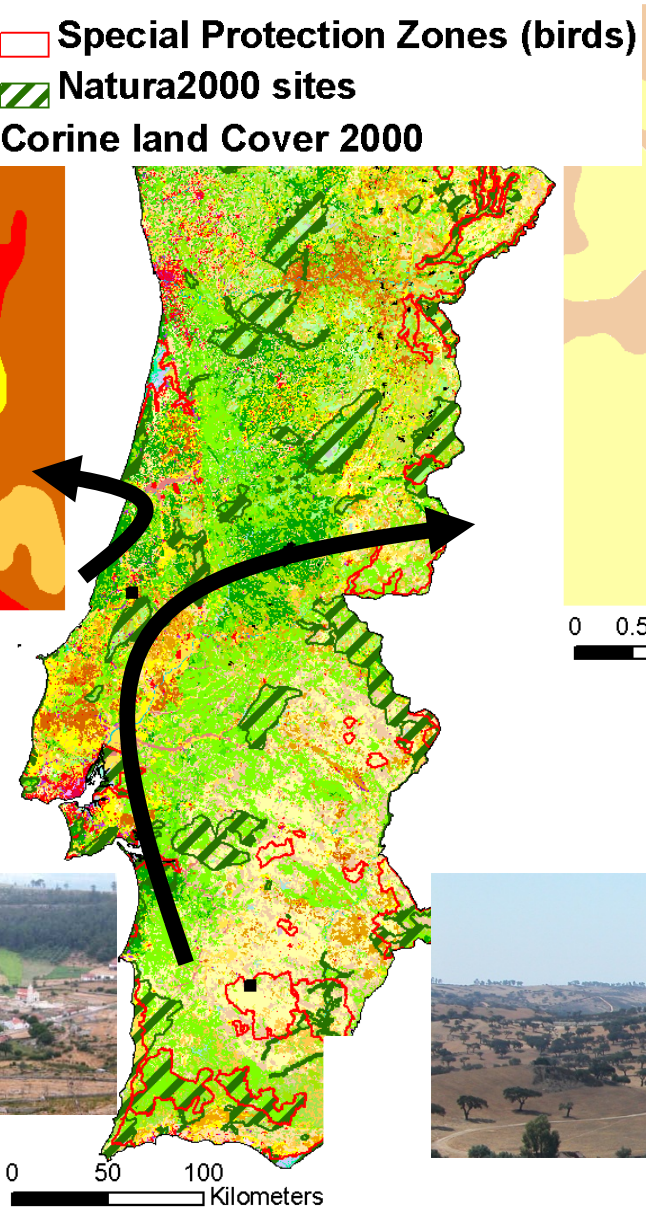
- no influence of neighboring olive-groves
- influence of neighboring agriculture areas in cyanolichens
- land-use intensity, even of low intensity as in impact in diversity, that can me mapped with lichens

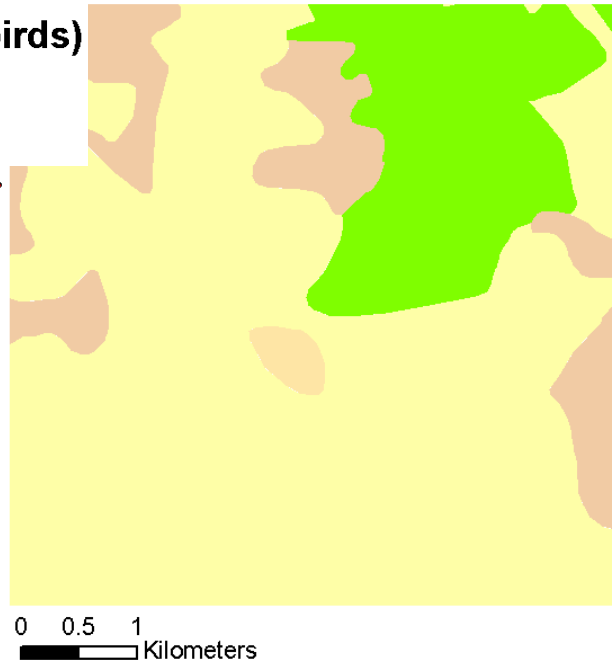
relation between LDV of cyanolichens and area occupied by agriculture in the neighborhood

- highly fragmented and diverse landscapes

- very continuous and homogeneous landscapes



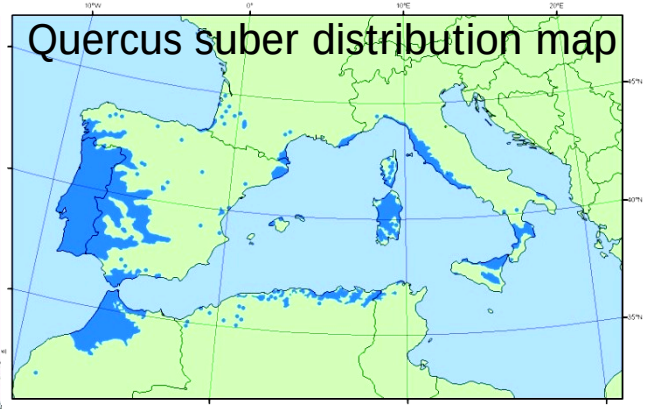




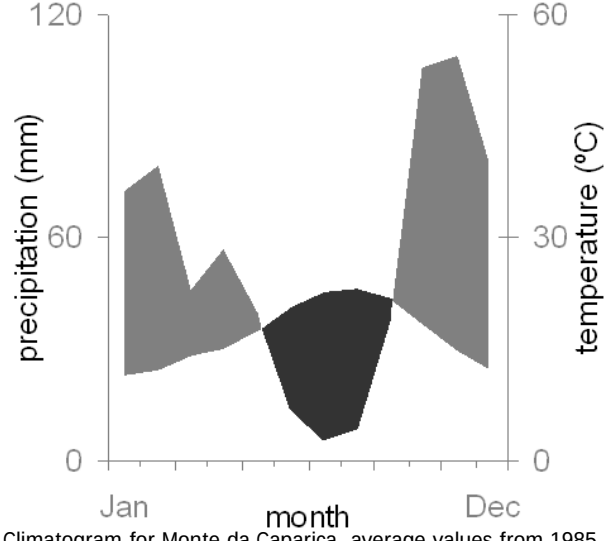
corine land-cover in Portugal, and two types of landscapes

two mediterranean landscapes: continuous cork-oak woodland and matrix type landscape

Does intensity matters?
Impact of low-intensity land-use in biodiversity



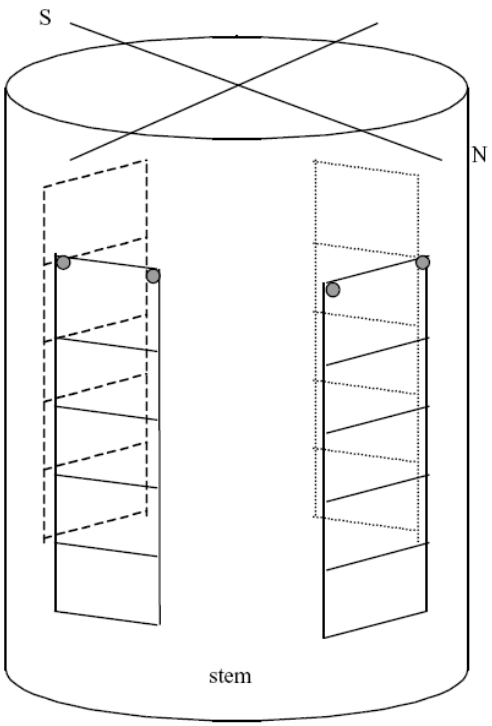
Source: European Forest Genetic Resources Programme, http://www.bioversityinternational.org/networks/euforgen



Climatogram for Monte da Caparica, average values from 1985 to 2007

sampling lichens

use of a standardize method, “European method”



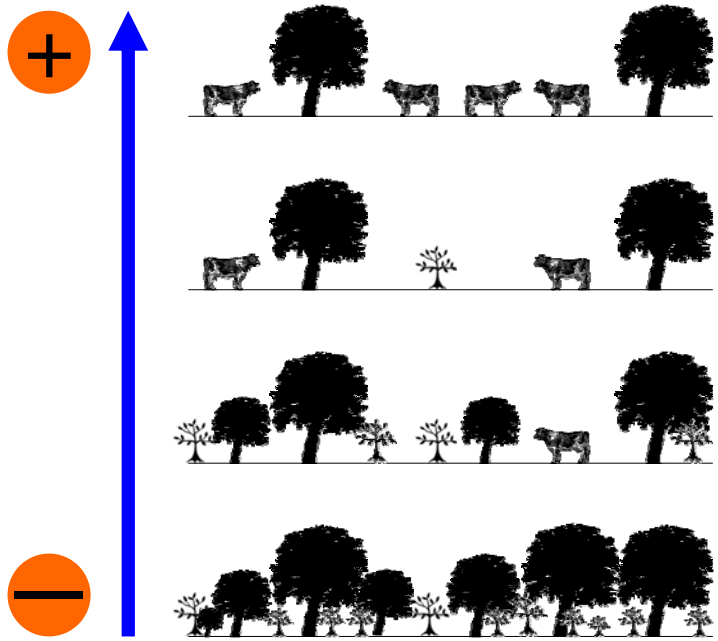
$$LDV = \sum_{a}^{d} \frac{\sum_{1}^{n} freq}{n}$$

