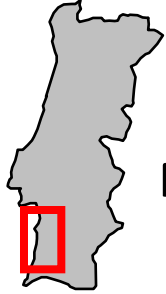




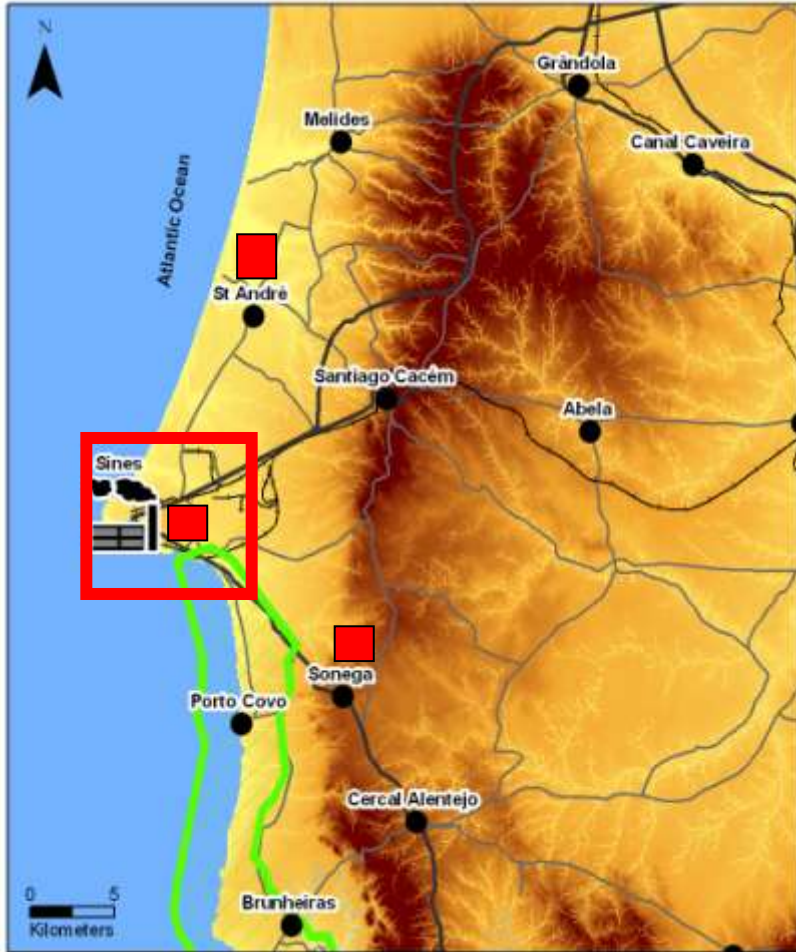
# Trinta anos de biomonitorização ambiental no Alentejo Litoral: o que aprendemos e o que nos falta saber

Cristina Branquinho,  
Universidade de Lisboa, Faculdade de  
Ciências, Centro de Biologia Ambiental  
[cmbranquinho@fc.ul.pt](mailto:cmbranquinho@fc.ul.pt)





# MULTIPLoS Usos do solo



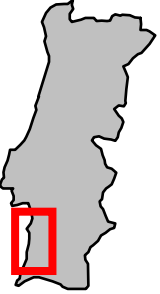
ais



ver

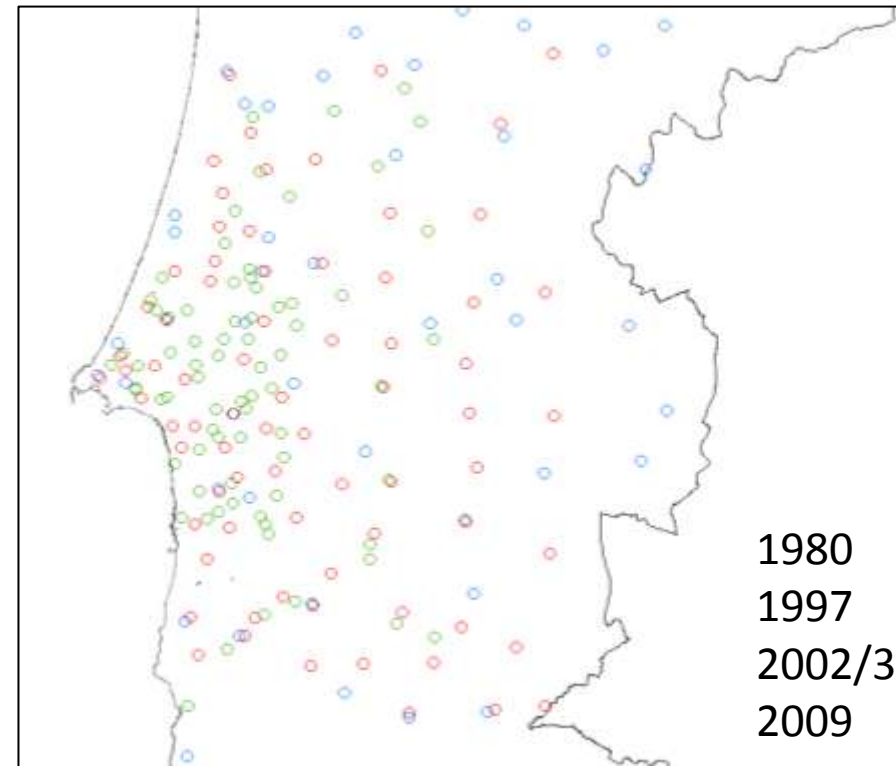
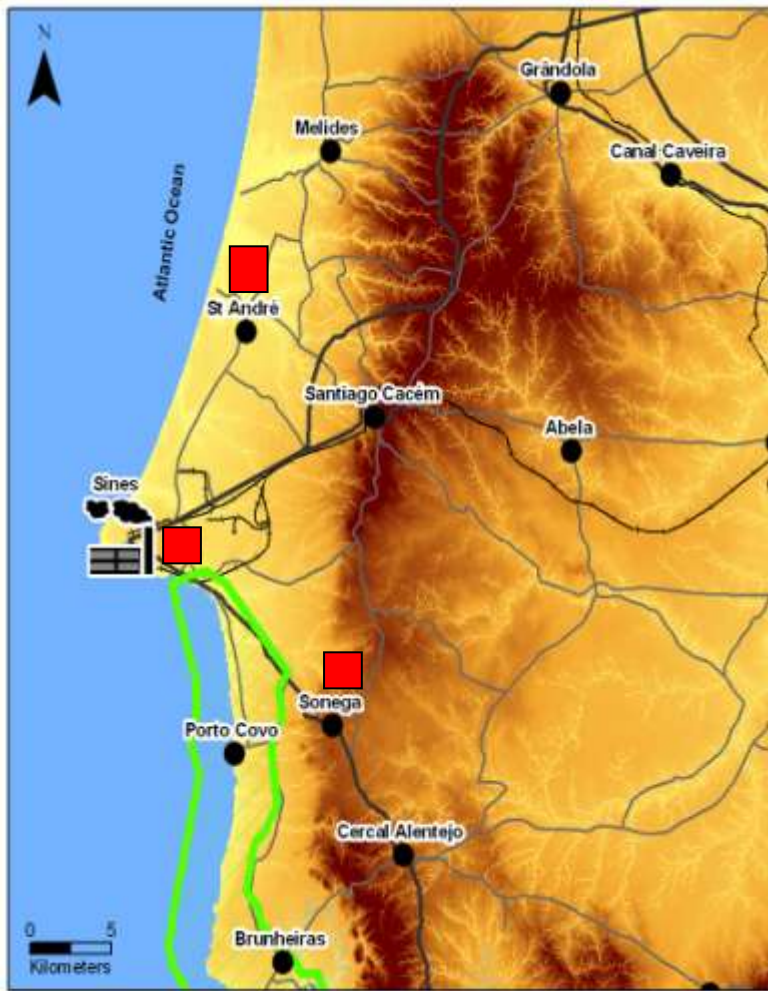
oogle

© 2025



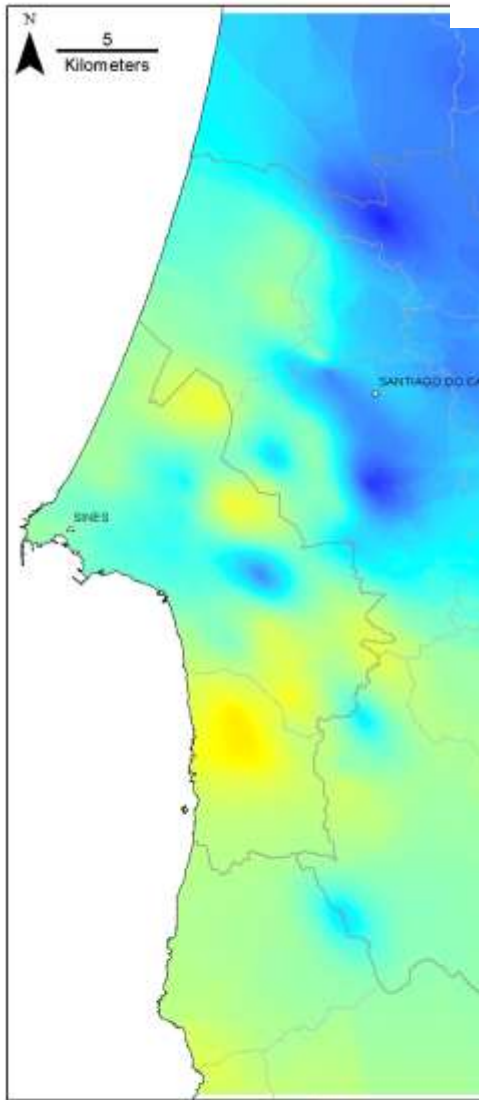
# Lichen Diversity Sampling along time

The sampling method was not the same; but we could look to total number of lichen species present



1980  
1997  
2002/3  
2009

# Difference in the Nº of Lichen Species 1980-2003



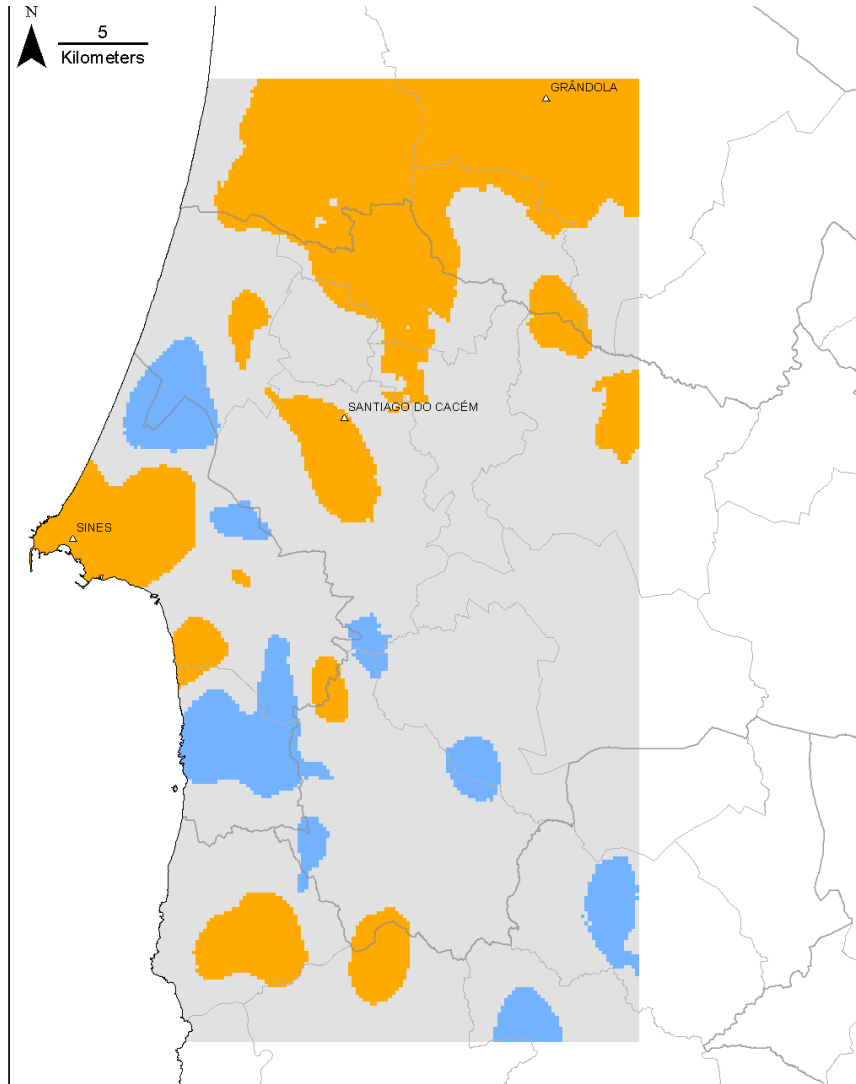
NrSp macro (JONES) 1980

High : 26

Low : 0

municipality

civil-parish



changes (%) in NrSp macro (1980 to 2003)

