VIMoS- An approach to develop Visual Indicators on Montados' Soil functions

IUFRO2023

González-Pelayo, O.; Guimarães, M.H.; Pinto-Correia, T.

Soil is the foundation of terrestrial ecosystems and the majority of ecosystem services needed for human survival arise from soil (Kibblewhite et al., 2008. doi: 10.1098/rstb.2007.2178)

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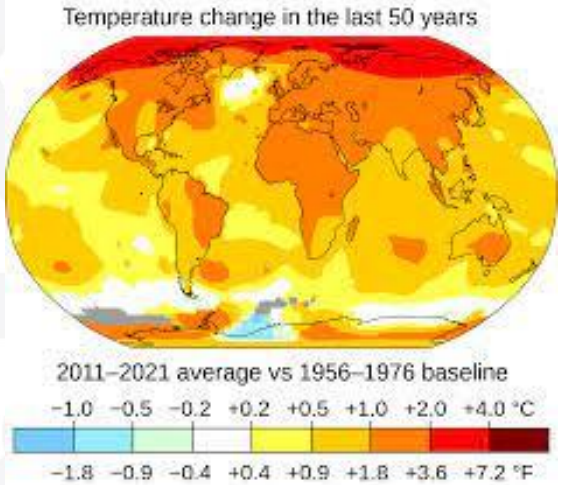
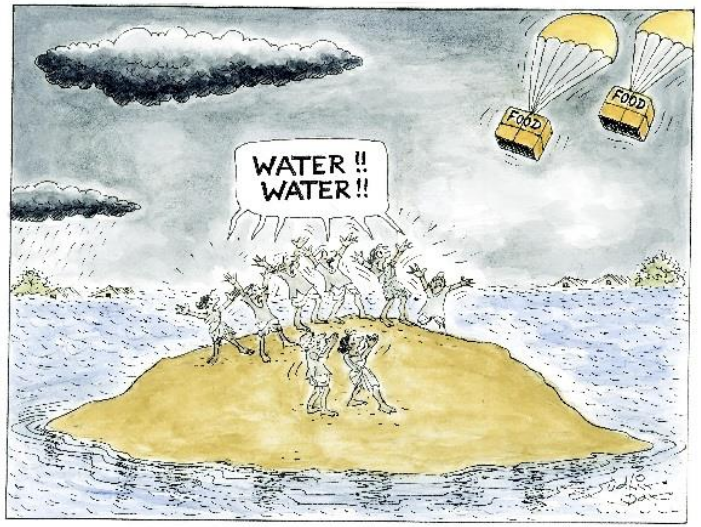
Problem

Climate change + **Soil Degradation** =





No water in soil,

No nutrientes in soil,

No biomass in soil

↓

DESERTIFICATION

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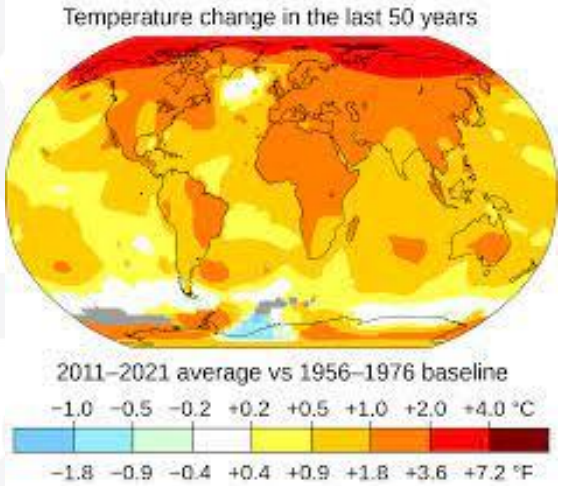
Solution??

Climate change + **Soil Correction** =



Lime, Ash, sewage, biochar, …,

YES water in soil,

YES nutrientes in soil,

YES biomass in soil

↓

Reverse DESERTIFICATION

Hypothesis

To correct soil limitant factos, thus

make soil functionning

Her. Abegoaria_Dr. Caetano Oliveira Soares

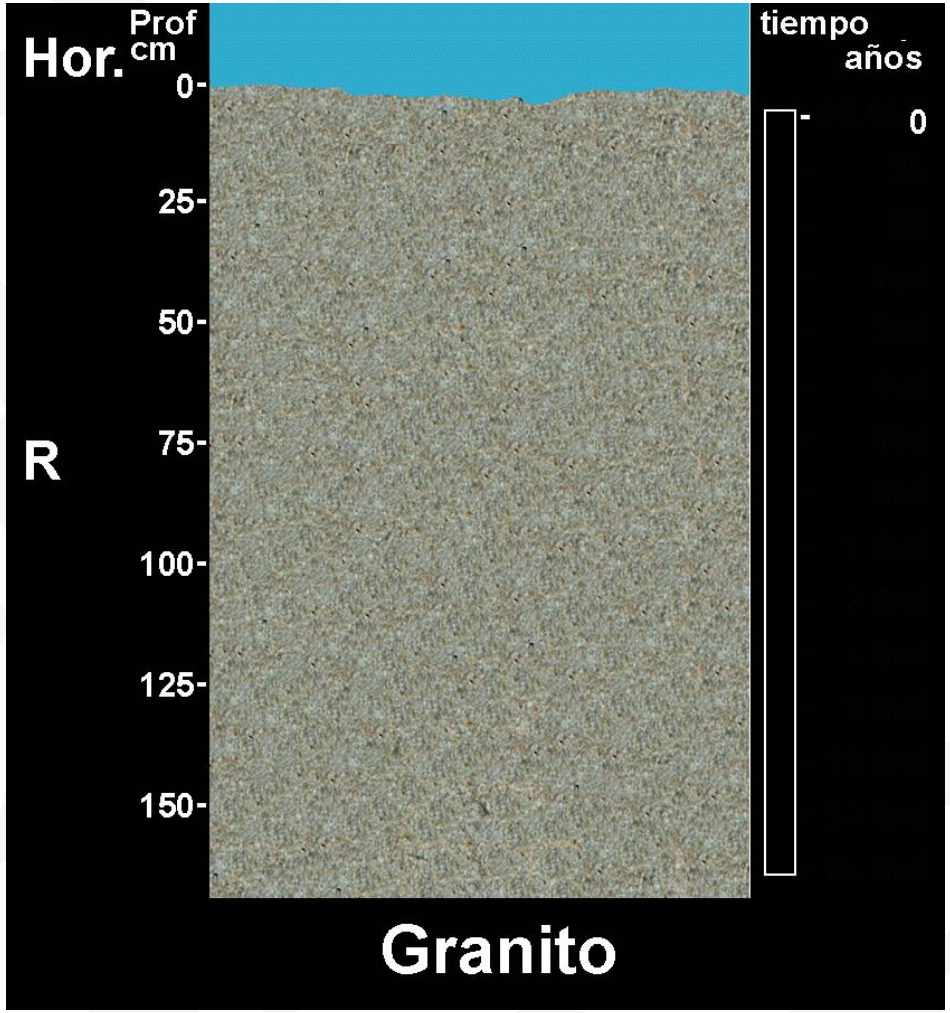
Her. Abegoaria_No tillage >10years, Dolomitic limestone appl + ash + sewage sludge.

Neighbour Her. Abegoaria_Dr. Caetano Oliveira Soares

Her. Abegoaria_Neighbour. Tillage, No Dolomitic limestone

Soil is dynamic

soil ? = essentially a non-renewable resource, at least for a human lifetime



SOIL FORMATION FACTORS (N=5)

Bedrock + weather + relief + organisms + time = SOIL

Velocity of formation (slow)

+/-1Tn/ha/year, Verheijen et al. (2009)

***Based on bedrock properties:**

-Hard rock — slow. i.e.: Granite, Quartz

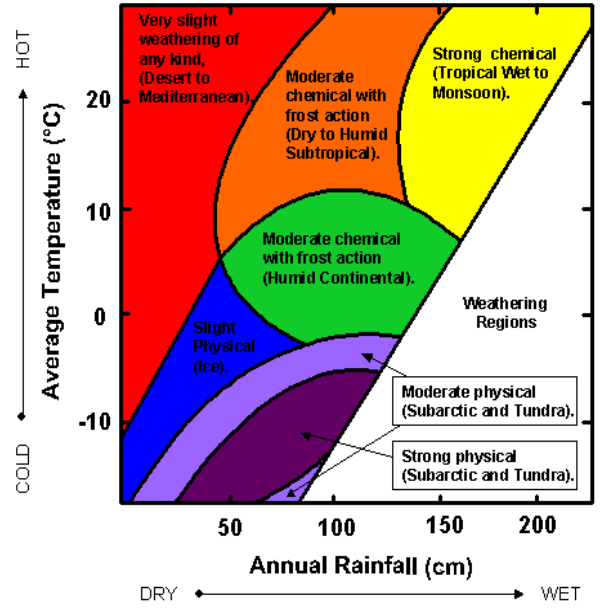
-Soft rock — quick. i.e. Clay, sandstones

