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Soil Survey in Cyprus

Costas Hadjiparaskevas¹

Introduction

Cyprus is an island in the Eastern Mediterranean region with an area of 9, 250 Km². The island's topography includes two mountain ranges, the Pentadactylos in the North, which rises up to 1,024 m and Troodos in the centre, rising 1,951 m. The plain of Mesaoria lies in between them.

The climate of Cyprus is typical as for the other countries of the Eastern Mediterranean having mild winters and long hot summers. The mean annual precipitation is about 500 mm with large variations in rainfall and rain distribution from year to year. Over the last three years for example, annual precipitation has been much below the mean average and water in the reservoirs is now at about 10% of their total capacity. The quantities of water available both for drinking and irrigation purposes have not been adequate, hence the Government has been looking at other potential sources such as desalinated and recycled water.

In 1998 the cultivated area was estimated at 134, 000 ha of which 80, 000 ha consisted of annual crops, 43, 000 consisted of permanent crops and 11,000 ha seasonal crops while the state forestland is about 18% of the total area of the country.

Status of soil surveys

Systematic soil studies and soil classification surveys started in Cyprus in 1957 aiming at collecting information and data about the physical and chemical properties of soils and at preparing soil maps for the areas surveyed mainly for agricultural purposes.

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The first soil classification system used was based mainly upon the formation, the origin and the parent materials of soils. Accordingly, soils were classified as Red soils, sedentary soils, and alluvial or colluvial soils. Usually, an examination of the master horizons (A, B, C, D) including soil physical and chemical analyses were carried out in order to classify the soils of these groups into soil series and types.

The FAO soil classification system was introduced in Cyprus in 1970. Through this system a new effort was undertaken to establish a common international language in soil classification.

Within the national framework of soil survey, a system of soil horizons has been adopted in the procedure of the soil map preparation. The soil horizons, which are used for identifying soil-mapping units, are called diagnostic horizons.

The definitions used in this system are drawn from those adopted in the Soil Taxonomy of the U.S.A. Department of Agriculture 1975 (Soil Survey Staff 1975). The definition of these horizons have been summarised and sometimes simplified in accordance with the requirements of the FAO-UNESCO legend for the soil map of the world (FAO-UNESCO 1974).

As a result of local observations in soil studies and investigations, the following diagnostic horizons derived from the FAO system have been adopted during soil surveys: Mollic, Ochric, Argillic, Natric, Cambic, Calcic and Gypsic.

In order to separate soil units, a number of soil characteristics (i.e. textural changes, hydromorphic properties, carbonate content, etc.) are used and a number of soil orders and sub-orders have been consequently recognised.

According to the FAO system and taking into account the local experience a number of soil orders have been recognised, which correspond to the following general definitions: Lithosols, Regosols, Rendzinas, Solonchauks, Solonetz, Vertisols, Cambisols, and Luvisols.

Land use classification

The land use classification and potential cropping pattern map of Cyprus (Land Use of Cyprus, Natural Vegetation and Agricultural Use, Republic of Cyprus, 1999) has been prepared to present the main agricultural productive zones and natural vegetation. This map has been completed in 1999 at scale 1:250.000 based on data and records from the land use map (Land Use Map, Department of Agriculture, 1971) and recent agricultural farm survey and Forest Department.

Criteria used in land suitability classification

In order to prepare Land Use Suitability Classification map the following factors have been taken into consideration:

- Soil physical properties (texture, structure, bulk density, infiltration rate, etc.);
- Soil chemical properties (lime content, pH, salinity);
- Soil depth;
- Productivity;
- Expenses required for land levelling or reclamation;

Land suitability classes

Five suitability classes have been mapped. These are numbered from I-V, in the decreasing order of suitability. Classification assumes the availability of water supply for irrigation purposes. Besides that, each suitability class indicates the crops that can be successfully grown on each class of soils.

Class I

This class has no limitations. Although these soils differ in their origin, physical and chemical

characteristics, they have many common properties. These soils are suitable for any kind of crop without limitations as far as soil productivity and expenses are concerned considering that climatic conditions are not limiting factors for any specific crop.

Class II

This class includes soils belonging to various soil series having slight to moderate limitations in regard to slope, lime content or soil physical properties. When the existing limitation is only due to slope, no limitation on crop selection exists. The soils included in this class are mainly suitable for deciduous trees, vines and vegetables.

Class III

This class includes soils having serious limitations mainly in soil depth, physical properties and/or slope. Due to the above limitations tree crops should be avoided in those areas. Vegetables, however, can be successfully grown.

Class IV

This class includes soils having unfavourable soil conditions especially shallow soil depth. These soil conditions lead to severe limitations in productivity, (2nd order), in crops, (3rd order) or in expenses, (3rd order). The soils of this class should not be normally irrigated, but in case of land shortage, these areas may be used for shallow rooted vegetables.

Class V

The soils included in this class are completely unsuitable for irrigation due to very severe limitations. The class includes bare rocks or rocks covered with a thin soil layer in pots or soils having unfavourable physical and chemical conditions.