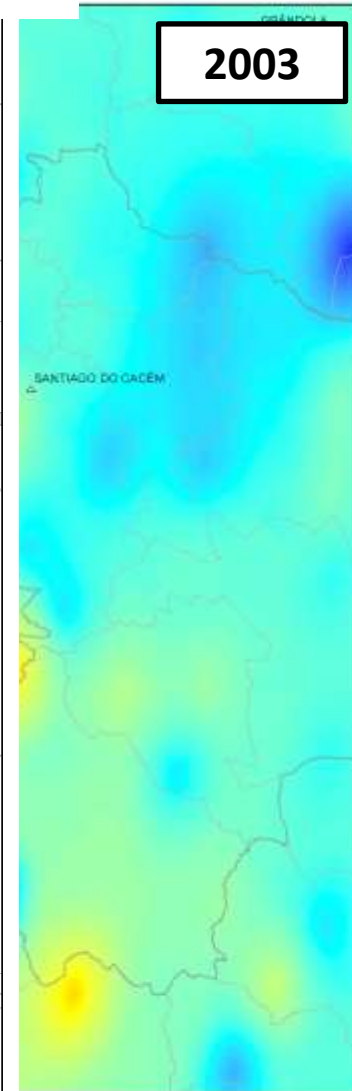
more than 20% decrease

no change

more than 20% increase

municipality

civil-parish



municipality

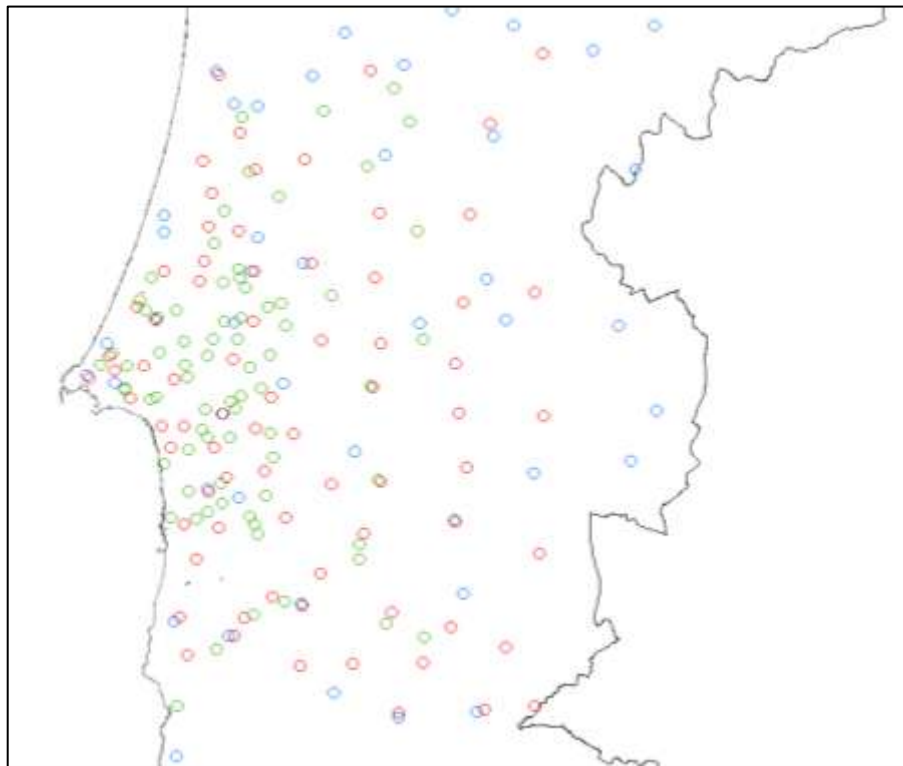
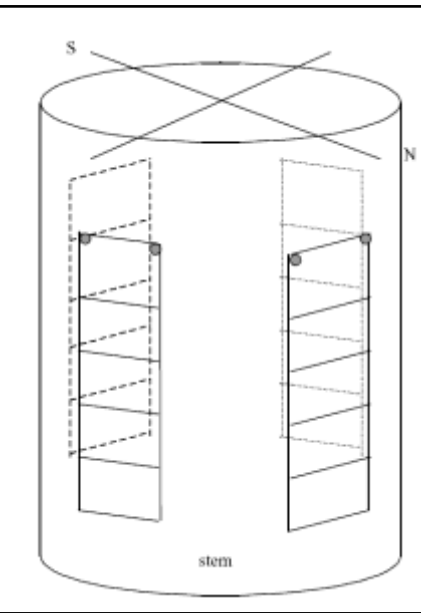
civil-parish

Jon

Pinho et al., 2004

# METHODS

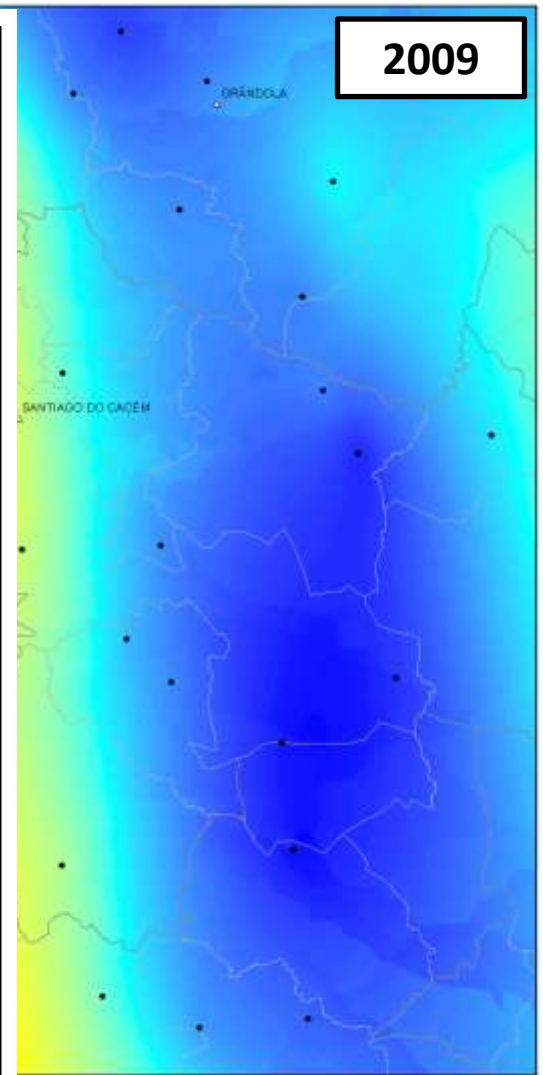
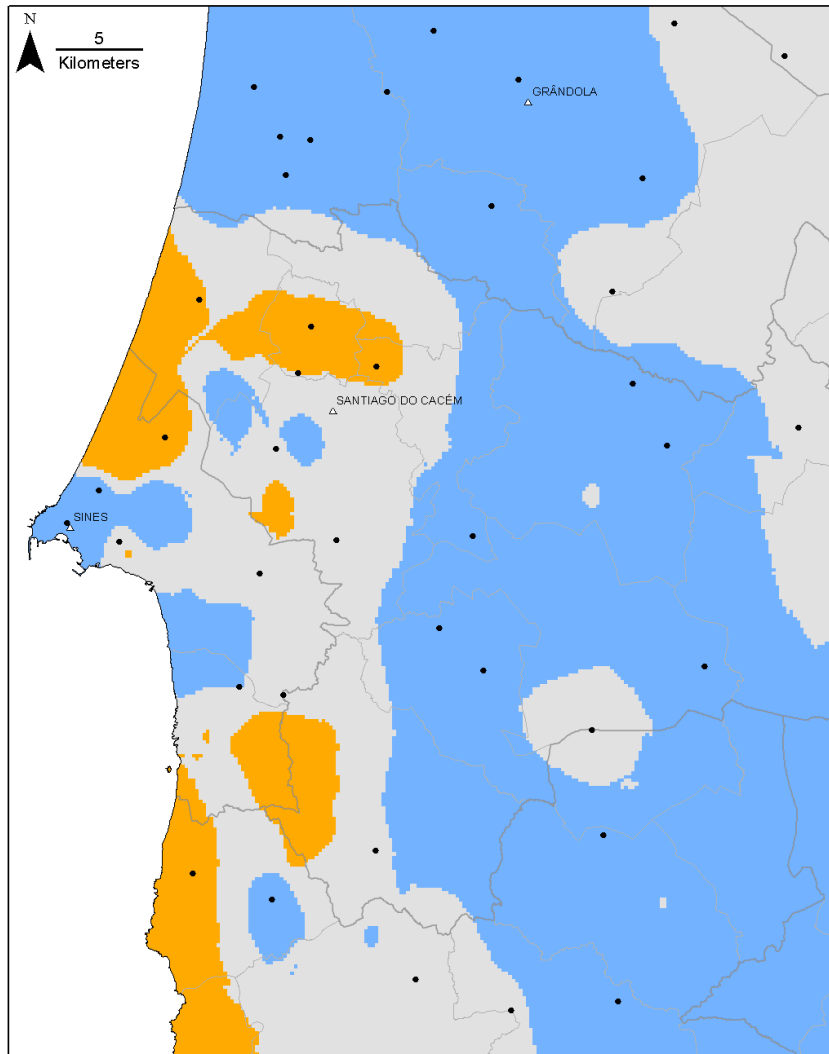
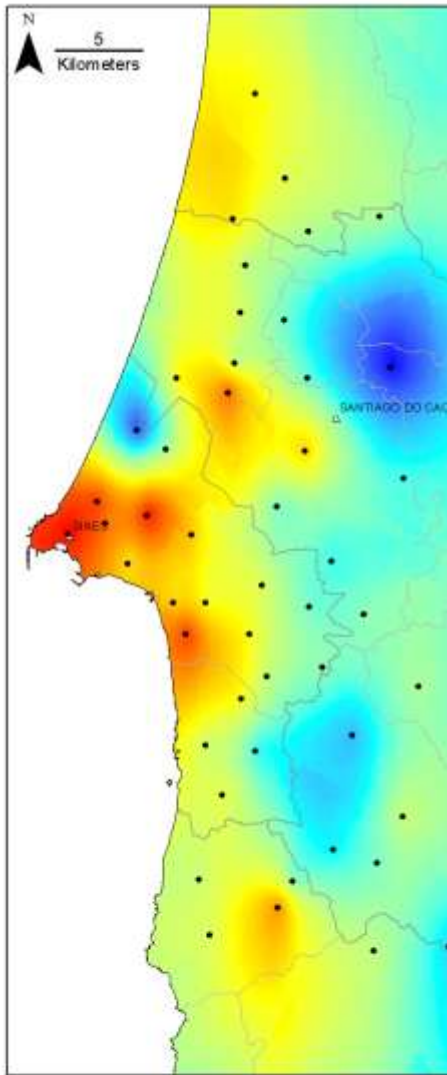
## *Lichen diversity*



Lichen diversity accordingly to  
Asta et al. (2002) and  
Scheidegger et al. (2002)

Calculated LDV (species number  
and frequency)

# LDV differences 2003-2009



2009

LDVmacro (SINESBIOAR) 2003

- sampling sites (2003)
- municipality
- civil-parish

49.2

0.10

changes (%) in LDVmacro (from 2003 to 2009)

- sampling sites (2009)
- municipality
- civil-parish

more than 20% decrease

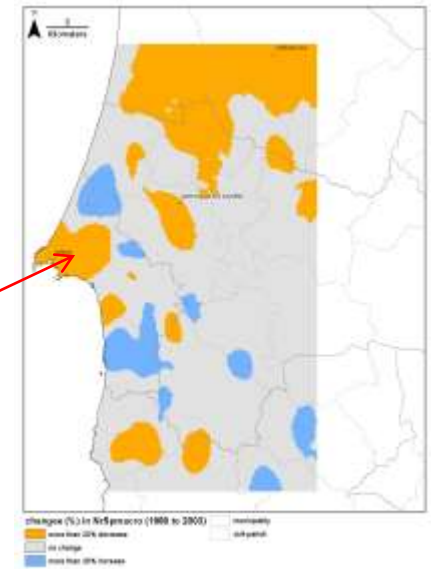
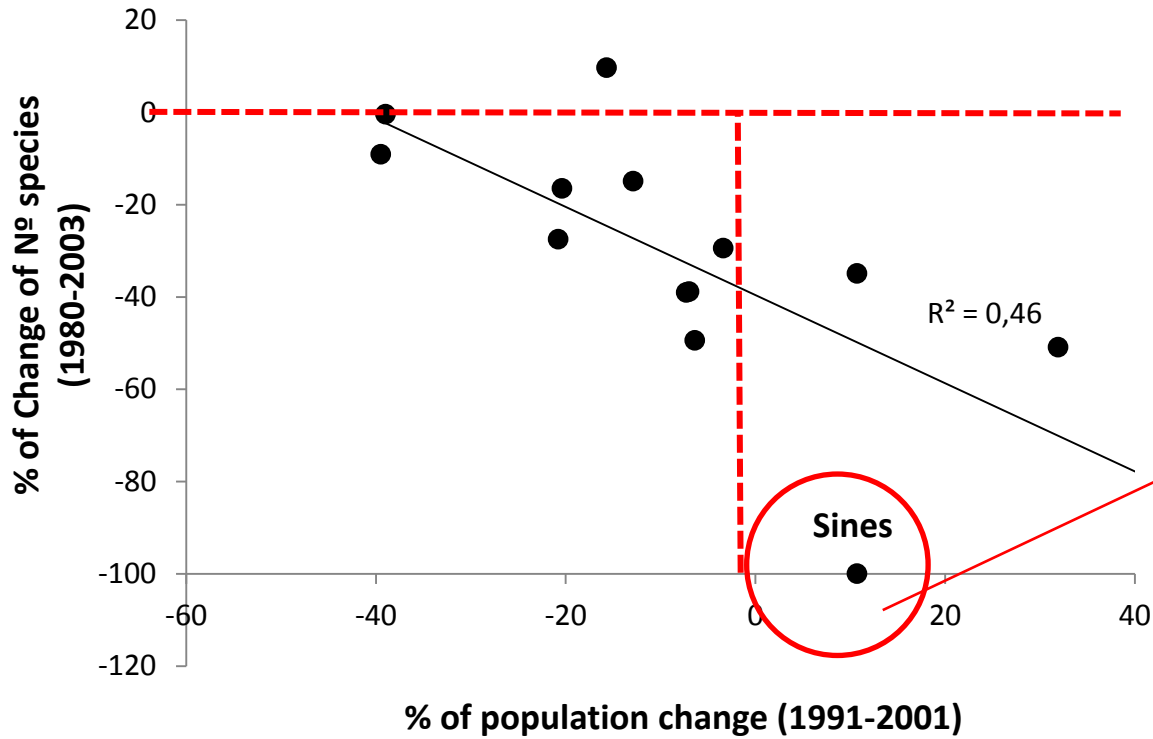
no change