***Based on weather**

***Based on time**

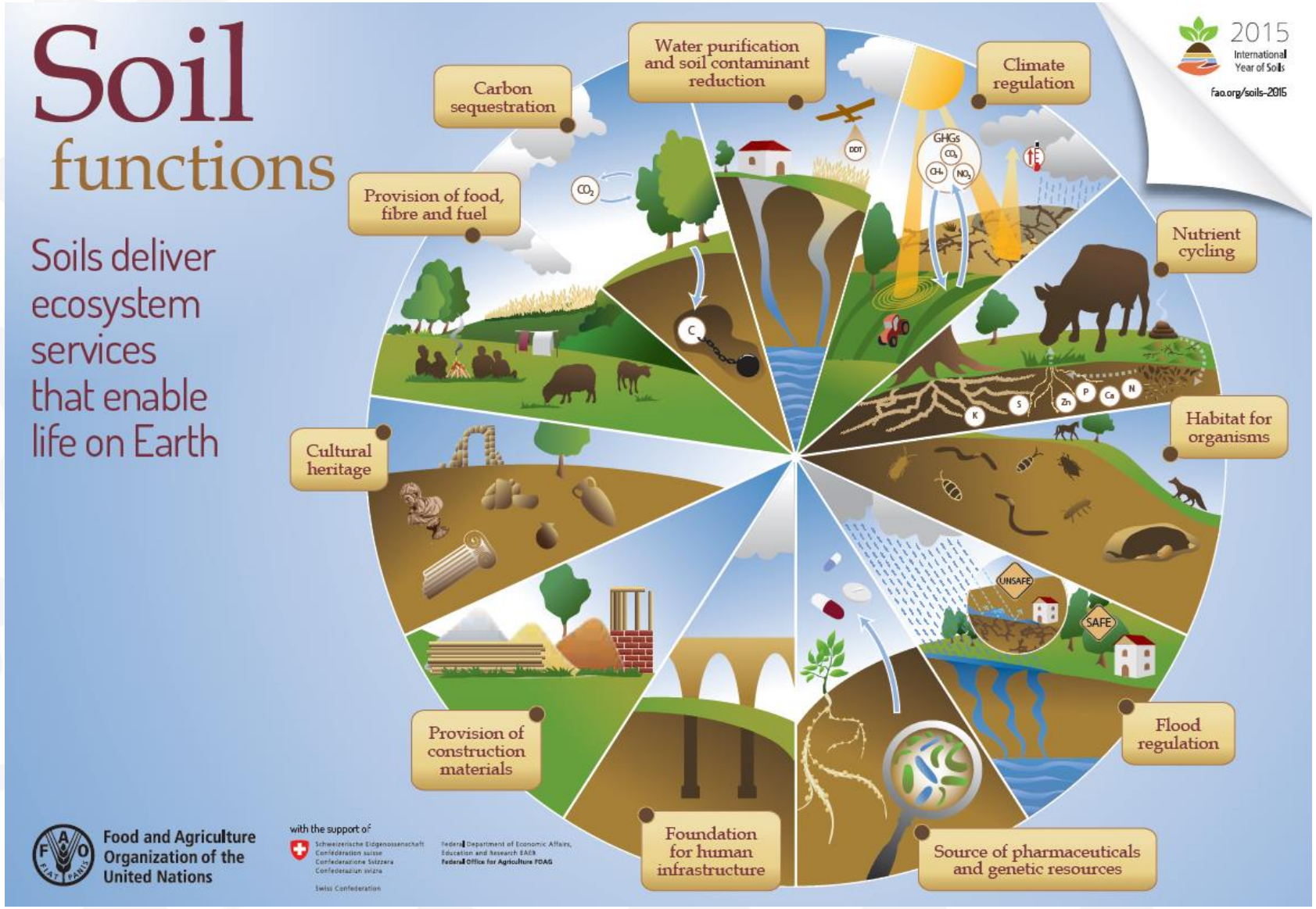
Soil water & Temperature drives

SOIL WEATHERING



Verheijen et al. (2009) https://doi.org/10.1016/j.earscirev.2009.02.003

Soil performs Functions that delivers ECOSYSTEM SERVICES



Major Soil Functions

Soil structure maintenance

Nutrient cycles

Carbon transformations;

Regulation of pests and diseases

Soil Ecosystem Services

ES1. Water & Soil conservation

ES2. Nutrient cycling

ES3. Carbon sequestration

ES4. Biodiversity

Soil degradation promotes desertification

Soil as a non-renewable resource (at human scale)

↓

availability and scarcity

↓

Soil degradation means loss of FUNCTIONS

↓

THREATS

SOM decline

Erosion

Compaction

Pollution

Impermeabilization

…

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Montado: unique Mediterranean silvo-pastoral system

T. Pinto-Correia, personnel communication

since the 13th century and expanded in the 18th century

wood pastures for high quality livestock + cork production

open forest (< 80 trees/ha), **functional complexity**, high spatial fuzzyness

Montado spatial dynamics

From 1990 to 2006 losses of ~90.000 ha of Montado (5625 ha/year)

FACTORS

Agroforest Syst (2016) 90:177–192
DOI 10.1007/s10457-014-9757-7

Management

Assessment of environment, land management, and spatial variables on recent changes in *montado* land cover in southern Portugal

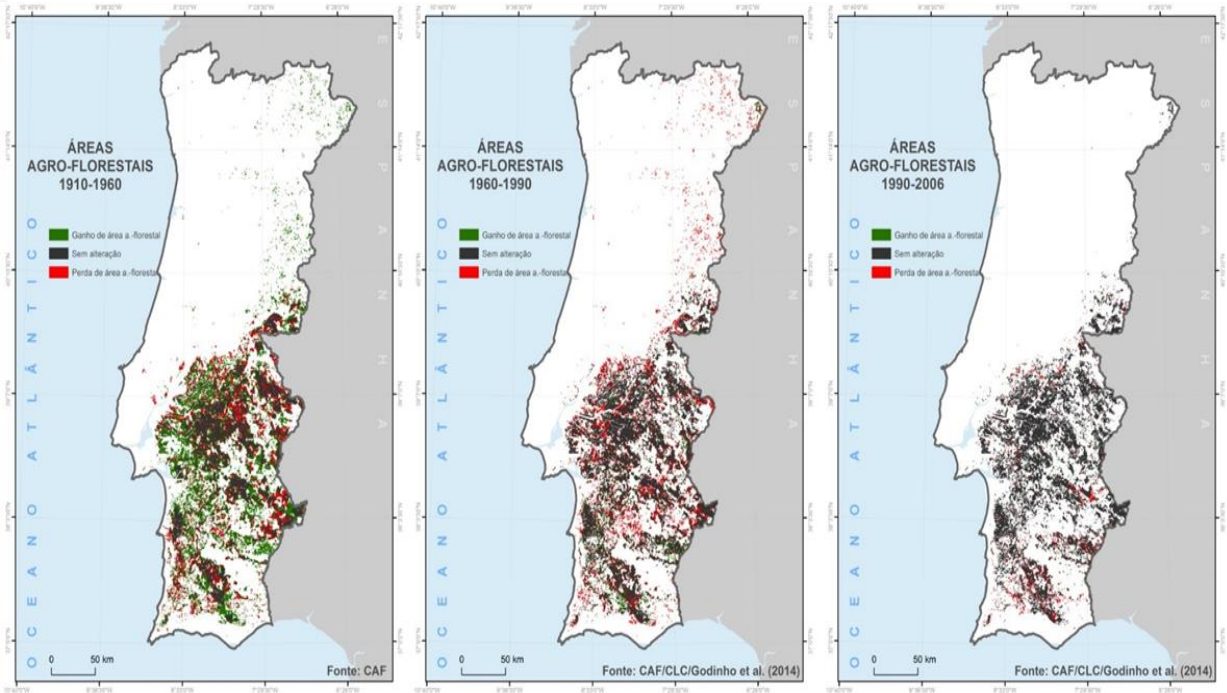
Sérgio Godinho · Nuno Guiomar · Rui Machado · Pedro Santos · Paulo Sá-Sousa · J. P. Fernandes · Nuno Neves · Teresa Pinto-Correia