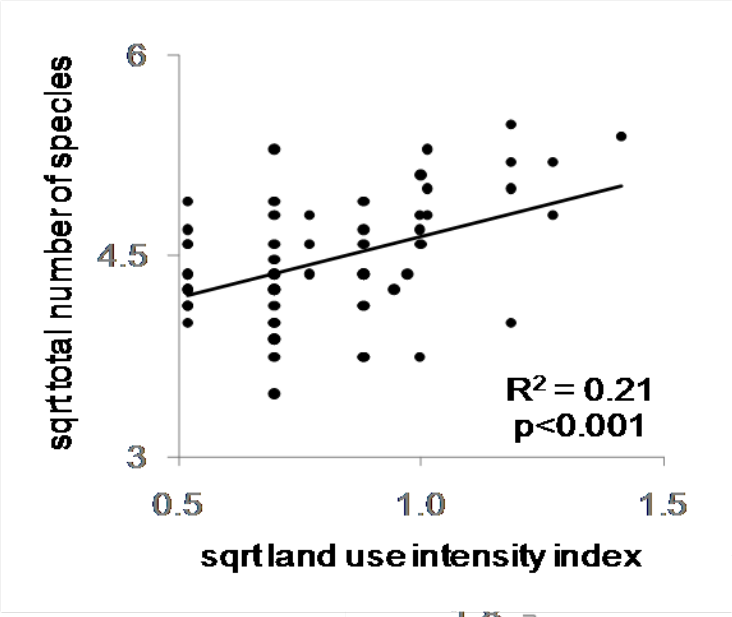
Onde **a – d** são as quatro orientações principais (Norte, Sul, Este e Oeste), **n** é o nº de árvores amostradas e **freq** a frequência das espécies em cada orientação.

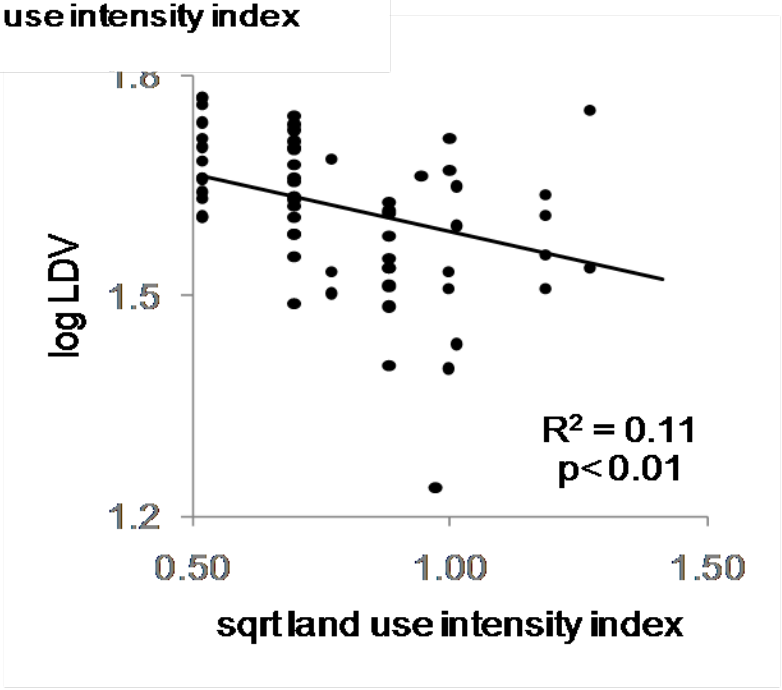
Asta J, et al (2002) **Mapping lichen diversity as an indicator of environmental quality**. In: Nimis PL, et al. (Ed.), Monitoring with Lichens- Monitoring Lichens, Kluwer Academic Publisher, 273-279.

gradient of very low land-use intensity

N-tolerant species increase in richness and abundance; N-sensitive species decrease in abundance but not richness;



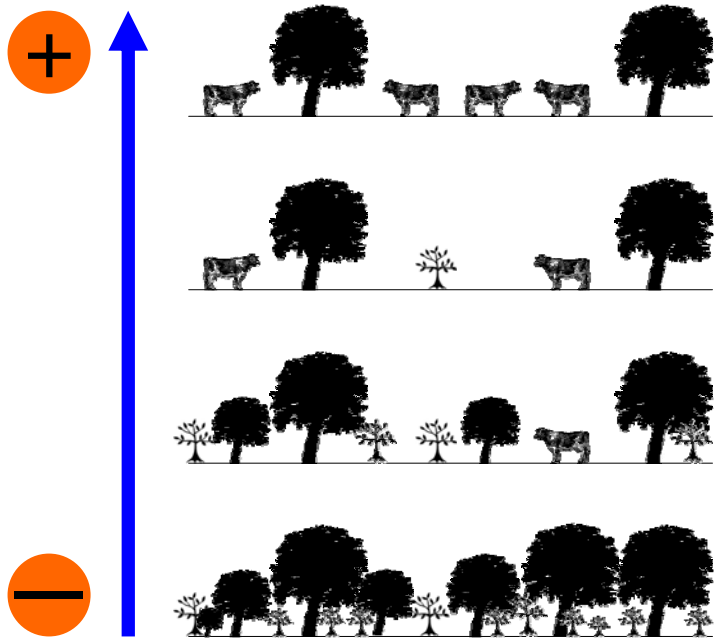




a low intensity land-use gradient related to cattle density;

gradient of land-use intensity

N-tolerant species increase in richness and abundance; N-sensitive species decrease in abundance but not richness;



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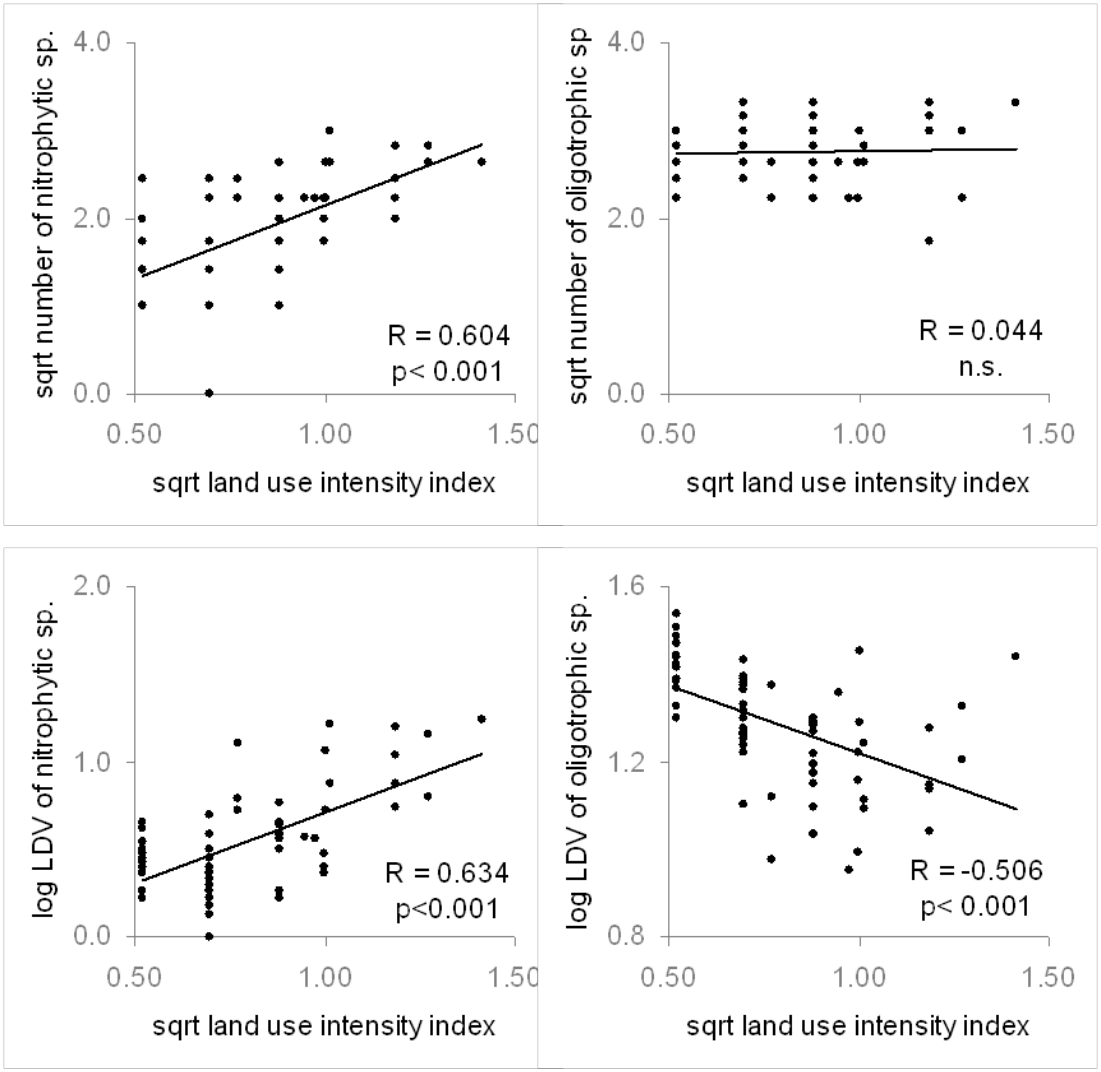
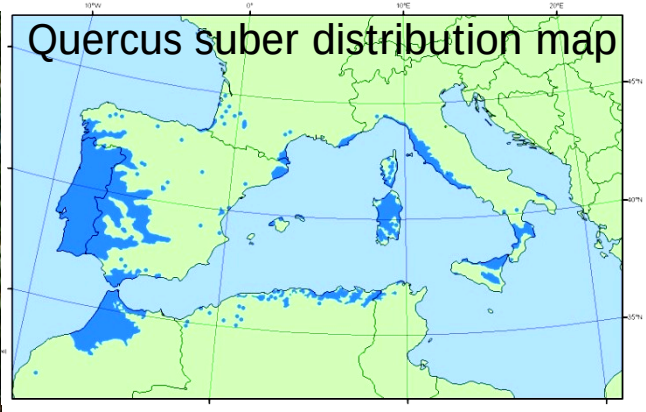
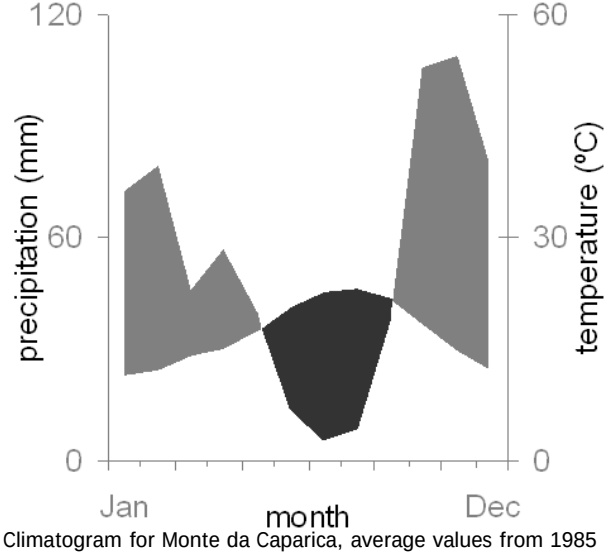


