# Soil mapping as a tool for mitigation and adaptation to climate change

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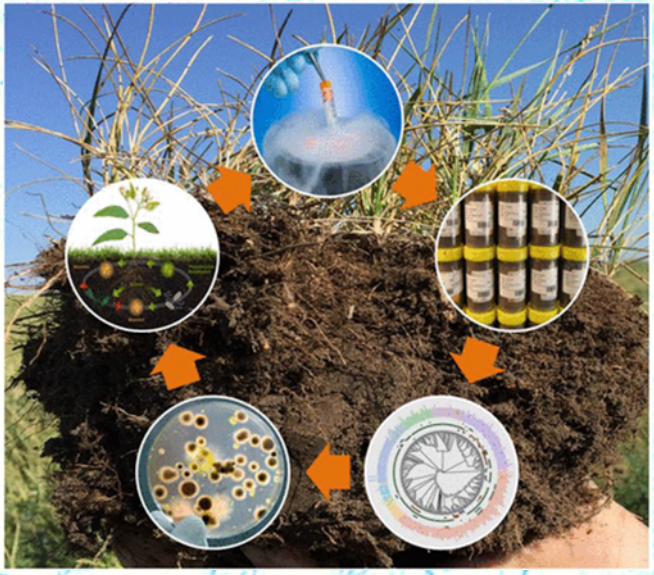
**Soil information** is required for:

- Agricultural performance and food security issues
- Conservation of soil biodiversit
- Management of ecosystem ser
- Urban expansion


**Soil mapping** is a way to make good use of soil information that is gathered by soil survey missions and analysis of soil samples in the lab

**digital soil fertility maps** ⟶ **adaptation and mitigation to climate change**

The motivation for the creation of a new soil map in Cyprus was the undertaking of a project called “MAGNET”, targeting the establishment of a modern national infrastructure capable of collecting and storing soil microorganisms and soil microbial genetic material. Its ultimate goal is to investigate the structure, function and dynamics of soil microbial communities.



Manter et al., 2017 PNAS December 26, 114 (52) 13587-13590

In many cases analysis of microbial community structure revealed that it was largely independent of geographic distance and was controlled primarily by edaphic factors such as pH, calcium carbonate content etc. Therefore, the study of the relationship between the spatial distribution patterns of microbial communities and soil physico-chemical properties is essential.