Agroforest Syst (2016) 90:69–85
DOI 10.1007/s10457-014-9778-2

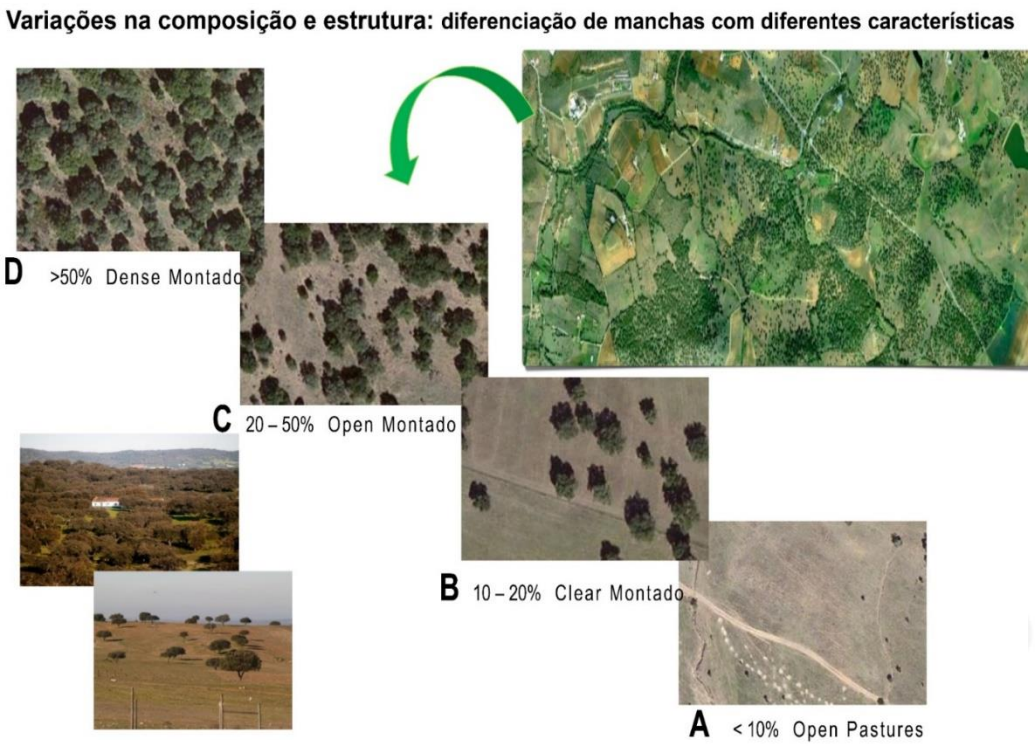
Grazing

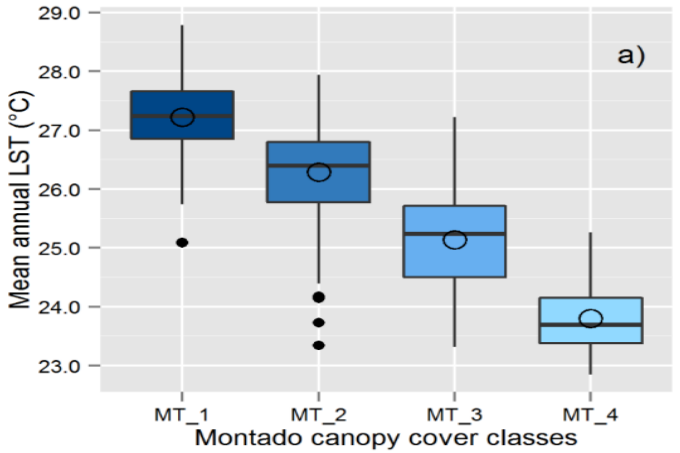
The effects of grazing management in *montado* fragmentation and heterogeneity

Mara Almeida · Carla Azeda · Nuno Guiomar · Teresa Pinto-Correia



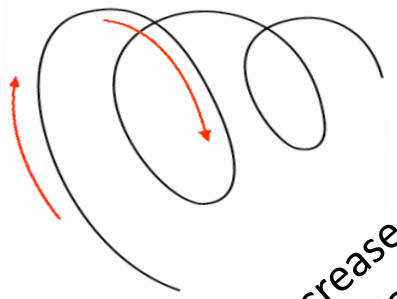
Canopy cover cover decline in Montado





Godinho et al., 2016. doi.org/10.1016/j.apgeog.2016.07.004

Cathastrophic Shift



Decrease in resilience over time

TYPING POINT???

Ageing of the system

Scarcity of new generations of individuals

Tree cover changes

Progressive degradation of the system over time, even in the absence of disturbance, or a decrease in the intensity of use.

Montado developed on Px soil type (Luvisol). NO NEW INDIVIDUALS.

Ageing of the system

N. Guiomar, personnel communication

How can we halt soil degradation? Making Soil Functioning

The 8 Mission objectives

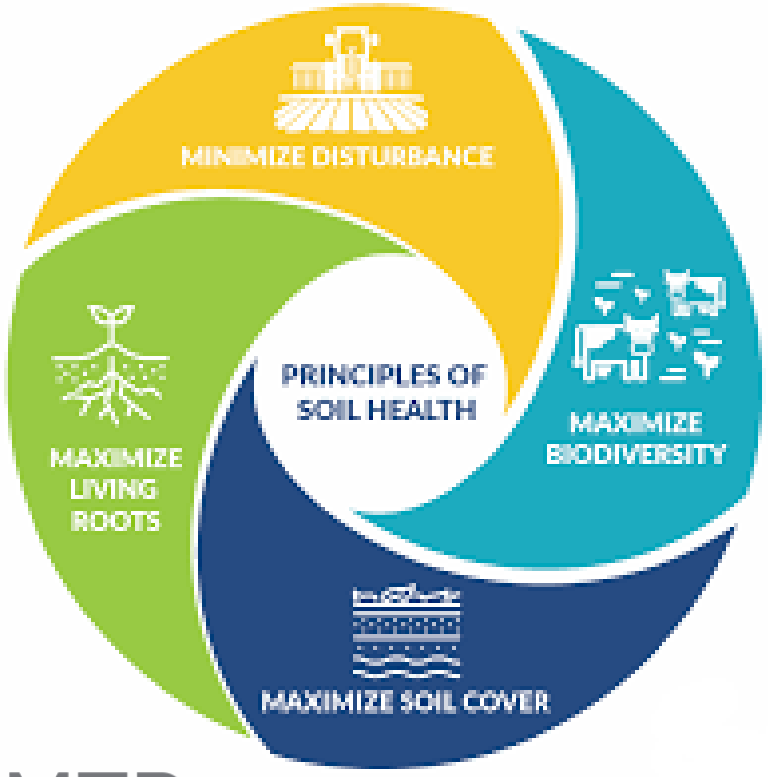
1. reduce desertification
2. conserve soil organic carbon stocks
3. stop soil sealing and increase re-use of urban soils
4. reduce soil pollution and enhance restoration
5. prevent erosion
6. improve soil structure to enhance soil biodiversity
7. reduce the EU global footprint on soils
8. improve soil literacy in society

NEWS ARTICLE | 9 June 2022 | Joint Research Centre

Healthy soils, a necessity for the EU

What is “SOIL HEALTH”?

Soil health is presented as an integrative property that reflects the capacity of soil to respond to agricultural intervention, so that it continues to support both the agricultural production and the provision of other ecosystem services (ES).



Source: USDA

Soil health is dependent on the maintenance of 4 major functions:

-carbon transformations;

-nutrient cycles;

-soil structure maintenance;

-regulation of pests and diseases

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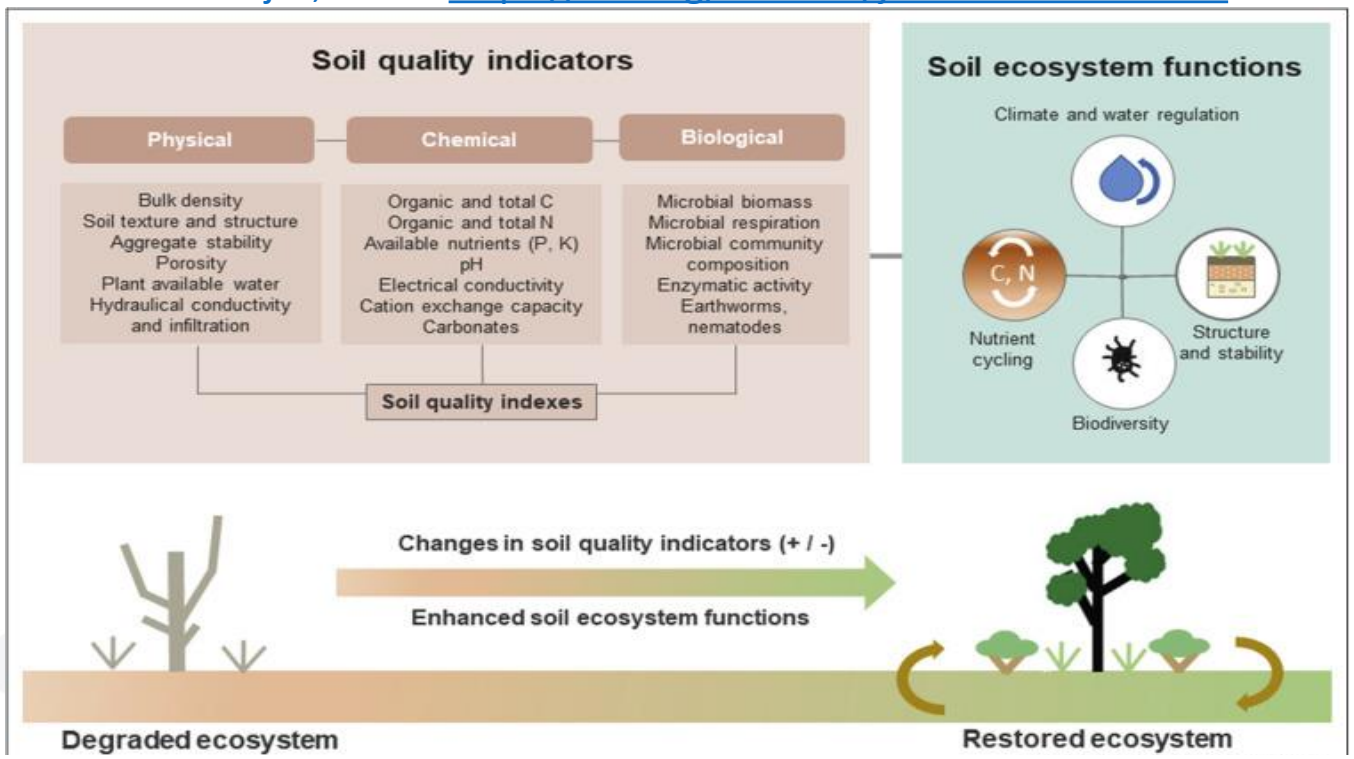
What is “SOIL QUALITY”?

The **capacity of soil to function**, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation” (SSSA).