Major soil constrains

Generally speaking, soils in Cyprus can be divided into two major categories. The first category includes deep soils located mainly in the valley areas. The second one includes shallow soils lying on geological formations of the mountain and semi mountain areas.

Deep Soils

Despite the fact that soils included in this category are deep they have some limitations concerning their productivity.

- In some areas soils are heavy due to the texture and vertic properties (clay content is up to 60%);
- Large parts of the cultivated land are classified as calcareous with calcium carbonate content up to 40-60%;
- The great majority of soils have pH values on average rising from 7.5-8.6;
- The mean value of organic matter into the cultivated soils is less then 1% due to the hot climatic conditions and higher mineralisation rates.
- Salt concentration in few areas is high due to their geological origin and pedogenic formation of the soil horizons. .

Shallow soils

The soils of this category are formed mainly on igneous rocks and on calcareous sedimentary layers. The shallow soils in the valley areas are the very well known red Mediterranean soils on conglomerate (accumulations of loose materials). Their limiting factor for agricultural use is not only the shallow depth but also other parameters such as:

- Shallow soils on hard rocks usually are accompanied by severe erosion and soil degradation;

- Shallow soils or marls with drainage problems and high calcium carbonate concentration up to 70% in some geological layers.

The above different limiting factors determine the kind of cultivation (c: crop), productiveness (p: productivity), and cost (e: expense) per unit.

This situation is not existing on a rather theoretical aspect but it's a reality for the Cypriot farmers. They are producing under unfavourable conditions. If the severe water shortage is added to the picture then it becomes evident that the future of the agricultural sector is not so promising.

Having mentioned all the above unfavourable conditions, the Cypriot Government would welcome any suggestion or proposals to overcome the existing productivity limitations.

Environmental problems

The subject of "acute environmental problems" for the time being is not so severe in Cyprus. The concentration level of heavy metals for instance in soils and water is very low compared with the European Union regulations. This is favoured by the lack of heavy industries and nuclear power stations in Cyprus, however the country is faced with different environmental problems, such as:

- Soil erosion and soil degradation as the result of the heavy rainfall in winter period followed by high temperatures and dry weather conditions during the summer;
- Nitrate pollution due to the excessive use of nitrogen fertilisers in shallow soils with high runoff;
- Due to the lack of water, it's a common practice among the farmers to remove soil from one area to another leaving behind excavations and open pits;.

- The use of brackish waters irrigating clay and shallow soils is causing increasing salinity problems;
- Fertile land is used for urbanisation other than for agricultural purposes;
- Recycled water from domestic tertiary treatment of sewage sludge is being used for the irrigation of forage crops. At full implementation of this programme the recycled water is expected to cover around 12% of the country's water needs.

Institutions or research centres dealing with soils

In Cyprus there is no specific soil institution or research centre. The Agricultural Research Institute (A.R.I.) is the only one scientific agricultural centre in the country. The institute includes in its activities some research in soil science mainly in soil productivity, soil fertility and the physical soil properties.

A lot of research work on fertilisation, recycle water use and many other relevant sectors have been established. Furthermore A.R.I. is in close cooperation with different centres and institutions in Europe and the Near East region.

The Soil and Water section of the Department of Agriculture in the Ministry of Agriculture is the only government entity responsible for soil mapping and other relevant soil activities.

Available soil maps

All the existing soil maps are mainly prepared for agricultural purposes. The first efforts in Cyprus for soil mapping were based on the topographical sheets at scale 1:5,000. The purpose of these initial surveys was to study the physical properties of the soils. At a later stage, a soil map at scale 1:25,000 was prepared for the main agricultural developing areas, including dams and water reservoirs.

As a common practise, for each irrigation project a detailed land suitability map was developed at scale 1:5,000. The next step on soil mapping was the preparation of the General Soil Map of Cyprus at scale 1:200,000 based on the FAO Legend, which was published in 1970.

The most recent soil map of Cyprus was based on the World Reference Base for Soil Resources (WRB) system published by FAO-ISSS-ISRIC (1998) and was prepared in electronic (GIS) format and printed at scale 1:250,000 in 1999.

Concerning the areas that haven't been surveyed by any means, other methods have been used such as extrapolation, photo interpretation as well as revision of the general soil map of Cyprus. For small countries, like Cyprus, maps at small scale can not be successfully used for local land-use planning. In such cases only detailed soil maps are useful.

Cyprus didn't create its own detailed soil taxonomic system because up to 1960 it was an English colony and due to this the background on soil classification is rather limited. Considering this, no effort was made to develop a national system but to propose the acceptance of an existing soil classification systems.

Since 1970 the decision was to follow the F.A.O. classification system for two reasons. The system was not so complicated compared with other international systems and the system itself was not too much data demanding. Moreover, the decision for establishing a world soil map by the FAO was another occasion to introduce this system.

In regard to copyright considerations on soil data, the general policy is that those data belong to the owner who generate them. The access to soil maps is not limited. A general law provides protection of copyright and no specific consideration on the above subject exists.

