N – Monitoring and Impacts in Portugal
nitrogen
a major threat to biodiversity, impact is expected to increase;
nitrogen
a major global change driver; rate of change is greater than safety boundary

Climate change

Biodiversity loss

Nitrogen cycle

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 SO₂, NOₓ e NH₃
NOx emissions in 2005 including natural sources

NH3 emissions in 2005
There are 3 monitoring stations for NH$_4^+$
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 NH₃ emissions for the Natura 2000 network in Portugal based on NH₃ 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 worldwide;
Corine land-cover in Portugal, and two types of landscapes

- Highly fragmented and diverse landscapes
- Very continuous and homogeneous landscapes
Portuguese-oak woods: a strongly fragmented “pristine” habitat, with a high biodiversity
Quercus faginea woods

Portuguese-oak woods

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

Land-cover around the woods

A large (c. 8ha) wood:

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


**methods used:** Lichen diversity value and area occupied by agriculture in the neighborhood
more sensitive (oligotrophic)

more tolerant (nitrophytic)

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
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 be 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
**Sampling lichens**

use of a standardize method, “European method”

\[
LDV = \sum_{a}^{d} \sum_{1}^{n} \frac{\text{freq}}{n}
\]

Onde a - d são as quatro orientações principais (Norte, Sul, Este e Oeste), n é o n° de árvores amostradas e freq a frequência das espécies em cada orientação.

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;

1. ammonia from extensive pasture

a low intensity land-use gradient related to cattle density;
High intensity point source of ammonia

Quercus suber distribution map

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

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

**critical level of ammonia**
calculated in $1 \, \mu g \, m^{-3}$ using epiphytic lichens communities;

### Lichens Diversity Value (LDV)

#### LDV oligotrophic species

- $R^2 = 0.91$

- Control 1 and 2

#### LDV nitrophytic species

- $R^2 = 0.83$

- Control 4 and 5

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

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

\[ R^2 = 0.53 \]

atmospheric ammonia (mg m$^{-3}$)

% Nitrogen

% Nitrogen (Usnea sp.)

mapping of Nitrogen concentration in lichens and relation to atmospheric ammonia
MULTIPLE Land-Uses

- Coal Power Plant
- Oil Refinery
- Chemical Plant
- Large Harbour
- Town

MULTIPLE Sources of Industrial Pollution
Mapping lichens communities

Lichen abundance of non-nitrophilous species

Lichen abundance of nitrophilous species

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


methods used: LDV, pollutants and land-cover
Calibrating total nitrogen concentration in lichens with nitrogen emissions at regional scale

mapping of nitrogen concentration measured in lichens
Calibrating total nitrogen concentration in lichens with nitrogen emissions at regional scale

mapping of nitrogen concentration measured in lichens

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

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

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

Pinho P Maria-Amélia Martins-Loução, Cristina Mágua, 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
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