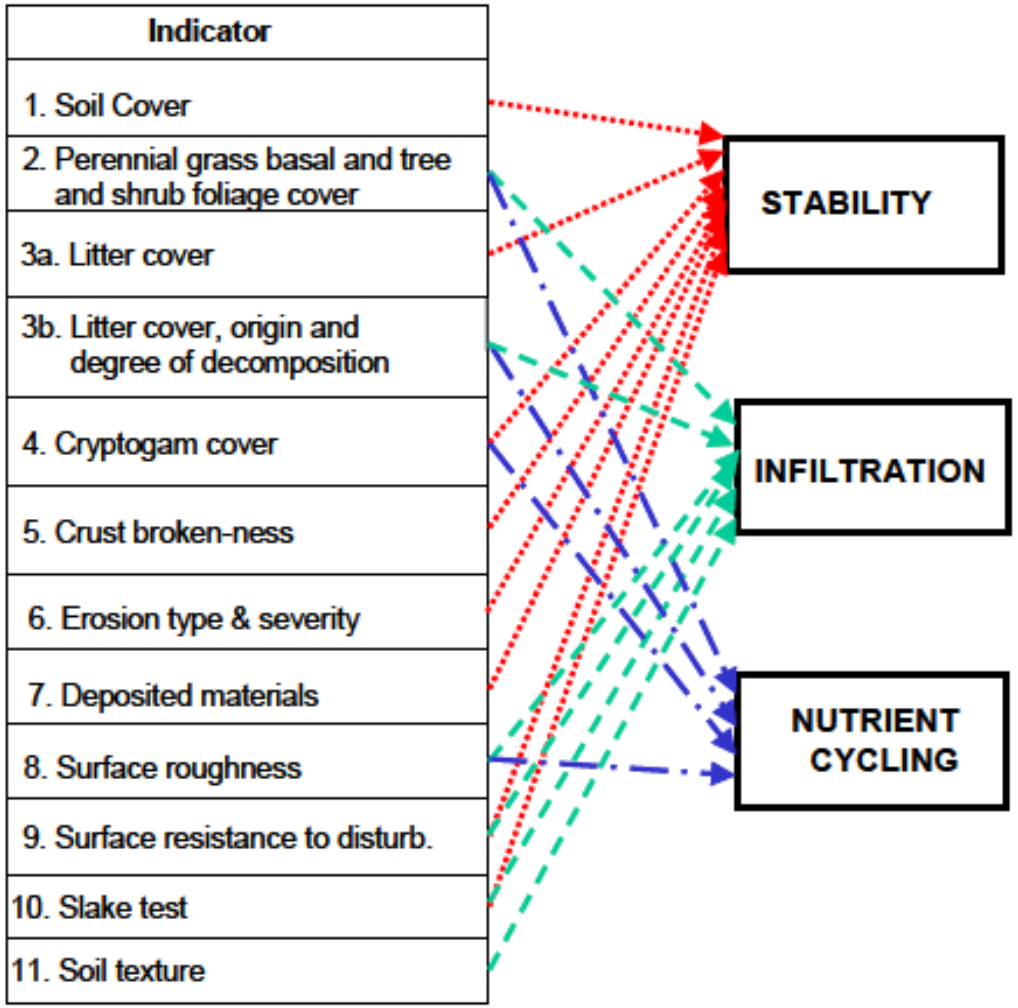
Muñoz-Rojas, 2018. https://doi.org/10.1016/j.coesh.2018.04.007



Evaluated in terms of **measurable soil attributes** that measure specific physical, chemical, and biological properties, known as **soil quality indicators** (**SQIs**). The **applicable SQIs** are those that integrate the **combined effect of several properties or processes that affect the capacity of a soil to perform a specified function**.

What are “SOIL QUALITY INDEXES”?

Are a ‘minimum set of parameters that, when interrelated, provide numerical data on the capacity of a soil to carry out one or more functions’. They are a combination of SQIs to assess ecosystem changes.



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VIMoS- An approach to develop Visual Indicators on Montados' Soil functions

Aim & Scope

To identify the current **soil health** status on the major soil types in the Montado system of central Alentejo, by using a methodology that quantify and value **SQI** by a chrono sequence approach.

Set-up is based in a paired treated/control plots assessment. Treated-plot is a soil correction (*dolomitic limestone, sewage, ashes, …,)*. In Control-plot any soil correction is implemented. The effectiveness of corrective measures will be quantified by comparing treated versus control plots.

Her. Abegoaria_Dr. Caetano Oliveira Soares

Her. Abegoaria_No tillage >10years, Dolomitic limestone appl + ash + sewage sludge.

Neighbour Her. Abegoaria_Dr. Caetano Oliveira Soares

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The **specific objectives** (3 major soil types) are:

i) to characterize and quantify specific soil quality indicators (SQI) in the three major soil types;

ii) to develop visual indexes of soil functionality and validate the sensitivity with the SQI;

iii) to capture Montado´s soil functions improvement after a soil correction (lime,ash,sewage, biochar, ..)

Data ADQUISITION

Soil Quality Indicators (SQIs)
- -BD
- -MWD
- -WHC
- -SWR
- -SOC
- -microbiology
- -Nutrient (pH/EC/Pav/N)

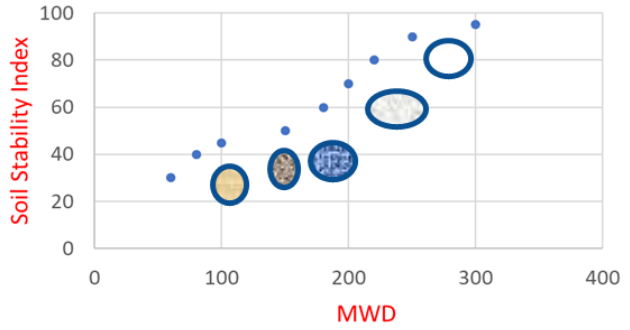
Data VALIDATION

Indexes of
- -Soil Stability
- -Infiltration
- -Nutrient cycling

LANDSCAPE FUNCTION ANALYSIS:

PROCEDURES FOR MONITORING AND ASSESSING LANDSCAPES

VALIDATION using SQIs



Data VERIFICATION

		Soil type 1	
Soil functions	Soil quality indicators	Control	Treated
Water & Soil Conservation	BD (Mg/m^3)		
	MWD (mm)		
	Field Capacity (%)		
Nutrient Cycling	pH		
	EC		
	Labile SOM (%)		
	P		
	K		
	CEC (Ca, Mg, Na, ..,)		
	Micronutrients		
	Microbiology		
Carbon Sequestration	C-stored in Plant biomass (Mg/ha)		
	C-stored in Root biomass (Mg/ha)		
	SOC (Mg/ha)		
	BD (Mg/m^3)		
	Microbiology		
Biodiversity	Functional grass balance		
	Vegetation biomass (Mg/ha)		

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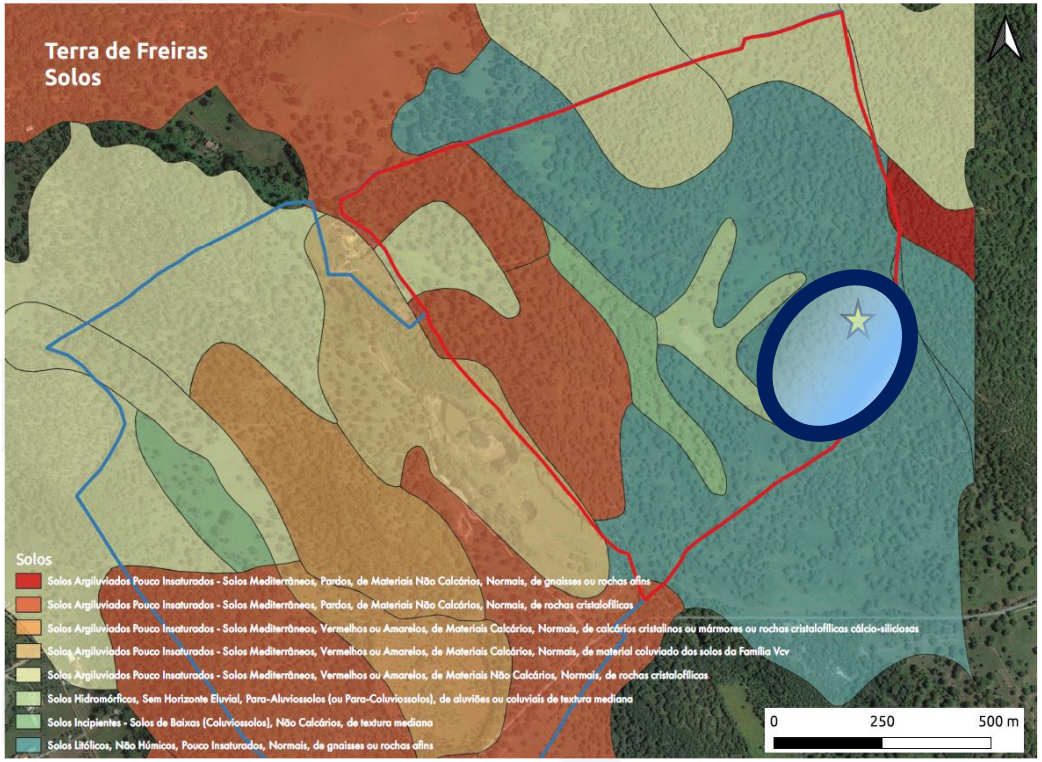
Practical approach



-Oct 20XX.-Control BEFORE TREATMENT ★ done by the land owner.

1 soil sample taken at Out Canopy and analysed for chemical (nutrient cycling): pH, EC, CEC, Micro, NPK, SOM.