Code of practice for agricultural use of land

The Government's policy concerning the agricultural production and the sustainable use of land resources is that the highest possible effective and efficient utilisation of land resources should be done.

The term "efficient use" includes the maximum utilisation of land and with "effective use" the goal is to obtain optimum yield per unit of land. The overall strategy is to maximise positive effects of land resources and minimise environmental hazards. Between the agricultural production and the environmental protection there is a continuous interaction, which should not be competitive but complementary for balanced development.

Very recently a code of practice has been formulated and applied in Cyprus. This code refers to the amount, the form, the time and method of chemical application on soil's surface, aiming at the protection of both soil and ground water resources from pollution due to run off and depletion of the chemicals.

The code is addressed to the land users and farmers aiming their information and education on the existing measures and rules. Some of these rules are:

- Fertiliser application is allowed at a certain distance from water sources (not less than 50 m);
- Protective measures must be taken in slopping areas to prevent soil and fertiliser run off (i.e. vertical plowing to the slope, opening small furrows, creating small benches etc.);
- Restrictions for agrochemical use (mainly herbicides and long lasting chemicals);
- Rotation of cultivation.

Soil Analyses

The usual soil analyses and methods used in Cyprus are as follows:

- Total Nitrogen: Kjeldhal method
- Nitrate Nitrogen: Ion selective electrode
- Phosphorus: Sodium bicarbonate extracting (Olsen method)
- Exchangeable cations (Na, K, Ca, Mg): Ammonium Acetate method (Richards)
- Soluble (Na, K, Ca, Mg) and (Cl, HCO₃, CO₃, SO₄): Water extractable (Richards)
- Boron: Hot water extractable (Berger and Truog)
- Micronutrients (Fe, Zn, Mn, Cu): DTPA Extractable (pH 7.3)
- Mechanical analysis: Bonyoucos method
- Calcium Carbonate: Titrimetric method
- Organic matter: Potassium Dichromate method
- Electrical conductivity: Saturated paste
- pH: Soil: water 1:5
- Cation Exchange Capacity: Ammonium Acetate method

Presence of International Institutions in Cyprus

As mentioned above, other than the Agricultural Research Institute, which conduct some soil activity, there are not specialised soil institutions in Cyprus, therefore efforts are being made to establish a close technical co-operation with other international soil centres.

Recently a technical co-operation between the Federal Institute for Geosciences and Natural Resources, Hanover, Germany and the Ministry of Agriculture, Natural Resources and Environment, of Cy-

prus was carried out. The subjects of this co-operation were:

- the study of calcareous soils, and
- the long- term erosion measurements.

The reason for carrying out these studies is due to the fact that Cyprus may be regarded as being the most representative country of the Eastern Mediterranean with its typical Mediterranean soils and climate.

The first project started in 1981 and was completed in 1986 and the second was initiated in 1988 and completed in 1998 (Michaelides and Krone, 1999).

The results of the projects have shown the following conclusions.

Calcareous soils

- Results from five-years measurements indicates that about 36% of the total area of Cyprus is categorised as slightly to high calcareous;
- The available rooting volume is limited by the underlying strata;
- The high CaCO_3 content and the silt fraction reduce infiltration rates and enhance water erosion;
- Calcium concentration in the soil solution inhibits phosphorus and nitrogen uptake.

Long- term erosion measurements

- Many parts of Cyprus are characterised by severe topsoil erosion losses and the most fertile part of the soil has been subject to soil loss caused by water (heavy rainfall) and human induced factors (deforestation, and cultivation of marginal land);
- Loss of soil is higher under no vegetation cover conditions. After the vegetation cover has been removed, it makes little difference whether

initial plowing was up and down the slope or across the slope;

- High erosion hazards are more severe for calcareous soils than for non calcareous soils;
- Soil loss is proportional to the intensity of rainfall and not the quantity of rain.

At present, no project or any other form of close collaboration is in progress. The Cyprus delegation therefore, welcomes the idea of this Euro-Mediterranean Network of Soil Information and is committed to be an active partner of the Network.

Conclusions and Suggestions

- The establishment of an efficient and permanent Euro-Mediterranean network on soil information for regional and international collaboration is a much needed requirement;
- We support the approach for a common soil information system on which all members agree. We understand that the European Soil Bureau of the European Commission will provide the required methodology;
- The definition of uniform guidelines for soil mapping, sampling, analyses etc and the same soil classification system that will be used will facilitate the efforts for the establishment of a "common soil language";
- The sustainable use of land and environmental protection must be a true challenge for planners and decision-makers at all levels;
- All the existing institutions and research centres in the region dealing with soil science can be used as the basis for further co-operation;
- Technical and financial support is required for those countries that are interested to collaborate with the European Union;
- Uniform laws concerning the copyright on soil data and maps provided to the Euro-Mediterranean Network should abide all the countries;

- For small countries like Cyprus, it is recommended not to adapt in soil mapping smaller scales than 1:250,000 for their national territory.

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