more than 20% increase

LDVmacro (SINESBIOAR) 2009

- sampling sites (2009)
- municipality
- civil-parish

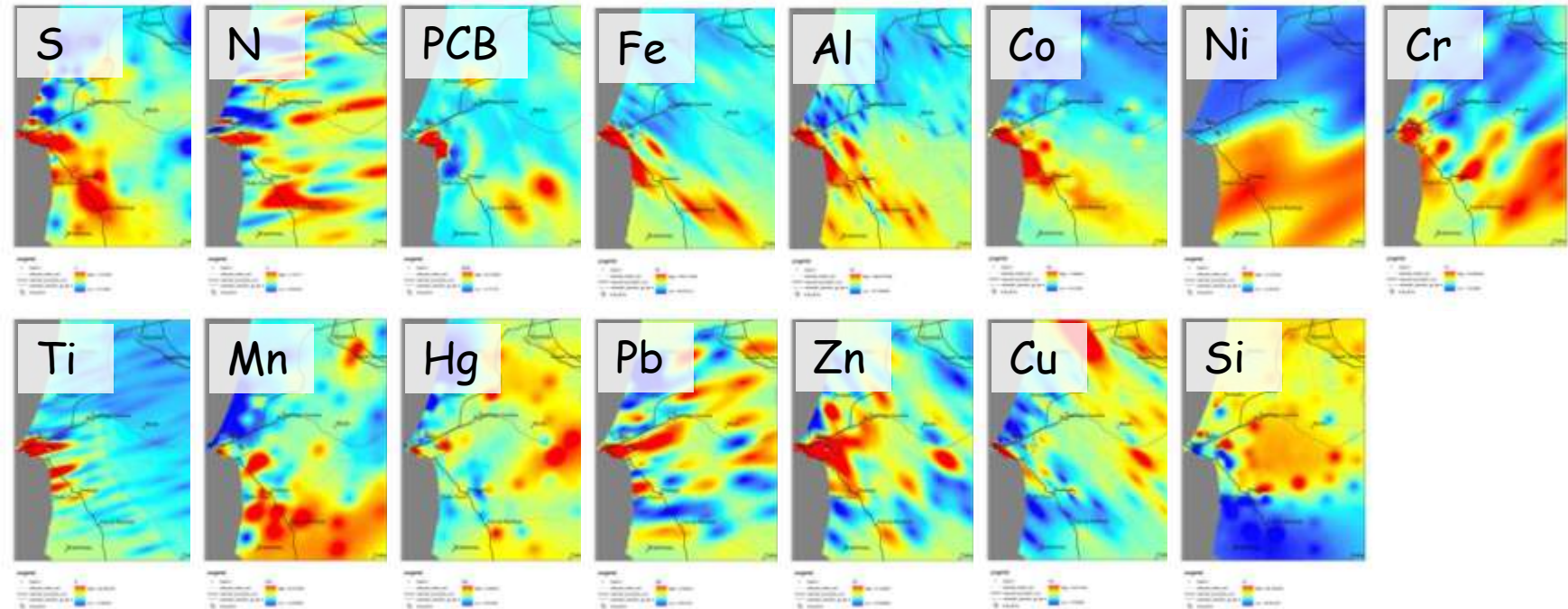
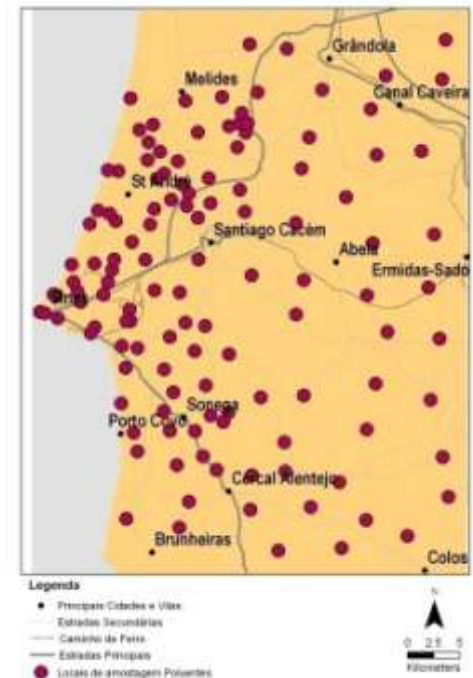
# Does the changes in population explains the changes in LDV?



## Energy consumption in Industry

Geographic Location	2004
	kWh/ consumer
Alcácer do Sal	40227,50
Grândola	18032,70
Odemira	9557,60
Santiago do Cacém	28343,90
Sines	3029830,60

# Lichen Pollutants

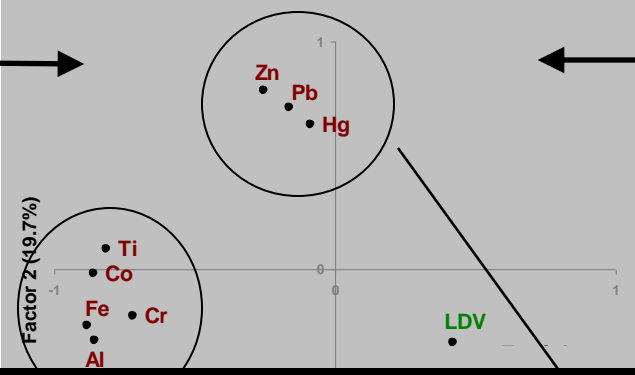




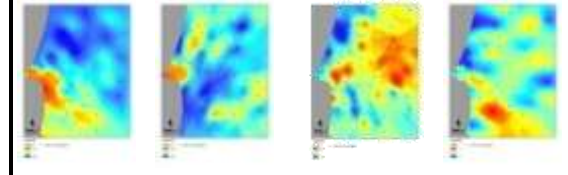
Data from the model of lichen diversity in the region



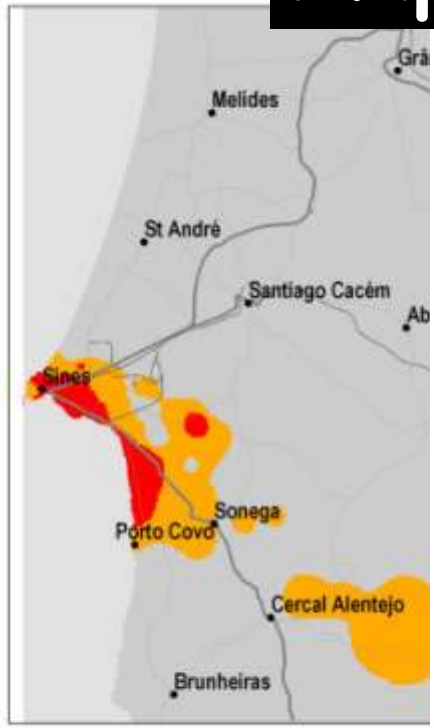
Factor 1 e 2 da ACP



Data from the model of all pollutants in the region



# Map of the "Chronic Pollution"



**Legenda**

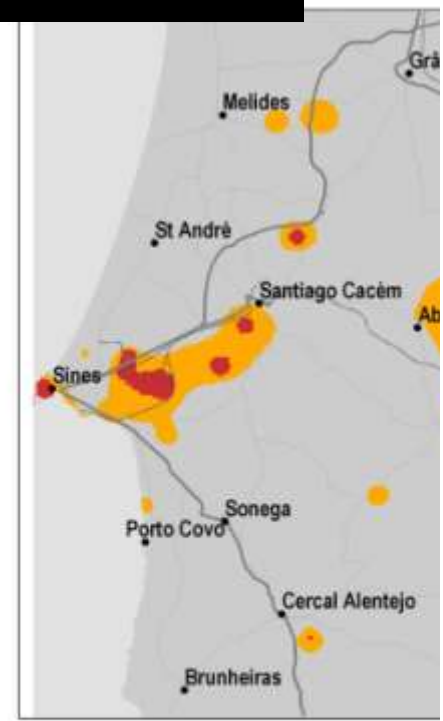
- Principais Cidades e Vilas
- Estradas Secundárias
- Caminho de Ferro
- Estradas Principais

**Factor 1 (biodiversidade & poluentes)**

- muito degradado
- degradado
- não degradado



Factor 1 (36.8%)



**Legenda**

- Principais Cidades e Vilas
- Estradas Secundárias
- Caminho de Ferro
- Estradas Principais

**Factor 2 (biodiversidade & poluentes)**

- não degradado
- degradado
- muito degradado



# Qualidade do ar Urbana



# GISA

Gestão Integrada Saúde e Ambiente

Dez 2007 a Dez 2011

5 municípios

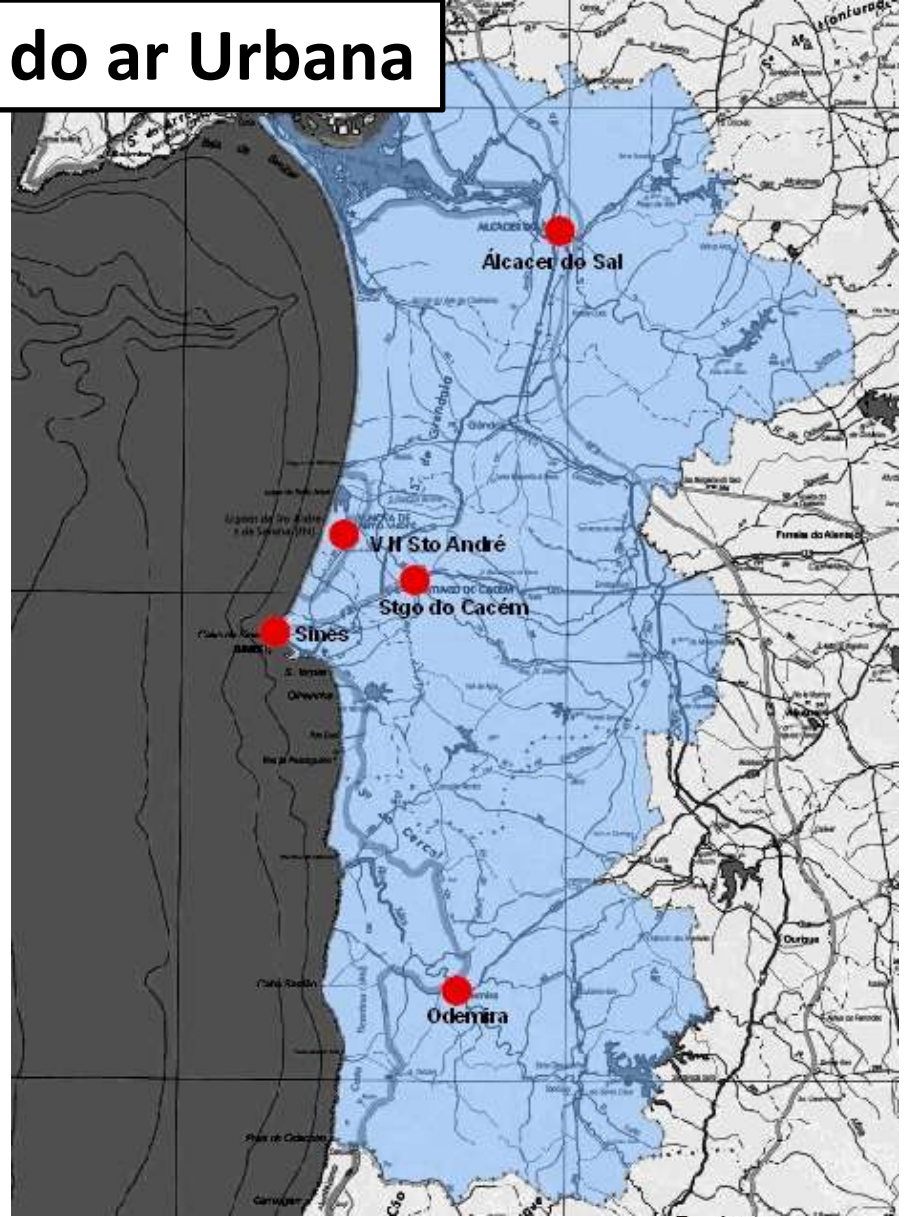
Saúde: ARSLVT

Ambiente: CCDR-A

FCUL; IST; ISCTE

Ricardo Jorge

12 empresas



Organização:



Câmara Municipal de Sines

Parceiros:

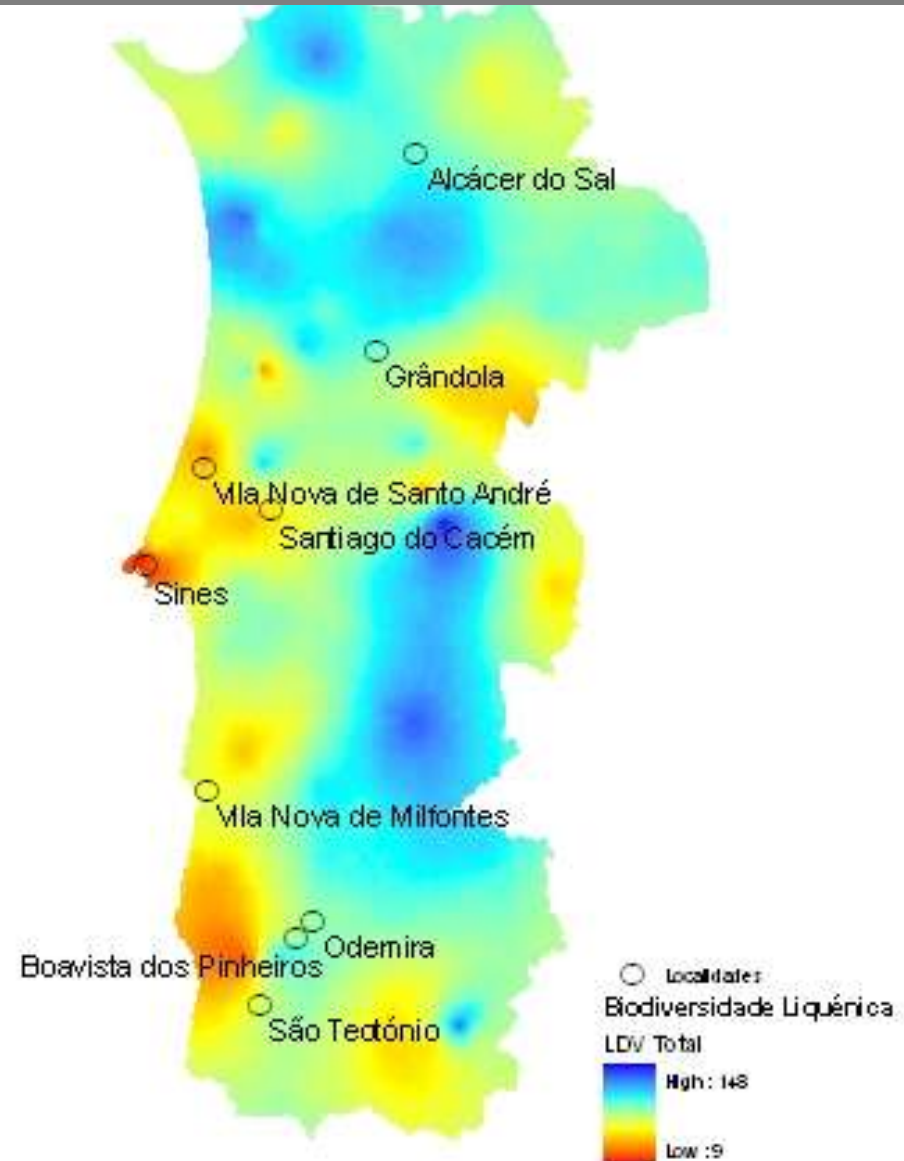


Apoio:

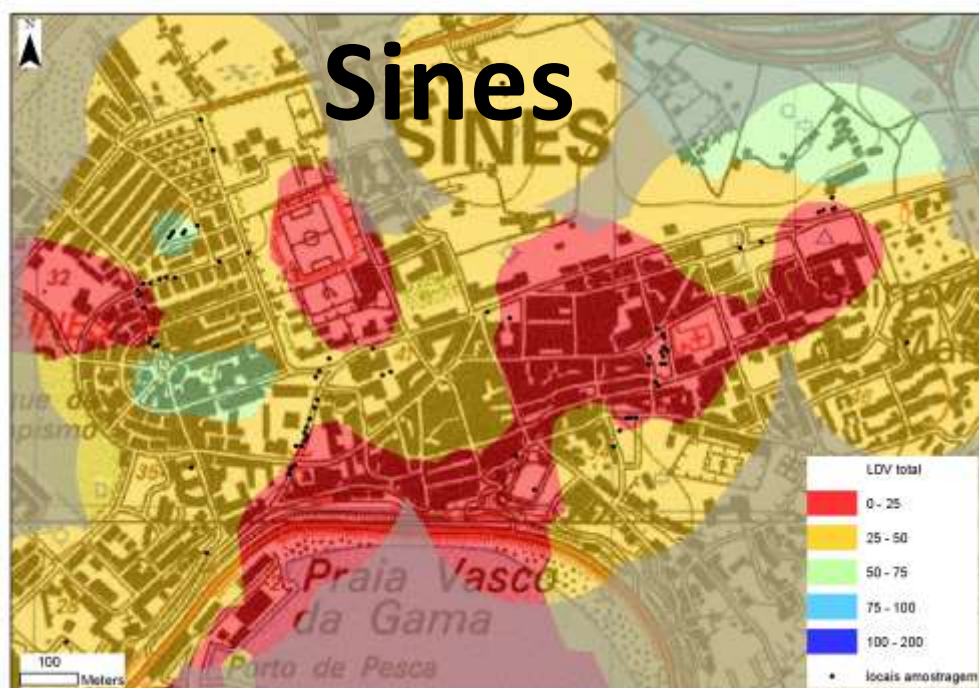


Regi

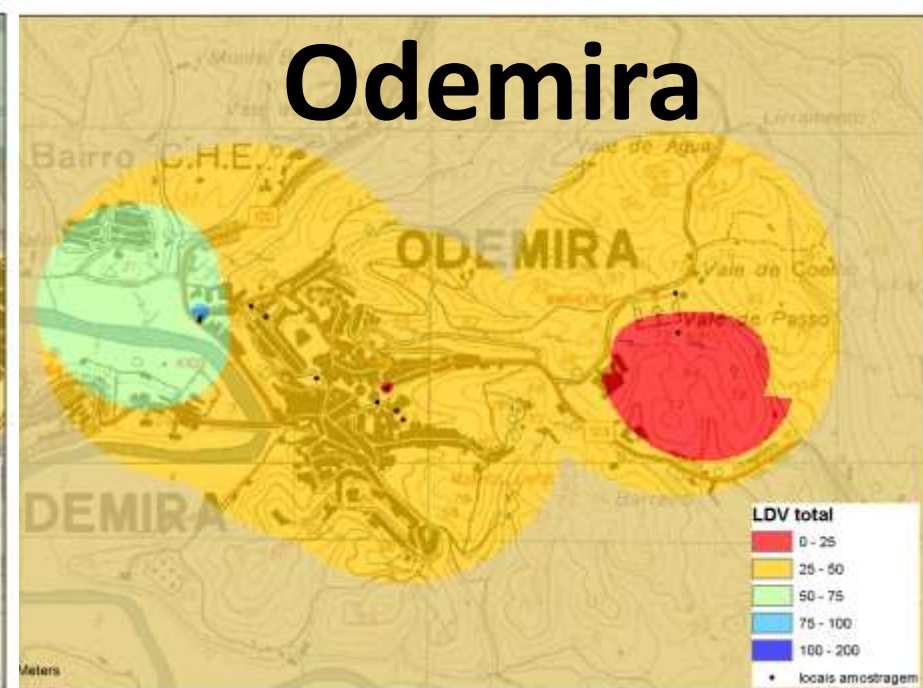
# Líquenes e como indicadores da qualidade do ar: o caso de estudo do Alentejo Litoral



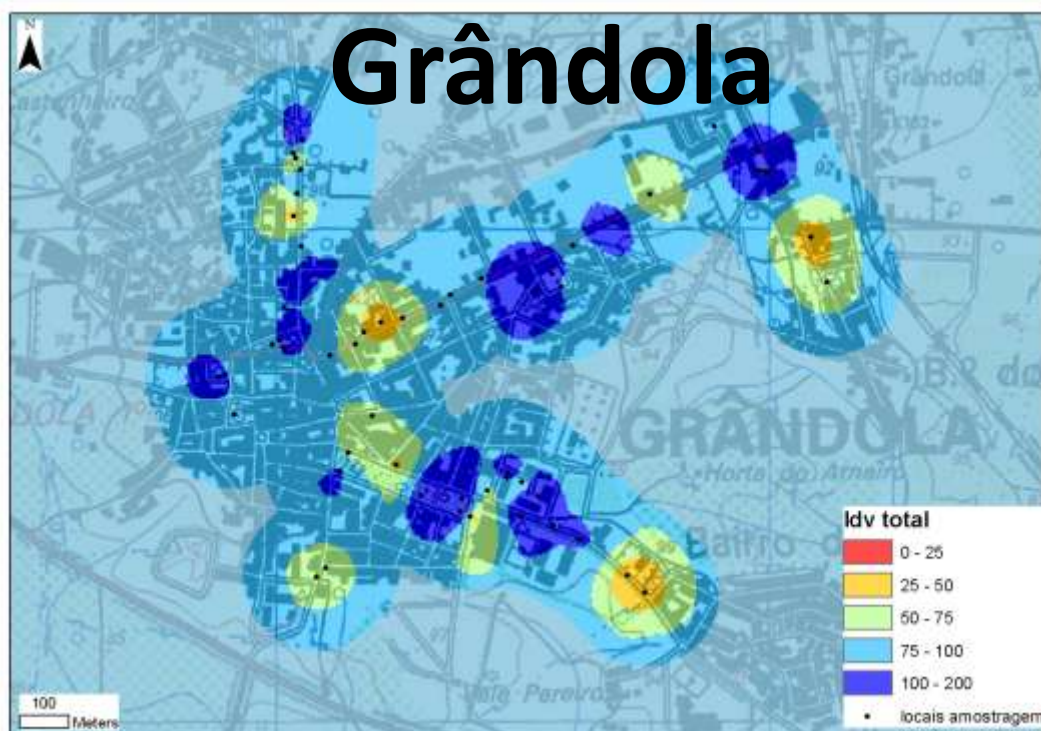
# Sines



# Odemira



# Grândola



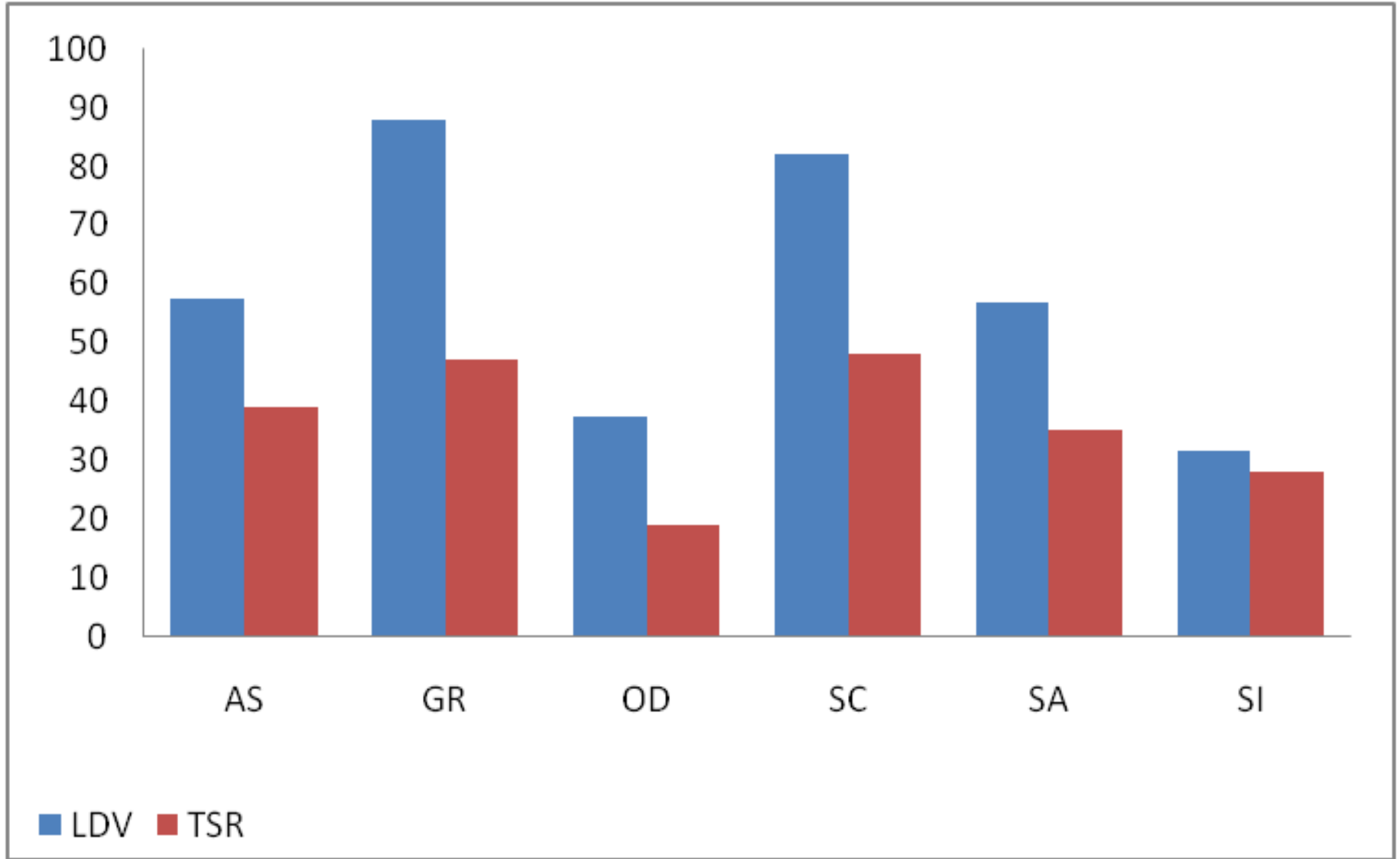
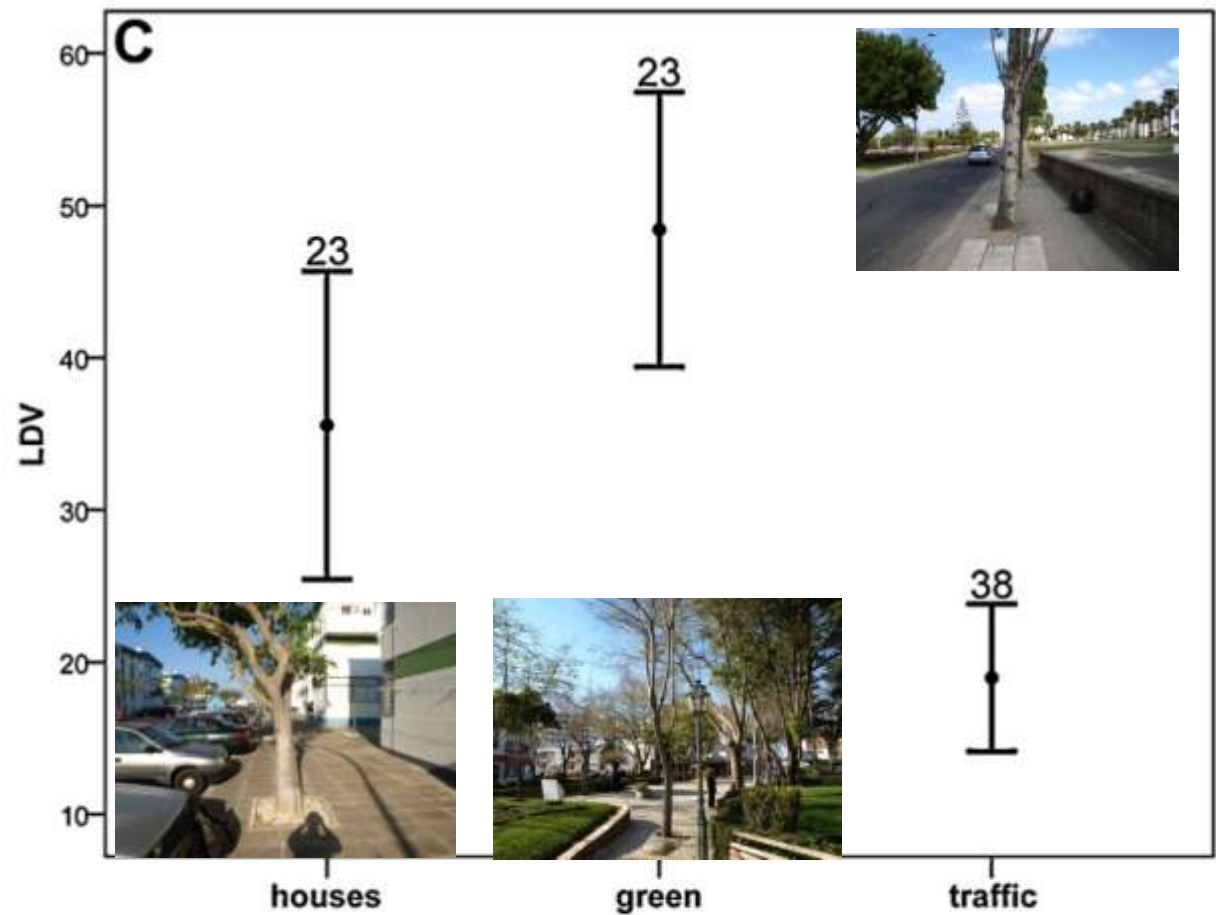