+ Treatment-Calcario dolomítico (done by the land owner)

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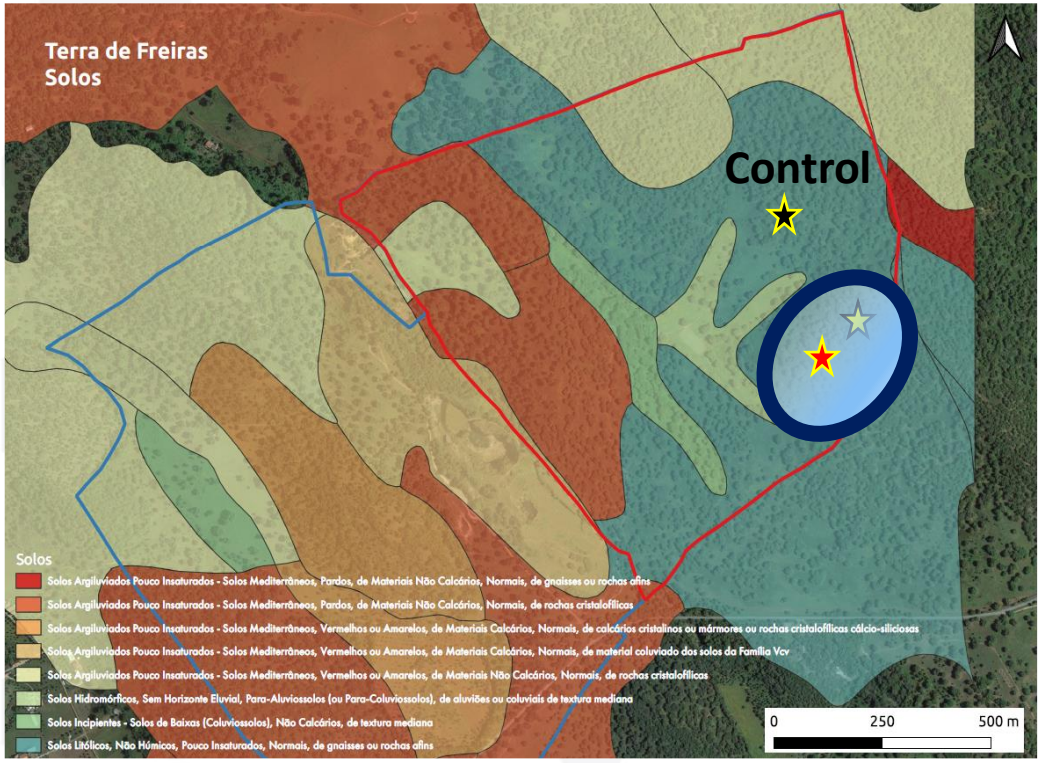

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+

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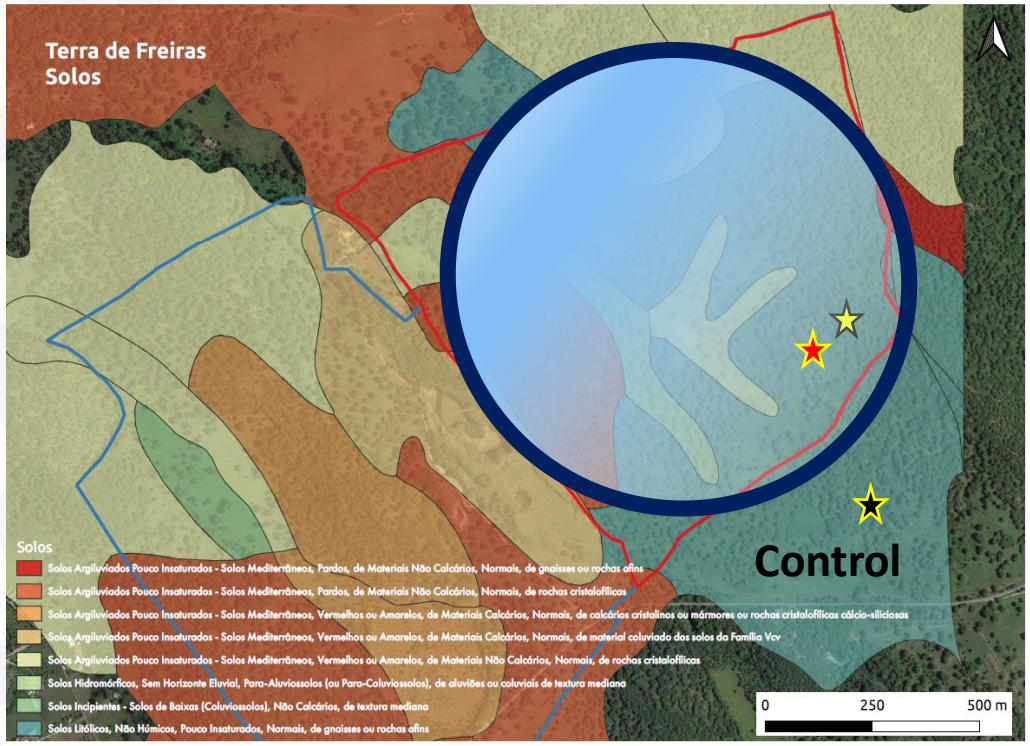
VIMoS- An approach to develop Visual Indicators on Montados' Soil functions

Practical approach



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1 soil sample taken at Out Canopy and analysed for chemical (nutrient cycling): pH, EC, CEC, Micro, NPK, SOM. + microbiological

WHY A SOIL CORRECTION in Montados´ soils?? For instance: Dolomitic limestone

The typical Montado soil has an acidic pH and manganese toxicity, which affect the productivity and soil functioning. One of the low-cost alternatives suggested in this context is the application of dolomitic limestone as a way of improving soil fertility (Carvalho et al., 2015). That amendment of soil acidity is a slow and gradual process that improves soil Mg/Mn ratio and has a positive impact on pasture productivity and quality (Serrano et al., 2021).

The application of Dolomitic limestone should have an impact on soil properties thus improving soil functions and this is what we aim to capture with the SQIs

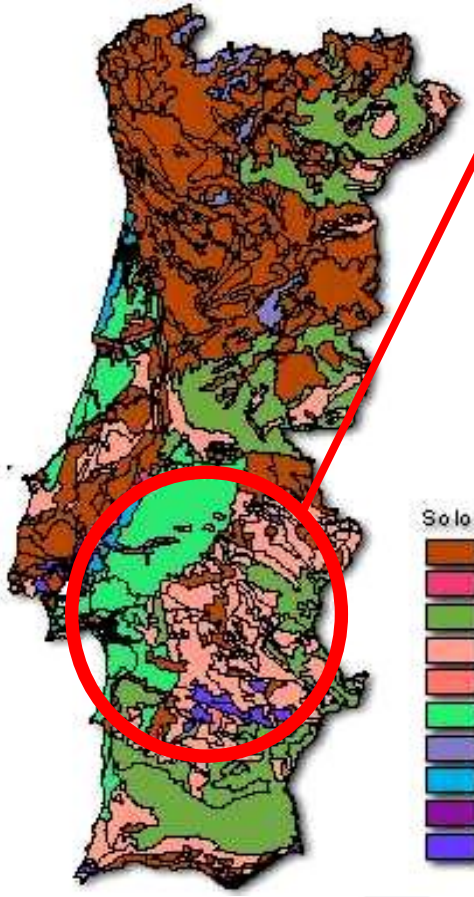
Carvalho, M. et al. (2015).Rev. Cienc. Agrar.: 38, 518-527/ Serrano et al. (2021).Agronomy: 11, 514. https://doi.org/10.3390/agronomy11030514

WHAT ARE THE MAJOR SOIL TYPES ??

Major soil types
FAO *vs.* SROA

Carta dos solos
de Portugal (FAO)

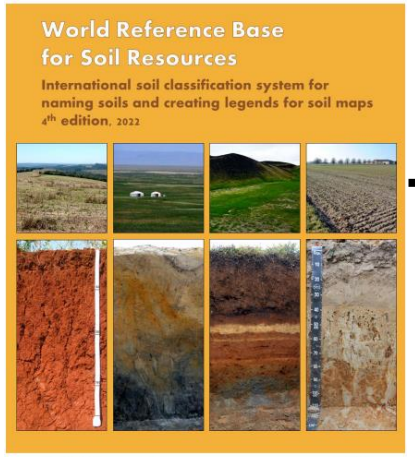
1: 1 000 000

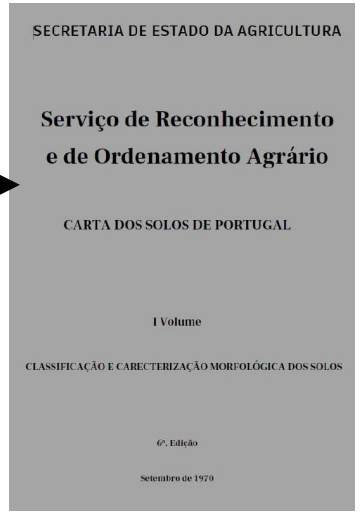


PODZOIS (Sandy soil)