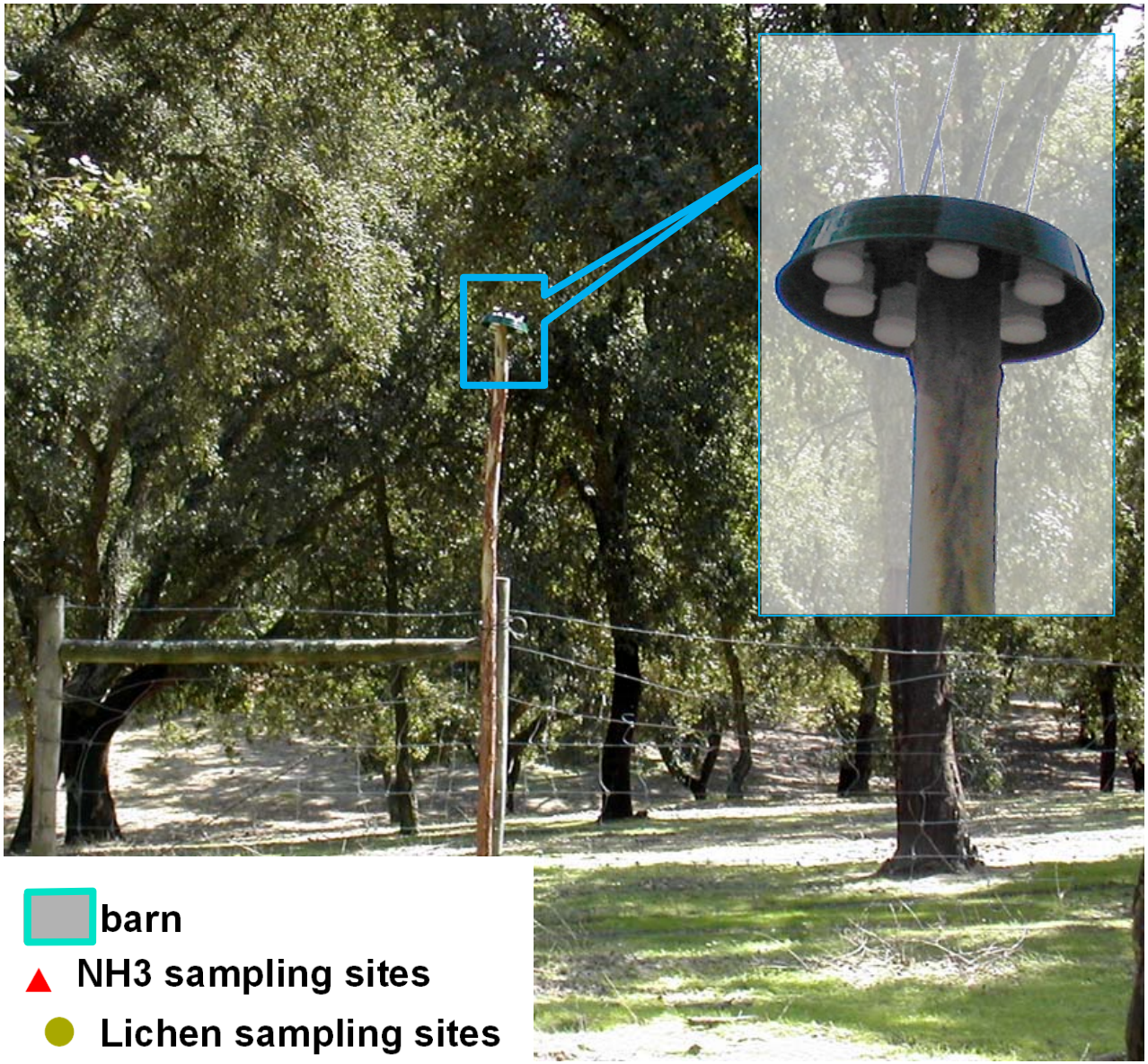
High intensity point source of ammonia



Source: European Forest Genetic Resources Programme, http://www.bioversityinternational.org/networks/euforgen



Climatogram for Monte da Caparica, average values from 1985 to 2007



barn

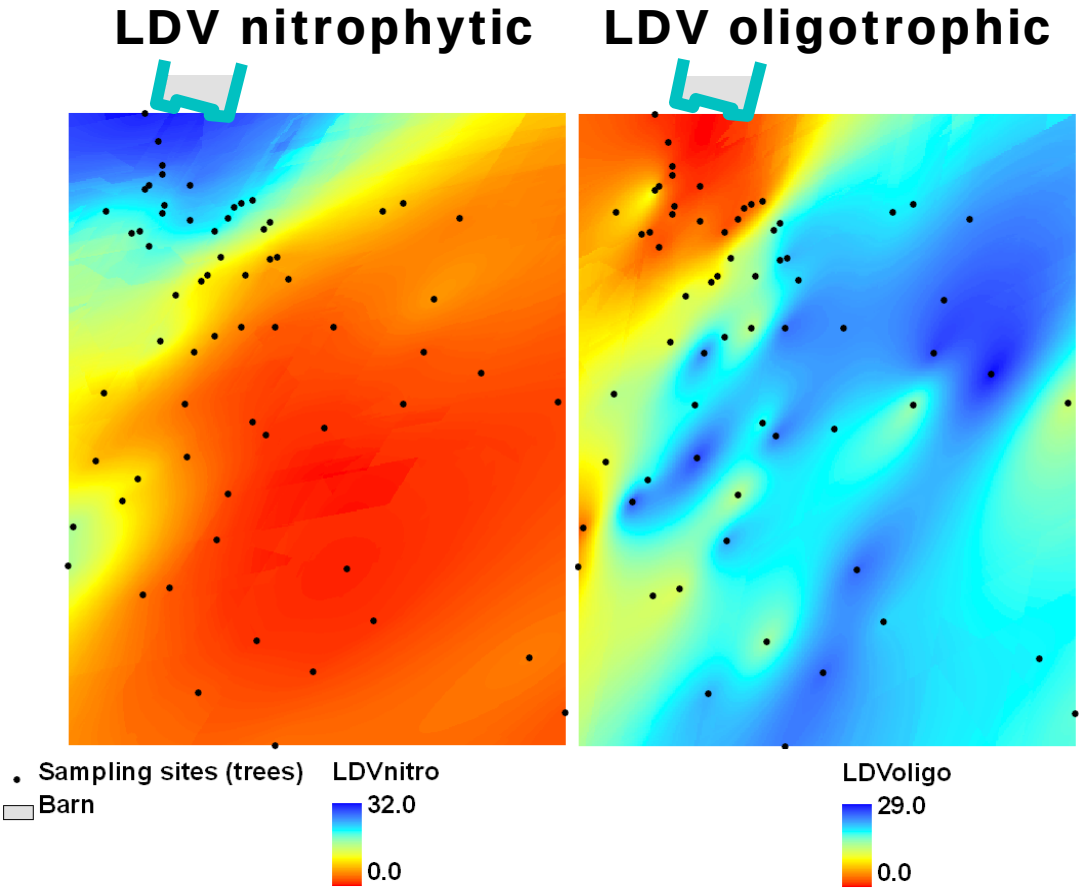
NH3 sampling sites

Lichen sampling sites

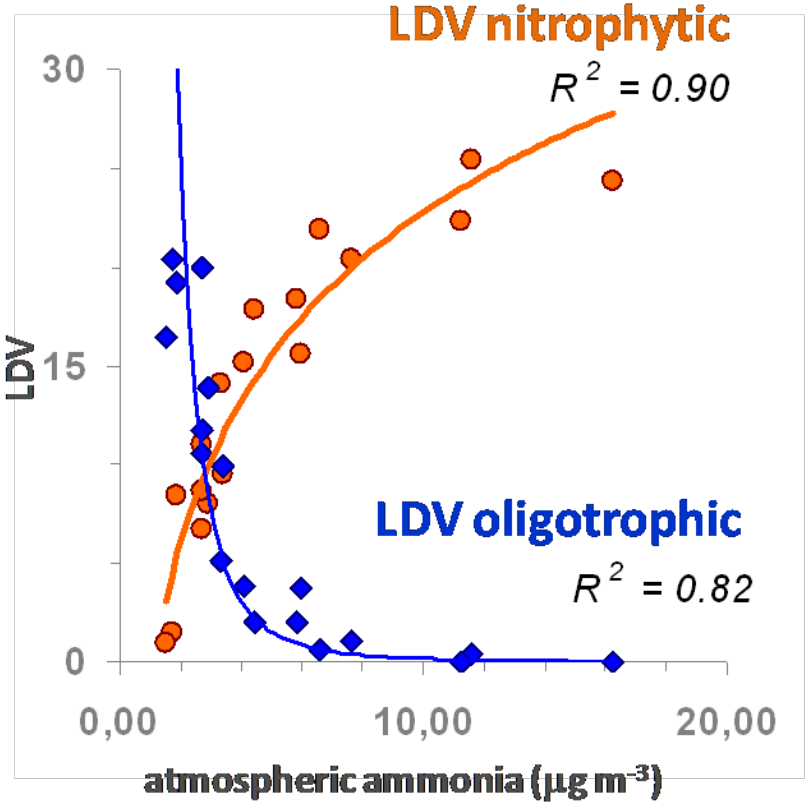
sampling design: NH3 and functional diversity downwind a cattle barn

point-source of ammonia

complete community replacement, from oligotrophic to nitrophytic



interpolation of LDV of nitrophytic and oligotrophic species from tree level data