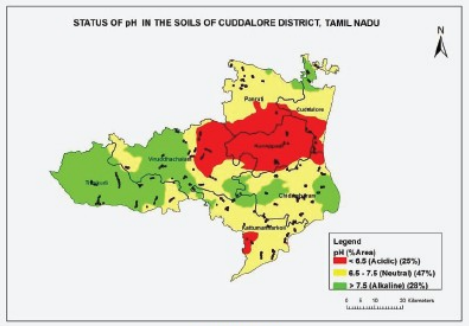



Fig.1a pH

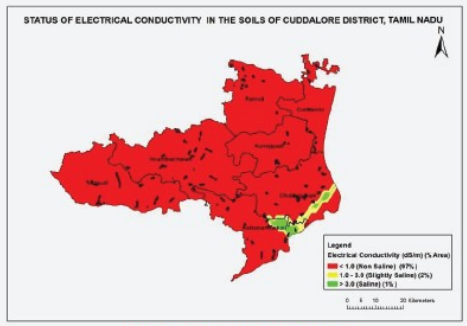



Fig.1b Electrical Conductivity

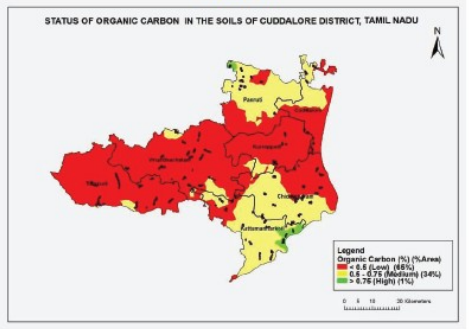



Fig.1c Organic Carbon

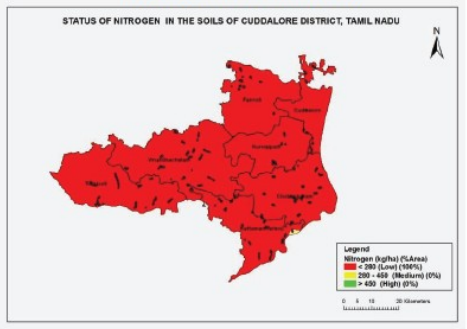
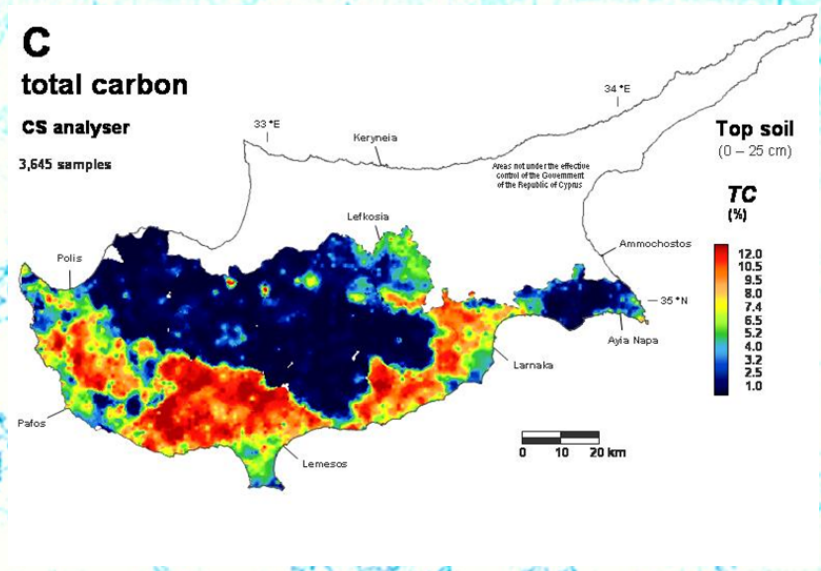



Fig.1dAvailable Nitrogen

Thiyagarajan et al., 2017, GPS and GIS BASED Soil Fertility Mapping for Cuddalore District of Tamil Nadu




A. Zissimos, Geological Survey Department of Cyprus

## What are **soil fertility maps?**

- Groups of thematic maps illustrating the geographic variation of soil physical and chemical properties or indices (e.g. pH, EC, organic C available P, available K)
- They derive directly or indirectly from soil analysis
- Coloured areas in such maps indicate weighted means of a variable in the area or continuous change of a variable following the principle of distance decay relationship (kriging interpolation)

Digital maps could become tools of adaptation and mitigation to climate change because they have new important qualities:

- ✓ they can be easily updated
- ✓ they require digital space for storage, which is practically unlimited
- ✓ they do not have the same scale limitations as paper maps
- ✓ they allow filtering for specific features
- ✓ **they can be linked with simulation models or calculation**
- ✓ **they are dy**

*Soil map of Cyprus*

## 1) Fertilization schedules – precision agriculture

The reduction of unnecessary use of fertilizers is one of the main adaptation and mitigation measures to climate change.

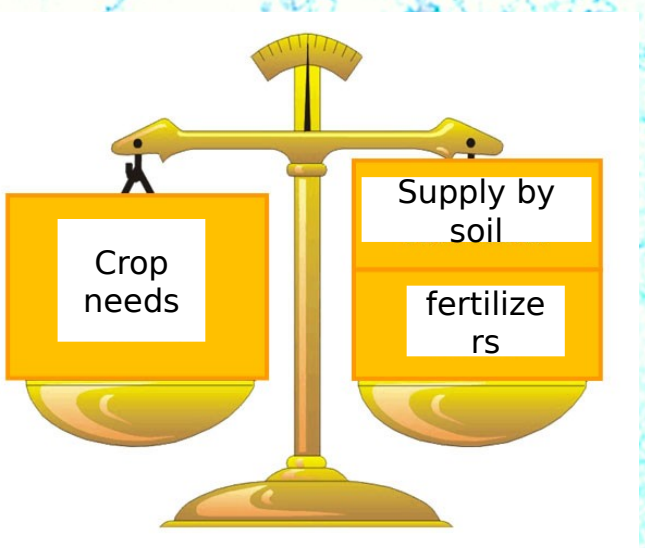
Excessive use of fertilizers may decrease yields but certainly it increases production costs and greenhouse gas emissions. Agriculture is accountable for an influential part of all human induced climate gas emissions worldwide. Arable farming emits $CO_2$ and $N_2O$, a great part of which is associated with the use of nitrogen fertilizers.