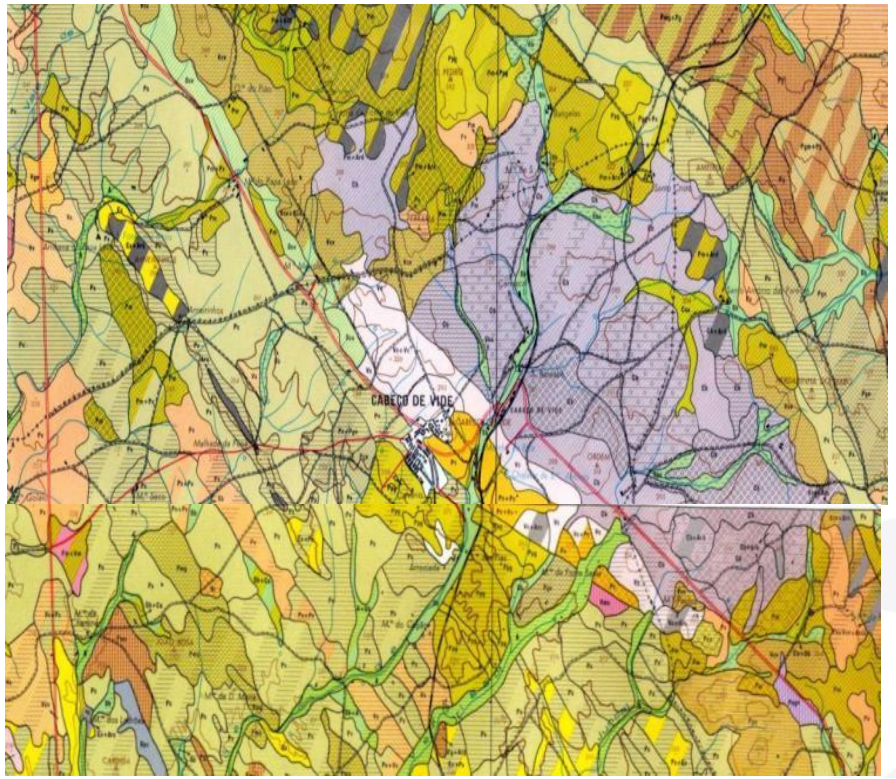
CAMBISSOLOS

LUVISSOLOS





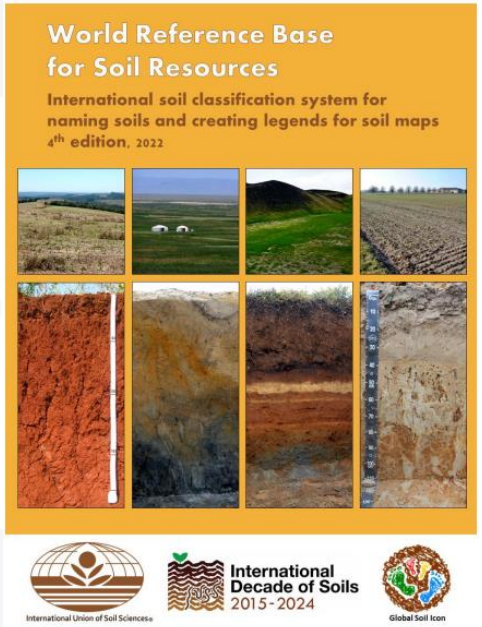
SROA, 1970
Carta de solos de Portugal
1:50.000



Px - Solos Argiluviados Pouco Insaturados - Solos Mediterrâneos, Pardos, de Materiais Não Calcários, Normais, de xistos ou grauvaques)

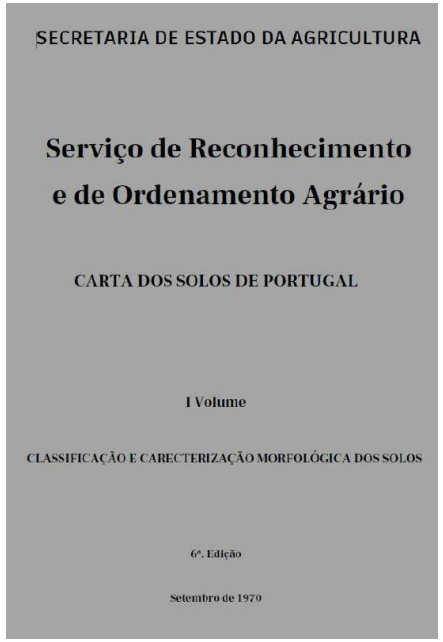
Pv - Solos Argiluviados Pouco Insaturados - Solos Mediterrâneos, Vermelhos ou Amarelos, de Materiais Não Calcários, Normais, de rochas cristalofílicas

WHAT ARE THE AVAILABLE SOIL MAPS IN PT ??



Soil Formation Factors

Soil Formation Processes



FAO (1st level)	available	SROA (1st level)	available
First level	YES	First level	YES
Second level	NO	Second level	YES

FAO soil maps based on PROCESSES (iluviation, humification, …)

SROA soil maps based on PROCESSES & PROPERTIES

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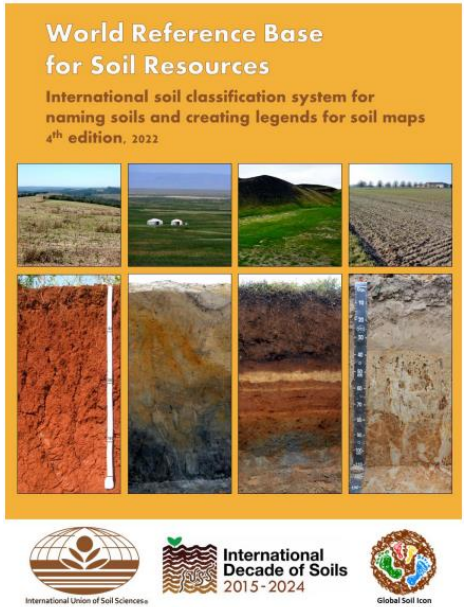
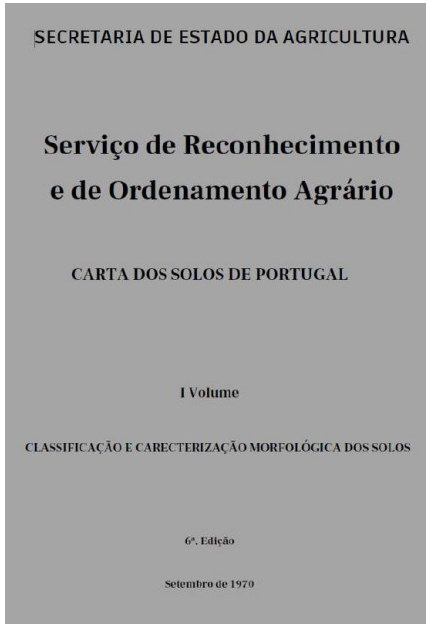
WHAT ARE THE AVAILABLE SOIL MAPS IN PT ??



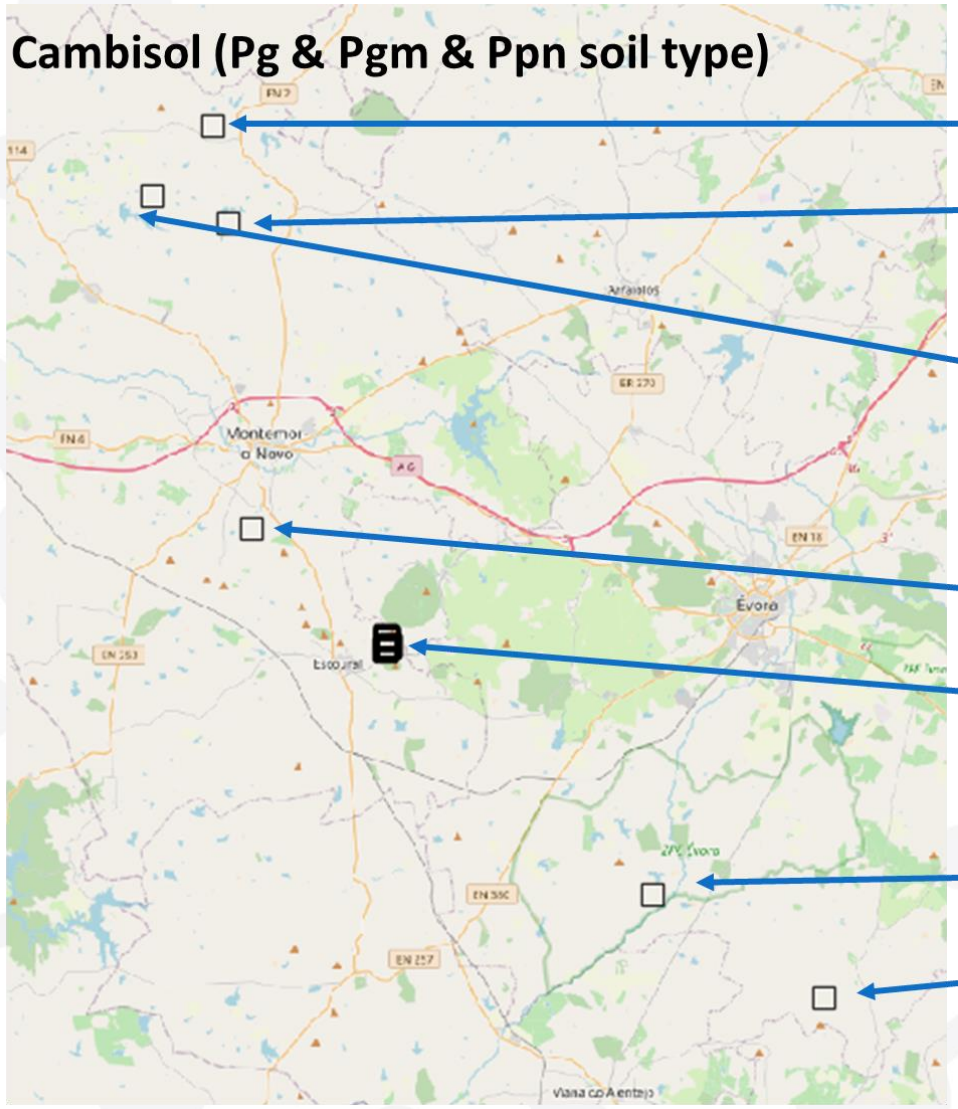


FAO	SROA
Cambisol	Pg; Pgm; Ppm
Luvisol	Pv; Px; Pmg; Pag
Sandysoil	Rg; Ppt

Huge soil type **diversity in SROA maps.** The most common soil types according to SROA (1970)

SITE SELECTION

Huge soil type **diversity in SROA maps.** The most common soil types according to SROA (1970)



Pg_cambisol_Parreira_Nuno Marques_dolomitic application_2 tn/ha in 2016??

Pgm_cambisol_Fontes Portas_Nuno Marques_dolomitic application_2 tn/ha in 2016??