Figure 1. Values of LDV and species richness (TSR) for the sampled towns. AS: Alcácer do Sal, GR: Grândola, OD: Odemira, SC: Santiago do Cacém, SA: Santo André, SI: Sines.

# Líquenes e como indicadores da qualidade do ar: o caso de estudo das zonas urbanas do Alentejo Litoral



**Fig. 2.** Range plots for pH (A), separated by bark of trees (B) and LDV (C) for the considered land uses. The bars represent the 95% confidence interval. The number on top of bar indicates the amount of trees included in each plot.

Llop E, Pinho P, Matos P, Pereira MJ, Branquinho C. 2012. The use of lichen functional groups as indicators of air quality in a Mediterranean urban environment. *Ecological Indicators*

# Emissões das principais empresas



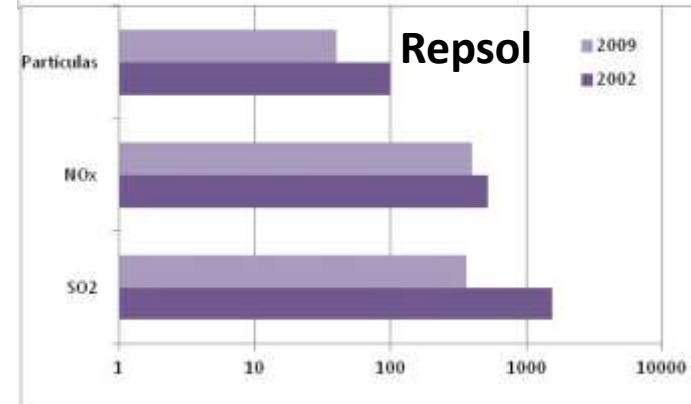
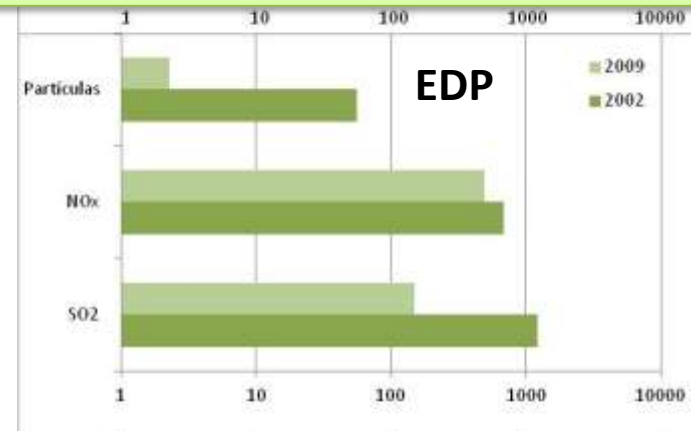
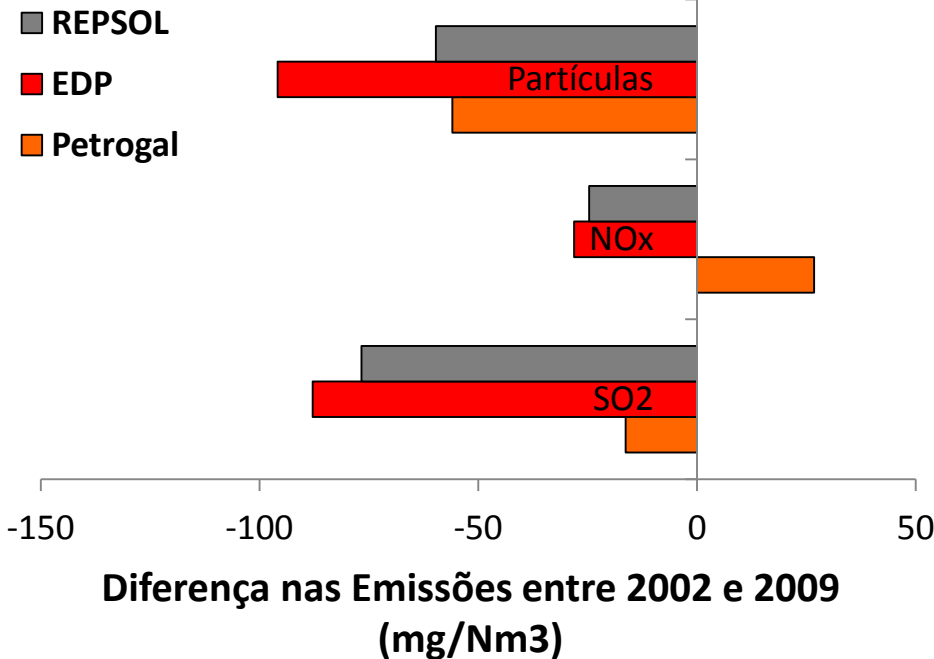
De acordo com o cenário adoptado na Estratégia Temática, prevê-se que a **redução de emissões (entre 2000 e 2020) provenientes de fontes fixas, para Portugal, seja de:**

**48%** para as PM<sub>2,5</sub>

**52%** para o NO<sub>x</sub>,

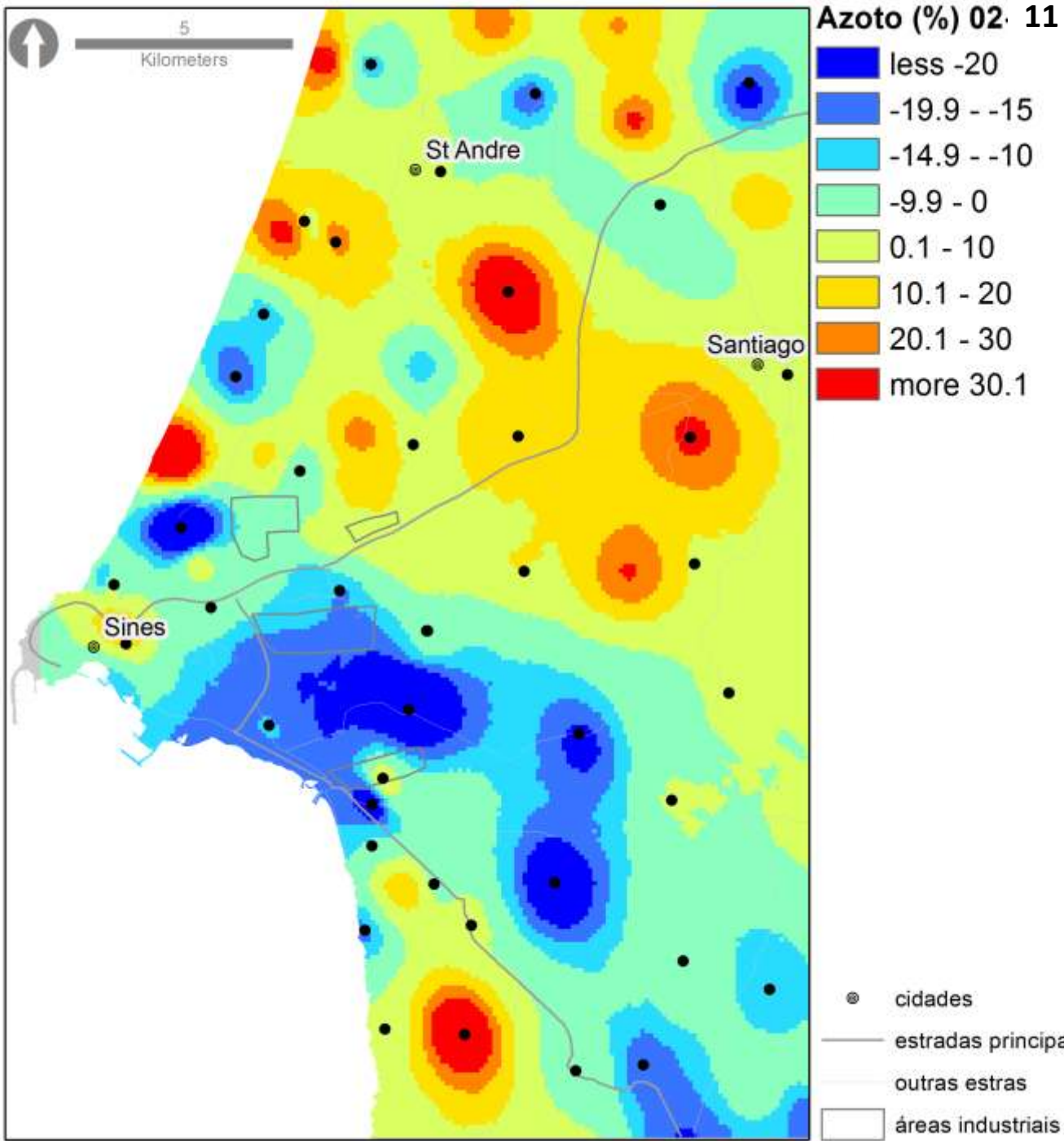
**79%** para o SO<sub>2</sub>,

## 2002-2009



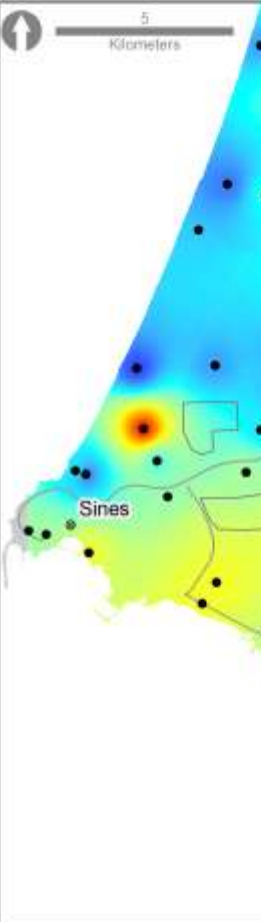
Emissões - Medianas anuais de 2009 e 2002 (mg/Nm<sup>3</sup>)