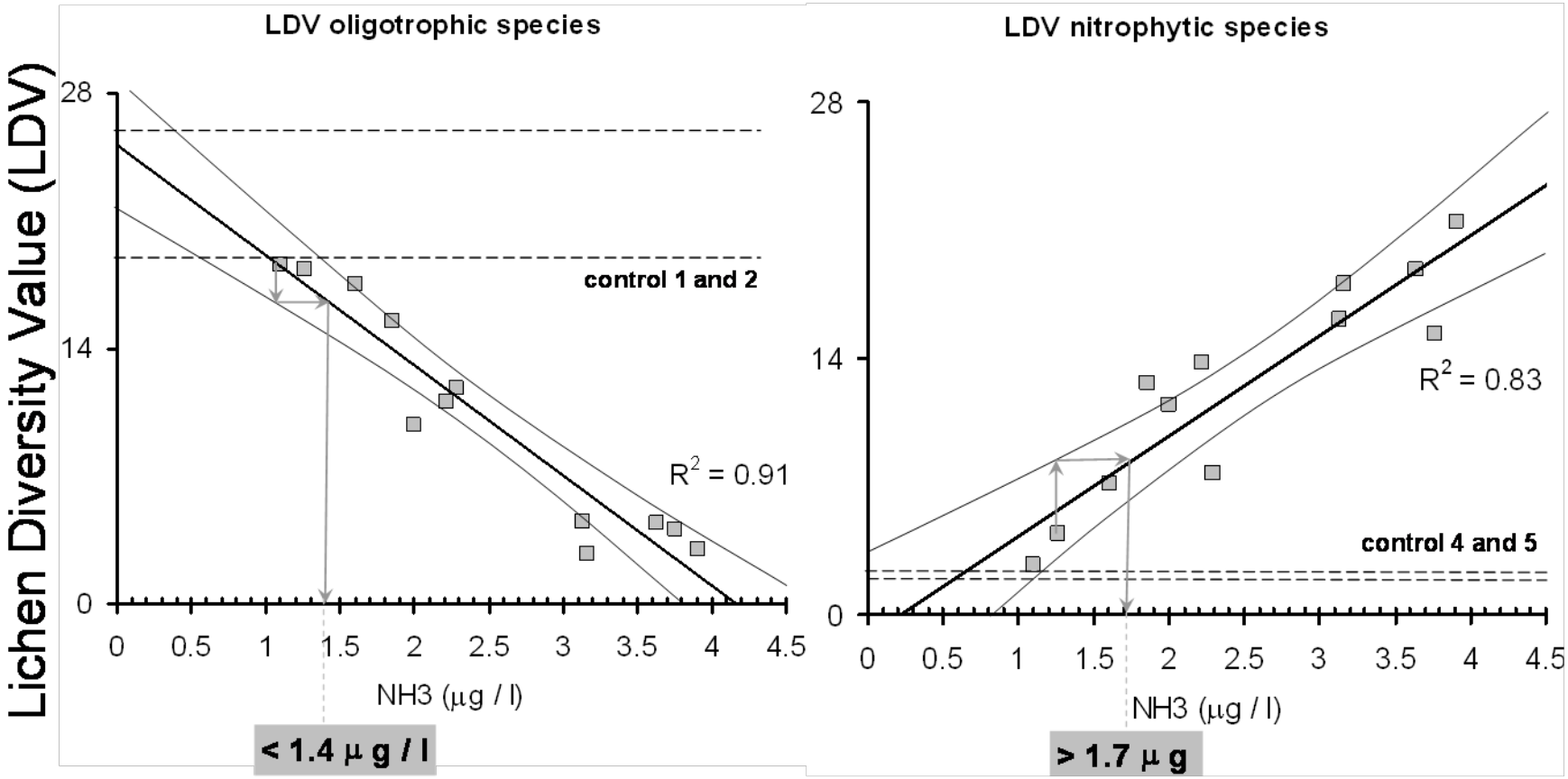


relation between LDV and atmospheric ammonia

Pinho P, Branquinho C, Cruz C, Tang S, Dias T, Rosa, AP, Máguas C, Martins-Loução MA, Sutton M. (2009). Assessment of critical levels of atmospherically ammonia for lichen diversity in cork-oak woodland, Portugal. Chapter: Critical Loads. In "Atmospheric Ammonia - Detecting emission changes and environmental impacts - Results of an Expert Workshop under the Convention on Long-range Transboundary Air Pollution", Mark Sutton, Stefan Reis and Samantha Baker (eds), Springer, 464p.

critical level of ammonia

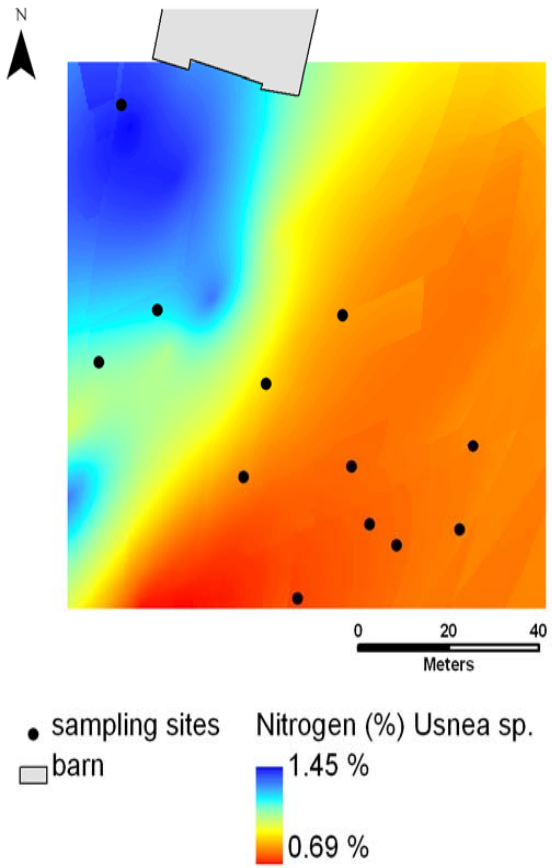
calculated in 1 μg m^{-3} using epiphytic lichens communities;

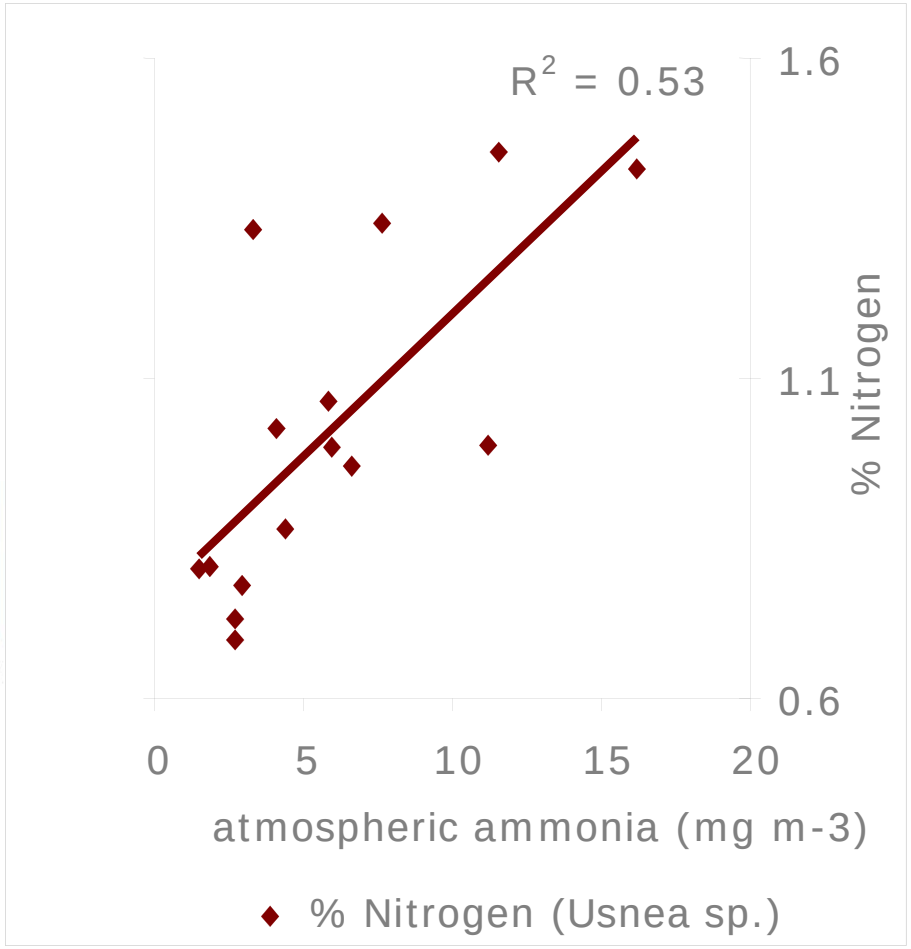


critical level of atmospheric ammonia, the concentration above which a verifiable change will occur in the ecosystem ($p<0.05$);

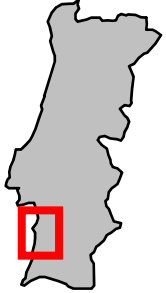
Pinho P, Branquinho C, Cruz C, Tang S, Dias T, Rosa, AP, Máguas C, Martins-Loução MA, Sutton M. (2009). Assessment of critical levels of atmospherically ammonia for lichen diversity in cork-oak woodland, Portugal. Chapter: Critical Loads. In "Atmospheric Ammonia - Detecting emission changes and environmental impacts - Results of an Expert Workshop under the Convention on Long-range Transboundary Air Pollution", Mark Sutton, Stefan Reis and Samantha Baker (eds), Springer, 464p.