Pg+Pgm_cambisol_Her Lobeira_NEGATIVE CONTROL_NO DOLOMITIC APPLICATION AND YES TILLAGE

Pg_cambisol_São Mateu_Antonio Marques_dolomitic application_3 tn/ha in 2023

Ppn_cambisol_gneiss_Terra Freiras_Antonio Marques_dolomitic application_3 tn/ha_Nov2022

Pg_cambisol_Her. Camoeira_Dr. Caetano Soares_dolomitic application_3 tn/ha in 2013

Pg_cambisol_Her. em Torre Coelheiros_Monte das Feijoas dos Ramos_Lourenço Beja da Costa _1.5 tn/ha in 2018

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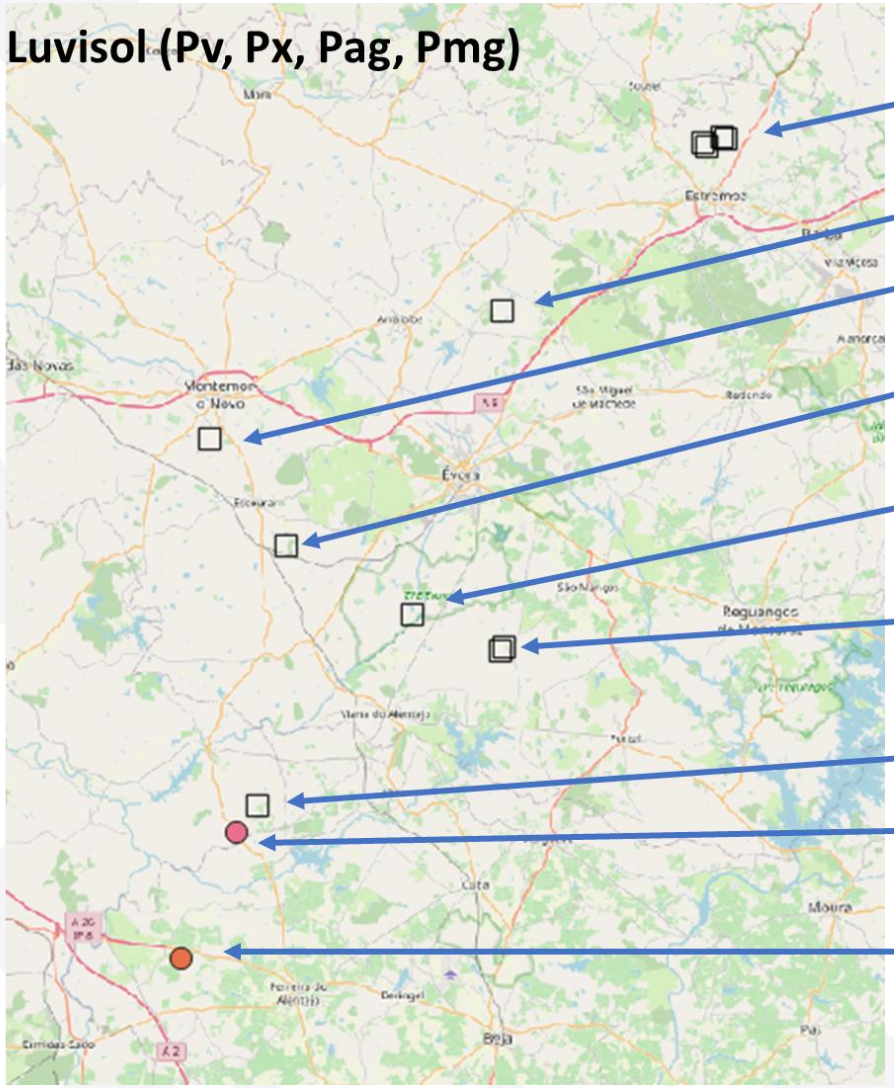
SITE SELECTION

Huge soil type **diversity in SROA maps.** The most common soil types according to SROA (1970)



Px & Pv & Pm**.** Her. Barbosa e Serrinha_Francisco Guedes_Estremoz

Pv. Her. Coelheiros

Pv. São Mateu_Antonio Santos_3 tn/ha_2023

Pmg. Casa Agrícola Mira da Silva_Her. do Padrão_Casa branca_20211007_1Tn/ha

Pmg. Her. Camoeira_Dr. Caetano Soares_dolomitic application_3 tn/ha in 2013

Px & Pv. Lourenço Beja da Costa. Monte das Feijoas dos Ramos . Torre Coelheiros

Pag. Monte das Soberanas_João Santos_Torrão

Pag. Nuno Rodrigues_Her. Fontainhas in the plot "Poço de agua branca". 2023

Pag. Nuno Rodrigues_Her. Monte Branco in the plot "Primos". 2023

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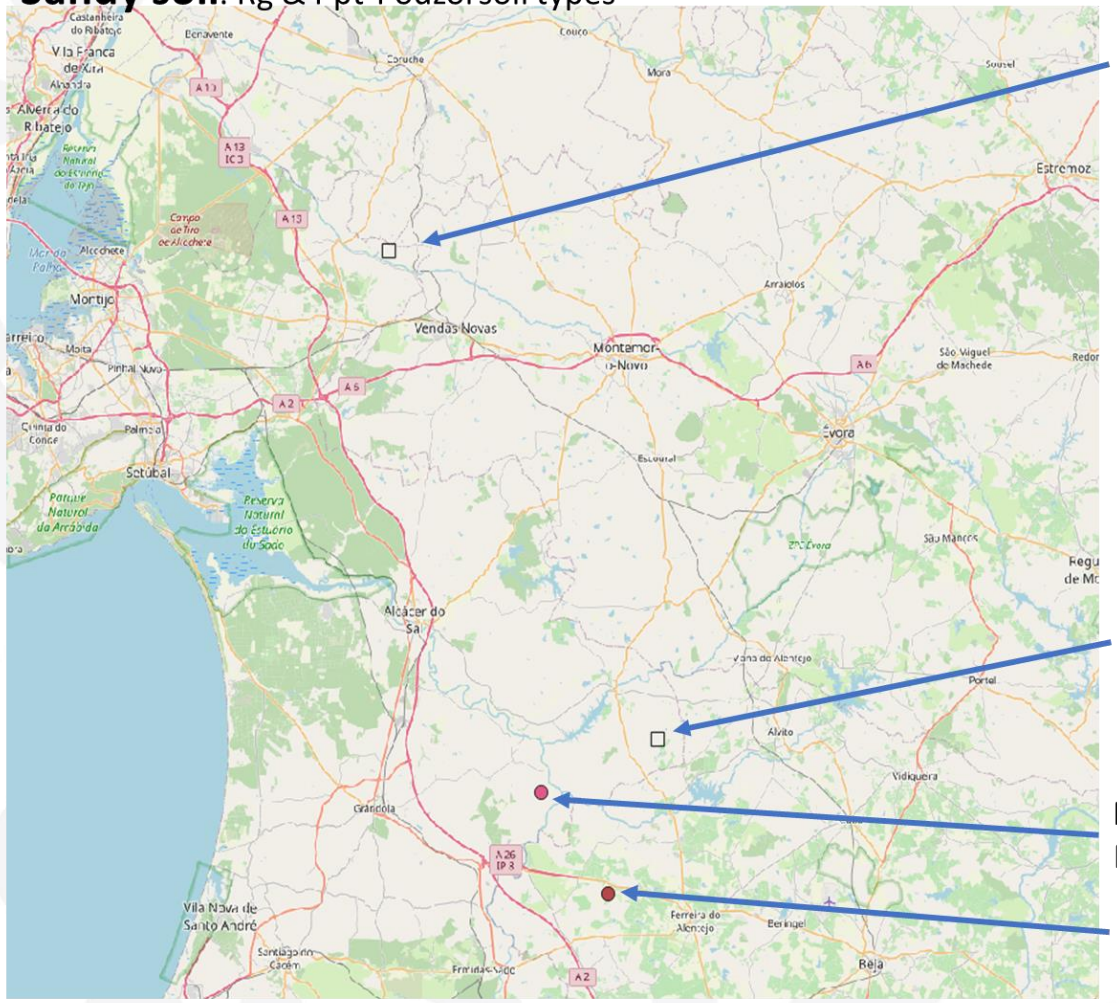
SITE SELECTION

Huge soil type **diversity in SROA maps.** The most common soil types according to SROA (1970)

Sandy soil. Rg & Ppt-Podzol soil types



Rg & Ppt_Her. Abegoaria_Vendas Novas_ Dr. Caetano Soares_2013 dolomitic application_3 tn/ha

Rg_sandy soil_soberanas_JSantos_Torrao_2022 dolomitic application_3Tn/ha

Rg_Varzea Redonda_Depósitos_Torrão_Nuno Rodrigues_2023 expected application_3Tn/ha

Rg_Monte branco_Toí da Engrossa_Torrão_Nuno Rodrigues_2023 expected application 3Tn/ha