# mpo de N



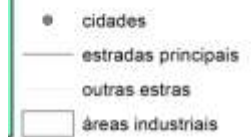
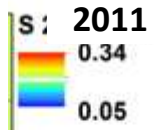
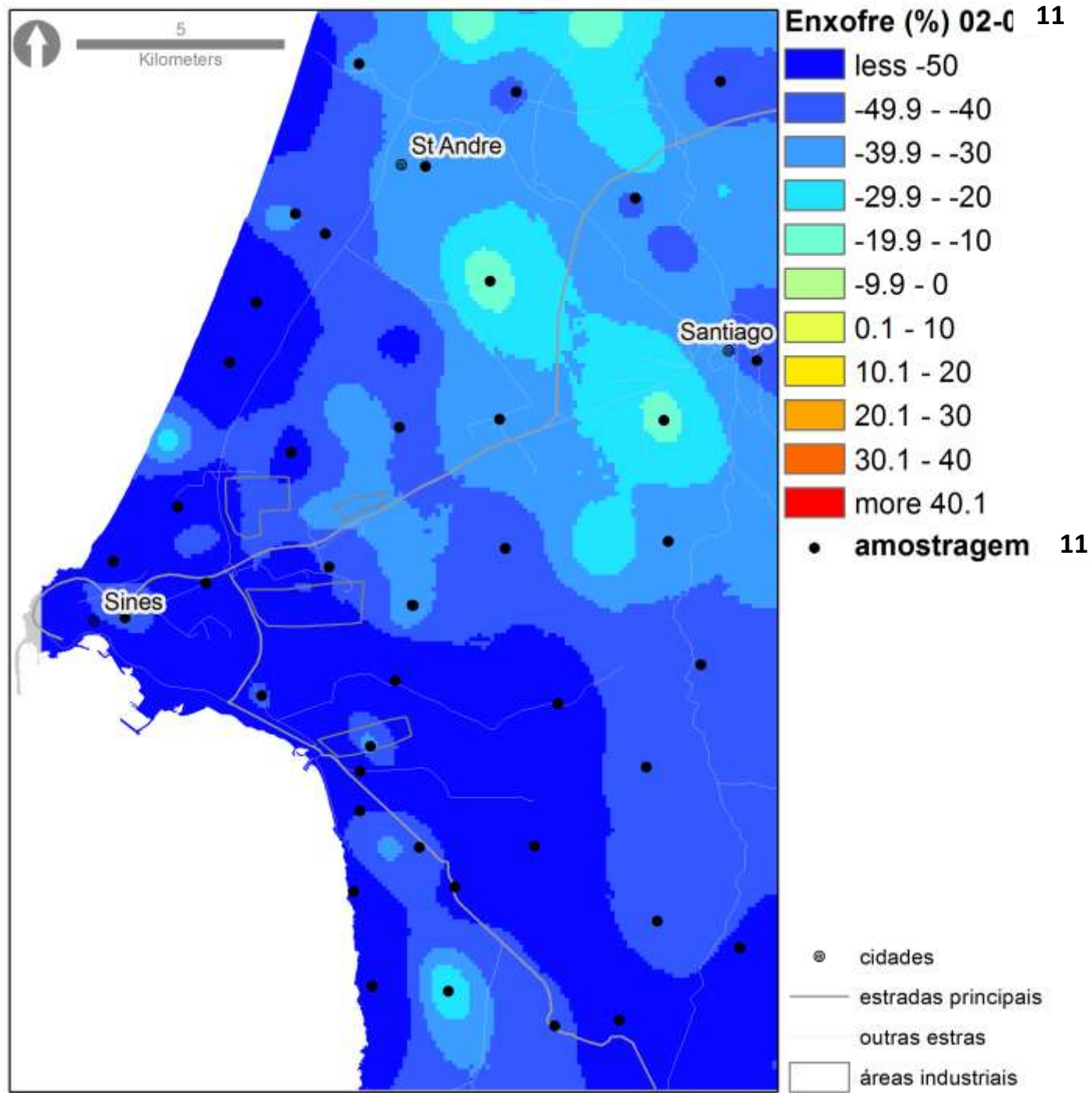
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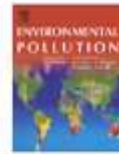
● cidades  
— estradas principais  
— outras estradas  
□ áreas industriais





# tempo ial de S

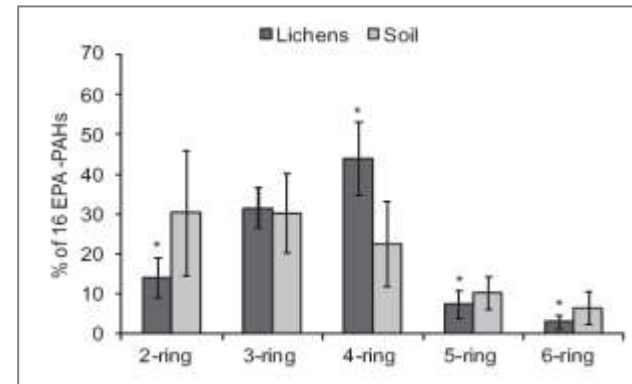
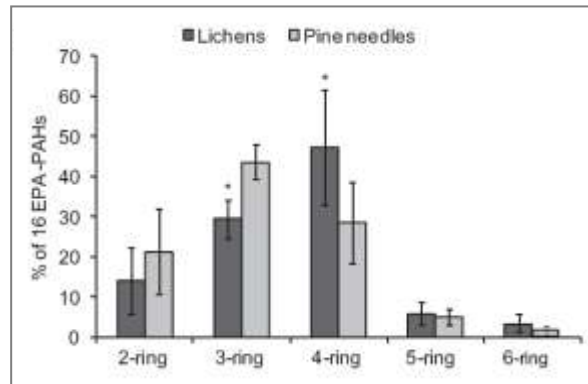




Optimising and inter-calibrating biomonitors, soil and air

Lichens as an integrating tool for monitoring PAH atmospheric deposition: A comparison with soil, air and pine needles

Sofia Augusto <sup>a</sup>, Cristina Máguas <sup>a</sup>, João Matos <sup>b</sup>, Maria João Pereira <sup>c</sup>, Cristina Branquinho <sup>a,\*</sup>



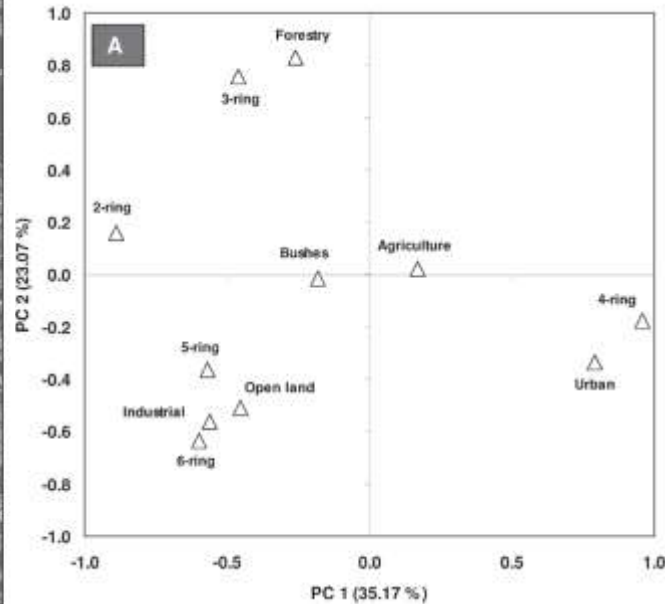
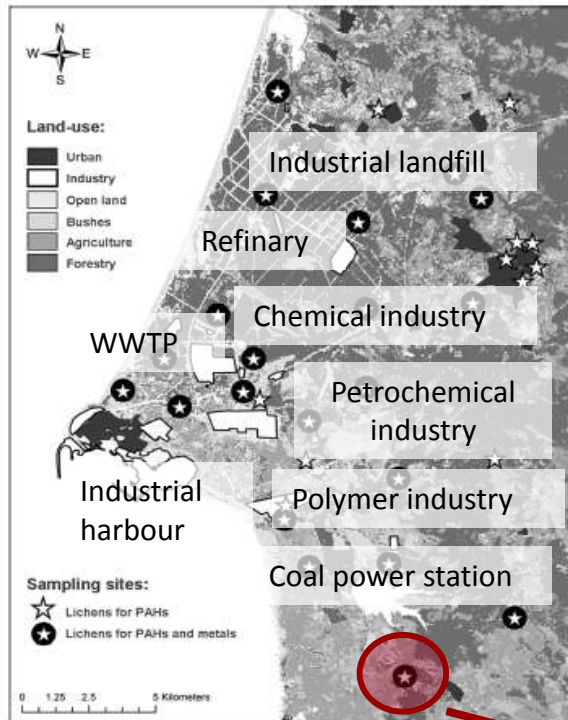
## Spatial Modeling of PAHs in Lichens for Fingerprinting of Multisource Atmospheric Pollution

SOFIA AUGUSTO,<sup>†</sup> CRISTINA MÁGUAS,<sup>†</sup> JOAO MATOS,<sup>†</sup> MARIA JOAO PEREIRA,<sup>‡</sup> AMÍLCAR SOARES,<sup>§</sup> AND CRISTINA BRANQUINHO<sup>\*†</sup>

ecosystem level and in the human food-chain; for that, not only must the sources be identified but also the sites where PAHs are being deposited.

Chemical analyses of air, soil, and plant and animal bioindicators have been used to monitor atmospheric deposition from different sources (5–7). While measurements in air (in the vapor- and particulate-phases) reflect a short-term indicator that varies considerably in space and time, soils are sinks for organic compounds and therefore reflect a typical profile of long-term atmospheric pollution deposi-

Fingerprinting pollution sources using biomonitoring tools



Relative cover of each land-use class in circular buffers (1 Km radius) centered at each sampling site.

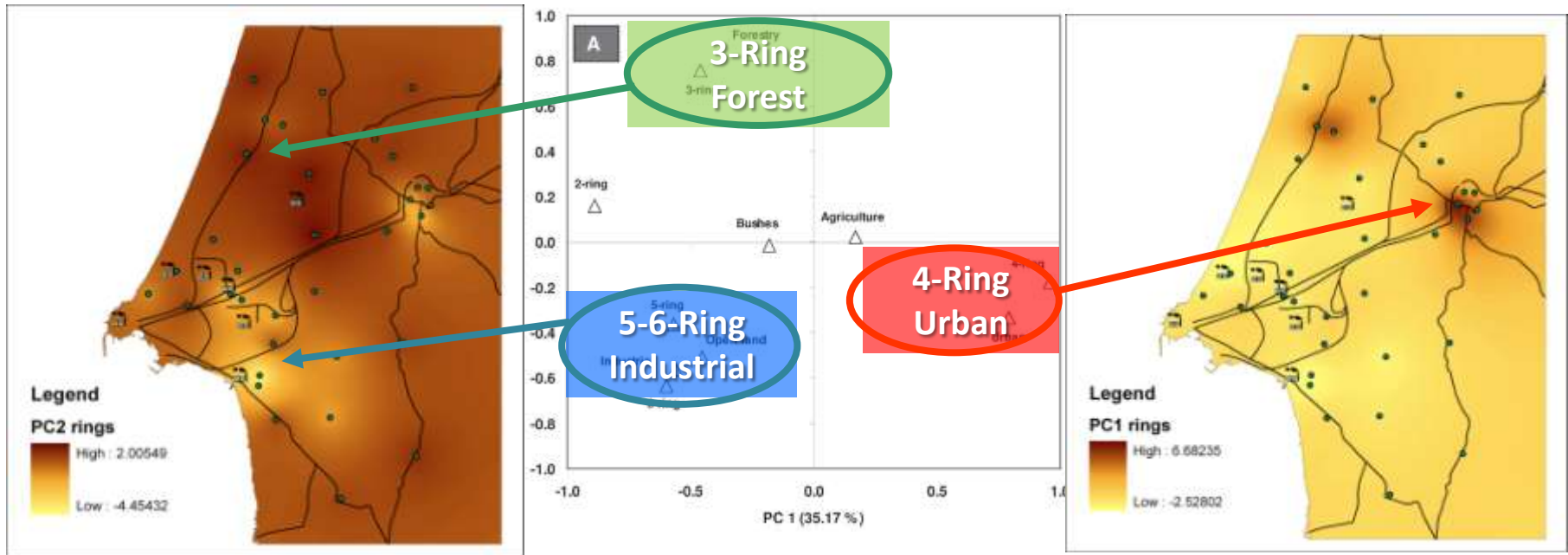
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Fingerprinting pollution sources using biomonitoring tools





**Optimising and inter-calibrating biomonitors, soil and air**

A step towards the use of biomonitors as estimators of atmospheric PAHs for regulatory purposes