- changes in communities (species, functional groups)
- lichens as accumulators of pollutants

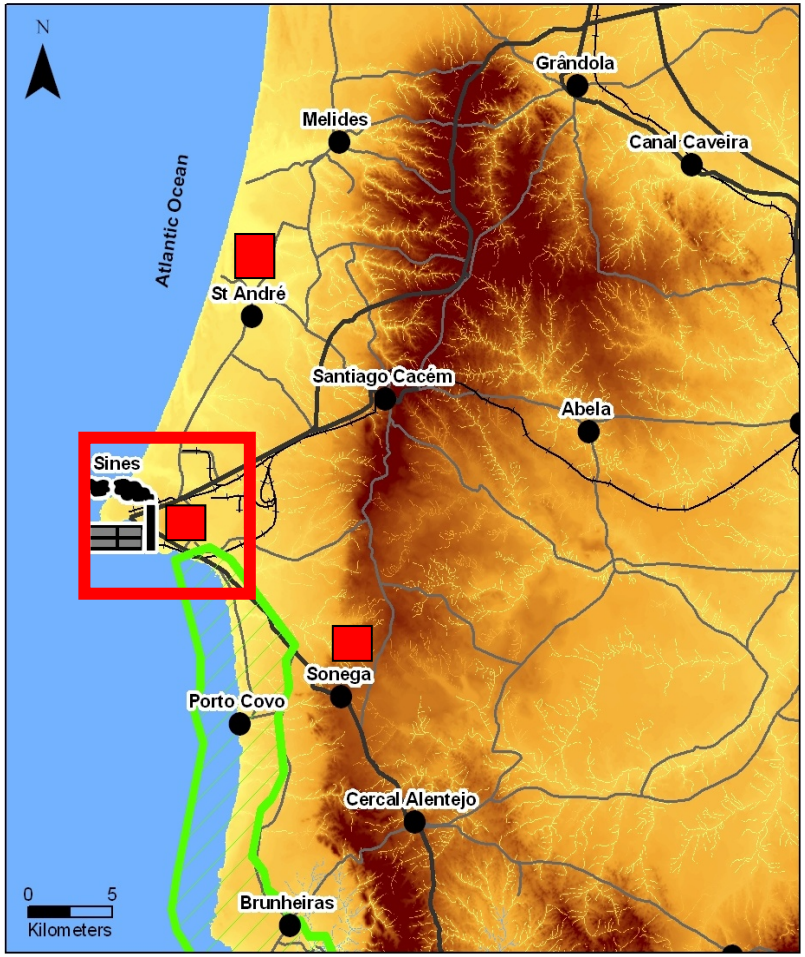




mapping of Nitrogen concentration in lichens and relation to atmospheric ammonia



MULTIPLE Land-Uses



Mapping lichens communities

Lichen abun
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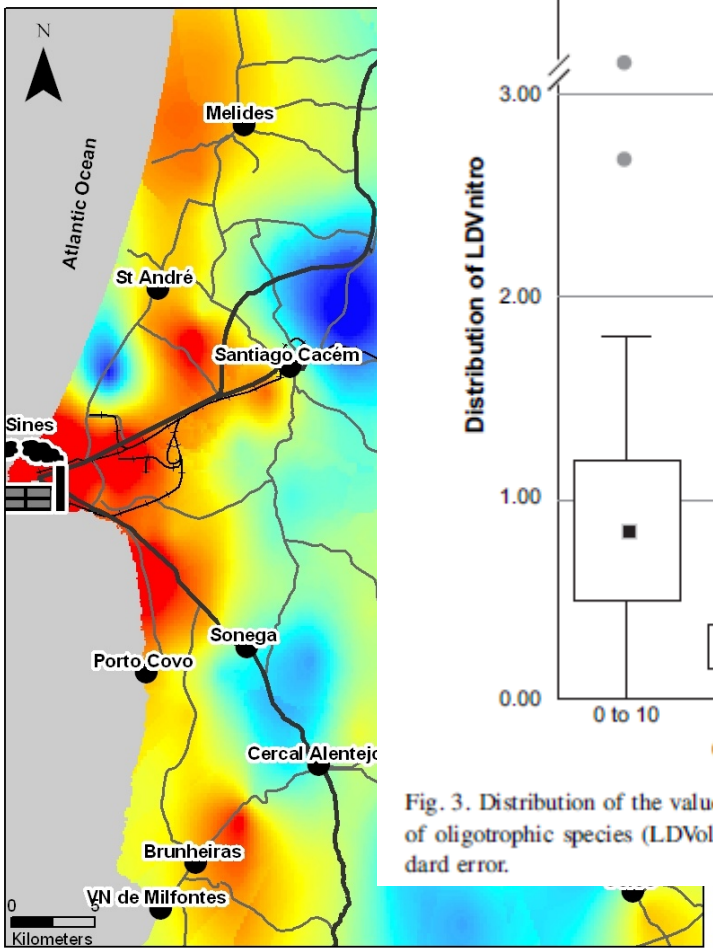


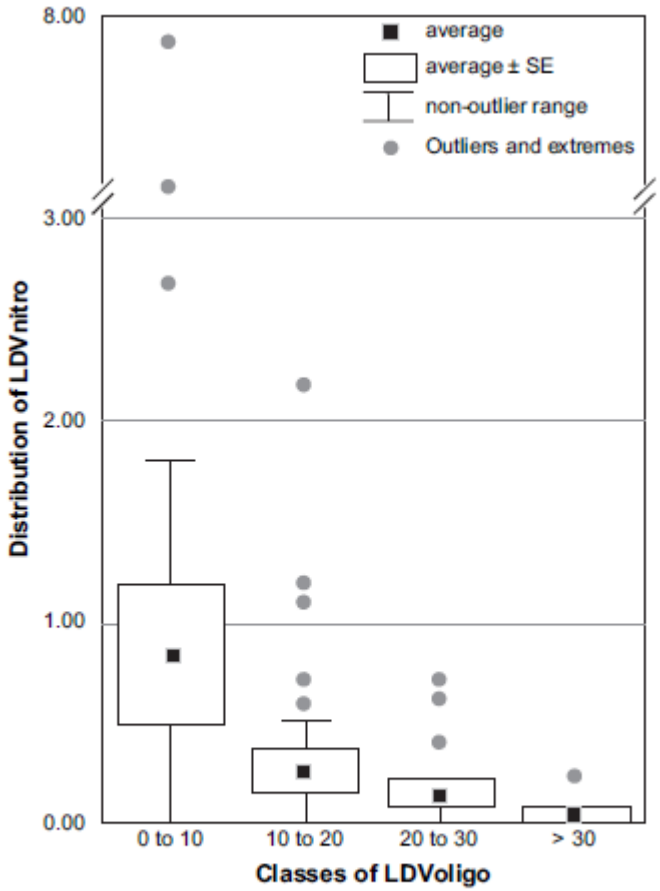
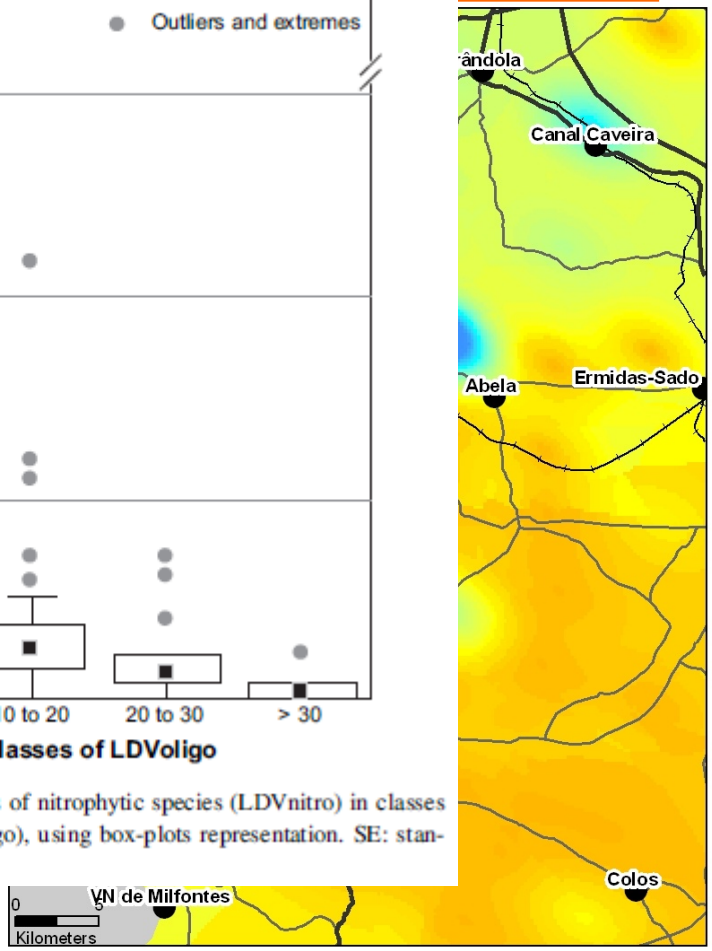


Fig. 3. Distribution of the values of nitrophytic species (LDVnitro) in classes of oligotrophic species (LDVoligo), using box-plots representation. SE: standard error.