Optimization of fertilizer inputs in the field needs to balance needs of crops with

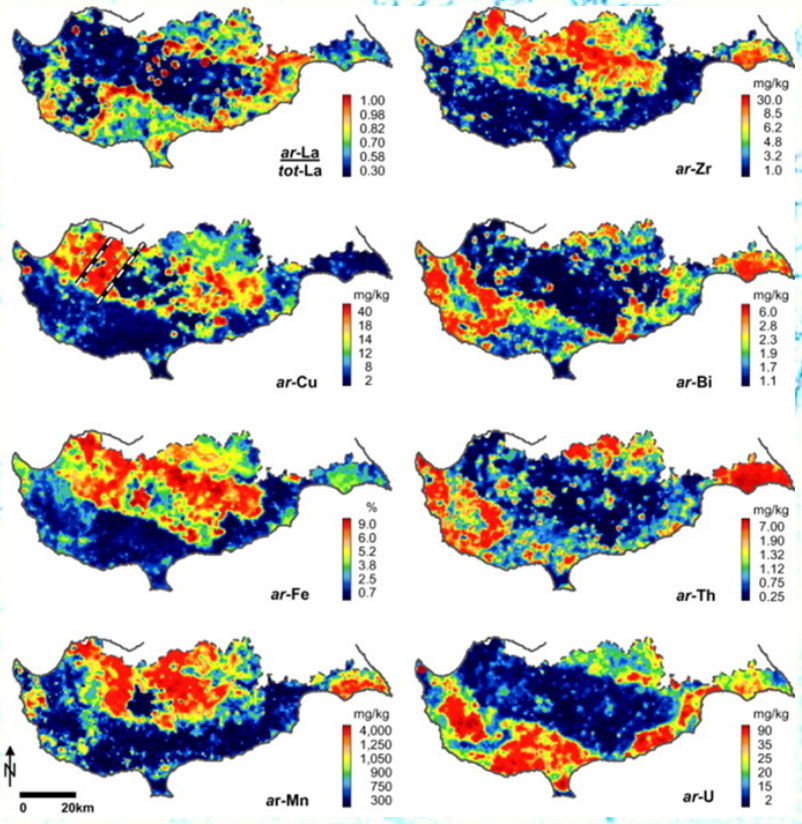
1) available quantities of nutrients in soils

(assessed with soil analysis)

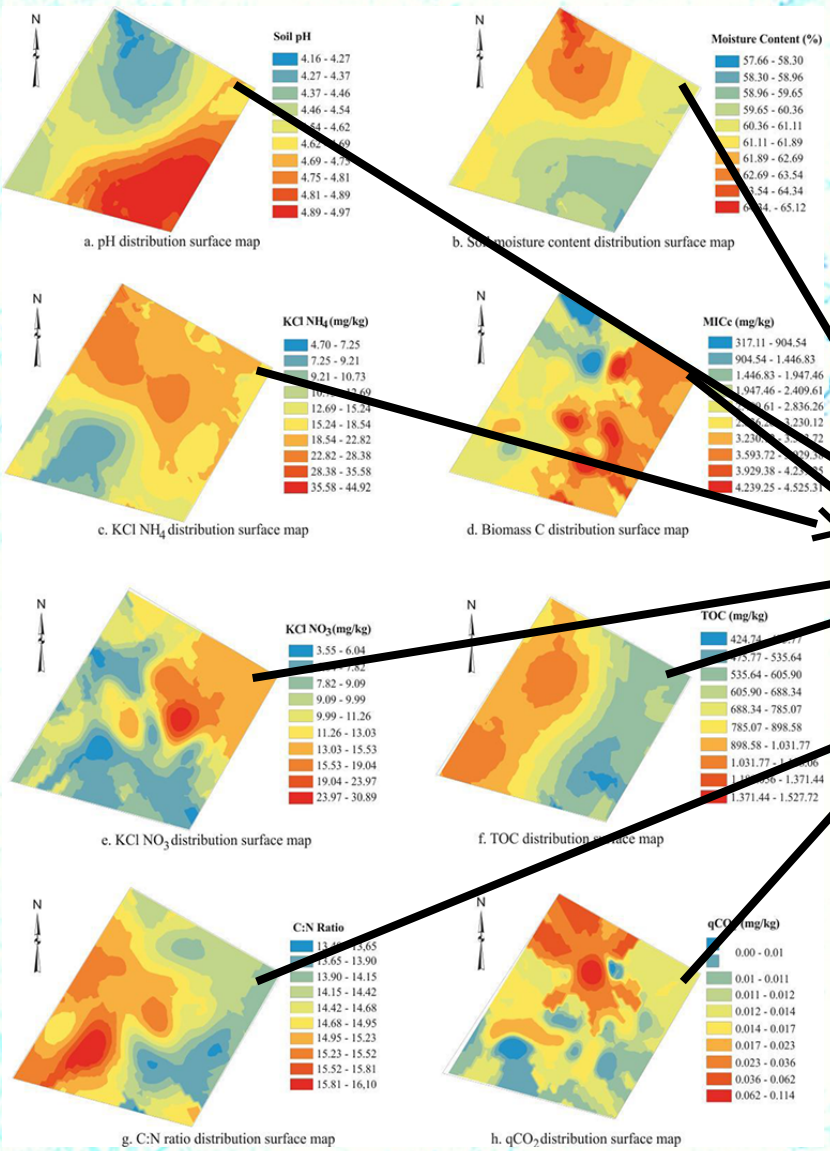
2) amount of fertilizer added (determined