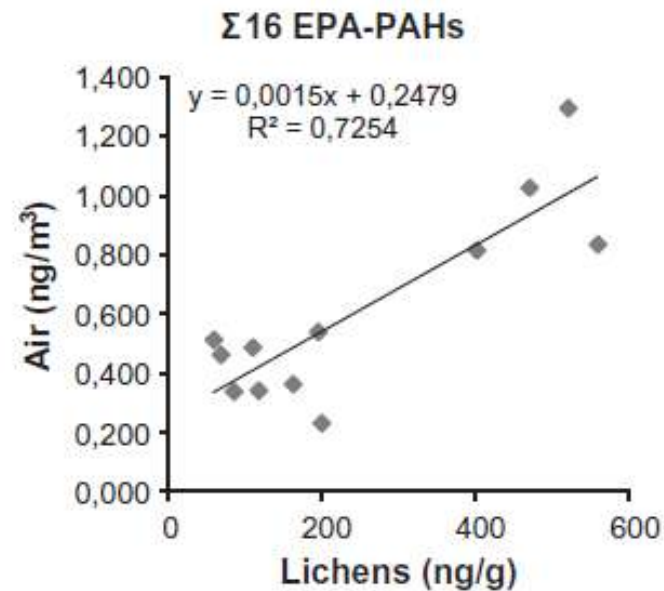
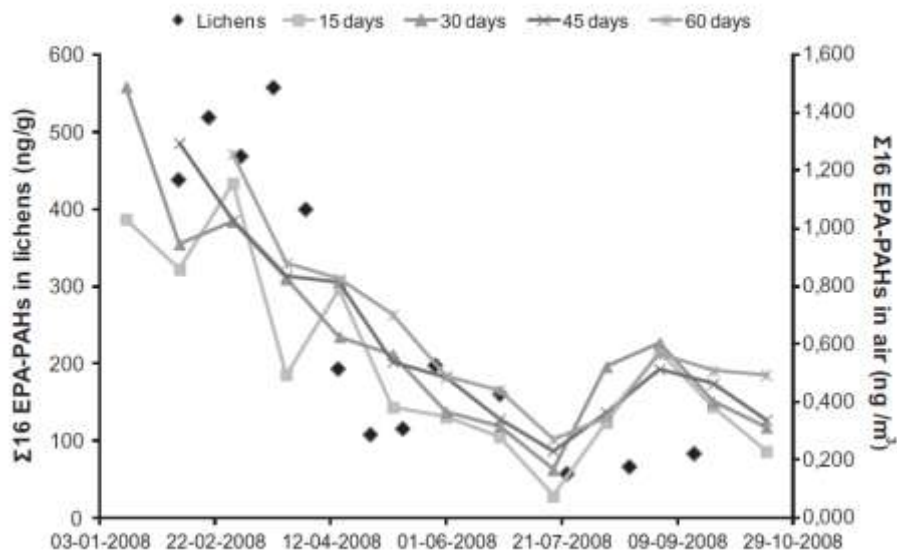
Sofia Augusto <sup>a</sup>, Maria J. Pereira <sup>b</sup>, Cristina Máguas <sup>a</sup>, Cristina Branquinho <sup>a,\*</sup>



Lichens



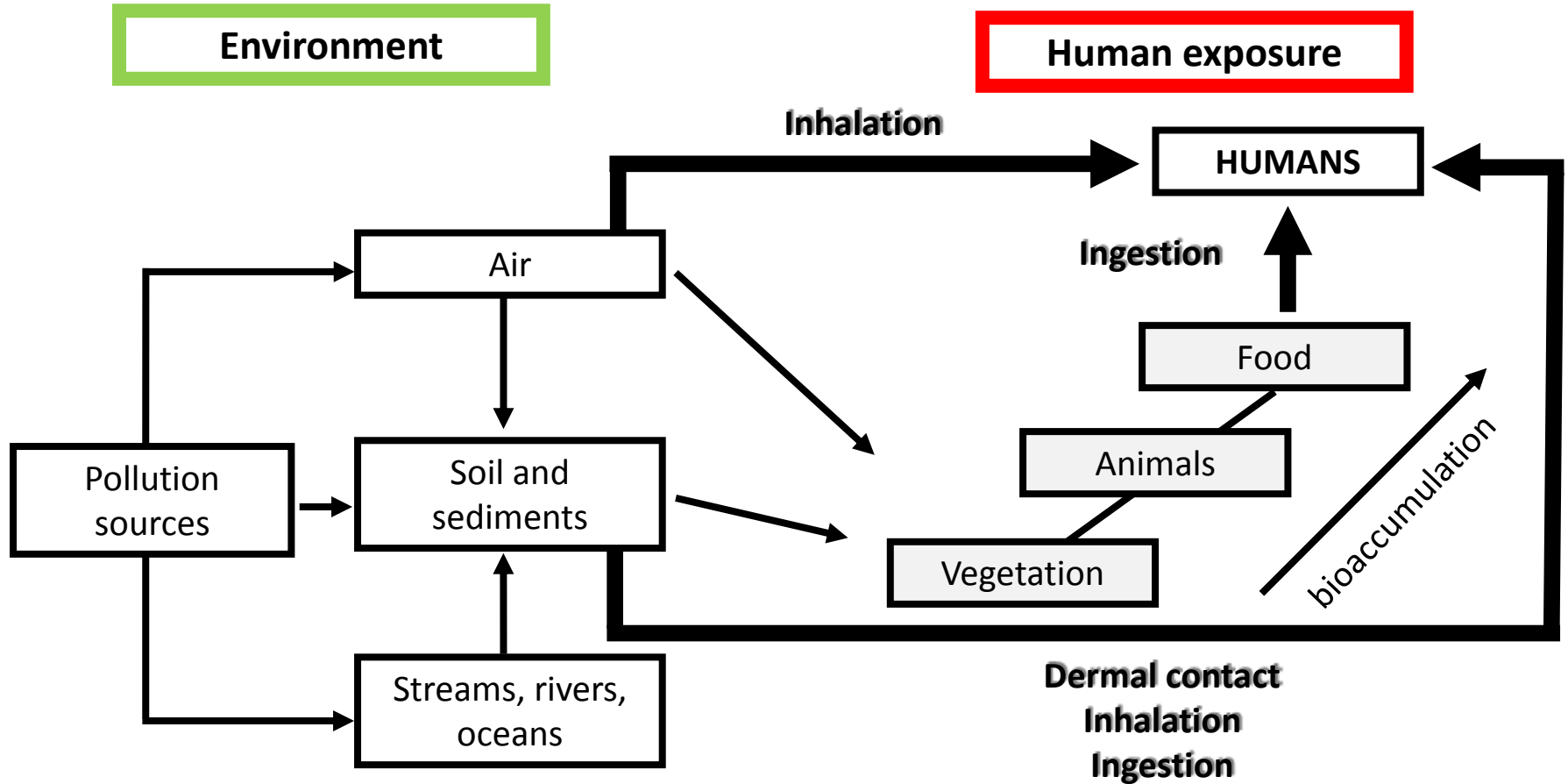
Air (filters)



# Assessing human health risk based on different monitoring approaches

## ASSESSING HUMAN EXPOSURE TO POLYCYCLIC AROMATIC HYDROCARBONS (PAH) IN A PETROCHEMICAL REGION UTILIZING DATA FROM ENVIRONMENTAL BIOMONITORS

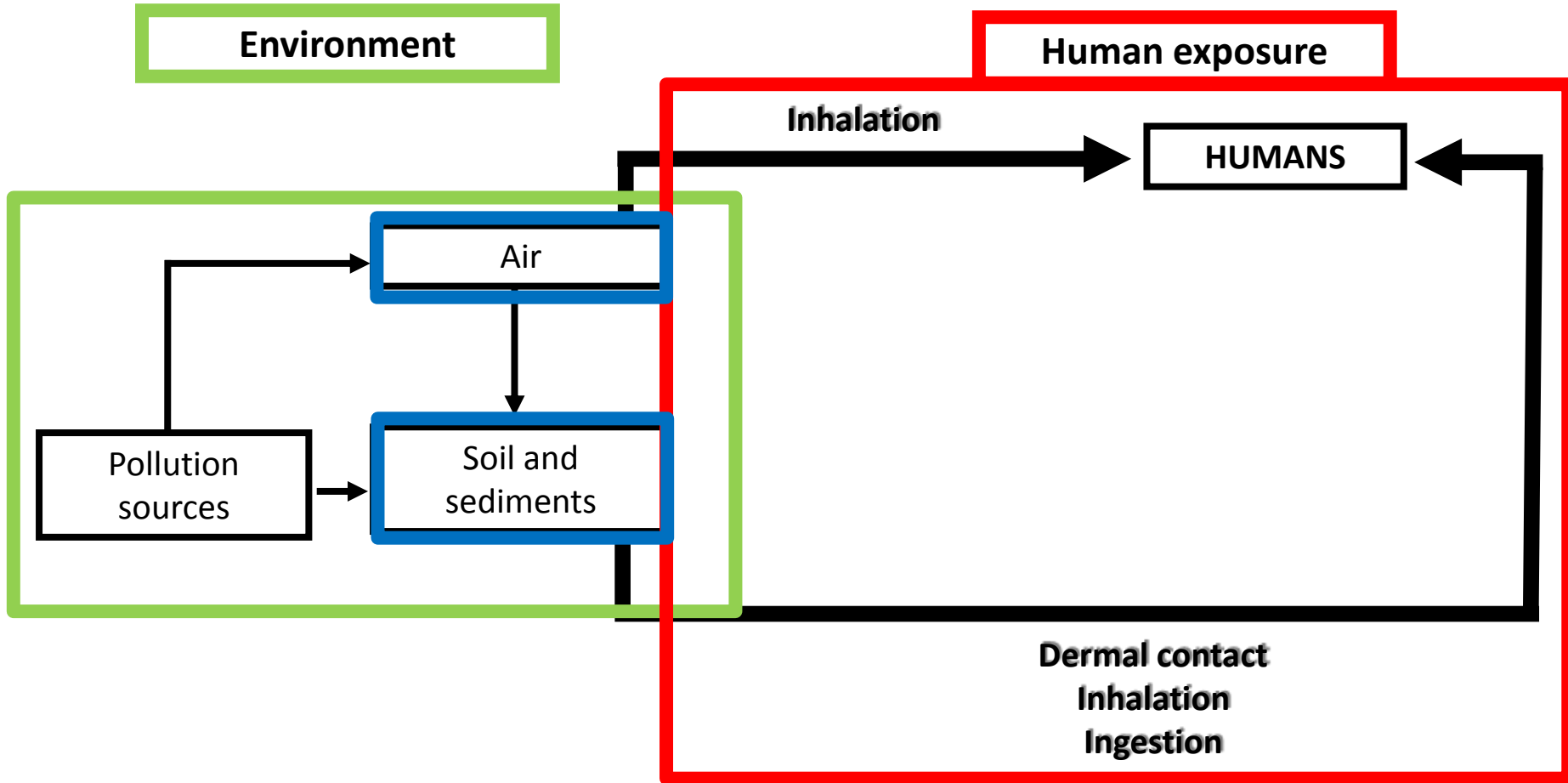
Sofia Augusto<sup>1</sup>, Maria João Pereira<sup>2</sup>, Cristina Mágua<sup>1</sup>, Amílcar Soares<sup>2</sup>, Cristina Branquinho<sup>1</sup>



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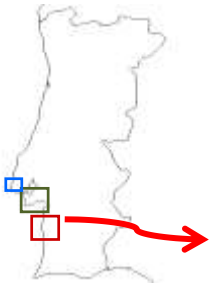


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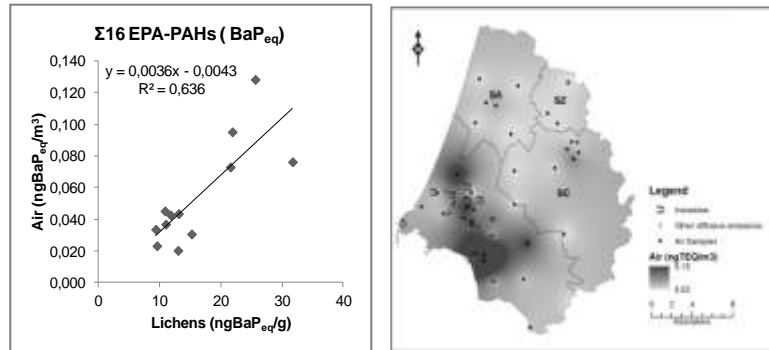
Sofia Augusto<sup>1</sup>, Maria João Pereira<sup>2</sup>, Cristina Mágus<sup>1</sup>, Amílcar Soares<sup>2</sup>, Cristina Branquinho<sup>1</sup>

### PAH toxic concentrations



Inhalation

#### Air (estimated using lichens)

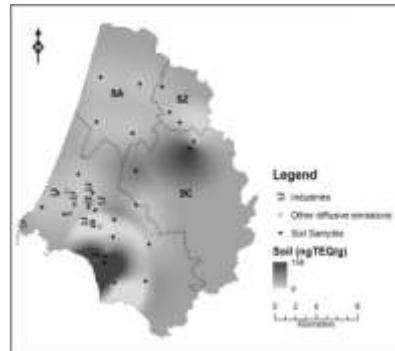


Ingestion

Inhalation

Dermal Contact

#### Soil



Exposure (adult)	SZ	SC	SA	S
Inhalation Air	76	100	88	166
Ingestion Soil	99	198	99	168
Inhalation Soil	4200	8426	4208	7134
Dermal	0,06	0,12	0,06	0,10
<b>Individual exposure (ngBaPeq/day)</b>	<b>4375</b>	<b>8723</b>	<b>4395</b>	<b>7468</b>