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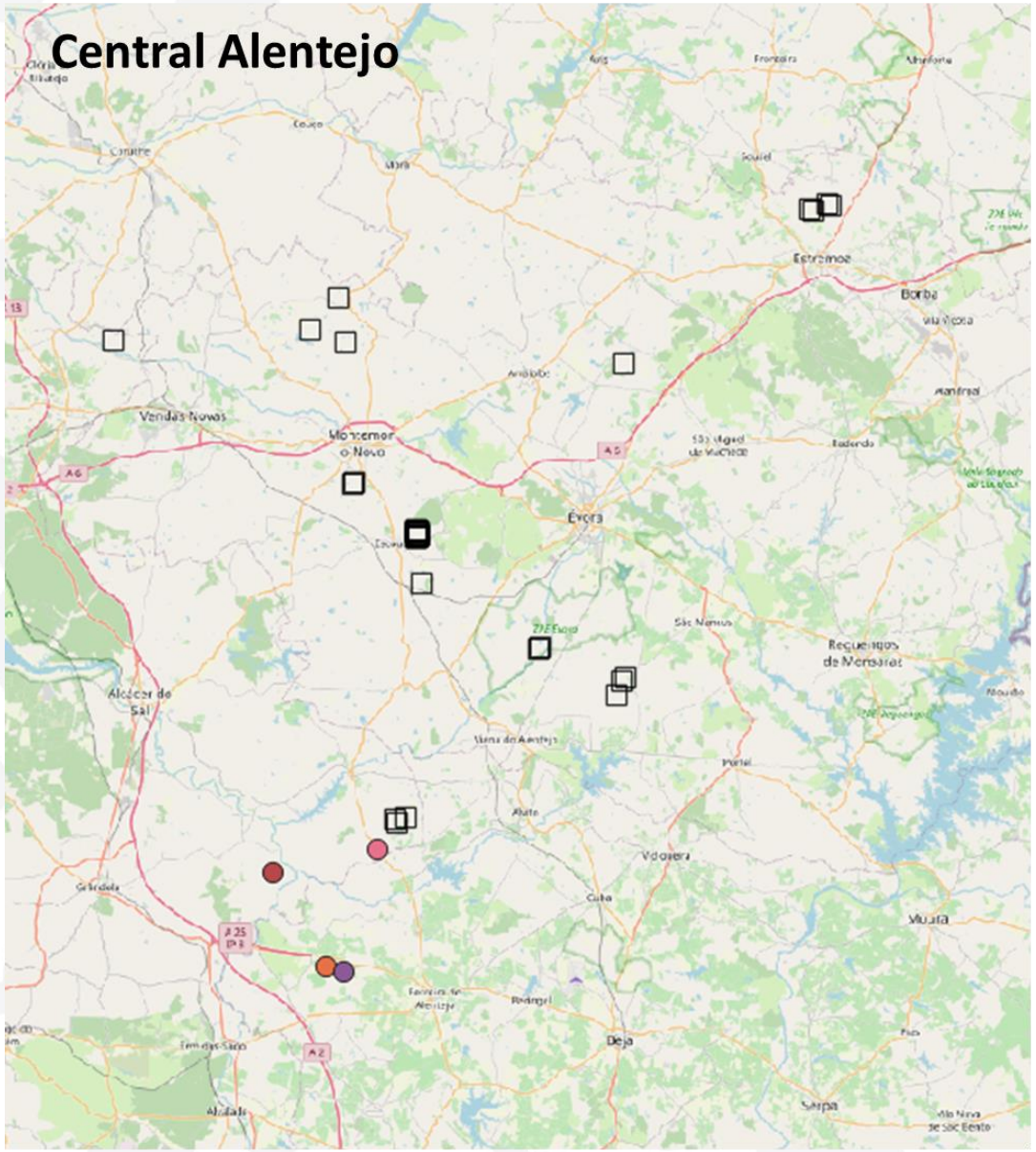
VIMoS- An approach to develop Visual Indicators on Montados' Soil functions



Selected PLOTS

Total of 24:


SECRETARIA DE ESTADO DA AGRICULTURA

Serviço de Reconhecimento e de Ordenamento Agrário

CARTA DOS SOLOS DE PORTUGAL

I Volume

CLASSIFICAÇÃO E CARACTERIZAÇÃO MORFOLÓGICA DOS SOLOS

CAMBISOL (granite bedrock, **Pg** & **Pgm & Ppn** type)- 6 plots

CAMBISOL (Schist bedrock)- 0 plots

LUVISOL (sandy bedrock, **Pag** type)- 3 plots

LUVISOL (gneiss bedrock, **Pgn** type)- 2 plots

LUVISOL (granite bedrock, **Pmg** type)- 2 plots

LUVISOL (schist bedrock, **Pv & Px** type)- 7 plots

SANDY SOIL (sand bedrock, **Rg** & **Ppt** type)- 4 plots

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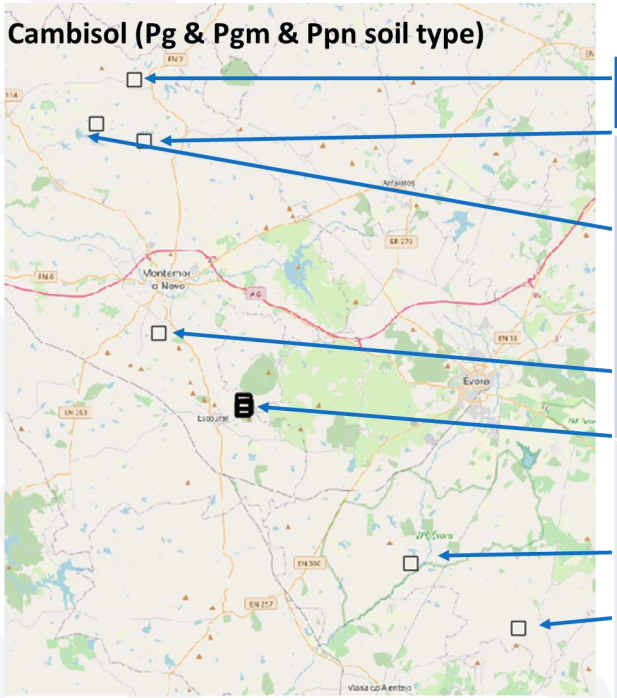
FAO	SROA
Cambisol	Pg; Pgm; Ppm



Chronosequence approach based on Dolomitic limestone application

T0	T1	T2
Pg_cambisol_São Mateu_Antonio Marques_dolomitic application_3 tn/ha in **2023**	**Pg**_cambisol_Parreira_Nuno Marques_dolomitic application_2 tn/ha in **2016?**?	**Pg**_cambisol_Her. Camoeira_Dr. Caetano Soares_dolomitic application_3 tn/ha in **2013**
Ppn_cambisol_gneiss_Terra Freiras_Antonio Marques_dolomitic application_3 tn/ha_**Nov2022**	**Pgm**_cambisol_Fontes Portas_Nuno Marques_dolomitic application_2 tn/ha in **2016**??	**Pg**_cambisol. Mitra. Application_3 tn/ha in **2013**
	Pg_cambisol_Her. em Torre Coelheiros_Monte das Feijoas dos Ramos_Lourenço Beja da Costa _1.5 tn/ha in **2018**	

MED-CHANGE-UÉvora / Citizen -Synergies

-Synergies with MED SCIENTIFIC SOIL DATASETS?

Precision Agric (2016) 17:274–295
DOI 10.1007/s11119-015-9419-4

CrossMark

Monitoring of soil organic carbon over 10 years in a Mediterranean silvo-pastoral system: potential evaluation for differential management

J. M. Serrano[1] · S. Shahidian[1] · J. Marques da Silva[1] · M. Carvalho[1]

agronomy

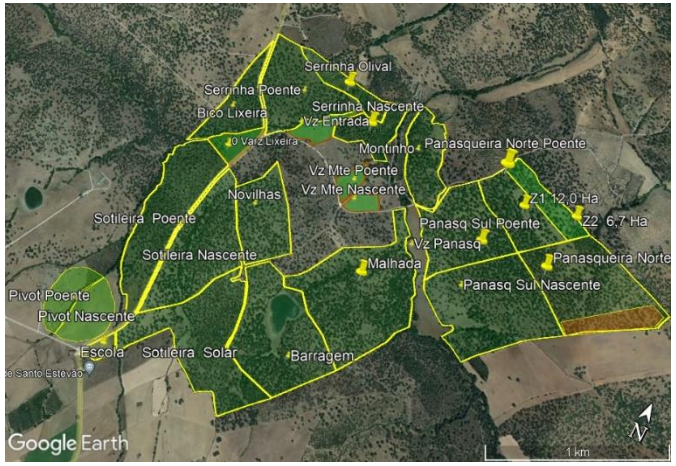
MDPI

Article

Can Soil pH Correction Reduce the Animal Supplementation Needs in the Critical Autumn Period in Mediterranean Montado Ecosystem?

João Serrano *, Shakib Shahidian, Francisco Costa, Emanuel Carreira, Alfredo Pereira and Mário Carvalho

-Synergies with PRIVATE SOIL DATASETS?



Her. Barbosa e Serrinha. F. Guedes. Estremoz

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Herdade	Parcela	Área da Pa	Coberto	Textura de	Co	Fr	Calagem S	Tipo de correctivo	Qtd aplica	Data c	Prad	Data instalação do prad	Co	tipo de solo	Remarks
Fontaínhas	Poço da Á	54	Sobro	Arenoso	Al	To	S	Calcário Dolomítico (tudidol)	1000	####	S	01/10/2021	htt	Pag (Luvisolo) + Vt (Cambisolo)	Luvisolo
Monte Branco	Primos	39	Azinho	Média (ca	Fe	Fi	N	Calcário Dolomítico (tudidol)	3000		S	01/10/2021	htt	Pag (Luvisolo)	Luvisolo
Várzea Redonda	Depósito	42	Sobro	Arenoso	Al	To	N	Calcário Dolomítico (tudidol)	2000		N		htt	Rg-Regosolo_Ppt-Podzol + Rg-Regosolo+Pz-Podzol	Arenosolo
Monte Branco	Tói da Eng	70	Sobro	Arenoso	Fe	Fi	N	Calcário Dolomítico (tudidol)	2000		N		htt	Rg-Regosolo	Arenosolo

Key home message

-Necessity to know SOIL HEALTH status and how their FUNCTIONS are working & interacting.

-Each SOIL TYPE has its own attributes that perform different Soil Functions.

-Define simple & measurable SQIs by SOIL TYPE.

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-MED-CHANGE-U.ÉVORA facilities

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Obrigado pela vossa atenção

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