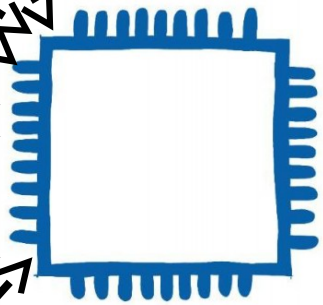
Soil fertility maps can be a vey useful tool for optimal fertilization schedules because they are practical, quick, flexible, they can be carried out by non professionals and they can be applied even in fields for which soil analysis data are not available



## Balanced nutrition of plants is provided to farmers or agriculturists



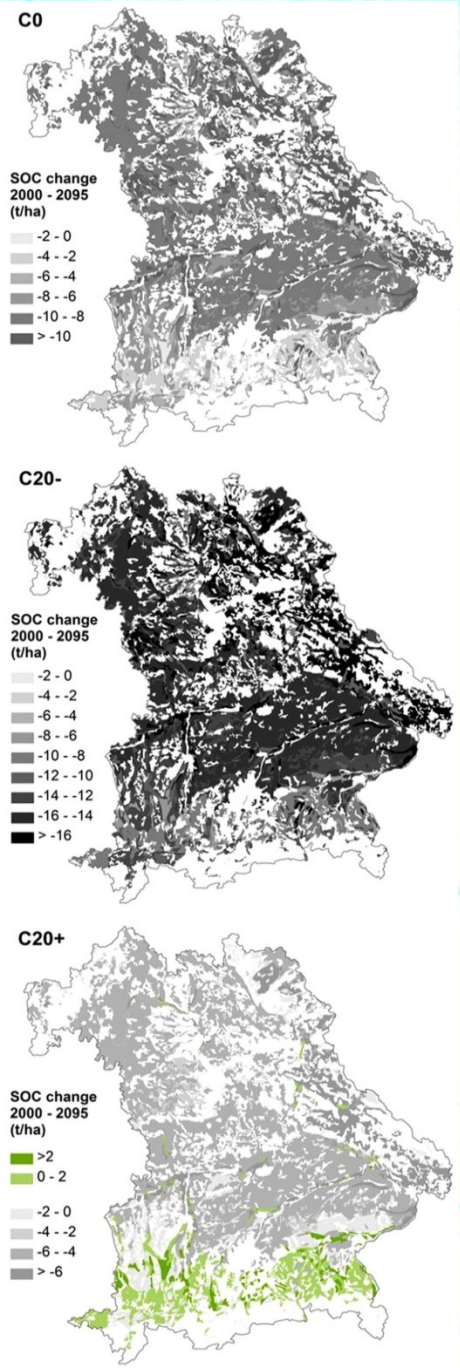

Digital soil maps showing the spatial variability of a soil property within a region contain also electronic databases that are based on soil sampling and laboratory analysis



Fertilizer recommendation

Plant nutrition mathematical models attached to GIS maps retrieve data from their Attribute Tables and calculate the fertilization needs of a selected

GIS Applications in Agronomy
By Suarau O. Oshunsanya and



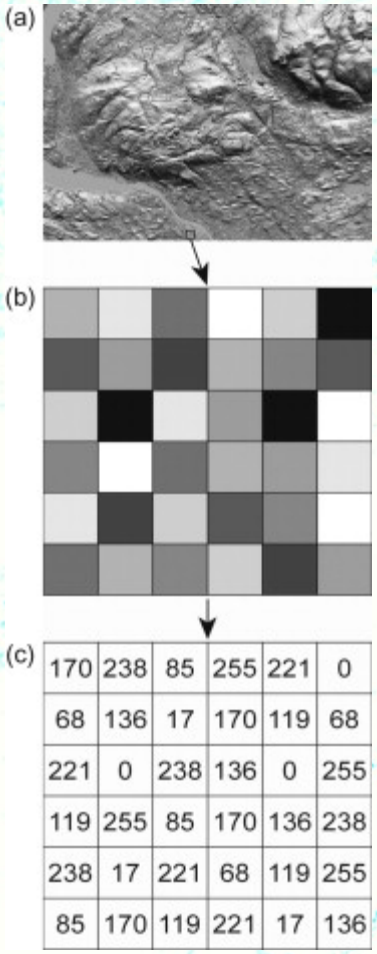

## 2) Soil carbon stocks

**Loss of soil carbon** threatens to increase the potential for soil erosion, reduce soil quality, lower agricultural productivity and negatively impact food security and global sustainability.