Human Exposure



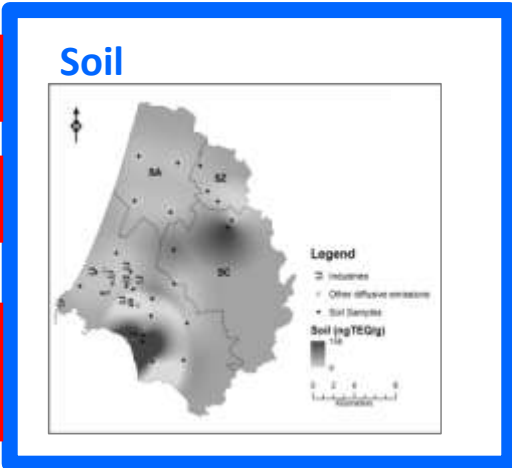
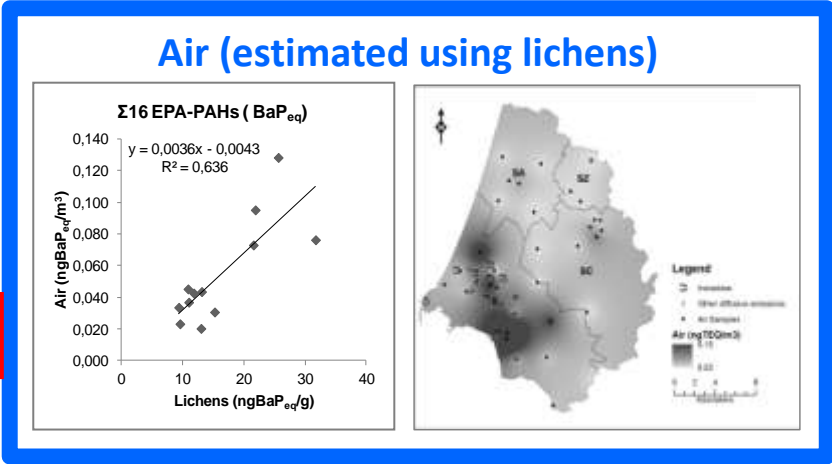
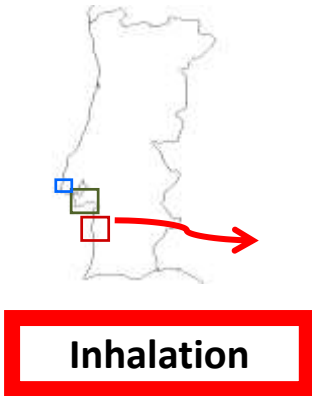


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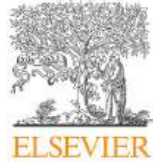
Human Exposure



Carcinogenic risk

Incremental lifetime cancer risk (ILCR)	SZ	SC	SA	S
ILCR	2,7x10 <sup>-4</sup>	5,5x10 <sup>-4</sup>	2,7x10 <sup>-4</sup>	4,7x10 <sup>-4</sup>
<b>Subjects developing cancer in their lifetime</b>	<b>0,1</b>	<b>3,2</b>	<b>2,3</b>	<b>4,5</b>

In press:



Contents lists available at SciVerse ScienceDirect

Environmental Pollution

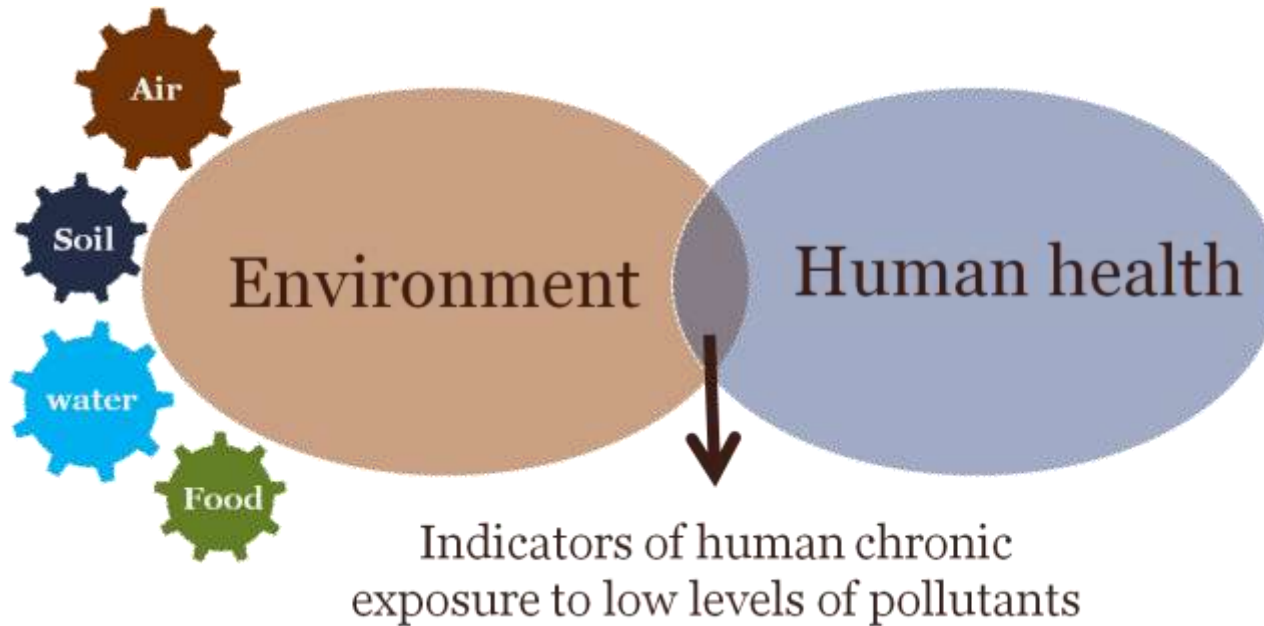
journal homepage: [www.elsevier.com/locate/envpol](http://www.elsevier.com/locate/envpol)



Review

Guidelines for biomonitoring persistent organic pollutants (POPs), using lichens and aquatic mosses – A review

## Future research



# E o que nos falta saber?

- Qualidade Solos (IST);
- Água doce subterrânea (IST);
- Água doce superficial (FCUL);
- Massa de água marinha (FCUL);

# BioKid – “Diz-me o que comes...”

- Escolas primárias nos vários concelhos;
- Recolher amostras humanas não invasivas (unhas, cabelo, urina);
- Analisar os alimentos;
- Analisar o ar;
- Analisar a água;
- Analisar os solos
- Calcular a exposição de compostos orgânicos tóxicos em cada uma das vias de contaminação.



# BioAr – “Insustentável leveza do Ar”

- Utilizar diferentes tipos de abordagens para avaliar os odores;
- Desenvolver sensores que sejam capazes de captar e reter os COVs que têm odor;
- Envolver a população num sistema de monitorização sensorial do odor;



# BioPaleo – “Back to the Future

- Fazer um core de sedimentos;
- Avaliar as diatomáceas;
- Avaliar os poluentes nos últimos 500-200 anos;
- Identificar indicadores baseados em grupos funcionais de diatomáceas que nos estimam a perturbação da vida marinha ao longo do tempo;

Introdução desta sp de dinoflagelado que produz bloom tóxicos

Eutrofização; começo do fornecimento público de água em Lx.

Começo das actividades humanas

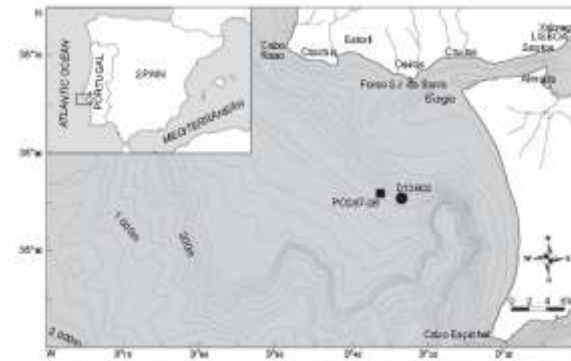


Figure 1: Map of the Tagus Estuary mouth and area date showing the sample location. The date corresponds to the location of the piston core and the core corresponding to the box core (adapted from Amorim et al. 2005)

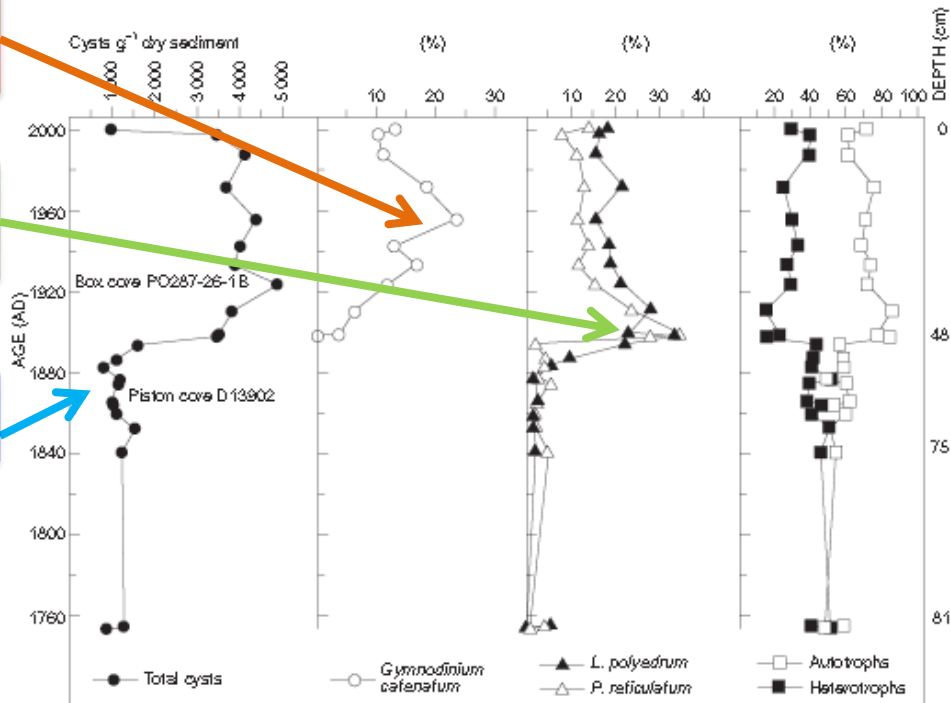
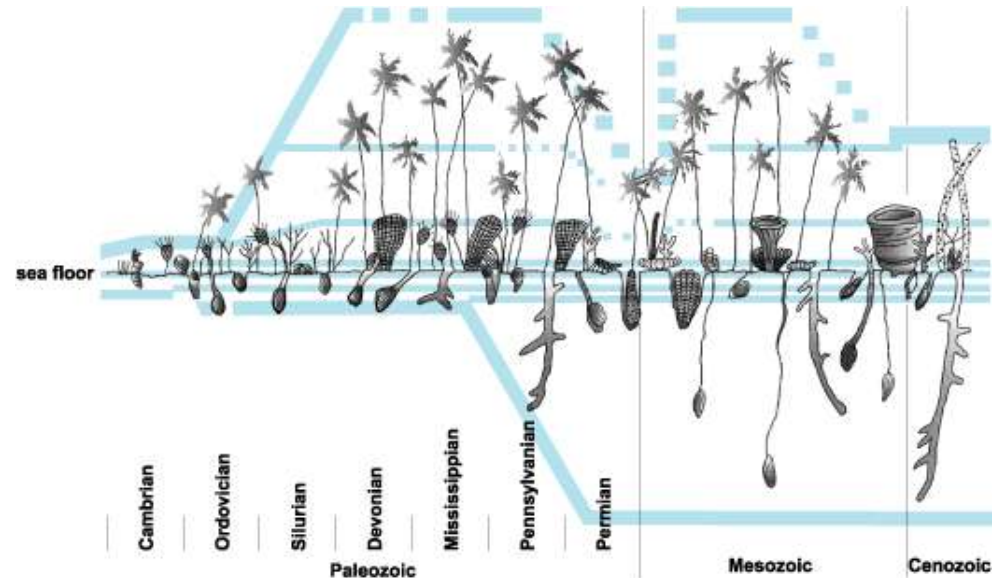
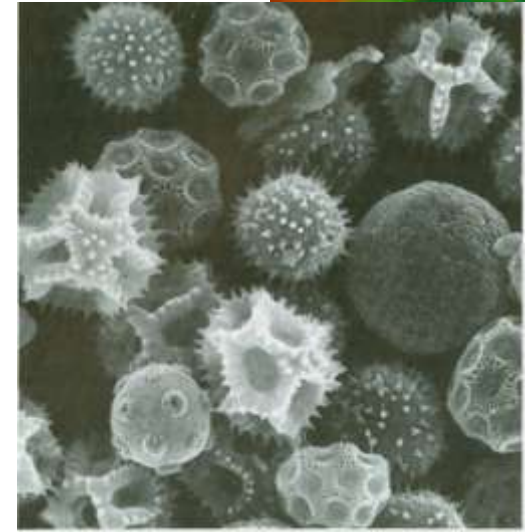


Figure 2: Cyst data for the spliced sediment cores: (a) total cyst concentration; (b) relative abundance of *Gymnodinium catenatum*; (c) relative abundance of *Lingulodinium polyedrum* and *Proboscoidium reticulatum*; and (d) trophic structure of the cyst assemblage

# BioPaleo – “Back to the Future”



- Fazer um core de sedimentos em lagoas;
- Avaliar os poléns;
- Avaliar os poluentes nos últimos 2000 anos;
- Identificar as perturbações e as consequentes alterações nos padrões de vegetação ;



# BioRio – “Por este rio abaixo”



•Augusto S, Gonzalez C, Vieira R, Máguas C, Branquinho C. Evaluating the sources of PAHs in urban streams based on land-use and biomonitors. *Environmental Science and Technology*, 45:3731-3738.



*Fontinalis antipyretica*, musgo aquático seleccionado como biomonitor



Sofia Augusto (FCUL) – Pedro Pinho (IST)

Transplante colocado numa Ribeira em Oeiras



# BioMar - “Message in a bottle”

- Desenvolver bio-sensores de PAHs no mar baseados em consórcios cianobactérias/microalgas;
- Desenvolvimento dos suportes;
- Teste preliminar do tipo de cianobactérias/microalgas mais adequadas;
- Teste do tempo ideal de exposição;
- Análises de PAHs e estimativa das fontes;



# Comunicação e divulgação

Um  
docu  
mentário  
para  
todos...

## um projecto GISA

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# Ambiente e Ecologia Funcional do CBA - FCUL



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