Legend

ldvnric

Value

High : 7.346148

Low : -0.683547

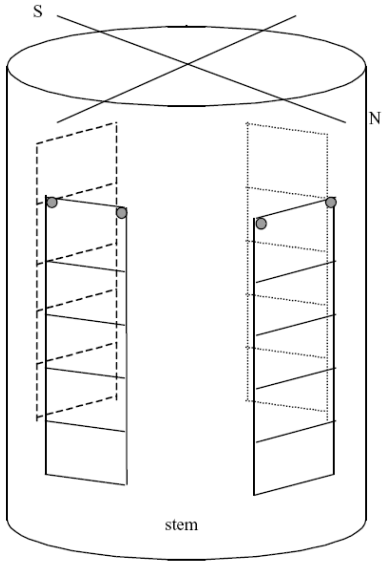
Main towns and cities

Sines

Main roads

Secondary roads

Railway



Lichen Diversity Value (LDV)

$$\sum_{a}^{d} \frac{\sum_{1}^{n} freq}{n}$$

Asta, J., Erhardt, W., Ferretti, M., Fornasier, F., Kirschbaum, U., Nimis, P.L., Purvis, O.W., Pirintsos, S., Scheidegger, C., van Haluwyn, C., Wirth, V., 2002. Mapping lichen diversity as an indicator of environmental quality. In: Nimis, P.L., Scheidegger, C., Wolseley, P.A. (Ed.), Monitoring with Lichens- Monitoring Lichens, Nato Science Program-IV, Kluwer Academic Publisher, The Netherlands, volume IV, 273-279.

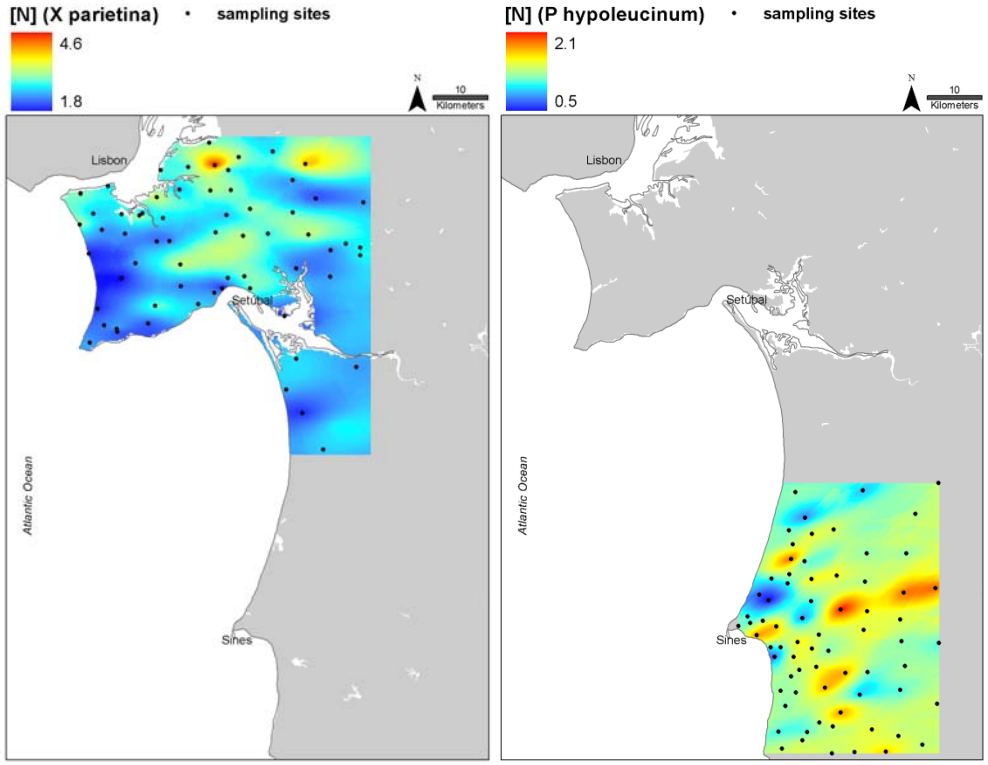
nitrogen and other elements concentration in *Parmotrema hypoleucinum*

NOx and other gases concentration in diffusion tubes

area occupied by several land-cover types

methods used: LDV, pollutants and land-cover

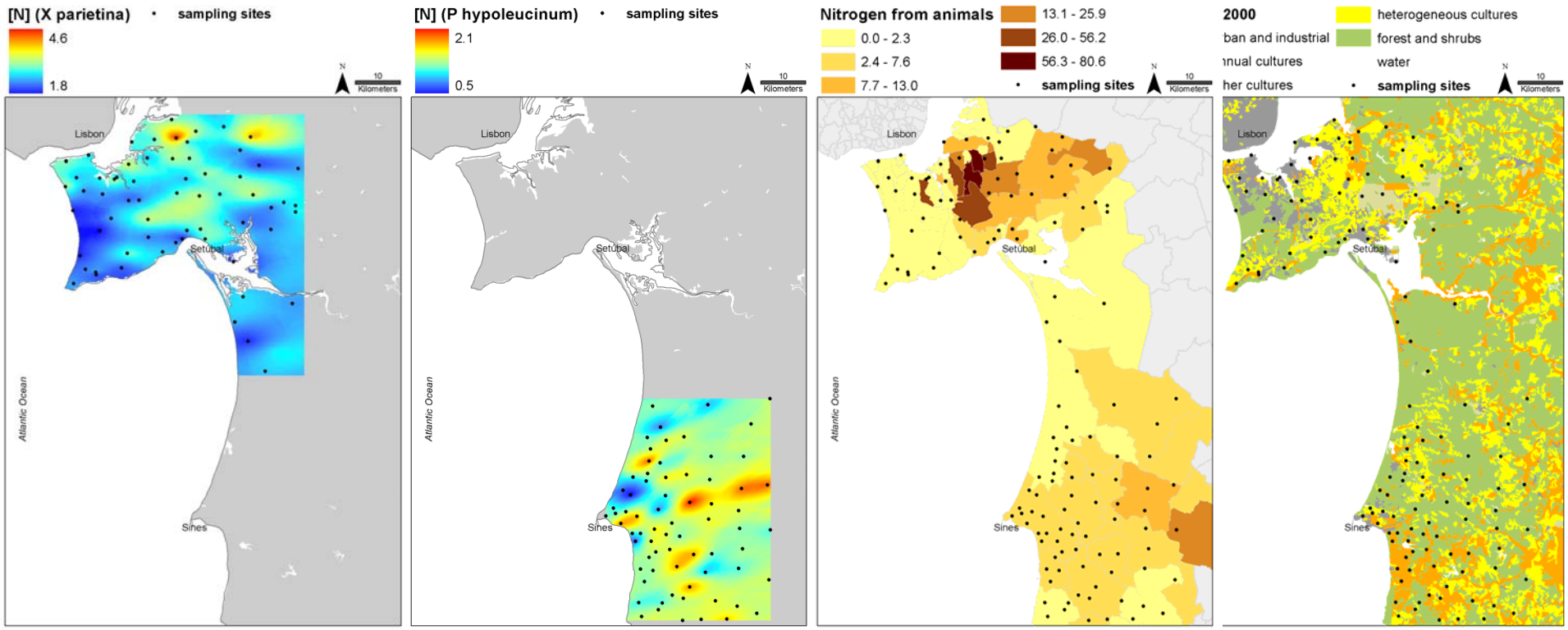
Pinho P, Augusto S, Branquinho C, Bio A, Pereira MJ, Soares A, Catarino F. (2004) **Mapping Lichen Diversity as a first step in air quality assessment**. Journal of Atmospheric Chemistry. 49: 377-389.



mapping of nitrogen concentration measured in lichens

Pinho P Maria-Amélia Martins-Loução, Cristina Máguas, Cristina Branquinho (submitted) **Calibrating total nitrogen concentration in lichens with nitrogen emissions at regional scale**

calibrating N in lichens regionally

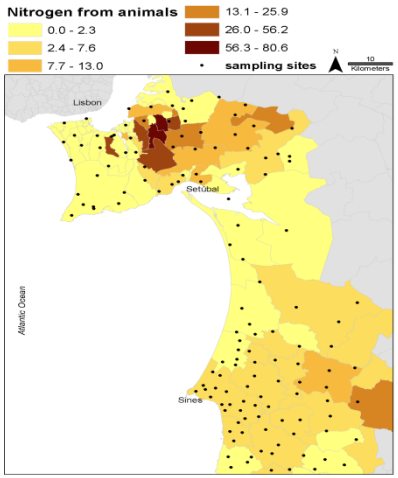


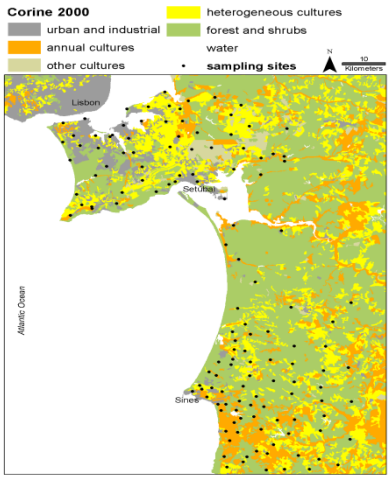
mapping of nitrogen concentration measured in lichens