In recent years there has been an increasing focus not only on preserving soil carbon stocks but also on actively increasing them through farming practices.

Management decisions regarding conservation practices, such as no-till, conservation agriculture, returning crop residue to the field and using organic amendments such as manures or composts,

Wiesmeier et al., 2016 Scientific Reports volume 6, Article number: 32525




Geomorphological Mapping
Mike J. Smith, in Developments in Earth Surface Processes, 2011

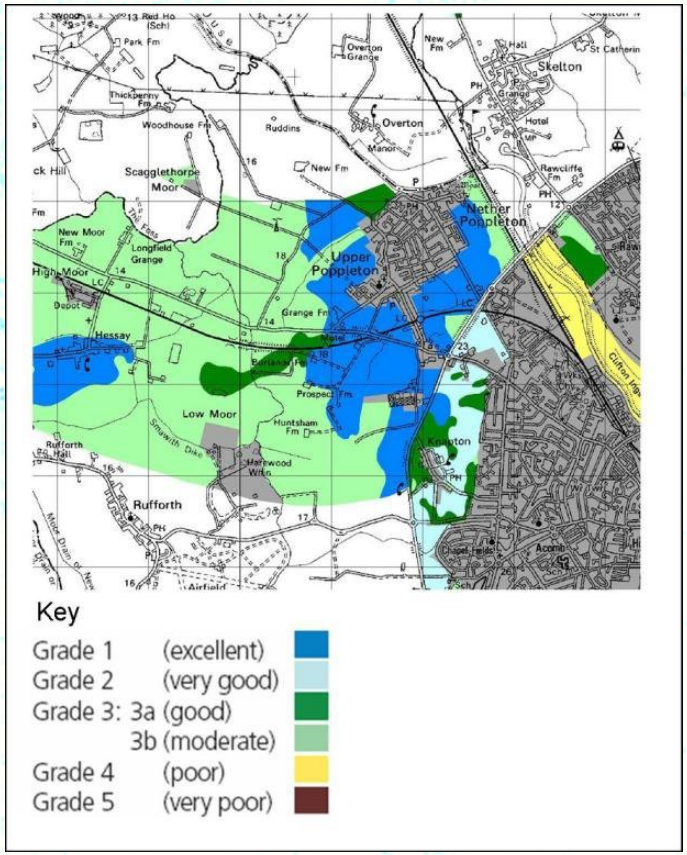
Soil maps can delineate and most importantly provide **quantitative data** of future development of SOC stocks of cropland, grassland or forest soils under a climate change scenario.

Given that a starting point on soil carbon contents is available (based on sampling and analysis) then a C model like *RothC model* can be used to simulate SOC development under different C input scenarios.

New maps are created to visualize changes

### 3) Land evaluation

Soil is a non-renewable natural resource that carries out multiple functions, including the support of agricultural economy. Urban development and infrastructure construction and its associated soil sealing poses have significant impact on the production capabilities of the agricultural sector and on the capability of fields to produce food. Sealed areas are lost to agriculture or forestry while the ecological soil functions are severely impaired or even prevented (e.g. soil working as a buffer or filter of




From Strutt & Parker Agricultural Land classification site https://www.struttandparker.com/knowledge-and-research/agricultural-land-classification

**Land classification** which refers to the process of categorizing land, depending upon the characteristics of the soil, its quality and its potential for agricultural use.

Fertile soils have the greatest capacity to sequester carbon (mitigation) and should have the greatest priority for preservation in an effort to guarantee food security (adaptation to climate change)

**Soil fertility maps** represent significant tools of land classification systems, particularly helpful when urban and rural development plans are to be devised.

**Concluding remarks**

Soil maps have to become something more than tools of multiple applications and technological progress allow for such development

They have to be progressively transformed to:

1) **Ecological data archives** (keeping data identity and origin)

i) Incorporate already existing data possessing some form of geographic reference

ii) regularly update data bases

iii) expand the list of attributes that are recorded

2) **Digital platforms** working as ecological decision support systems

Thank you