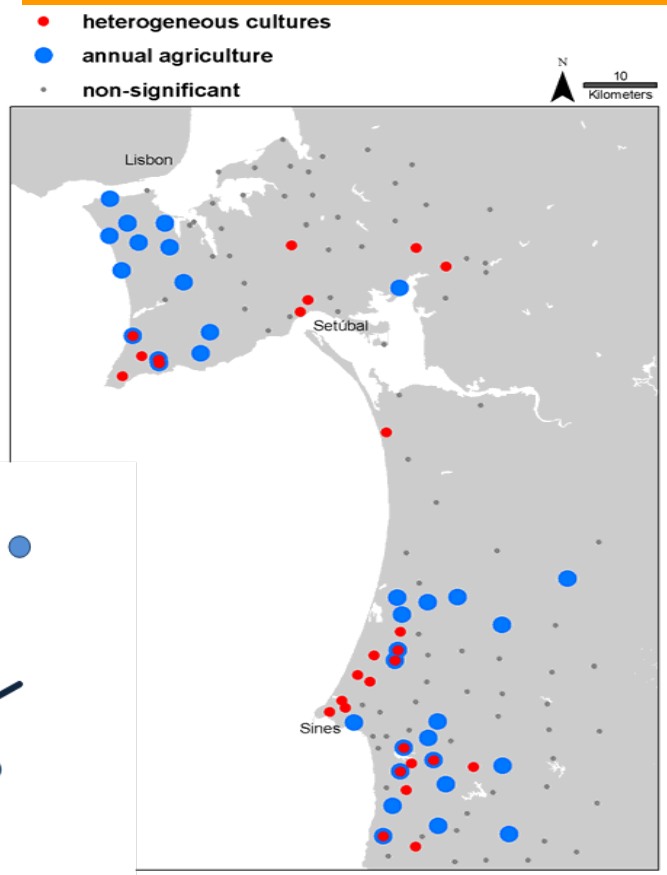
N-emission from cattle (municipality) and land-cover

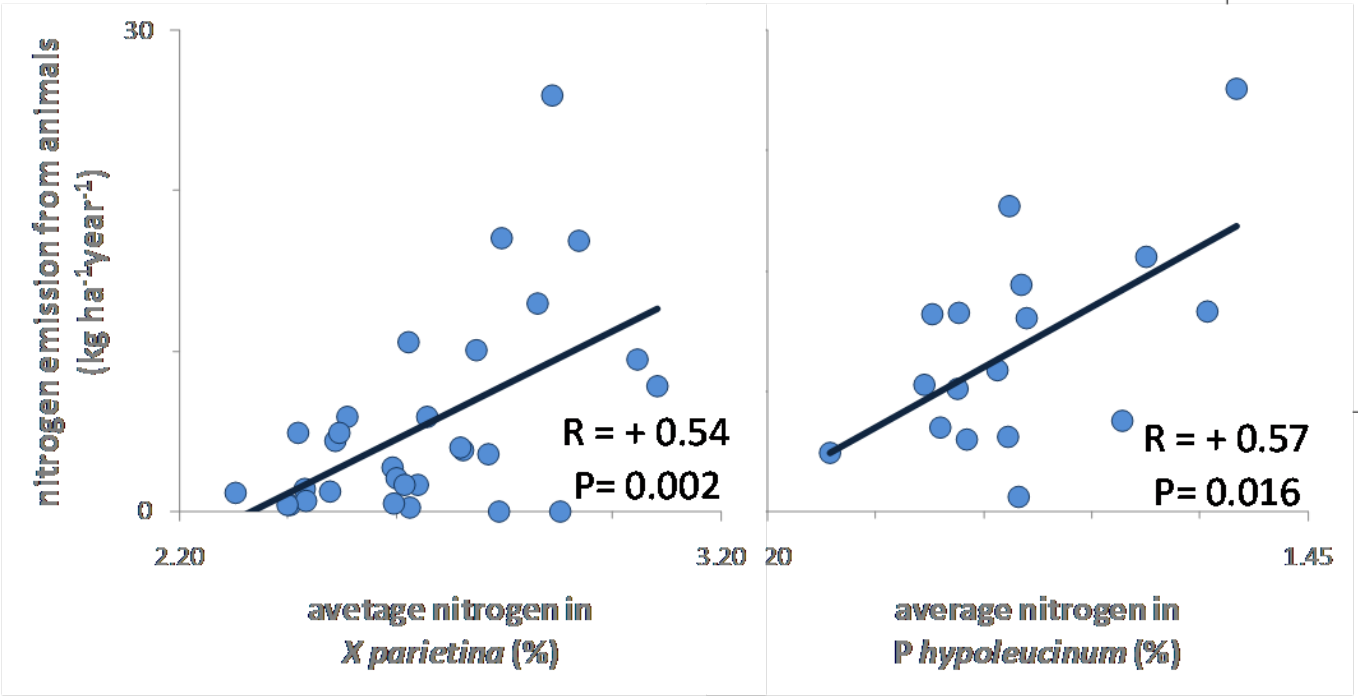
Pinho P Maria-Amélia Martins-Loução, Cristina Máguas, Cristina Branquinho (submitted) **Calibrating total nitrogen concentration in lichens with nitrogen emissions at regional scale**

calibrating N in lichens regionally





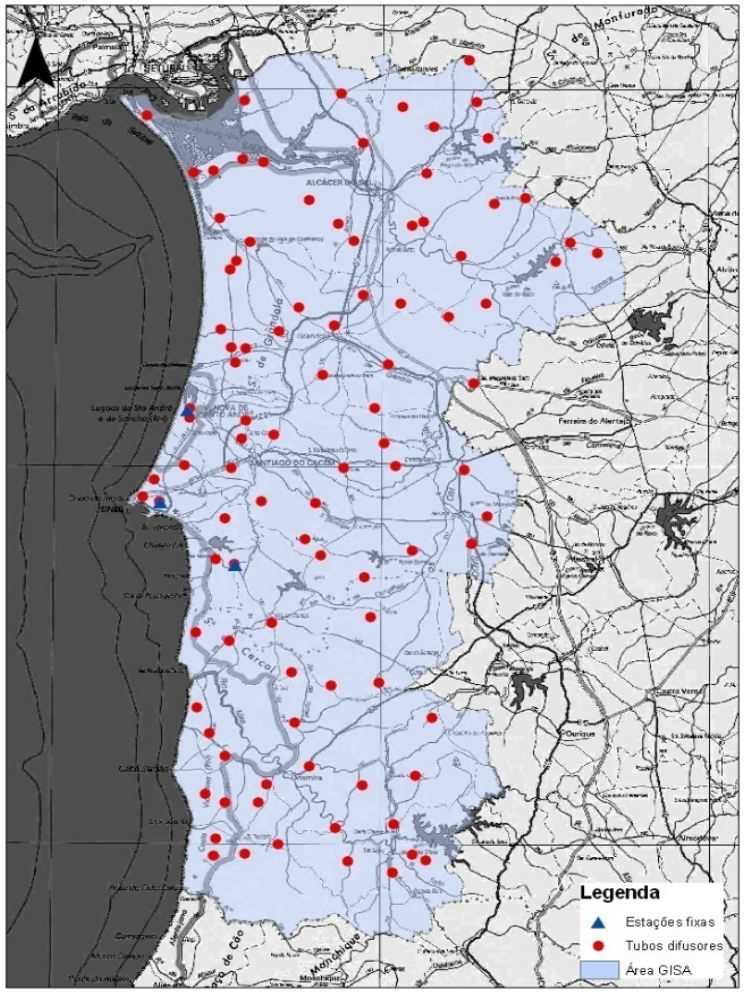




relation between nitrogen concentration in lichens and nitrogen emited from animals (municipality level) and estimated from agriculture land-cover

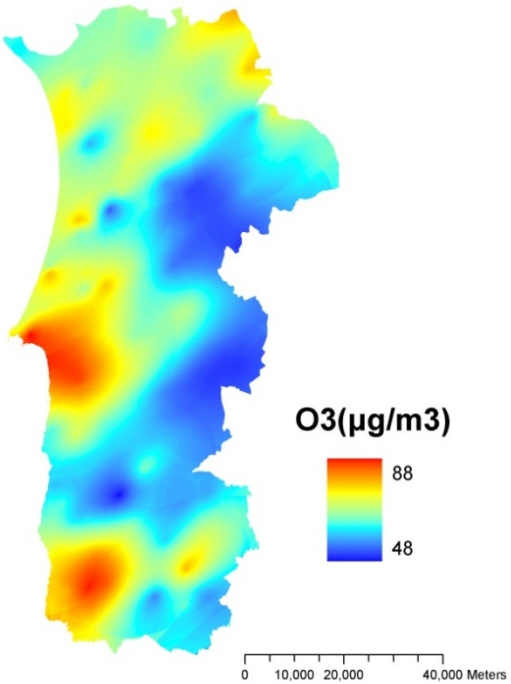
Pinho P Maria-Amélia Martins-Loução, Cristina Máguas, Cristina Branquinho (submitted) **Calibrating total nitrogen concentration in lichens with nitrogen emissions at regional scale**

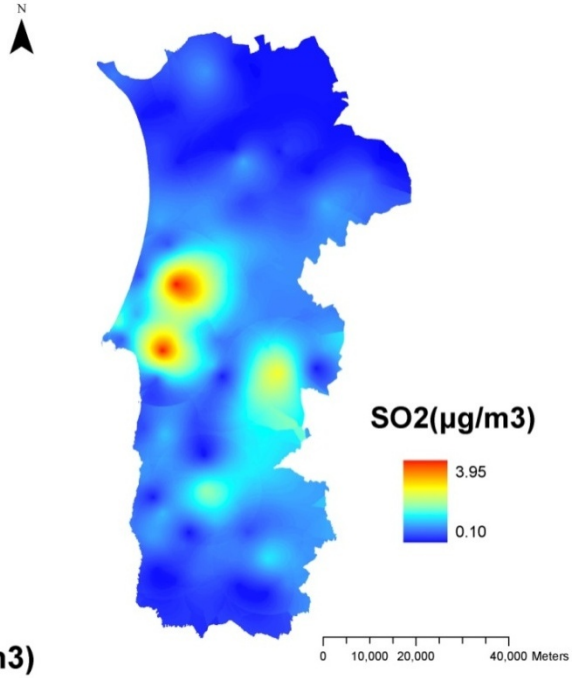
Integrated Multi-pollutant approach at the landscape level with high resolution

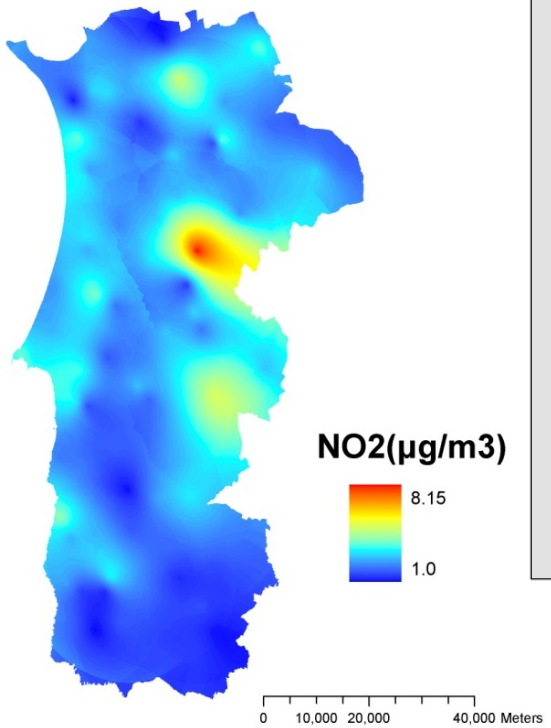


GISA
Gestão Integrada Saúde e Ambiente

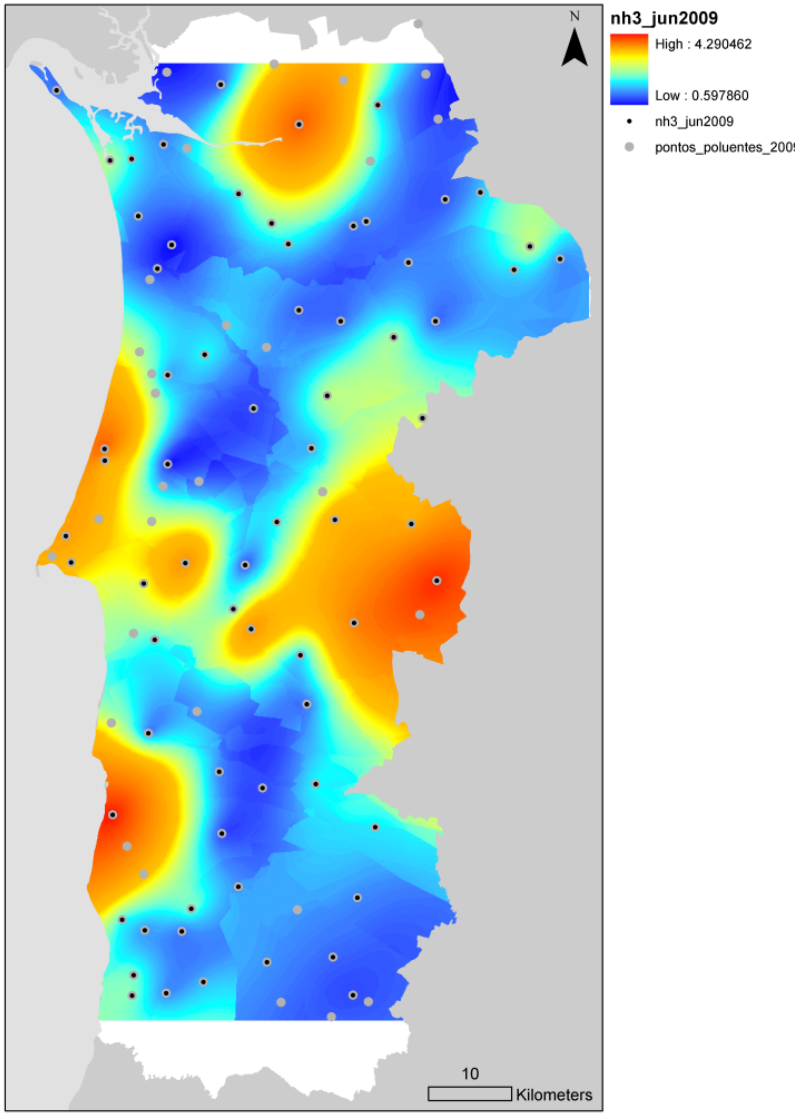
GISA
Gestão Integrada Saúde e Ambiente





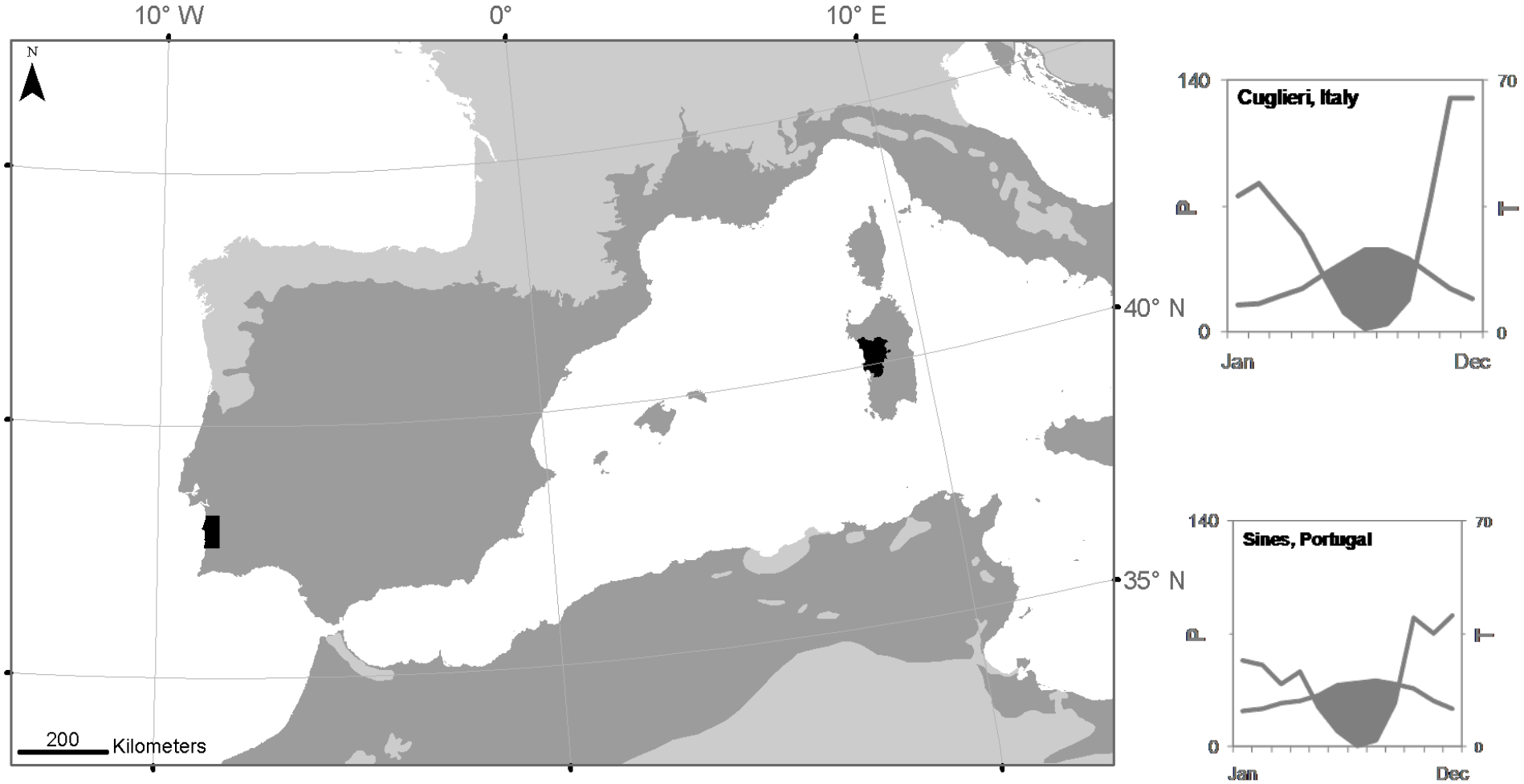


NH_3



Integrated Multi-pollutant approach at the landscape level with high resolution

Next step:
Validate this in a common approach with other countries with Mediterranean Climate



Thank You